Simulating Tall Fescue Pasture Growth in Argentina

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Introduction

Tall fescue (*Festuca arundinacea* Schreb) pastures have the potential to maintain high production rates under limiting climate conditions, especially in dry summers, improving the seasonal distribution of forage growth and year round production (Tharmaraj *et al*. 2008). The purpose of this work was to test the ability and flexibility of the DairyMod biophysical pasture-simulation model (Johnson *et al.* 2008), to predict herbage mass accumulation (HMA), of tall fescue pastures from Argentina under several environmental conditions that included different seasons, nitrogen fertilizer application levels and irrigation.

Methods

Data from five one-season pasture growth experiments on established pastures of temperate, summer active, tall fescue carried out at INTA Balcarce Experimental Station, Argentina (Long: 58º 18' 12.5'' W Lat: 37º 45' 57.7'' S 125 m a.s.l) were used to test pasture growth predictions from DairyMod. Nitrogen (N) fertilization and irrigation were the main treatments compared in spring 2006, spring 2009, summer 2009, autumn 2009 and winter/spring 1996. Annual fertilizer N rates ranged from 0 to 225 kg/ha except for spring 2009 where rates of 0 to 500 kg/ha were used. Pastures had not received previously any N fertilization. DairyMod was set to simulate plant N dynamics. Phosphorus, potassium and sulfur were assumed to be not deficient. Pasture growth parameters used in the model are presented in Table 1. Pasture responses to fertilizer rates of 150 kg N/ha or higher were simulated by increasing the number of living leaves per tiller from 3 to 4, based on findings from previous experiments (Lattanzi 1998), and the optimum N% in herbage from 3.5 to 4.5%. Each field experiment was simulated by using specific climate files from the same date range as the experiments. Comparison of the measured and modelled HMA was carried out by calculating the mean bias (Mb), mean prediction error (MPE), model efficiency (MEF), variance ratio (v) and the bias correction factor (Cv), (Tedeschi 2006). Additionally, a Bland-Alman plot (Bland and Altman 1986) was drawn from all data.

Results and discussion

Simulated and measured HMA were generally in good agreement. Across all datasets, Mb ranged from -136 and 288 kg DM/ha of HMA with MPE between 25 and 32%. The highest deviation occurred in the irrigated data. MEF range was 0.5 in autumn but higher than 0.75 in all other datasets. The variance in the simulated data was close to that of the measured data (v = 0.87, Cv = 1.09). This is in agreement with the Bland-Altman plot (Fig. 1), which also showed a slightly higher dispersion as HMA increased. Mean and standard deviation of the differences were -66.9 and 600, respectively.

Table 1. Parameter settings in the simulations

Factor	Parameter	Value
Growth	Leaf appearance interval 20ºC (Days)	13.3
	Initial shoot DM (kg DM/ha)	600
	Initial green % DM	100
	Initial root DM (kg DM/ha)	1000
	Optimum N content of leaf tissue (%DM)	3.5
	Nutrient as percentage of leaf nutrient composition (%)	50 (Stem), 50 (Root)
Temperature	High temp. effects	Inactivated
	Low temp. effects (°C)	Onset, 5; Full, 3; Critical T-sum 3
Photosynthesis	Min. temp. (°C)	5
	Opt. Temperature (°C)	20
	Curvature (q)	0.5
Root	Maximum root depth (cm)	120
	Depth to 50% of root mass (cm)	50
	Empirical scaling factor	3

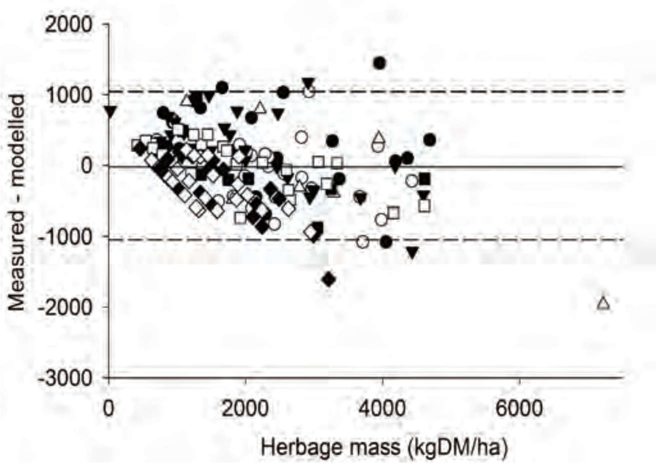

Figure 1. Bland-Altman plot for irrigated spring 09 (○), summer 09 (⌂), and autumn 09 (♦); and non-irrigated winter/spring 96 (□), spring 06 (●),spring 09 (▼), summer 09 (■), and autumn 09(◊) experiments.

The tightest matching between simulated and modeled HMA was observed in winter/spring 1996 and in springs 2006 and 2009 with fertilizer rates up to 150 and 350 kg N/ha, respectively. Similarly, the overall trends in measured HMA in summer 2009 for the two evaluated N rates (40 and 200 kg N/ha) and in autumn 2009 up to 75 kg N/ha were fairly well represented by the model, albeit not detecting a consistent lag time in the first stages of regrowth in the former experiment. Conversely, model estimations at high fertilization rates diverged from observed HMA in spring 2006 and 2009 (225 and 500 kg N/ha, respectively) and in autumn 2009 (150 and 225 kg N/ha). The N nutrition principles of the model assumes that optimum N concentration for plant growth stays constant independently of HMA, although, within dense canopies it decreases unequivocally with the increase in HMA (Lemaire and Salette 1984). Consequently, the contrast between actual and modelled N demand would be expected to concomitantly increase with observed HMA. This situation would explain the highest discrepancies observed between measured and simulated data at the highest N doses. Previous discussion further indicates that when the model adequately represented field results, an overestimation of the N effectively utilized to produce comparable HMA would be expected.

Conclusion

The sound representation of tall fescue performance by DairyMod under well characterized edapho-climatic and management conditions shown in this study supports its use to estimate pasture growth patterns in Argentina. However, any upgrade of the model to improve N nutrition simulation would enhance its value to address the effectiveness of N management practices for jointly attending production, economic and environmental issues.

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References

Bland, JM and Altman DG (1986) Statistical methods for assessing agreement between two methods of clinical measurements. *The Lancet* **327**, 307-310.

Johnson IR, Chapman DF, Snow VO, Eckard RJ, Parsons AJ, Lambert MG and Cullen BR (2008) DairyMod and EcoMod: biophysical pasture-simulation models for Australia and New Zealand. *Australian Journal of Experimental Agriculture* **48**, 621-631.

Lattanzi FA (1998) Efecto de la fertilización nitrogenada sobre el crecimiento de festucas de tipo templado y mediterráneo. Universidad Nacional de Mar del Plata (UNMdP).

Lemaire G and Salette, J (1984) Relation entre dynamique de Coissance et dynamique de prélèvement d`azote pour un peuplement de gramiries fourrageies. I. Etude de l`effet du milien. *Agronomie* **4**, 423-430.

Tedeschi LO (2006) Assessment of the adequacy of mathematical models. *Agricultural Systems* **89**, 225–247.

Tharmaraj J, Chapman DF, Nie ZN and Lane AP (2008) Herbage accumulation, botanical composition, and nutritive value of five pasture types for dairy production in southern Australia. *Australian Journal of Agricultural Research* **59**, 127-138.