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EFFECT OF PASPALUM ON THE PRODUCTION PATTERN OF LADINO WHITE CLOVER UNDER IRRIGATION ON HEAVY CLAY SOILS IN CENTRAL QUEENSLAND

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SUMMARY

Ladino white clover (*Trifolium repens* L.) when associated with paspalum (*Paspalum dilatatum* Poir.) at Theodore had a radically different pattern of seasonal growth compared to clover grown alone or clover grown with prairie grass (*Bromus unioloides* H.B.K. cv. Priebe) or Ronpha grass (*Phalaris* sp.) at Biloela. When associated with paspalum, clover growth rate was severely depressed in late summer, autumn and winter but was equivalent or even superior in spring to that grown alone or when associated with Priebe prairie grass. The growth of clover when planted with Ronpha grass was depressed throughout the year.

A series of fertilizer trials on the Theodore pastures which covered N, P, K, S, Mo, Cu, Zn, Bo and Mn failed to increase midwinter forage. The fodder gap in midwinter was narrowed by a major response by paspalum to nitrogen in May and a white clover response to sulphur in spring. The response to sulphur did not always reach a significant level, while application of the nitrogen too early in autumn resulted in a significant depression of clover in early winter. Zinc gave a minor stimulation of clover in midwinter and manganese a minor stimulation of paspalum in spring.

Renovation with a rigid tine tiller in autumn depressed paspalum yield 5 months later, but did not increase the yield of either persistent or oversown clover. Sod-seeding of a mixture of winter growing legumes also failed to improve winter forage availability.

I. INTRODUCTION

On the heavy clay soils at Theodore Research Station in subcoastal Central Queensland both Priebe prairie grass (*Bromus unioloides* H.B.K.) and *Phalaris arundinacea* L., recommended by Grof (1961) for use with Ladino white clover (*Trifolium repens* L.) in irrigated pastures in Central Queensland, have been unsatisfactory. Prairie grass rarely persists longer than 9 months, while satisfactory stands of *P. arundinacea* have not been obtained. Ronpha grass, a natural hybrid of *Phalaris tuberosa* L. and *P. arundinacea,* persists well but both its acceptance by stock and its compatability with Ladino white clover are questionable.

The only stable pastures on these soils have been based on paspalum (*Paspalum dilatatum* Poir.), with various cultivars of white clover. These are weed-free but production and species composition fluctuate widely from spring to autumn. They change from almost pure paspalum swards in late summer to clover dominant in spring, a phenomenon also recorded by Nagle (1959) for such pastures in south-eastern Queensland. At Theodore by late June the Ladino white clover stand is adequate so far as plant numbers is concerned but leaves are exceptionally small ($\frac{1}{4}$-$\frac{3}{8}$ in. diam. leaflets) and growth is very slow.

For 9 months of the year these pastures are very productive. Higher year-round carrying capacity is restricted by poor growth over the three winter months. To achieve even the 10-12 adult sheep per acre presently being carried requires heavy reliance on supplementary fodder crops and hay during winter.

Differences in the winter growth pattern of clover with paspalum at Theodore and of clover with other grasses under similar climatic conditions at Biloela have been observed. This paper reports on the relative growth patterns of pastures at the two centres, with particular reference to the effect of different grasses on the seasonal production of Ladino white clover. Attempts to do this under the Theodore environment were not successful because prairie grass and *Phalaris arundinacea* failed to persist. Results of other experiments aimed at stimulating the winter growth of clover are also briefly reported.

II. EXPERIMENTAL

The pasture mixtures, their management and sampling techniques were as follows:—

(a) *Paspalum and Irrigation white clover* was planted at Theodore in August 1956 but Ladino white clover was subsequently oversown. By the commencement of sampling in August 1960, Ladino had become the dominant clover. Sampling by means of moveable livestock exclosures was carried out at 28-day intervals for the first 12 months. Subsequently, grazing and sampling were carried out as forage became available. This resulted in regrowth periods from as short as 19 days in spring to as long as 70 days in winter. Five randomly placed 9·6 sq ft quadrats were cut on each occasion, using hand shears. The soil is a heavy grey clay and the pasture was rotationally grazed by sheep. It was flood irrigated with a border check system at intervals ranging from a fortnight in summer to a month in winter.

(b) *Priebe prairie grass and Ladino white clover* was planted at Biloela in April 1960 on a grey-brown clay loam and rotationally grazed from November 1960 onwards by dairy cattle. A recovery interval of approximately 28 days was used throughout. A 3 ft x 16 ft mower strip was cut from each of four

180 ft x 21 ft plots immediately prior to grazing. Flood irrigation on a border check system was used, with intervals ranging from 7–10 days in summer to a month in winter.

(c) *A Ronpha grass and Ladino white clover trial* of grass alone, grass plus clover and clover alone was established at Biloela in October 1960 in 44 gal oil drums (56 cm diam.) filled with top soil similar to that of the pastures described under (b). The pots were sampled at approximately 28-day intervals from December 1960. All top growth was removed from the pots at each sampling. Oven-dry weights were obtained after separating grass and clover where these were grown in mixtures. The mean yields from the six replicates at each sampling after July 1961 were used in the present study. The pots were watered twice weekly in summer and weekly in winter.

For the two field pastures green weights of individual quadrats were obtained. At Theodore a single subsample from the bulked quadrat material was transported to Biloela in a sealed plastic bag, and at Biloela individual quadrat subsamples were obtained. The subsamples from both centres were used for determination of botanical composition and oven-dry yields.

The yields at individual samplings from the three sources were converted to daily increments of oven-dry matter and were plotted on log-vertical graph paper year by year to bring out lower magnitude differences. An approximate mean curve of seasonal production was obtained by superimposing the data from the 3 years for each experiment.

III. RESULTS

The mean annual growth curves of the various pastures for total dry matter per acre are shown in Figure 1. This shows similar shaped curves, although at different levels, for all sources except the paspalum-clover pasture, which is much greater in spring and summer and much depressed in winter.

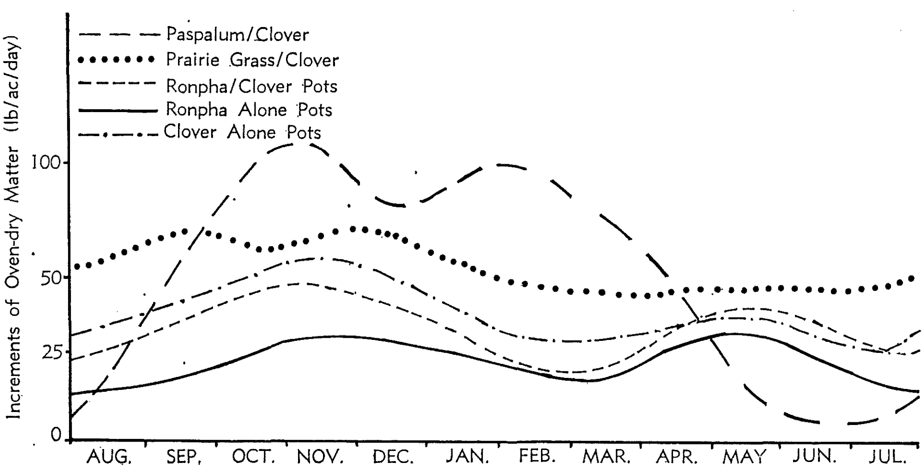

Fig. 1.—Total dry-matter production rates.

The curves for the various grasses are shown in Figure 2. Ronpha and prairie grass again have similar shaped curves only differing in levels of production. Paspalum, on the other hand, is substantially higher in summer and depressed in winter.

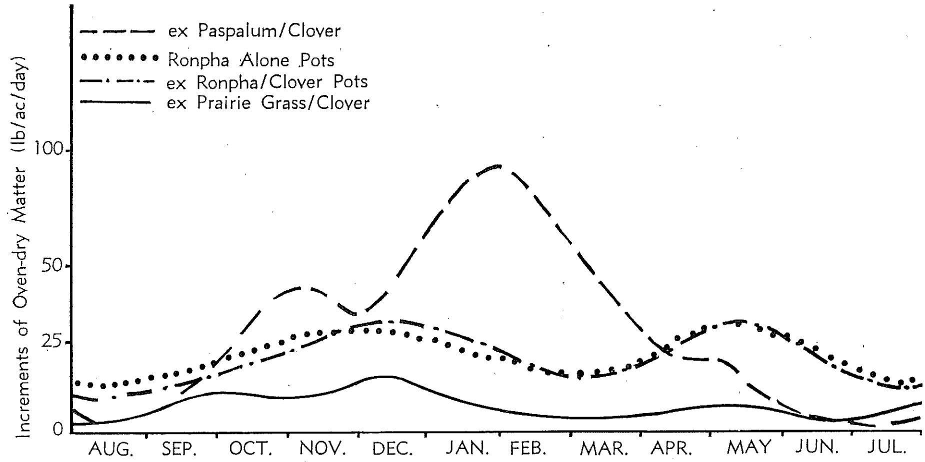

Fig. 2.—Grass dry-matter production rates.

In Figure 3 the clover curves are presented. The striking difference in the shape of the clover curve when associated with paspalum is most noticeable. There is a major peak in October and intense depression for the rest of the year despite the fact that the paspalum is dormant over winter. With Ronpha grass the clover growth was depressed throughout the year.

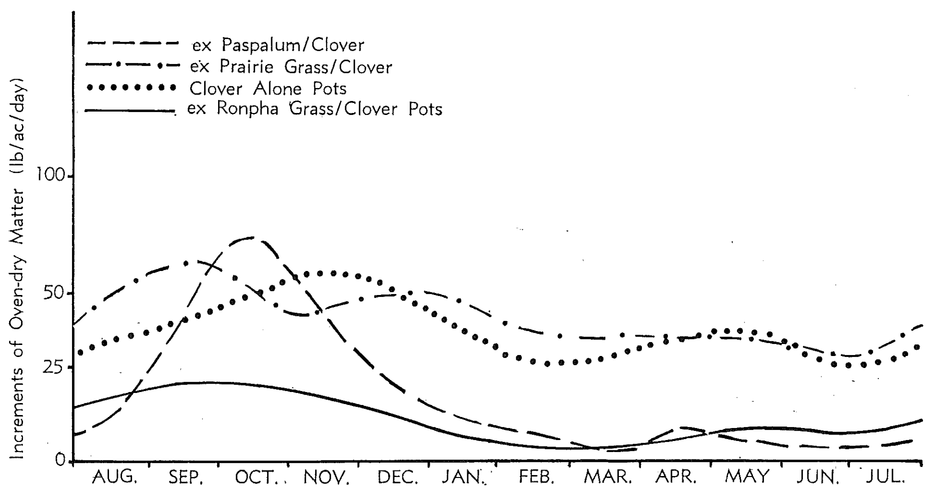

Fig 3.—Clover dry-matter production rates.

In Table 1 growth data are presented on a seasonal basis as follows: summer: December-February; autumn: March-May; winter: July-August; spring: September-November.

TABLE 1

SEASONAL GROWTH PATTERNS—LADINO CLOVER PASTURES, BILOELA AND THEODORE RESEARCH STATIONS

(Expressed as daily increments oven-dry material (lb/ac)

—	Year	Summer	Autumn	Winter	Spring	Year
Paspalum-Theodore Total sward growth	1960–61	74·6	70·1	8·8	116·7	60·9
	1961–62	122·3	56·1	18·1	95·9	63·1
	1962–63	79·0	63·1	13·3	60·3	56·0
	Mean	89·1	63·4	13·5	87·3	59·9
Clover growth	1960–61	9·4	6·2	3·0	94·3	22·2
	1961–62	35·2	9·3	10·3	55·0	23·5
	1962–63	15·8	3·1	2·1	34·5	14·4
	Mean	18·7	6·1	5·6	58·0	19·9
Prairie Grass-Biloela Total sward growth	1960–61	62·3	55·7	39·1	68·1	56·6
	1961–62	73·4	54·2	51·8	81·0	66·2
	1962–63	48·5	36·5	51·3	58·3	47·9
	Mean	62·1	46·1	47·5	69·3	56·6
Clover growth	1960–61	30·7	44·8	29·3	55·4	39·8
	1961–62	64·8	48·0	46·1	71·4	58·5
	1962–63	44·2	31·7	42·7	52·7	42·0
	Mean	46·8	39·3	39·5	60·0	46·7
Ronpha Grass—Biloela Total sward growth (ex mixture)	1961–62	37·8	39·4	29·6	40·4	36·9
	1962–63	44·5	33·8	32·5	45·5	38·8
	1963–64	28·6	18·1	35·8	42·4	31·8
	Mean	37·0	30·4	32·7	42·7	35·7
Clover growth (ex mixture)	1961–62	6·9	4·5	9·1	19·4	9·9
	1962–63	12·1	13·1	14·9	28·3	16·87
	1963–64	9·1	3·0	9·8	28·1	13·4
	Mean	9·4	6·9	11·4	25·5	13·4
Clover alone (in pots)	1961–62	36·2	38·3	40·1	47·8	40·4
	1962–63	61·3	52·2	43·0	52·9	52·1
	1963–64	30·9	20·7	30·4	47·4	33·1
	Mean	42·8	36·8	37·9	49·2	41·7

Samples cut during these months are included in the respective seasons even though in one or two cases sampling was at the beginning of the first month of a season and most of the growth occurred during the previous season.

The prairie grass-clover pasture at Biloela exhibited a relatively constant growth rate throughout the year and from year to year. Production of the paspalum-clover pasture fluctuated widely from season to season but had a similar trend for the same season from year to year. The Ronpha grass-clover and clover alone pots also showed relatively even growth throughout the year and for the same season from year to year.

IV. ADDITIONAL EXPERIMENTATION

It was thought from these comparisons that the clover component of the paspalum-white clover pastures should be able to make much better growth over the winter months when the paspalum, for all practical purposes, is dormant.

In an attempt to test this hypothesis a series of experiments were conducted on paspalum pastures of similar age and composition to that used in the main study.

The first of these was a 2^4 x 3 absolute factorial design using nitrogen as urea at 1 cwt/ac, phosphorus as sodium orthophosphate at 250 lb/ac, potassium as muriate of potash at 2 cwt/ac, and sulphur as elemental sulphur at 90 lb/ac. Application in early April 1963 and again to the same plots in mid May 1964 failed to produce worthwhile responses over the winter period (June, July and early August).

By late May paspalum showed a major response to the nitrogen applied in early April. From late August to mid October clover responded significantly to both April and May applications of sulphur. The application of 90 lb of elemental sulphur increased sulphur levels in the clover in 1964 from 0·19 to 0·21% total sulphur. In paspalum this led to an increase in sulphur from 0·20 to 0·27% up to 0·35 to 0·42% total sulphur.

In April 1963 a 5 x 5 latin square of nil, 1, 2, 4 and 8 cwt of gypsum per acre was established adjacent to the major elements trial and the treatments reapplied in May 1964. A base dressing of NPK at the former rates was used. Again no measurable increases in winter production were obtained. Even the spring response of the clover to sulphur was not significant, although clover yields did tend to increase with increasing rate of gypsum. Figure 4 illustrates some clover yields. The sulphur content of the clover at the final sampling in August 1964 increased from 0·17% for the control to 0·21% for 8 cwt gypsum treatment.

In 1964 a 6 x 5 randomized block design was installed with 2 cwt urea (46% N) per acre applied to different plots in mid March, mid April, mid May, mid June and mid July. The experiment was sampled and grazed at monthly

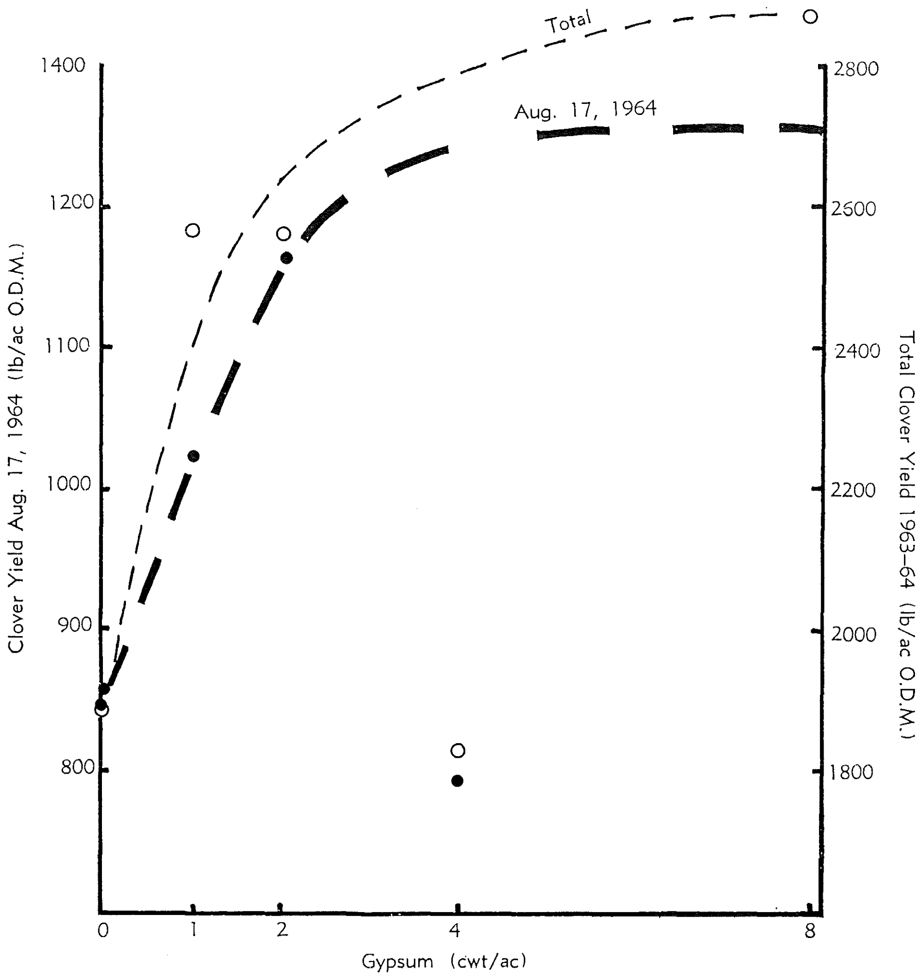

Fig. 4.—Clover yields as influenced by gypsum application rates. Because of inter-plot variability, differences were not significant.

intervals immediately prior to the fertilizer application. Highly significant increases in total dry matter were recorded in April, May and September. This was as a result of the paspalum response to the most recent nitrogen application. The March application seriously depressed the clover yield but subsequently significant responses (5% level) by clover to applied nitrogen were recorded. Figure 5 shows the total yield and clover yields expressed as a percentage of the nil fertilizer treatments at each sampling.

In an attempt to clarify results from these studies a further experiment was carried out over the 1965 winter. This involved factorial combinations of

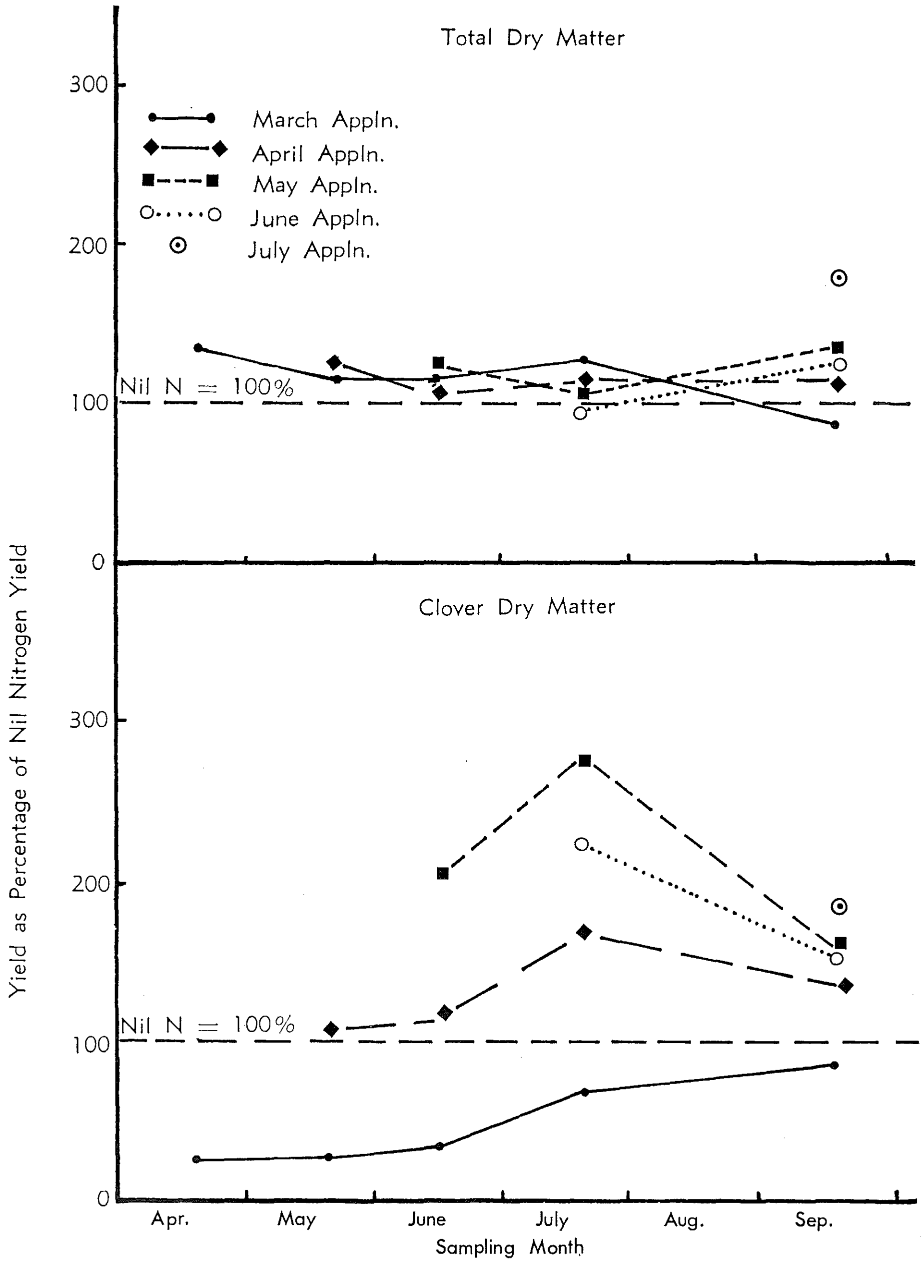

Fig. 5.—Total dry-matter and clover yields at various samplings from monthly applications of nitrogen; expressed as a percentage of nil-nitrogen yield.

nil and two rates of elemental sulphur (45 and 90 lb/ac); nil and two rates of nitrogen (1 and 2 cwt urea per acre) and two times of application (mid May and mid June). Highly significant increases in paspalum yield were obtained from August and October samplings but total dry-matter yields were not significantly affected. At both samplings clover yield increased with increasing rate of sulphur but differences were not significant. Nitrogen had no significant or consistent effect on clover yields. Sulphur levels in the clover on this occasion were anomalous. At the October sampling S0 = 0·24%, S1 = 0·22% and S2 = 0·25% total sulphur. In paspalum, sulphur levels increased progressively from S0 = 0·28% to S2 = 0·43% total sulphur.

The fifth fertilizer trial was a $\frac{1}{2}$ x 2^5 factorial of minor elements laid out in four blocks of eight. The following treatments were applied in April 1967: molybdenum as ammonium molybdate at 2 oz/ac; copper as copper chloride at 7 lb/ac; boron as borax at 3½ lb/ac; and manganese as manganese chloride at 14 lb/ac. Sampling in late July and early October again revealed no major responses. Clover responded to zinc and grass to manganese (5% level) each at one sampling. These were not reflected in total dry-matter yields.

In an earlier attempt to improve the winter yield of clover, a 4 x 5 randomized block design was established in April 1964, using plots 30 ft x 20 ft with the following treatments:—

(a) Renovation only.

(b) Renovation plus overseeding of a legume mixture.

(c) Sod seeding of the legume mixture.

(d) Nil treatment.

The legume mixture, sown at 12 lb/ac, consisted of 1·5 lb Ladino white clover, 1·5 lb Louisiana white clover and 3 lb each of barrel medic 173 (*Medicago tribuloides* Desr.), Clare subclover (*Trifolium subterraneum* L.) and Yarloop subclover.

Renovation with a rigid-tine tiller worked over the area twice, in opposite directions, depressed paspalum yield 5 months later but did not result in any increase in yield of either persistent or oversown clover. Sod-seeding of a mixture of winter-growing legumes also failed to improve available winter forage.

V. DISCUSSION

Paspalum is a summer-growing, winter-dormant species with a peak of production in summer. As the grass becomes dormant in autumn it could reasonably be expected that clover would take over and at least partially fill the winter production trough. This it fails to do. By late June the clover stand is reasonably complete as a sward but plants have small leaves and are unthrifty.

Both Nagle (1959) and Grof (1961) considered that the suppression of clover from summer to early winter by paspalum was caused by excessive shade from the tall, rank grass. At Theodore the paspalum was kept in check by regular grazing and slashing. Preferential grazing of the clover by sheep, however, may have been a partial cause of the depression of clover yield, but by late May a proportion of old plants remained and a widespread germination of seedlings occurred in April-May. Normally the seedlings are capable of active growth by July-August. Pastures planted in autumn have by early August yielded 2,000 lb oven-dry clover plus other herbage.

That the depressed winter growth of the clover is not entirely due to the heavier soil and different stock and management to those at Biloela is shown by Table 2. This presents yields at Theodore during 1963 from Priebe prairie grass–Ladino white clover established in autumn 1962. These are compared with the paspalum pasture used in the present study. Both were receiving similar management. The winter production of the clover in the absence of paspalum is most noticeable.

TABLE 2

COMPARISON OF YIELDS (LB/AC)—BORDERS A1 AND B1, THEODORE RESEARCH STATION, 1963

Date	A1 Priebe Prairie-Ladino Clover			Date	B1 Paspalum-Ladino Clover		
	Total Yield	Prairie Grass	Clover		Total Yield	Paspalum	Clover
Jan. 15	2,003	765	765	Jan. 15	1,800	1,230	450
Feb. 12	1,377	140	630	Feb. 12	2,011	1,460	170
Mar. 14	962	20	370	Mar. 10	2,044	1,320	80
Apr. 9	1,444	Nil	118	Apr. 9	1,916	1,200	50
May 28	1,396	40	550	May 28	1,468	894	140
July 14	1,760	510	930	Aug. 1	863	186	135
Sept. 10	2,299	640	1,586	Sept. 24	1,826	300	1,280
Oct. 20	2,615	604	1,635	..	..	..	..
Nov. 12	1,927	390	1,370	Nov. 12	3,122	1,323	1,555
Dec. 10	1,751	410	532	Dec. 10	1,775	970	490
Jan. 7	1,889	Nil	300	Jan. 7	1,633	960	330
Total	19,423	3,519	8,786	Total	18,458	9,843	4,680

As there is no climatic difference between Biloela and Theodore, only 70 miles apart, climatic conditions are eliminated as a possible reason for the very poor winter growth of clover with paspalum at Theodore.

When combined with Ronpha grass, clover production was depressed throughout the year but the shape of the curve was not greatly different from that for clover alone. With paspalum a totally different shaped curve was obtained. Again it is doubted if the suppression of clover by Ronpha grass was due to shading, as a height greater than 2-3 in. was rarely obtained in the closely cut drums.

The depression in growth of Ladino white clover by both paspalum and Ronpha grass is considered to be due to some factor other than competition for light or moisture, both being maintained at adequate levels throughout. Since soil type, class of stock or management is unlikely to be responsible for the depressed clover yields it was concluded that it should be possible to stimulate the winter growth of clover in paspalum stands at Theodore.

This inference led to a series of fertilizer experiments, which revealed major nitrogen responses by paspalum in late autumn. They also indicated clover responses to sulphur in spring, a response not always clearly recorded. No practical midwinter responses were obtained, however, at any stage. Minor responses by clover to nitrogen in one trial and to zinc in another were obtained over the winter.

Many of these experiments suffered from marked variability between plots. During summer these pastures are even over the whole paddock but in late winter and early spring growth of the white clover is patchy. In particular, it has regularly been noticed that clover on the check banks of the irrigation bays commences to grow evenly before that in the bays themselves. By late September all areas are again growing evenly and vigorously. It was held that an effective fertilizer treatment would remove the patchiness from treated plots and would have been readily apparent. This did not happen and because of the patchy clover growth it is desirable to treat all but highly significant differences in yield with a degree of caution.

One weakness of the fertilizer studies was that the major elements were investigated in the absence of a base dressing of minor elements and *vice versa.* It is desirable therefore that at least N, S, Zn and Mn be brought together in one final trial.

When the early fertilizer trials failed to stimulate winter growth, attention was directed to other methods of achieving this. A number of authors, including Whittet (1926), Whittet, Dunlop, and Medley (1928) and Winders (1938) have indicated that winter production of paspalum-clover pastures could be improved by drastic renovation and oversowing. It had also been noticed on two occasions that burr medic (*Medicago polymorpha* L.), which occurs naturally in the area, had shown visual responses over winter to severe autumn rotary hoeing in areas where paspalum occurs sparsely.

The renovation oversowing study suggested by these factors did not have any effect on winter production of the clover.

The latent effect of paspalum on the winter growth of associated clover is emphasized by the failure of fertilizer and cultural treatments to markedly improve the growth of the white clover in winter.

VI. ACKNOWLEDGEMENTS

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REFERENCES

GROF, B. (1961).—Irrigated pasture mixtures for Central Queensland. *Qd Agric. J.* 87:599.

NAGLE, A. (1959).—Getting the best from irrigated paspalum-white clover pastures. *Qd Agric. J.* 85:593.

WHITTET, J. N. (1926).—Paspalum renovation trials. *Agric. Gaz. N.S.W.* 37:760.

WHITTET, J. N., DUNLOP, D. V., and MEDLEY, R. N. (1928).—Paspalum renovation experiments. Wollongbar Experiment Farm, Lismore. *Agric. Gaz. N.S.W.* 39:119.

WINDERS, C. W. (1938).—Renovation of paspalum pastures. *Qd Agric. J.* 49:5.

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