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BRIEF COMMUNICATION

Relationship between contents of chlorophyll (*a+b*) (*SPAD* values) and nitrogen of some temperate grasses

N. GÁBORČÍK

Faculty of Ecology and Environmental Sciences, Kolpašská I. 1738 9/B, 969 00 Banská Štiavnica, Slovakia

Abstract

In a field experiment the chlorophyll (*a+b*) (*SPAD* readings) and nitrogen contents of three grass species (*Festuca arundinacea* Schreb., *Lolium perenne* L., and *Lolium multiflorum* Lam.) and three intergeneric hybrids of *Festuca pratensis* Huds.×*Lolium multiflorum* Lam. and *Festuca arundinacea* Schreb.×*Lolium multiflorum* Lam. were measured. Close relationships were found between *SPAD* readings and nitrogen leaf content ($r^2 = 0.873^{**}$, 0.491^{**} and 0.938^{**}) for the 1st, 2nd, and 3rd cut, respectively. *SPAD* readings and N contents were closely correlated ($r = 0.836^{**}$) confirming that *SPAD* measurements could be used in grass selection and/or breeding for high N concentration in herbage.

Additional key words: cultivar differences; *Festuca*; *Lolium*; species differences.

Earlier studies of conifers (Linder 1980) as well as grasses (Gáborčík 1985, Kantety *et al.* 1996) indicated that chlorophyll (Chl) concentration is a trait indicating plant nitrogen (N) status. Due to labour- and time-requirement for Chl determination (Šesták and Čatský 1996) the indirect determination of N based on Chl concentration was not used. Hardacre *et al.* (1984) published a prototype of a handheld Chl meter and other authors (Yamada 1986, Marquard and Lipton 1987) confirmed a close relationship between Chl (*a+b*) content and *SPAD* readings [dimensionless] obtained from the portable Chl meter *SPAD 501* or *502* (*Minolta*, Japan). Also, a close relationship between *SPAD* readings and N (or crude protein) content was confirmed (Neilsen *et al.* 1995, Li *et al.* 1998). The aim of this work was to determine the relationship between *SPAD* readings and N concentration of an assortment of temperate forage grasses.

A field trial was conducted in a sub-mountain region of Slovakia (Matejovce, 700 m elevation, λ = 20°15′, φ = 48°04′) in which the grass species *Lolium perenne* L. cv. Mustang, *Festuca arundinacea* Schreb. cv. Lekora, *Lolium multiflorum* Lam. cv. Kroto and Jiskra, and intergeneric hybrids (IGH) of *F. arundinacea*×*L. multiflorum* cv. Bečva and Lofa and *F. pratensis*×*L. multiflorum* cv. Perun were studied. Seeding rate was 3.5 g m^{-2}. The soil chemical concentration (pH/KCl = 7.0) at the beginning of the experiment in the 0-150 mm horizon was [g kg^{-1}] C_{ox} 221.8, humus 37.6, N_{tot} 2.7, and [mg kg^{-1}] P 49.6, K 164.5, and Mg 250.5. Swards were cut three times over the growing season in 1998 (1st cut on 5 May, 2nd cut on 8 September, and 3rd cut on 14 October). Three times 3 g(N) m^{-2}, and 3 g(P) m^{-2}, and 6 g(K) m^{-2} in spring were applied. On the day in which swards were cut, twenty developed (mature) green leaves were taken (at 07:00-08:00 in the morning) and *SPAD* readings [= Chl(*a+b*)] were determined with a handheld Chl meter *SPAD 502* (*Minolta*, Japan) along the leaf blade (twenty measurements per leaf). After drying (105 °C, 24 h, a laboratory dryer) the N content of leaf samples was determined using a *CHN* analyser (*Carlo-Erba*, type *1106*, Italy) as in a previous study (Gáborčík 1997). *ANOVA* was used to test for significant differences between means.

Differences between means of grass cultivars for *SPAD* readings and N content in grasses leaves (Table 1) were not significant ($p > 0.05$). Average values for *SPAD* readings varied between 44.3 for *Festuca arundinacea* cv. Lekora and 40.5 for annual ryegrass (*Lolium multiflorum* Lam.) cv. Jiskra. These two species also had the highest and lowest N content in leaves (26.5 *vs*. 24.5 g kg^{-1}, respectively). *SPAD* readings tended to increase over the growing period ($p < 0.05$) with small, non-significant differences between the 2nd and the 3rd cut. Average N content, however, increased at the 2nd cut and significantly decreased at the last cut ($p < 0.05$). There

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Fax: ++421-45-692 0117, e-mail: gaborcik@vsld.tuzvo.sk

was a close relationship between *SPAD* readings and N content in grass leaves within individual cuts, $r^2 = 0.491^{**}$ to 0.938^{**}. However, the *b* values in the linear regressions differed between cuts indicating that this relationship is dependent on the stage of plant and/or sward development and on environmental factors. Nevertheless, there was a close correlation between mean values of *SPAD* readings and N content ($y = -0.90105 + 0.868\ x$, $r^2 = 0.836^{**}$). Similar results were found for different plant species (Reeves *et al*. 1993, Fatyma *et al*. 1998, Užík and Žofajová 2000) including forage grasses (Kantety *et al*. 1996, Gáborčík 2000), but both parameters, *i.e. SPAD* values and N content in leaves were usually varied by increasing N fertilisation. Li *et al*. (1998) and Neilsen *et al*. (1995) confirmed this relationship in cultivars of grapefruit and apple leaves, respectively. Previous studies on grasses showed a close relationship between Chl (*a*+*b*) and N (crude protein) content in forage grasses (Gáborčík 1981, 1998). Therefore this method can be used in grass breeding programmes (Gáborčík 1998) using a portable Chl meter. As grass cultivars with higher *SPAD* readings and leaf N content have more robust root (Gáborčík 1998), selection for higher Chl content may result in better soil water and N use. This could be of particular relevance if global climate change results in soil water deficiency and higher air temperatures. Golinski and Xi (2000) confirmed that red fescue (*Festuca rubra* L.) cultivars with higher *SPAD* values were more resistant again soil water shortage and they had more robust root system.

Table 1. Chlorophyll (*a*+*b*) (*SPAD* readings) and nitrogen contents [g kg^{-1}] in leaves of grasses.

Cultivar	Cutting date 1st (5May)		2nd (8 Sept.)		3rd (14 October)		Mean ± s_x	
	SPAD	N	*SPAD*	N	*SPAD*	N	*SPAD*	N
Mustang	42.3	29.3	44.3	31.3	44.0	21.4	43.5±1.1	27.3±5.2
Lekora	45.8	27.2	43.6	30.2	43.5	22.1	44.3±1.3	26.5±4.1
Bečva	39.9	22.6	41.1	31.6	48.0	25.4	43.0±4.4	26.5±4.6
Perun	38.2	21.4	46.9	31.8	44.7	21.3	43.3±4.5	24.8±6.0
Lofa	42.0	25.4	44.5	32.5	40.6	17.3	42.4±2.0	25.1±7.6
Kroto	36.6	21.7	41.8	29.2	39.4	18.4	39.3±2.6	23.1±5.5
Jiskra	35.7	17.7	42.8	30.5	46.1	22.3	41.5±5.3	23.5±6.5
Average	40.1	23.6	43.6	31.0	43.8	21.2	42.8	25.4
s_x	3.6	3.9	1.9	1.1	3.0	2.7	1.3	1.6

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