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Improving alfalfa forage quality

by Carla SCOTTI[1]* and Bernadette JULIER[2]

Abstract: Morphological and physiological traits contributing to the nutritive value of alfalfa forage are examined at harvesting and during a productive cycle. Leaf-to-stem ratio and the dynamics of development of stem internodes appear the main factors driving the nutritive value at the plant level. Within-population variation for these traits, in addition to between-population variation, can be exploited to improve digestibility and protein content.

Key words: alfalfa, crude protein, fiber fractions, leaf-to-stem ratio

The nutritive value of alfalfa forage is mainly a result of the forage chemical composition and in particular of the content of crude protein and fiber fractions (neutral detergent fiber, NDF, acid detergent fiber, ADF, and acid detergent lignin, ADL) estimating the proportion and composition of cell walls. ADF and ADL contents show strong negative correlation with ruminal digestibility of forage.

An alfalfa stem at harvest time includes a series of internodes separated by nodes carrying a leaf, and a branch (vegetative nodes) and/or a flower or pod (reproductive nodes). Proteins are mainly located in the the green and healthy leaves. Leaf protein content shows a limited variation (25% - 30% of biomass) that is determined by leaf position along the stem, with the highest contents in the upper young leaves exposed to light. Similarly, fiber content of the leaves is rather stable (20% - 25% NDF, 15% - 18% ADF). Stems, on the contrary, show a high variation for fiber content that is related to the developmental stage of the internodes (not yet elongating, elongating or mature). In the basal internodes, the mature stage implies a higher content in secondary lignified vascular tissues (mainly xylem) than in elongating internodes. ADF content of stem portions can vary from 55% in the basal internodes to 40% in the apical ones. In parallel, protein content varies from 9% - 11% to 16% - 20% from the basis to the top of the stem. The dynamics of shoot elongation during a regrowth affects the forage quality through changes in the proportion of leaves and the developmental stage of the internodes (3). At the beginning of regrowth just after harvest, the biomass of leaves is prevailing as internodes have not yet entered the elongation phase. When the stems reach about 30 cm height, the proportion of leaves has decreased but most internodes are still in the elongation stage. Around the phenological stage of 50% green bud stem, when the stems can reach 80 cm to 100 cm height, stem biomass becomes prevalent as a result of internode elongation, and most internodes are in a mature stage with high lignification; leaf biomass remains stable, as newly formed leaves are counterbalanced by the senescence and loss of older leaves triggered by the decline of incidence radiation (4). As a consequence, protein and fiber contents of alfalfa forage are mainly driven by the leaf-to-stem biomass ratio and secondly by the developmental stage of internodes. (Fig. 1).

The main strategies adopted to improve alfalfa protein content and digestibility rely on these morpho-physiological traits. One strategy is improving alfalfa tolerance to an early cutting schedule (e.g. cutting at 5% blooming), which implies plant selection for early restoration of nitrogen root reserves in order to fuel the shoot regrowth and ensure sufficient crop persistence (4). A second strategy is to act on the stem morphology by increasing the node number, decreasing the average internode length and making it more uniform along the stem. That resulted in higher leaf-to-stem ratio (0.80 *vs.* 0.76 in experimental synthetics selected for short and long internodes, respectively) and a final increase of CP production per plant (5). Since the development stage is negatively correlated with plant CP concentration and positively related with fiber fractions content, one further strategy is the uncouplement of growing and development processes by selection for high DM production and delayed triggering to reproductive phase (high vegetative-to-reproductive node ratio).

Within-population variation for plant and stem morphology, multifoliolate trait and rate of secondary wall deposition (1) can account for a major fraction of the genetic variation in digestibility among alfalfa plants with comparable biomass production. High-throughput screening of forage nutritive value by means of near infrared reflectance spectroscopy (NIRS) is currently used to exploit such variation. One last strategy for the genetic improvement of alfalfa stem quality relies on genetic transformation applied to a crucial point of the lignin metabolic pathway (2). Interestingly, alfalfa higher stem digestibility could positively impact not only on ruminant nutrition but also on bio-conversion processing for ethanol production. ■

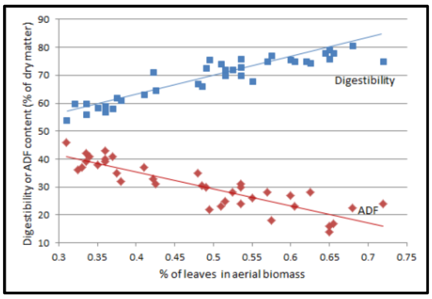

Figure 1. Relationship between forage digestibility or ADF content and leaf proportion in the biomass (from Lemaire and Allirand, Fourrages, 1993)

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References

(1) Guines F, Julier B, Ecalle C, Huyghe C (2003) Among- and within-cultivar variability for histological traits of lucerne (*Medicago sativa* L.) stem. Euphytica 130:293-301

(2) Guo D, Chen F, Wheeler JS, Winder JA, Selmon S, Peterson M, Dixon RA (2001) Improvement of in-rumen digestibility of alfalfa forage by genetic manipulation of lignin 0-methyltransferases. Transgenic Res 10:457-464

(3) Lemaire G, Cruz P, Gosse G, Chartier M (1985) Etude des relations entre la dynamique de prélèvement d'azote et la dynamique de croissance en matière sèche d'un peuplement de luzerne (*Medicago sativa* L). Agron 5:685-692

(4) Rotili P, Gnocchi G, Scotti C, Zannone L (1991) Some problems in the alfalfa breeding for quality: Protein content. Proceedings, EUCARPIA IX *Medicago sativa* Group Meeting, Kompolt, Hungary, 11-13 September 1990, 5-33

(5) Scotti C, Gnocchi G, Carelli M, Pintus B, Ursino A, Odoardi M (2006) Breeding of the alfalfa stem morphology for quality. Proceedings, EUCARPIA Fodder Crops and Amenity Grasses Section and *Medicago* spp Group Meeting, Perugia, Italy, 3-7 September 2006, 80-83