NATIVE GRASSES IN THE PILBARA REGION, AUSTRALIA; RESOURCE ACQUISITION, ALLOCATION AND GROWTH.

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ABSTRACT
Biomass production and nitrogen content of the native perennial grasses, Barley Mitchell grass (*Astrebla pectinata*) and Kangaroo grass (*Themeda triandra*), were studied over the 1996 growing season. After 160 mm of rain, the biomass of *T. triandra* increased from 2 to 4 t/ha, while *A. pectinata* increased from 1.1 to 1.5 t/ha. N in aboveground biomass of *T. triandra* increased from 14.5 to 17 kg/ha and of *A. pectinata* from 8.5 to 10 kg/ha. *A. pectinata* leaves senesced quickly increasing the total amount of N in dead leaves. *T. triandra* senesced more slowly but dead leaves provided the major portion of the pool of N in the biomass. Net mineralization, nitrification and plant uptake were greatest in the middle of the year (Winter) for both species, correlating with peak biomass production and greatest amounts of total aboveground N. Soils supporting *A. pectinata* were consistently nitrifying, whereas immobilization limited the amount of ammonium available for nitrification in soils supporting *T. triandra.*

KEYWORDS
nutrient cycling, perennial grass, grazing, semi-arid grasslands

INTRODUCTION
The Pilbara region of north-western Australia is about 180, 000 km^2 in area. The major industries are cattle production and mining. Although much of the area has been grazed for ~ 130 years there has been minimal research on the effects of grazing on native perennial tussock grasses. While annuals and ephemerals are important fodder following summer rains, perennial tussock grasses remain the major fodder for the latter part of the year. We have initiated a long term study of the effects of grazing on the physiology (eg., nutrient uptake and distribution within the plant), nutrient cycling (nitrogen mineralization) and productivity of two important grazing species, Barley Mitchell grass (*Astrebla pectinata* (Lindley) F.Muell.) and Kangaroo grass (*Themeda triandra* (Forsk.)). We report here our on our results for the 1996 (March to November) growing season.

MATERIALS AND METHODS
Grazing effects were studied at replicated sites for *T. triandra* and *A. pectinata* on 'Hamersley Station', a pastoral lease located in the central Pilbara (Long. 117º 40' 33" E, Lat. 22º 16' 48" S). In February 1996 a single plot of one hectare was fenced to exclude both cattle and kangaroos. A matching plot, equivalent in size and site characteristics but open to stock, was established within 250m of the exclosure. Study sites were situated between 1.5-3.2 km from watering points.

Growth and Nutrient Distribution. Plots were first sampled in March 1996 and again in May 1996 to establish 'baseline' aboveground biomass. Thereafter plots were sampled at bi-monthly intervals. The plots were split into three blocks and from each block two 1m^2 quadrats, selected using a grid system, and all plant material and litter within the quadrant collected (to ground level).

Plant samples were sorted into green/dead leaf, tiller/stem, rhizome and seed head (if present). Sorted material was measured for dry weight and leaf area (Li-Cor instruments planimeter).

Plant tissue samples were analysed for N and P using a Technicon II autoanalyser after Kjeldahl digestion.

N Mineralization Studies. N-mineralization was measured using the technique described by Adams *et al.* (1989) at three locations in each fenced plot: midway between tussocks (MT), adjacent to tussock (AT) and centre of tussock (T). N-mineralization was measured at two depths intervals: 0-5 cm and 5-10 cm. Two samples from each block were bulked together by sampling location, depth and time (initial ,t_o and incubated, t_{60} days). Prior to analysis soil samples (t_o and t_{60} days) were sieved to 2 mm, and a 5 g sub-sample extracted by shaking with 50 mL 1 M KCl for 1 hr. Extracts were analysed for NO_3^- and NH_4^+ using a Technicon II Auto Analyser.

Results for soils and nutrient studies were analysed using the SuperAnova (1989) statistical package.

RESULTS/DISCUSSION
Soils and General climatic conditions. *A. pectinata* and *T. triandra* grow on alluvial plains, on extensive deep cracking clay soils. In some areas the soil profile includes a stony horizon and for the most part, soils are calcareous. Annual rainfall at Hamersley station is close to 350 mm and about 70% of the rain falls between December and March. Annual evaporation is more than 3200 mm per year (Shaw and Mitchell, 1994).

Growth and Nutrient Distribution. Fifty mm of rain fell in early April 1996 followed by a further 110 mm in mid-April which initiated new growth and an increase in biomass.
T.triandra biomass increased quickly, due to the production of new stems and leaves. At *A. pectinata* sites, production of new tillers and leaves accounted for the increase in biomass.

By August the biomass of *T. triandra* had almost doubled to approximately 4.3 t/ha (Fig. 1a), and was slightly higher than comparable studies (Norman 1969 and Groves 1965). Over the same period *A. pectinata* had increased from about 1.1 to 1.5 t/ha (Fig. 1a) and was similar to that recorded elsewhere for this species (Orr, 1980; Hall and Lee, 1980). For both species, there were no differences between exclosures and grazed plots.

The nitrogen content of both green and dead leaves varied significantly over time ($P<0.05$) and between species ($P<0.05$), but not due to treatment (ie. grazed vs ungrazed). The N content of green leaves of *T. triandra* remained relatively constant throughout the sampling period (Fig 1b). The sum of the N contents of green and dead leaves of *A. pectinata* declined slightly (Fig 1b), and was increasingly dominated by dead leaves.

The total N content of *T. triandra* was dominated by the N content of dead leaves whereas that of *A. pectinata* was dominated by stem material.

N Mineralization Studies. Production of inorganic N via mineralization is the source of N for plant uptake (Marschner, 1989). For both species, there were significant differences($P<0.05$) in net mineralization, nitrification and plant uptake of nitrogen with time, and also for the sampling location ($P<0.05$) in the *A. pectinata* plots. There were no differences due to site, or to sampling depth and the results shown are means for both sites and depths. The low basal cover (3-5%) and patchy distribution of *A. pectinata* tussocks may explain the significant effect of sampling location. *T. triandra* grasslands have a greater density of tussocks and thus a more even distribution of basal cover.

Rates of mineralization, nitrification and uptake were greatest during the mid-year sampling period for both species irrespective of sampling location (Fig 2). In *T. triandra* grasslands, we measured a net negative production of inorganic nitrogen in both the May-June and August-October sampling periods- a result due in part to losses of N as nitrate (presumably through leaching or denitrification) but mainly to the immobilization of ammonium (Figs 2a, b). Nitrification was consistently a significant process in *A. pectinata* grasslands. To date, the measured amounts of N uptake from the soil (Fig 2c) suggest little difference but are subject to large experimental errors.

GENERAL DISCUSSION

The production of fodder for cattle in arid and semi-arid regions of Australia is highly dependent on, and related to, the availability of water and the quality of that fodder is closely related to its nitrogen content. Estimates of N uptake based on the *in situ* incubation technique generally require longer periods than that reported here before they can be compared with estimates derived from mass balance calculations. Nevertheless, these results suggest that the production of aboveground biomass by *T. triandra* may be more dependent on redistribution of N from the belowground biomass (rather than on uptake from the soil) than by *A. pectinata.*

Patterns of nitrogen concentration in plant tissues and distribution varied greatly between the species. In general, total N content in *A. pectinata* and *T. triandra* green leaf tissue are similar but leaf tissues of *A. pectinata* senesce more quickly than those of *T. triandra.*

Mineralization of nitrogen measured to date in soils supporting the tussock grasses *T. triandra* and *A. pectinata* compares favourably with other ecosystems (Ihori et al., 1995 and Kelly et al., 1996) of comparable net primary productivity. Further studies will focus on the elucidation of the difference between species in their dependence on stored N or on soil N for growth.

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Figure 1a

A. pectinata and *T. triandra* biomass production (error bars are plus/minus one standard error)

Figure 1b

Total N in green leaf, dead leaf and other components of *A. pectinata* (A) and *T. triandra* (T).

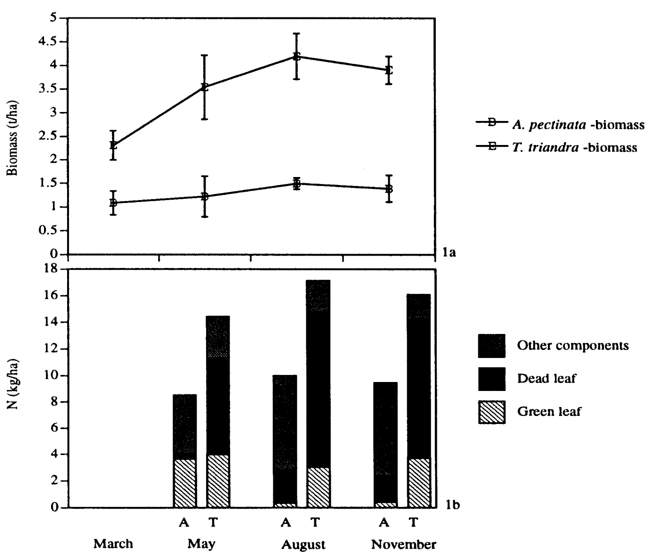

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Figure 2a

Net mineralization of N for *A. pectinata* and *T. triandra* at three locations, midway between tussocks (MT), adjacent to a tussock (AT) and centre of tussock (T).

Figure 2b

Net nitrifcation for *A. pectinata* and *T. triandra* at three locations.

Figure 2c

Plant uptake of N for *A. pectinata* and *T. triandra* at three locations. (error bars are plus/minus one standard error).