Radiation Use Efficiency of Alfalfa-Tall Fescue Mixtures in a Temperate Humid Area

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Radiation use efficiency of alfalfa-tall fescue mixtures in a temperate humid area

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Introduction Alfalfa (*Medicago sativa* L.) and tall fescue (*Festuca arundinacea* Screb.) have ecotypes with different responses to temperature. Hypothetically, combination of germplasm with different patterns of seasonal growth might exhibit advantages in radiation use efficiency (RUEfa). In the Humid Pampa region, grass is the main species in these mixtures in winter. However, seasonal transition is crucial to study mechanisms of dry matter accumulation in mixtures with cultivars of different temperature responses. In this work, RUEfa of two alfalfa-tall fescue mixtures are presented.

Materials and methods The experiment was carried out in Pergamino, Argentina (33°52′S; 60°35′W). The soil was typical Argiudol. The treatments were a complementary mixture (C_{ary}): alfalfa moderately dormant and tall fescue Mediterranean ecotype and a competitive one (C_{ive}): alfalfa short dormant and tall fescue north Europe ecotype. In each of two cycles of growth (2005/06 and 2006/07) weekly measurements were taken at the end of winter, summer and autumn. Complete random design was used (n: 2). In each period, leaf area index (LAI), above-ground biomass (AGB), and intercepted photosynthetically active radiation (PARi) were determined. RUEfa ($Mj \cdot m^{-2}$) was estimated, as the slope of the AGB accumulated on PARi. LAI, AGB and PARi were analyzed by ANOVA Procedure of SAS System ($p < 0.05$). Parameters estimators of RUEfa were analyzed by GLM Procedure.

Results LAI was higher in C_{ive} mixture than in C_{ary} at the end-winter. In autumn, value was higher in C_{ary} than in C_{ive} (Table 1). In autumn, PARi was higher in C_{ary} mixture. RUEfa, was higher in C_{ive} mixture in winter for cycle 2 ($y = 8.3 + 3.3x$, $r^2 = 0.89$, $p < 0.01$ and $y = 0.9 + 1.4x$, $r^2 = 0.86$, $p < 0.001$ in C_{ive} and C_{ary}, respectively). RUEfa was higher for Cycle 2 in summer: C_{ive} ($65.8 + 0.8x$, $r^2 = 0.58$, $p < 0.01$ and $y = 82.1 + 0.1x$, NS, in C_{ive} and C_{ary}, respectively). In autumn, both mixtures had the same RUEfa ($17.7 + 0.6x$, $r^2 = 0.40$, $p < 0.01$ and $-2.8 + 1.6x$, $r^2 = 0.77$, $p < 0.001$, in Cycle 1 and 2, respectively). The seasonal variations in RUEfa have been attributed to changes in the partition of carbon (Browna et al, 2006). For Cycle 2 at the end of winter and in summer, C_{ive} had higher AGB than C_{ary}.

Conclusions At the end of winter and in summer, when alfalfa was the main species in C_{ive}, this mixture had higher RUEfa values than C_{ary}. This was due to a higher LAI and, probably, to a more favorable structure. In autumn, when C_{ary} had higher PARi than C_{ive}, treatments had the same RUEfa. The differences in favour of C_{ive} in RUEfa were associated with higher AGB. In autumn, higher AGB in C_{ary} was related to a higher PARi.

Table 1 *LAI, PAR_i y AGB in two mixture end-winter, end-summer and end-autumn. Cycles 1 and 2*[1].

Cycle	Season	Date	LAI			PARi			AGB		
			C_{ive}	C_{ary}	P<	C_{ive}	C_{ary}	P<	C_{ive}	C_{ary}	P<
1	Winter	9/19	3.6	2.5	0.05	58	74	NS	153	102	0.05
		9/26	4.6	4.0	NS	91	81	NS	213	194	NS
	Summer	3/6	4.4	4.1	NS	92	91	NS	235	166	NS
		3/13	4.5	5.6	NS	93	91	NS	298	354	NS
	Autumn	5/30	2.7	3.2	NS	88	89	NS	83	106	NS
		6/6	3.2	3.5	NS	93	93	NS	67	110	0.05
2	Winter	9/12	3.2	1.4	0.001	51	62	NS	201	52	0.05
		9/18	4.8	2.0	0.05	80	66	NS	95	344	NS
	Summer	3/6	5.4	4.1	NS	77	82	NS	226	127	0.05
		3/13	5.3	3.8	NS	82	94	NS	203	70	0.05
	Autumn	6/5	3.0	4.2	0.05	35	70	0.01	98	141	NS
		6/12	3.6	3.7	NS	s/d[2]	s/d[2]	—	143	210	0.05

[1] By simplicity, only the last two dates of measurements are shown. [2] Bad weather conditions prevent measurements.

Reference

Browna, H.E., Mootb, D.J., Teixeirab, E.I., (2006). Radiation use efficiency and biomass partitioning of lucerne (*Medicago sativa*) in a temperate climate. *European Journal of Agronomy* 25 (4), 319-32.