The growth of *Chloris gayana* within and adjacent to a plantation of *Eucalyptus grandis*

J.B. ROBINSON
Wollongbar Agricultural Institute,
Wollongbar, New South Wales, Australia

Abstract

The effect of a three year old flooded gum (*Eucalyptus grandis*) plantation on the growth of rhodes grass was measured at Samford in south-east Queensland. Soil moisture and photosynthetically active radiation (PAR) levels were monitored.

During the productive early autumn period the growth of pasture was severely depressed by the trees. A clear relationship existed between PAR receipt and pasture production. During late autumn and winter, when growth was slower, pasture production was no different between the boundary of the plantation and in the open paddock. The pasture close to the trees was apparently protected from frosts, which occurred in the open paddock.

Resumen

*El efecto de una plantación de goma (*Eucalyptus grandis*) de tres años de edad sobre el crecimiento del pasto rhodes fue medido en Samford al sur-este de Queensland. Se registró la humedad del suelo y la radiación foto-sintéticamente activa (PAR).*

El crecimiento de la pastura fue severamente restringido por los árboles durante el período productivo al inicio del otoño. Existió una clara relación entre la PAR recibida y la producción de la pastura. Al final del otoño y durante el invierno, cuando el crecimiento fue lento, la producción de la pastura en los limites de la plantación y en el potrero descubierto no fue significativamente diferente. El pasto junto a los árboles estuvo aparentemente protegido contra congelamientos, los cuales ocurrieron en el potrero abierto.

Correspondence: J.B. Robinson, Wollongbar Agricultural Institute, Bruxner Highway, Wollongbar, NSW, 2477, Australia.

Introduction

Clearing trees in the woodlands and forests of eastern Australia results in reduced competition with pastures and typically results in two- to threefold increases in pasture production and livestock carrying capacity (Walker *et al.* 1972; Burrows *et al.* 1988). A recent study of tree density effects on tree and pasture productivity found that only low densities (<200 stems/ha) of three and a half year old flooded gums didn't seriously affect subtropical pasture production (Cameron *et al.* 1989). However, a study by Wilson *et al.* (1990) showed that the dry matter yield of a *Paspalum notatum* pasture under the shade of a *Eucalyptis grandis* plantation was higher than for a similar pasture growing nearby in full sun. The benefit of tree cover for the nitrogen nutrition of pasture grasses was discussed as a possible mechanism for producing this effect. The study site was adjacent to the Cameron *et al.* (1989) study, but the comparison involves a slightly lower tree density (237 vs. 305/ha), and greater plantation age (5 vs. 3.5 years). Also, pasture growth rates were much lower in the Wilson *et al.* (1990) study, which used much longer cutting intervals. Wong and Wilson (1980) have shown that green panic production was decreased by shade when measured by cutting over a short interval, but increased when cut after a longer interval. These field studies indicate that the effects of tree cover on the production of subtropical pastures are complex.

Physiological studies indicate that subtropical pasture grasses require full sunlight for maximum photosynthesis (Ludlow and Wilson 1970). Their net assimilation rates decline with reduced levels of illuminance because changes in their specific leaf area (m^2 lamina area/g lamina dry matter) and reductions in respiratory rates are insufficient to compensate for the reductions in photosynthesis (Ludlow *et al.* 1974). Because pasture production and stocking rate are the major determinants of animal production in Australia and New Zealand, reductions in pasture production usually result in a proportional reduction in livestock carrying capacity, animal production and income (Robinson and Helyar 1989).

This paper reports the growth of rhodes grass within and adjacent to a plantation of young flooded gums (*E. grandis*) in south-east Queensland.

Materials and methods

Site description

The experiment was conducted at Samford, 23 km north-west of Brisbane. The soil was a deep, grey-brown, fine sandy clay loam on an alluvial terrace. It had good water storage capacity and high nutrient availability (Thompson and Murtha 1960). The pH of the surface soil (0-20 cm) was 5.8 (1:5 soil:water).

Pasture and plantation descriptions

The pasture was dominantly Rhodes grass (*Chloris gayana* cv. Samford) but also contained minor amounts of green panic, setaria, and bahia grass. Prairie grass (*Bromus unioloides*) and vetch (*Vicia sativa*) largely replaced the subtropical grasses inside the plantation. The trees were three year old flooded gums spaced at 3.3 m on a grid pattern. They were 15 cm diameter at breast height and 8 m high when this experiment was conducted in 1982. The canopy of the plantation was continuous and two to three metres deep.

Methods

Sampling and measurements were done along five transects of 20 m length parallel to the edge of the plantation. One was 4 m inside, one on the boundary and the others were 2, 4 and 8 m outside the plantation's southern boundary. Pasture production was determined over two periods by clipping randomly distributed quadrats to 10 cm height. Samples were dried at 80 °C. The pasture was cut on February 24 and regrowth was measured 28 days later (March 23) and again 56 days later (May 18).

Tree canopy cover was estimated from hemispherical canopy photographs and analysed with a "spider web" grid. The ratio of one day's PAR reception at the site to the solar radiation (MJ/m^2) recorded at the nearby weatherstation (040241) was used to convert radiation records to above-canopy PAR values. PAR is an almost constant proportion of total radiation at a given site (Howell *et al.* 1983).

Specific leaf area was determined from a sample of 25 plants from the 0 m and the 8 m transects. Soil moisture was measured fortnightly adjacent to each quadrat from February to July on cores of 0-20 cm depth.

Statistical analyses

One-way analysis of variance was used to determine the statistical significance of differences in the pasture production, soil moisture and specific leaf area data.

Results

Average radiation levels for the two measurement periods were 16.6 and 15.5 $MJ/m^2/d$. Table 1 shows the pasture growth rates, tree canopy cover and PAR reception data for the transects during the two measurement periods. PAR levels were very low within and adjacent to the plantation. The specific leaf area of the rhodes grass was 58% higher at the plantation boundary than outside (significant at $P = 0.05$). Rainfall during the measurement period was higher than average at 238 and 82 mm, and no significant differences ($P = 0.05$) in the levels of soil moisture were measured.

Discussion

During the first measurement period the plantation intercepted a large proportion of PAR and there was negligible pasture production within the plantation, while the trees had little effect on pasture production at the 8 m transect. During this period, when pasture growth was rapid, the association between reduced pasture growth and shading by the trees was clear. This agrees with the glasshouse studies of Ludlow *et al.* (1974) who found that specific leaf area increases, similar to those found here, were insufficient to prevent reductions in growth.

Table 1. Pasture growth, tree canopy cover and PAR levels over two periods along transects within, bounding, and adjacent to a young flooded gum plantation

Distance from plantation	Feb 24-Mar 23 Growth rate	Feb 24-Mar 23 Cover	Feb 24-Mar 23 PAR	Mar 24-May 18 Growth rate	Mar 24-May 18 Cover	Mar 24-May 18 PAR
(m)	(kg/ha/d)	(%)	(mol/m²/d)	(kg/ha/d)	(%)	(mol/m²/d)
−4	4a[1]	94	7	2a	95	5
0	21b	82	11	10ab	85	11
2	21b	62	24	12b	65	21
4	31b	39	35	15b	47	30
8	68c	13	46	10ab	19	41
LSD P = 0.05	15			9		

[1] Pasture growth values followed by different letters are significantly different (P = 0.05) within each period

The results are different to those of Wilson *et al.* (1990), where a plantation had a positive effect on the growth of *Paspalum notatum*. Differences in the density of the tree cover, length of the pasture measurement periods, and shade tolerance of the pasture grasses are likely sources of the differences in the results. The Wilson *et al.* (1990) plantation consisted of 237 five year old trees per hectare, which is lower than this study (1000 three year old trees/ha), and lower than the density (305 trees/ha) at which Cameron *et al.* (1989) found pasture growth reductions under three and a half year old flooded gum. Wilson *et al.* (1990) accumulated pasture for periods of 240 and 70 days (June to February, May to July), while this study used 28 and 56 day periods (February to March, March to May). The growth rate over 240 days that they measured in the open was below 11 kg/ha/day, very much less than the 68 kg/ha/day measured in this study.

During the second measurement period there were no significant differences (P = 0.05) between pasture growth at the boundary of the plantation and at the 8 m transect. Like the previous period, negligible production occurred under the plantation. Late in this period frosts occurred in the open paddock and on the 8 m transect, decreasing in frequency and severity with proximity to the trees. The tree cover would reduce back-radiation on clear nights, elevating the grass temperature and reducing the incidence and severity of frosts.

Given the likely balance of effects the plantation had in the two periods, the results are in agreement with those of Cameron *et al.* (1989) who found that flooded gums of a similar age and density reduced total annual pasture production severely.

Acknowledgements

Thanks to Mr Z. Hochman, Dr G.J. Murtagh and Mr P. Stace for commenting on the manuscript, and to Mrs M. Copeland for preparing it. I am grateful to Dr R.A. Hynes for his supervision of the project. Help from Mr D. Cameron and the field staff of the CSIRO Samford Research Station who set up the plantation was invaluable.

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(Received for publication December 24, 1990; accepted June 15, 1991)