RESPONSE OF A MAT GRASS—PASPALUM SWARD TO FERTILIZER APPLICATION

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ABSTRACT

Nitrogen, applied at 200 lb per acre to a paspalum (Paspalum dilatatum), *mat grass* (Axonopus affinis) *and white clover* (Trifolium repens) *pasture at Beachmere (south eastern Queensland), over two successive growing seasons, increased the dry matter yield of total pasture from 4470 lb to 8650 lb per acre per year. Paspalum, comprising 3.9% of the ground cover, was the main contributor to this increase through a six fold increase in yield. The yield of mat grass was not increased by applied nitrogen, nor was its ground cover of 94% decreased. The maximum growth rate of paspalum was increased from 7 lb to 50 lb per acre per day during the main growing season.*

INTRODUCTION

Dairying is based predominantly on perennial pastures of paspalum (*Paspalum dilatatum*) in the strip of coastal Queensland between Gympie and the New South Wales border and inland to about the 50 in. isohyet. In limited areas of higher elevation and on kraznozems (e.g. Maleny, Tamborine, Beechmont) Kikuyu (*Pennisetum clandestinum*) makes a significant contribution.

A serious decline in pasture productivity of the area is associated with the spread of inferior species, among which mat grass or narrow leaf carpet grass (*Axonopus affinis*) is most common. Many swards, originally almost entirely paspalum, now carry mat grass as the dominant species. Pastures in the region carry no significant legume component except for white clover (*Trifolium repens*) which makes a significant contribution to forage quality in infrequent situations of favoured soil moisture and according to the level of management adopted. Nearly all soils in the area are deficient in nitrogen and phosphorus. An overall deficiency of available nitrogen has been defined as the most important limitation to grass growth in this environment. (Henzell 1963; Henzell and Stirk 1963)

One way of raising pasture productivity is that of destroying the existing pastures by cultivation and replacing them by well fertilized sown species. A more immediate approach, which is also particularly relevant where topography restricts land preparation and pasture establishment, is to determine whether alterations in management of the existing pastures will make them more productive. In this connection, nitrogen and phosphorus supply and severity of defoliation are important factors.

The work reported in this paper was designed to measure the effects of varying these three factors on the growth of paspalum and mat grass in a mixed sward.

MATERIALS AND METHODS

The experimental site (27°06′S, 152°59′E) was located in an area of low lying estuarine flats varying from nil to a few feet above sea level. The slightly higher areas and those on which successful drainage works had been established carried a sward in which mat grass, paspalum and blady grass (*Imperata cylindrica*) were prominent. Legumes comprised a small proportion of the flora, *Lespedeza striata* and *Desmodium triflorum* being the most common.

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The average annual rainfall at Caboolture (30 year mean) is 53.26 in. Monthly rainfalls for the period of the experiment are given in Table 1. About 75% of the rainfall occurs during October to March. Low night temperatures limit the growth of tropical and sub-tropical species during June, July and August when mean monthly minima (53-year mean) are recorded as 51.4, 48.7 and 49.9°F respectively.

TABLE 1

Monthly rainfall at Caboolture for the experimental period (in.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1962	6.44	3.79	4.33	1.74	1.27	0.70	4.69	3.52	1.73	1.28	3.37	8.53
1963	5.80	1.46	14.22	2.31	7.07	0.36						

The soil was a humic gley soil of pH 5.3 to 5.6 with the upper 4 to 6 in. of sandy loam containing highly decomposed organic matter. (Andrew and Bryan 1955)

The following basal fertilizer dressing was applied to all plots at the beginning of the experiment: calcium carbonate 1120 lb per acre, muriate of potash 112 lb per acre, copper sulphate 28 lb per acre, zinc sulphate 7 lb per acre, borax 7 lb per acre, sodium molybdate 1 lb per acre, sulphur 35 lb per acre (Andrew and Bryan 1955).

Treatments in 3 × 3 × 2 factorial arrangement were imposed as follows:

Nitrogen		*Phosphorus*		*Defoliation*
0		0		Cutting height 2 inches (C_L)
50 lb per acre (N_1)	×	22 lb per acre (P_1)	×	
200 lb per acre (N_2)		44 lb per acre (P_2)		Cutting height 6 inches (C_H)

Nitrogen was applied as calcium ammonium nitrate. Phosphorus was applied as tri-sodium phosphate.

There were two replications in a randomised block design. Plot size was 14 ft × 6 ft.

Harvesting was done with an autoscythe (cutting a 3 ft wide strip 10 ft long from each plot) approximately every four weeks according to the growth rate of the pasture during the growing season (October to May).

Sub-samples were taken for dry matter determination and the material was hand-separated into botanical components, before drying at 100°C for 24 hrs. After the final harvest an estimate of the sward basal area was carried out along six random 50 in. line transects on each plot.

The experiment was commenced on February 22, 1962, when the area was mown to a uniform height of approximately two in., all cut material raked off, and fertilizer treatments applied. Treatments for the second season were applied on October 3, 1962, and the basal dressings of muriate of potash and sulphur repeated.

RESULTS

Pasture yields

First season

Yield data for the first season are summarised in Table 2. Although no white clover was in evidence when the area was first selected it began to appear in small amounts during the first season.

The main feature of the first season's results was the positive response to applied nitrogen made by the minor components (including paspalum) with little or no contribution to the extra yield by mat grass. Because nitrogen treatments were applied late in the season this response was low, being 4.7 lb dry matter per lb of nitrogen applied at the highest level (200 lb per acre). The apparent inconsistency in overall herbage yields was caused by miscellaneous species (green couch and weeds). This diminished rapidly in importance as the experiment progressed.

TABLE 2

First season yields (lb per acre dry matter) from a paspalum-mat grass sward cut at 2 in.

Treatment	*Grass Species* Paspalum	Mat grass	Total Pasture
No nitrogen	48	530	699
50 lb/ac nitrogen	182*	460	834
200 lb/ac nitrogen	557**	714	1652**
No phosphorus	219	560	1012
No phosphorus	219	560	1012
22 lb/ac phosphorus	280	615	1184
44 lb/ac phosphorus	289	527	989

** Denotes $P < 0.01$

* Denotes $P < 0.05$

Second season

Main effects are presented in Fig. 1.

Nitrogen at 200 lb per acre resulted in a six fold increase in the yield of paspalum from 728 lb per acre to 4556 lb per acre. The response by this relatively minor component was almost solely responsible for the overall increase in herbage yields from applied nitrogen. At neither level of applied nitrogen was there any significant response by the dominant mat grass component.

White clover made positive contributions to herbage yields during the second season, with significant yield responses to applied phosphorus at both 22 lb per acre and 44 lb per acre. It can be seen in Fig. 1 that the response in total pasture yield to phosphorus was due to the increased growth of the clover and paspalum components.

Levels of defoliation resulted in no overall effect on total pasture yields for the second season. At the final harvest on May 14, 1963, all treatments were cut to the 2 in. level so that total yield responses could be computed.

There was a significant interaction between phosphorus level and defoliation treatment on white clover yield (Fig. 2). The consistent response to phosphorus application demonstrated at the 4 in. cutting height was not repeated at 6 in.

Seasonal growth rate

This is presented for a full growing season (i.e. the second season) as the main effect of nitrogen at 200 lb per acre on the rate of dry matter accumulation by total pasture (Fig. 3), by paspalum (Fig. 4) and by mat grass (Fig. 5).

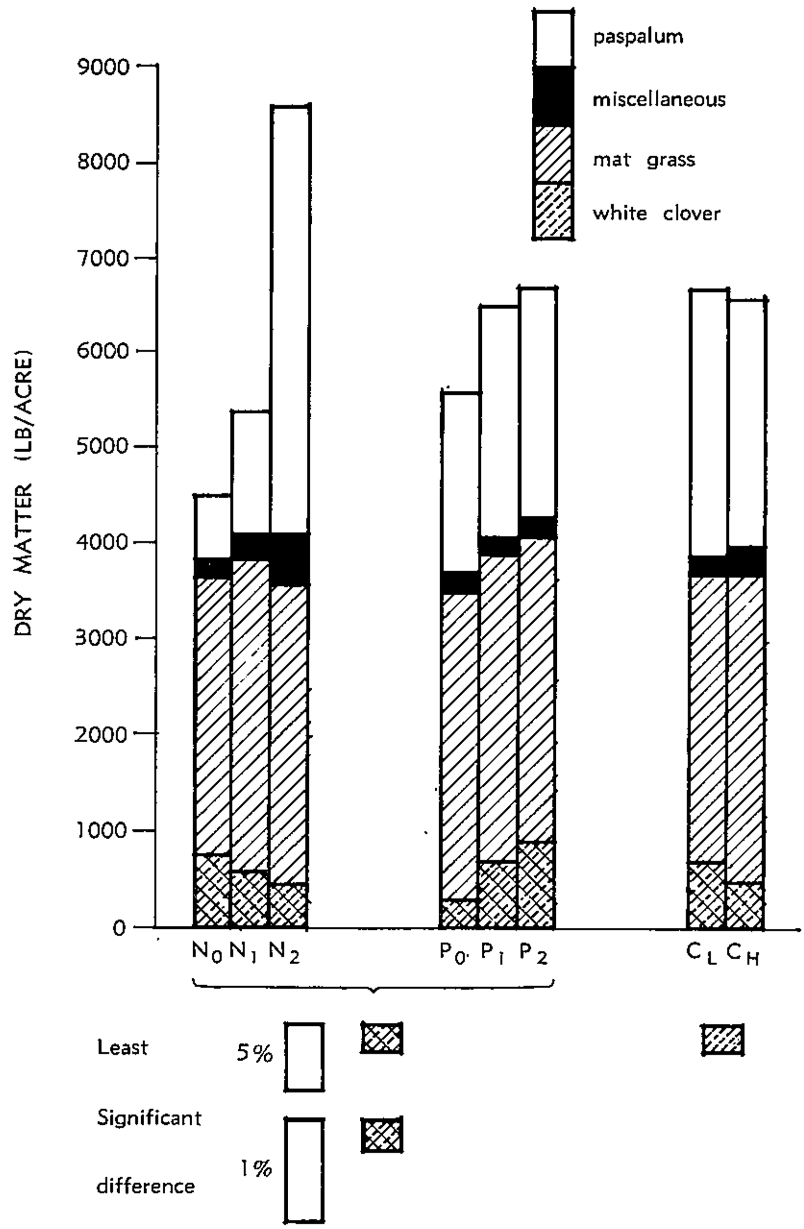

Figure 1. Total dry matter yields in the second season. Main effects.

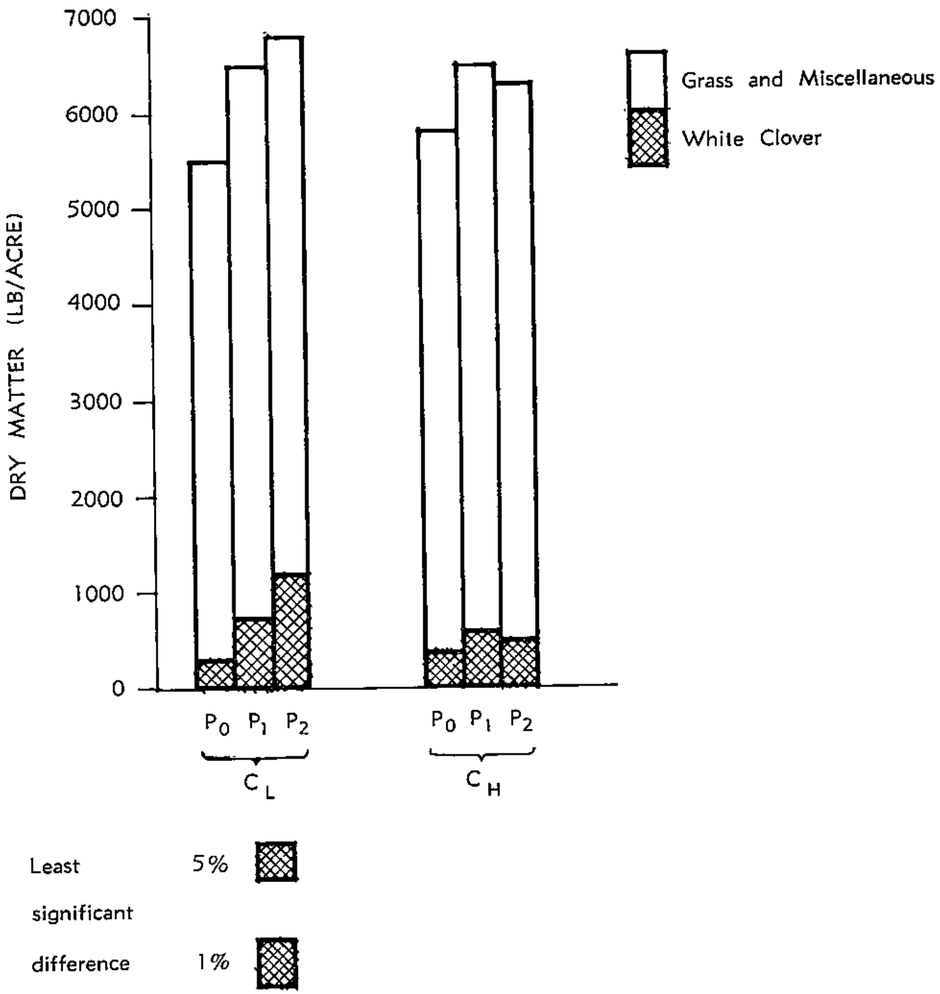

Figure 2. Phosphorus × cutting height interaction on dry matter yields.

The main dry matter increment in paspalum (Fig. 4) occurred during the November-January period, which is the main growing season for this grass. The application of nitrogen at 200 lb per acre increased maximum growth rate during this period from 7 lb per acre per day to 50 lb per acre per day. Nitrogen also increased the growth rate during the post flowering period (February-March) from 3 lb per acre per day to 12 lb per acre per day. Paspalum was in full flower on January 16, 1963.

Maximum growth rate of the mat grass component was not increased by nitrogen application (Fig. 5). However, early season growth in the unfertilized treatment appeared to be limited by nitrogen deficiency. With no nitrogen fertilizer it took about 4 more weeks to attain its maximum growth rate than when fertilized with nitrogen. This appeared to be the sole effect of heavy nitrogen application on mat grass.

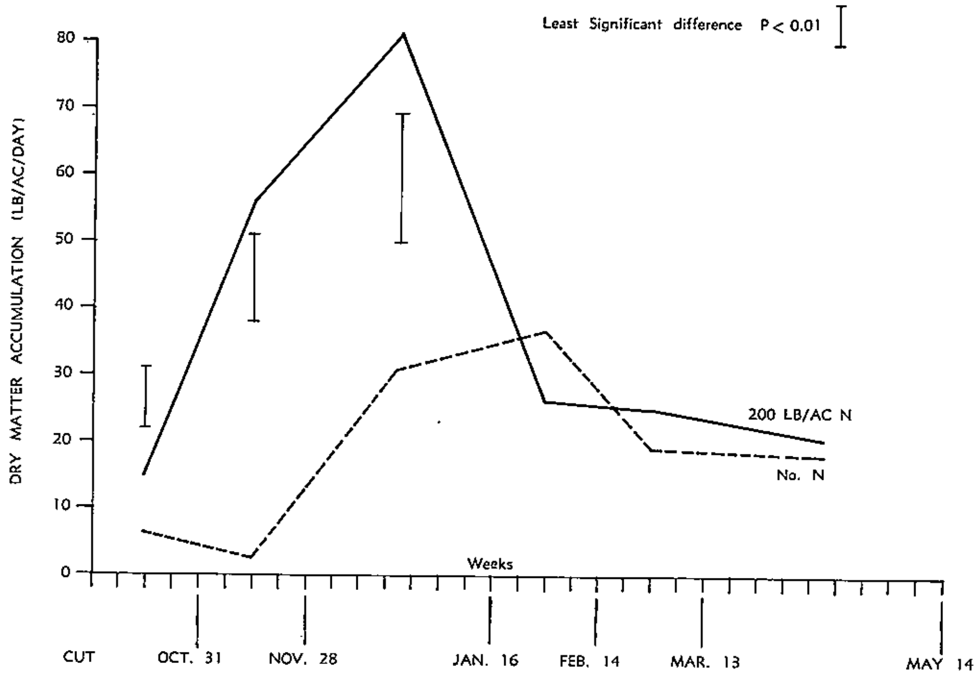

Figure 3. Effect of nitrogen on total pasture growth rate in the second season.

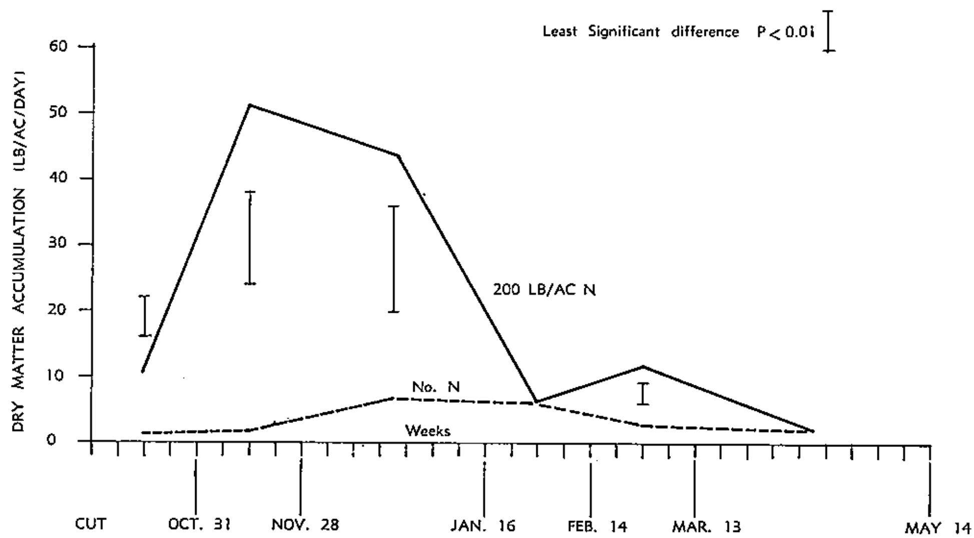

Figure 4. Effect of nitrogen on paspalum growth rate in the second season.

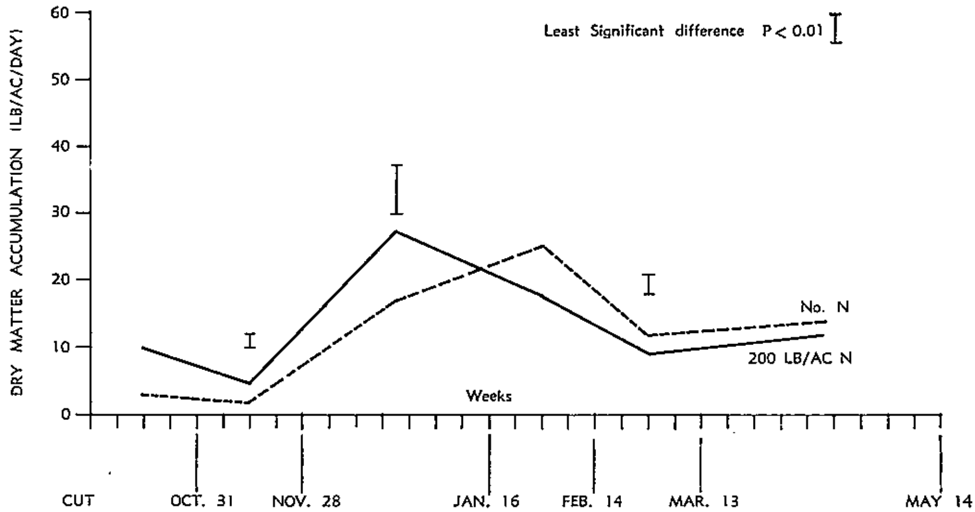

Figure 5. Effect of nitrogen on mat grass growth rate in the second season.

Following the final harvest, at which all treatments were defoliated to approximately 2 in., nine weeks were allowed to pass, and on July 19, 1963, percentage ground cover of each species was estimated using line transects.

During this time little or no grass growth took place but the seasonal clover component developed to the stage where some significant difference between treatments could be expected.

The results are presented in Fig. 6. The degree of dominance of mat grass is obvious. It occupies about 90% of the ground cover on all treatments. Although the overall contributions to ground cover by paspalum and clover were small, their basal cover was significantly affected by treatment.

The effects of high nitrogen on the basal cover of white clover was also significant. This was due mainly to low values of white clover in the N_2C_H treatment.

DISCUSSION

The late application of first season treatments in February 1962 resulted in a low total yield response. At 200 lb nitrogen per acre the seasonal dry matter response was 4.7 lb for every pound of nitrogen applied. The growth rates plotted for the second season (Fig. 4) indicated that, by this time, the main growing season for the pasture was over.

Although there was a highly significant difference in yield between the two defoliation levels for the first season it was of little importance because most of this difference was accounted for by the residual material left on the C_H plots at the end of the season. When fertilizer treatments were first applied on February 22, 1962, all plots were defoliated to a uniform 2 in. Differential defoliation treatments were not applied until the first harvest on April 18, 1962.

In the second season the total yield response was 20.9 lb dry matter at N_2 and 18.7 dry matter at N_1 for every pound of nitrogen applied. It is probable that uptake of the applied nitrogen was limited by the low density of paspalum in the sward (Fig. 6).

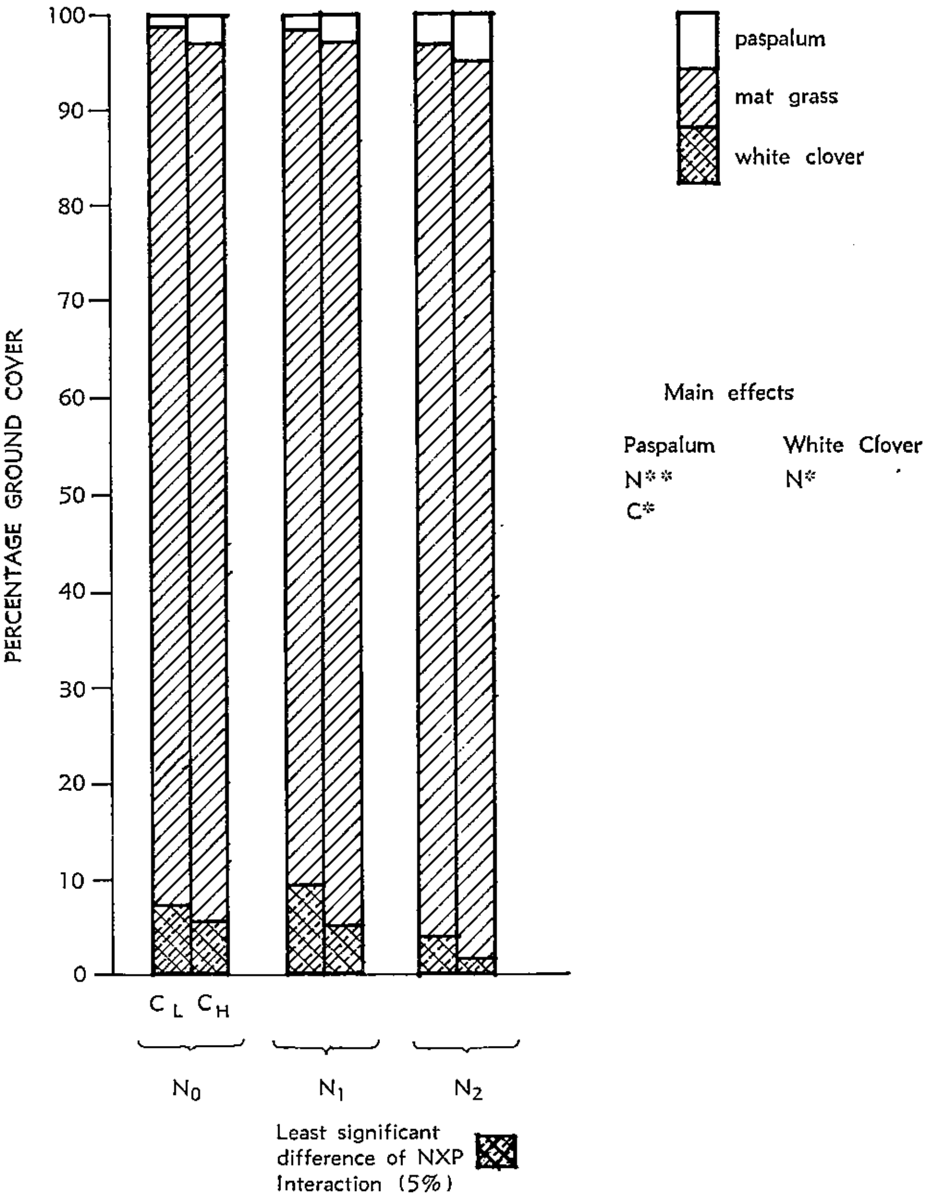

Figure 6. Effect of treatments on percentage ground cover at the end of the second season.

This level of nitrogen response agrees with that recorded by Gartner (1969) in North Queensland. In his experiment, carried out on a mixed sward of Kikuyu, paspalum and mat grass, ratios of dry matter yield responses to nitrogen applied ranged from 17.6 in the first season to 22.1 in the third season.

No significant growth responses as a main effect of phosphorus were recorded in either the paspalum or mat grass components of the sward. Although it was expected the low available phosphorus would limit paspalum growth at a higher level of nitrogen (Anderson and Arnot 1953) no significant nitrogen × phosphorus interaction emerged. Again this was attributed to the low density of paspalum plants in the association and its demonstrated ability to exploit soil nutrients at considerably greater depths than mat grass. (Burton, De Vane and Carter 1954).

Clover yield responded positively to the more severe defoliation treatment. This trend was in agreement with the depression of white clover growth due to shading by associated grasses demonstrated by Blackman (1938). Where white clover growth was not limited by phosphorus deficiency the effect of cutting height was highly significant (Fig. 2).

The effect of nitrogen on seasonal growth rates suggested that, if maximum dry matter yields are the object, under the climatic conditions operating on south east Queensland, early and adequate application of nitrogenous fertilizer is necessary (Fig. 3 and 4). Henzell and Stirk (1963a) have demonstrated a critical deficiency of nitrogen for perennial grasses at the beginning of the growing season. Nitrogen responses in this experiment during October and November were in agreement with their findings. It was interesting to note (Fig. 5) that even mat grass suffered from this early seasonal deficiency of nitrogen which affected the time taken to attain maximum growth rate, even though nitrogen application did not improve total dry matter yield for the season.

The late season growth response during March and April by paspalum (Fig. 4) was of some potential importance in spite of the yields. It is in general agreement with the results obtained by Colman (1963) on a pure paspalum sward, where nitrogen at 80 lb per acre applied in early April increased the growth rate from 35 lb dry matter per acre per day (over 5 weeks) to 49 lb per acre per day. The same rate applied in mid May increased the growth rate from 18 lb to 28 lb per day.

The significant increase in percentage ground cover by paspalum at the lenient defoliation was in accordance with the findings of Lovvorn (1944) that paspalum was more sensitive to defoliation than mat grass and also with those of Mitchell (1955) who demonstrated the depressing effect of close defoliation on both tiller production and shoot growth in paspalum.

The tendency for mat grass to give way to better grasses under conditions of better nitrogen availability was recorded by Gartner (1969). In his experiment the application of nitrogen at 200 lb per acre per year for three consecutive years changed the composition of a mixed sward of kikuyu, paspalum and mat grass from 39% mat grass to 11% mat grass.

In terms of pasture productivity for dairying, the results indicated that manipulation of defoliation practice and the supply of available nitrogen, as represented by the treatments, was not very rewarding in a typical mat grass dominant situation in that there was little increase of paspalum in the sward (i.e. ground cover). A more positive decrease in mat grass dominance, with a corresponding increase in ground cover by fertilized Kikuyu has been recorded where the latter was a component of the sward (Gartner 1969).

The positive yield responses by the paspalum component to applied nitrogen added to the existing seasonal peak of grass growth. On the farm, use of this material would need to be specialised—for instance limited fertilized areas could well be used for short term intensive grazing at a high stocking rate.

The main practical result of the applied phosphorus treatments was their positive effect on the seasonal incidence of white clover. The selection of a typical mat grass association for this experiment (i.e. without previously applied fertilizer) meant that while clover was present initially, if at all, in minimal amounts and that this component developed, during the first season, from naturally disseminated seed on the experimental area. However, its responses to applied phosphorus and defoliation treatments (Fig. 1) indicated its potential value as an overseeded component in this and similar situations where an extended season of available soil moisture every year would favour its development.

The results of this experiment confirmed the critical nitrogen deficiency limiting pasture growth in south-eastern Queensland defined by Hegarty (1958), Henzell (1963) and Henzell and Stirk (1963a). Moreover, these results emphasized the current serious limitations to dry matter response and nitrogen recovery inherent in the species composition of the existing grass pastures in the region affected by this investigation

The development of mat grass dominance in former paspalum pastures seems closely associated with progressive nitrogen deficiency. However, the simple correction of the deficiency by means of top dressing with fertilizer is not likely, under conditions of efficient utilisation, to bring about rapid changes in species composition unless a more effective competitor than paspalum can be used as the key.

Shaw *et al.* (1965) have demonstrated the ability of a range of introduced *Paspalum* species to out-perform naturalised *P. dilatatum* in terms of dry matter yield and autumn growth in the region. The establishment of more recently introduced better grasses and their maintenance by means of adequate nutrition, therefore, presents an effective way of completely replacing low quality mat grass dominant pastures where the topography is suitable.

The introduction and use of white clover by overseeding, fertilizing and management, has considerable potential for improving the existing pastures especially in lower situations, where unexploited reserves of winter soil moisture exist in the root zone during most years. Although in this experiment it was present as a minor natural component of the sward, its response to applied phosphorus and defoliation management are in keeping with its behaviour as recorded by Bryan (1967).

The general growth response pattern in this experiment suggests that nitrogen fertilizer has a place in spring and early summer when grass-legume pastures are slow and susceptible to overgrazing. A mat grass-paspalum pasture, well fertilized with nitrogen, could be heavily used at this time, while mixed tropical pastures are making adequate development for later use.

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