Seasonal variability of Rhodes grass production in the northern West Australia wheatbelt.

Roger Lawes[1] and Michael Robertson[2]

[1]CSIRO Sustainable Ecosystems, Private Bag 5 PO, Wembley WA 6913 Email roger.lawes@csiro.au
[2]CSIRO Sustainable Ecosystems. Private Bag 5 PO, Wembley WA 6913. Email Michael.Robertson@csiro.au

Abstract

Subtropical C4 grass-based pastures are being adopted by farmers in the northern WA wheatbelt interested in filling a summer/autumn feed gap, finding a pasture to grow on poor soils, managing salinity or to provide cover to protect soils over summer. Although there have been successes, summer rainfall is variable and may impact on the long term success of the species in the region. We calibrated the APSIM growth module for Rhodes grass using trial data from Mingenew and Moora in the WA wheatbelt. Long term simulations were conducted at four locations: Buntine Mingenew, Moora and Badgingarra, (330 to 560 mm annual rainfall), to explore the long term productive capacity of the grass at four locations, with two rates of nitrogen input (20 kg /ha and 100 kg/ha) on two soil types (shallow gravel and a deep yellow sand). High levels of biomass are produced on a deep yellow sand when nitrogen is applied at 100 kg/ha. Production on shallow gravels was poor at all locations and nitrogen did not influence production on these soils. Productivity varies greatly from one year to the next and in a quarter of all years production was at least 5 t /ha less than the long-term median. Most biomass was produced from October to May and production was highly variable. Unreliable summer rainfall means these species can only be used tactically to provide a useful but unreliable source of feed at these times of year.

Key words

Rhodes Grass, *Chloris gayana*, Western Australia, perrenial pastures

Introduction

The subtropical perennial C4 grass, *Chloris gayana*, was trialled throughout the 1990s in WA to assess its ability to grow and persist on leached sands (Moore et al. 2007). The species showed promise, as it survived through the hot dry summers typical of the Western Australian wheatbelt. Casual observation suggested the species had a role in WA farming systems where it could provide useable quantities of biomass outside the normal April to October growing season, when livestock feed is scarce. Trialling has continued and the grass is being adopted by farmers who are interested in filling a summer or autumn feed gap, finding a suitable species to grow on poor soils, providing cover over summer, or looking for a perennial to minimise the onset of salinity in confined catchments. Localised successes have occurred, as farmers have learned to successfully establish the pasture and these successes have heightened farmer interest in managing poor soils with subtropical grasses.

Rhodes grass is a summer active perennial and is dormant in winter, when soil moisture supply peaks. Although annual trials suggest the pasture can fill an important role in these production systems, the impact of the notoriously unreliable summer rainfall on production across a range of locations and soil types can not be tested easily with on-ground trials conducted over short time frames. Simulation modelling can provide some insight into the productive capacity of Rhodes grass across a range of soil types and locations. Thus, we constructed and calibrated a simulation model of Rhodes grass using the growth module in the APSIM modelling framework using available data from DAFWA field trials at Mingenew and Moora (validation and trial data not shown).

We subsequently conducted long term simulations to explore the productive capacity of Rhodes grass at Badgingarra, Moora, Mingenew and Buntine on two soil types, a deep yellow sand and a shallow gravel, where nitrogen is applied at low (20 kg/ha) and high (100 kg/ha) rates. Although farmers rarely apply nitrogen to pastures, subtropical C4 grasses are being trialled on poor soils and it was deemed prudent to provide some nutrition for the pasture.

Methods

Model adjustments

APSIM ver. 5.2 was used to construct and calibrate a model of Rhodes grass growth and development. Briefly, root depth was set to a maximum of 3 m. The model was parameterised so that mean temperature did not affect photosynthesis between 19 and 35^{o}C and was halted at temperatures of 0 and 50^{o}C. The remaining coefficients were extracted from the APSIM Bambatsi model. (http://www.apsim.info/apsim/publish/apsimui/types.xml#bambatsi)

Model application

Long-term simulations were conducted at Buntine (329 mm), Moora (447 mm), Mingenew (393 mm) and Badgingarra (559 mm) in the northern Western Australian wheat belt. Rainfall at all locations is winter dominant with occasional substantial but unreliable summer rainfall (Figure 1). Model parameters for two different soil types were used: a deep yellow acid sand (PAWC 187 mm to 3 m) and a shallow gravel soil (PAWC 70 mm to 1 m). Two fertiliser regimes were simulated: a low (20 kg/ha) and high (100 kg/ha) rate of N application, as nitrate in September. Output from long-term simulations was analysed from an annual perspective (January to December), a seasonal perspective focussing on summer (October to May) production, and a monthly perspective.

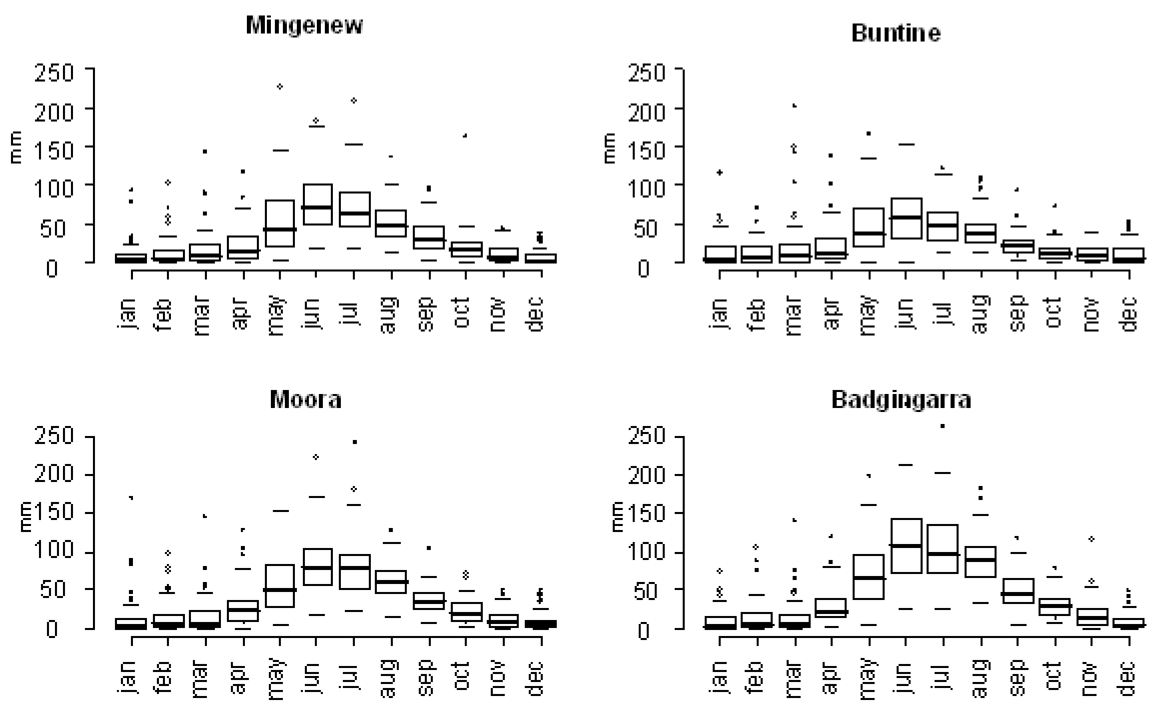

Figure 1. Long term median, quartile, decile and extreme monthly rainfalls at Mingenew, Buntine, Moora and Badgingarra.

Results

Annual production

On deep yellow sands with high levels of applied nitrogen, Rhodes grass produced high levels of biomass. At Mingenew, Moora and Badgingarra median annual production exceeded 10 t DM/ha, while median production in Buntine was 8 t DM/ha. Production on this soil type at this nitrogen rate was variable. In all cases except Badgingarra the inter-quartile range exceeded 5 t/ha and the difference between the 10th and 90th percentiles exceeded 10 t/ha in the drier locations of Mingenew and Buntine.

Rhodes grass responded to high applications of N on the deep yellow sand where median yields increased by 2.5 t/ha. Production on the shallow gravel, which limited root growth and therefore available water, was poor at all locations. This limitation was so severe that the substantial differences in rainfall that exist between the locations had no real influence in the long term prospects of this species on these soils. High applications of nitrogen had no influence on production at any locations on shallow gravel soils.

Summer production

Summer biomass production (October to May) on a deep yellow sand subjected to high levels of nitrogen ranged from 6 t/ha in Buntine and Mingenew to 8 t/ha at Moora and Badgingarra. Summer production was variable, particularly in Buntine, where the inter quartile range exceeded 3 t/ha. This variation was less than 2 t/ha in Moora and Badgingarra.

Production during the summer responded favourably to high levels of nitrogen on deep yellow sands. In contrast, when low levels of nitrogen were applied to the deep sands, substantial differences in rainfall between sites had almost no effect on production, where predicted median biomass ranged from 4 t/ha (Buntine) to 4.5 t/ha (Badgingarra). Median summer production on the shallow gravel soils was poor and ranged from just 2 t/ha to 2.5 t/ha regardless of the amount of nitrogen applied through simulation.

Monthly Production

More biomass was produced in October than any other month at the drier locations, Mingenew and Buntine. In the two wetter locations more biomass was produced in November than October, although the difference in production between the two months at both locations was generally small. At Mingenew and Buntine, median monthly production only exceeded 1 t/ha in October and November. At Moora and Badgingarra median production also exceeded 1 t/ha in December (Figure 2).

Although median production peaked in the latter months of the year, the variability of production in all summer months (October to May) was high at all locations. Thus, both high and low levels of production could occur, almost at random, during the summer months, depending on rainfall.

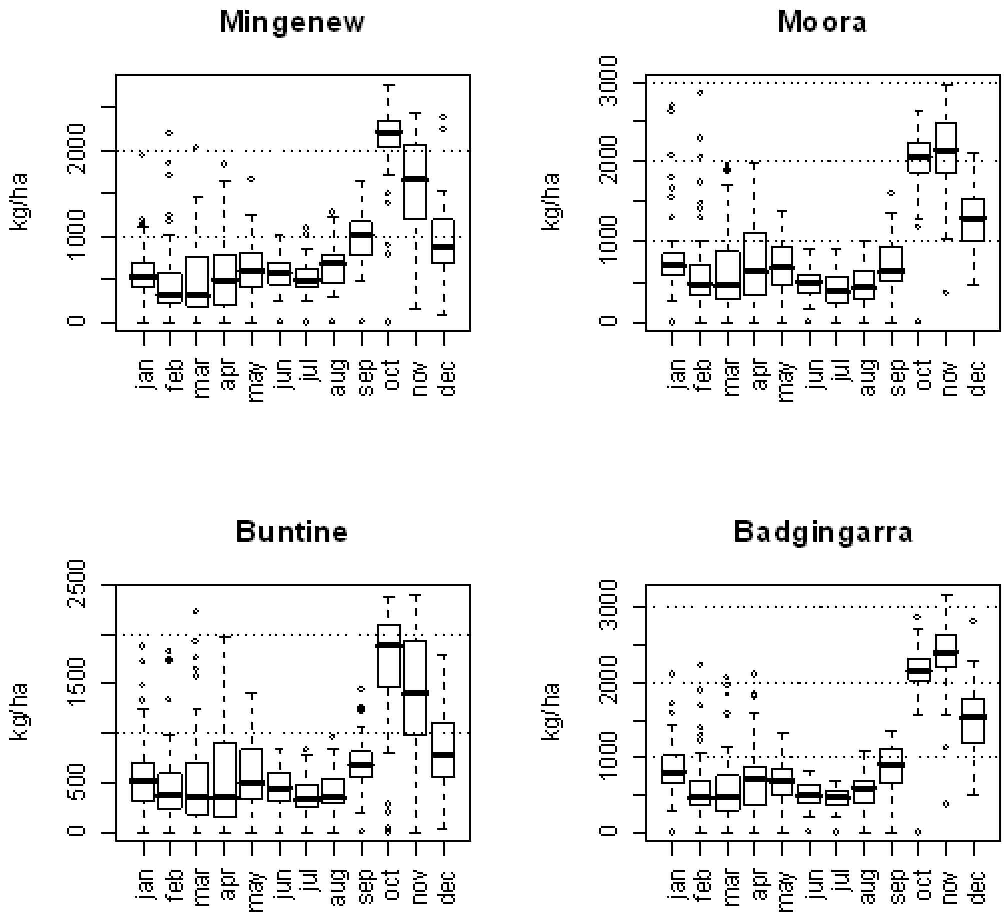

Figure 2. Median, quartile, decile and extreme monthly biomass of Rhodes grass on a deep sand with high applications of nitrogen.

Discussion

In the WA cropping environment, Rhodes grass behaves like a summer active perennial and is essentially dormant in winter. Growth commences in spring when temperatures reach an acceptable level and no-longer limit photosynthetic activity. In essence, Rhodes grass has the potential to extend the existing growing season into November and December at the expense of winter growth. However, the temporal dynamics of growth are closely aligned to the temperature stresses the pasture can endure and the temperature thresholds need to be studied in more detail. If the pasture copes with low temperatures it will respond earlier in late winter and growth would cease once stored soil moisture has been utilised. In contrast if the pasture requires higher temperatures before becoming photosynthetically active the initiation of pasture growth will be delayed and commence later in the summer, assuming stored soil moisture has not evaporated or been used by annual weeds or pastures and is still available for production.

Subtropical grasses may offer a viable alternative to cropping on soils that are traditionally unproductive. However, if the pasture behaves similarly to wheat on poor soils, production would be marginal. If it is adapted to poor soils with acidic profiles and low nutrient status as suggested by Moore (2006) and Ward *et al.* (2008), then the simulation study on poor soils would need to be re-evaluated as the plant would be able to access more soil moisture than indicated here. Establishment in a trial can be variable. The impact of plant density on growth and development, in the context of plant available water, should be explored to inform growers of optimal plant densities across a rainfall gradients and soil types. Although Rhodes grass is stoloniferous, the effect of plant to plant competition may still influence the rate of establishment across a field. The concept should be extended to include studies detailing the species interaction with annual grasses, cereal crops and legumes and enhance the capacity to incorporate the positive aspects of Rhodes grass into a farming system whilst eliminating or minimising the negatives. In reality, Rhodes grass will most likely be grown as a polyculture with other pasture grasses or cereals and between species interactions should be studied in detail at the plant and paddock scale.

Conclusion

In summary, Rhodes grass has the potential to extend the growing season in the WA wheatbelt and produce substantial quantities of biomass in October and November, while production in December, January, February and March is dependent on summer rainfall. Summer rainfalls are unreliable and essentially random and complicate the incorporation of Rhodes grass into a farming system. Rhodes grass does not produce much biomass early in the season and is most likely to fill a late season, early summer feed gap rather than an Autumn feed gap. Perennial pastures should be used tactically, particularly on soils less suited to cereal production, where they will grow when unseasonal rainfalls occur. They can provide a handy, but unreliable source of feed at these times of year.

Acknowledgements

This work was funded through the Grain and Graze initiative of LWA, GRDC and MLA.

References

Moore G. 2006. Chapter 5 – Sub-tropical Grasses. In ‘Perennial pastures for Western Australia’ Eds (Moore, G, Sanford, P, Wiley, T). Department of Agriculture and Food Western Australia Bulletin 4690.

Ward P, Knight S, Barrett-Lennard P. 2008. Production and water use by sub-tropical grasses in south-western Australia. 2nd International Salinity Forum Salinity, water and society—global issues, local action. Adelaide, Australia.