NIRS monitoring of quality parameters and digestibility of new lucerne cultivars in Northern Italy

Odoardi M., Tomasoni C., Borrelli L., Pintus B., Ursino A.

in

Delgado I. (ed.), Lloveras J. (ed.).
Quality in lucerne and medics for animal production

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 45

2001
pages 193-197

NIRS monitoring of quality parameters and digestibility of new lucerne cultivars in Northern Italy

M. Odoardi, C. Tomasoni, L. Borrelli, B. Pintus and A. Ursino
Istituto Sperimentale Colture Foraggere, Viale Piacenza 29, I 26900 Lodi, Italy

SUMMARY – Adaptation of the new lucerne cultivars to different environmental conditions in Northern Italy is routinely tested in replicated field trials organised by the Experimental Institute of Forage Crops. The continuous monitoring of the new accessions of the National Register of Varieties allows the organisation of Recommended Lists useful to farmers and extension officers. In addition to the traditional bio-agronomic traits, routinely controlled for inscription to the Register, the chemical composition of dry matter and the organic matter digestibility are now being determined and acquired for all the cultivars under evaluation. The second cycle, late-spring harvest, is used for near infrared reflectance spectroscopy analysis, using calibration equations previously prepared and checked for validation with a set of wet analyses. Results of the nutritional evaluation of the new lucerne varieties in the National List are reported and discussed for their best utilisation.

Key words: Forage quality, NIRS, yield, cultivars, comparative trials.

RESUME – *"L'emploi du NIRS pour l'évaluation des paramètres de qualité et de la digestibilité des nouveaux cultivars de luzerne en Italie du Nord". L'adaptabilité des nouveaux cultivars de luzerne aux différents milieux de culture du Nord de l'Italie est régulièrement vérifiée par l'Istituto Sperimentale Colture Foraggere de Lodi avec des expérimentations de comparaison dans plusieurs localités pour obtenir l'inscription dans les Listes des Variétés. L'analyse des composants responsables de la qualité et de la digestibilité du fourrage a été conduite régulièrement à l'aide du NIRS, sans coûts ni temps additionnel, pour signaler aux agriculteurs les cultivars les plus productifs et de qualité supérieure. Les premiers résultats de cette expérimentation sont présentés et discutés.*

Mots-clés : *Qualité du fourrage, spectroscopie proche-infrarouge, production, cultivars, comparaisons.*

Introduction

The number of new lucerne cultivars reaching the market in Europe has increased considerably in recent years. Particularly in Italy, there has been a rapid increase in the number of registered cultivars in the National Register of Varieties since 1995, when the Agricultural Ministry Decree (DM 3.3.1995) fixed the removal of lucerne ecotypes from the commercial market by 2001. Because of the large number of lucerne cultivars on the market, and the large number of new cultivars appearing each year, more information is needed on forage yield potential, adaptation, persistence and quality of lucerne cultivars based on data generated from field trials. Forage yield is the most important variable measured in most of these trials. Measurement of yield over several years and trials allows a determination of a particular cultivar's adaptation or persistence to a particular region, and this trait seems particularly important for the Italian farmers dealing with contrasting environmental conditions in terms of temperature, climate, water availability and soil fertility. Our Institute is currently involved in the organization of replicated field trials for the admittance in the National Register of the new lucerne varieties. In this paper, the main results of a comparative trial established in Lodi for evaluating forage potential and quality traits of 16 new lucerne cultivars and 4 control varieties are reported in order to establish a routine protocol for the utilization of Near Infrared Reflectance Spectroscopy (NIRS) as an additional tool to the Registration Trials, that rapidly and inexpensively allows the determination of forage quality.

Materials and methods

A four year field trial was carried out in 1996-1999 at Lodi Experimental Institute farm, Lombardy plain (alt. 82 m a.s.l., lat. 45º10'N, long. 9º30'E, mean annual rainfall and temperature respectively 812.6 mm and 12.2ºC, sandy loam soil pH = 5.6) with a randomised complete block design with four replications, fertilizations as in all the previous comparative trials organized by the Official Register of Varieties

(Tomasoni *et al*, 1999). Table 1 lists the sixteen new selected lucerne cultivars on trial, with three control cultivars and one ecotype, Romagnola, widely cultivated in North Italy and to be eliminated from the market after 2001.

Table 1. List of the cultivars on trial, origin and marketer or supplier in Italy (control cultivars in *italics*)

Cultivars	Origin	Marketer or supplier
Carmen	NLD	Limagrain Genetics, Scheemda - NL
Classe	ITA	Conase - Conselice (RA)
Elena	ITA	Bottos S. - S. Vito al Tagliamento (PN)
Equipe	ITA	SIS - Bologna
Gamma	ITA	Agroservice - S. Severino Marche (MC)
Letizia	ITA	Zignani L.&C. - Borello di Cesena (FO)
Linfa	USA	Emilseme - Finale E. (MO)
Lmsa313	NLD	Limagrain Genetics, Scheemda - NL
Lodi	ITA	Continental Semences - Traversetolo (PR)
Magistral	USA	Pioneer - Sissa (PR)
Melissa	FRA	Mycogen Verneuil sa.r.l. - Poggiorenatico (FE)
Monica	DEU	Semfor - Casaleone (CR)
Nemagone	USA	Emilseme - Finale E. (MO)
Point	USA	SIVAM - Casalpusterlengo (LO)
Premial	USA	Pioneer - Sissa (PR)
Prosementi	ITA	Produttori Sementi - Bologna
Romagnola†	ITA	SIS - Bologna
Sierra	USA	Limagrain Genetics, Scheemda - NL
Victoria	ITA	Continental S. - Traversetolo (PR)
Zas51	USA	Pioneer - Sissa (PR)

†Ecotype, out of market after 2001.

Plot size was 7.5 (5 1.5) m^2, seeding rate was 40 kg/ha; forage was harvested at 10-15% flowering stage, resulting from a total of 18 cuts. Assessments included establishment, ground cover percentage, earliness, fresh and dry matter yield, leaf/stem ratio, persistence, quality parameters estimated by NIRS, and derived Milk Feed Units (MFU) calculation according to Chase (1981). At the second harvest of the years 1997, 1998 and 1999, herbage samples were oven-dried at 60ºC for 48 h and ground to pass through a 1-mm screen before undergoing quality analysis. Forage quality was assessed by NIRS, with calibration equations created and validated with new sets of samples chemically analysed for Crude Protein (CP), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), Acid Detergent Lignin (ADL) (Goering and Van Soest, 1970), ash and Organic Matter Digestibility (OMD) (from Jones and Hayward, 1975, modified).

Results and discussion

Establishment was good for all the 20 cultivars, usually quite slow in the soil conditions of Lodi, and only three harvests were taken in the seeding year. Forage yield potential as total Dry Matter Yield (DMY) of the 18 cuts, and mean DMY at the second harvest of the year, when quality parameters were tested, are presented in Table 2.

The mean CP content reached 20.78 (% of DM), whereas the fiber content was around 40.5 as NDF and 33 as ADF (Table 3). The OMD ranged from 74.2 for 'Monica' to 68.7 for 'Carmen', with a mean value of 71.8. The high yielding new cultivars 'Point', 'Letizia', 'Victoria', 'Nemagone', 'Monica', 'Magistral' and 'Zas51' also showed high CP concentrations, and low or medium NDF levels (Table 3). The high-quality cultivars are those producing also higher levels of CP per hectare, as shown in Fig. 1, where at the same time the nutritive value of the 20 cultivars is reported as MFU per hectare.

Table 2. Total DMY (t/ha) and mean DMY at the 2nd cut of the 20 lucerne cultivars during 3 years of trial

Cultivars	Total DMY	DMY 2nd cut
Prosementi	66.49	4.45
Point	65.81	4.56
Letizia	63.70	3.78
Romagnola†	62.94	4.43
Lodi	62.67	3.50
Premial	61.94	3.83
Victoria	61.54	3.59
Nemagone	61.18	4.32
Monica	60.86	4.18
Magistral	59.62	3.84
Zas51	59.46	3.45
Gamma	58.11	3.64
Lmsa313	57.38	3.49
Linfa	56.41	3.56
Carmen	55.73	3.60
Sierra	55.10	3.71
Classe	54.47	3.70
Melissa	54.22	3.12
Elena	53.29	3.53
Equipe	51.31	3.70
Mean	59.11	3.80
LSD 5%	8.39	0.93

†Ecotype, out of market after 2001.

Finally, the forage yield potential of the 20 lucerne cultivars resulting from the field trial at Lodi has been compared with the results of the similar field trials conducted in two additional locations of Northern Italy (Tomasoni *et al.,* 1999), where the Official Tests for the National Register are regularly seeded. Figure 2 presents the mean yielding potential of the 16 new cultivars (with only one control variety in common) after the three location trials, expressed as percentage of the mean forage yield. In this case, cultivars with the highest degree of adaptation to the different, contrasting environments were the best performing on the whole in terms of biomass production. Looking at the quality parameters, cultivars with higher quality combined with good yield potential in the different locations would be proposed for a Recommended List to growers for forage production.

Conclusions

Forage cultivar selection based on quality parameters seems to give interesting results: the new lucerne cultivars, commercially available, seem able to combine high forage yield and higher quality than the traditional cultivars. With the aid of the rapid and inexpensive NIRS technique, more precise and accurate evaluations of the forage potential of new cultivars can be obtained and widely utilized.

Table 3. Forage quality traits – CP, NDF, ADF, ADL, ash (% of DM) – and OMD (%) of the 20 lucerne cvs. Mean values at the 2nd harvest of 3 years

Cvs	CP	NDF	ADF	ADL	Ash	OMD
Carmen	18.71	45.14	35.31	8.20	8.28	68.72
Classe	18.28	43.52	34.85	8.27	7.62	69.09
Elena	21.29	39.50	31.68	8.08	8.09	73.70
Equipe	21.45	38.60	31.18	7.99	8.48	73.34
Gamma	20.75	40.77	32.64	8.18	8.59	71.48
Letizia	21.19	40.32	32.57	7.93	8.42	71.42
Linfa	21.24	40.33	33.70	8.57	8.31	72.62
Lmsa313	20.80	41.08	33.84	8.33	7.78	71.05
Lodi	20.20	40.58	32.95	8.05	8.03	71.95
Magistral	21.17	40.73	33.28	8.37	7.98	71.04
Melissa	21.06	39.16	31.70	7.79	8.97	73.82
Monica	22.18	37.84	31.47	8.17	9.07	74.19
Nemagone	21.25	39.64	32.77	8.11	7.99	72.68
Point	21.66	41.00	33.11	7.63	7.72	71.32
Premial	19.52	42.17	34.67	8.24	8.04	70.34
Prosementi	19.29	41.08	33.86	8.08	7.40	69.58
Romagnola†	20.92	39.89	32.12	8.09	7.80	71.40
Sierra	21.49	40.50	33.60	8.39	8.18	72.63
Victoria	21.47	39.11	32.26	7.83	8.81	72.76
Zas51	21.70	40.22	32.84	8.01	7.86	72.30
Mean	20.78	40.56	33.02	8.11	8.17	71.77
LSD 5%	2.05	3.41	2.91	0.69	0.94	3.61

†Ecotype, out of market after 2001.

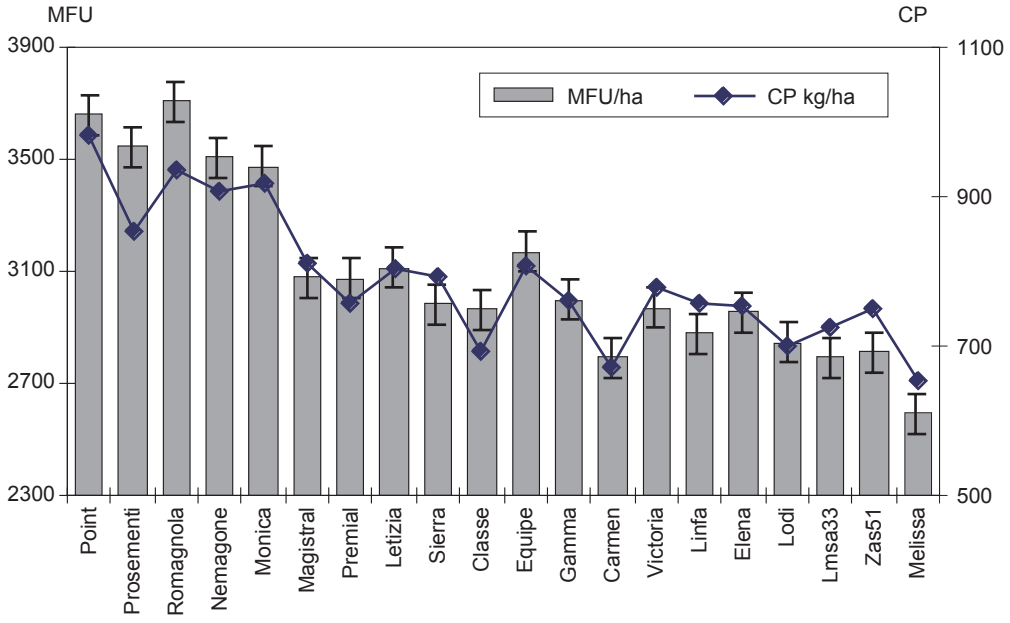

Fig. 1. Nutritive value of the 20 lucerne cvs as total Milk Feed Units (MFU) per ha, and Crude Protein (CP) yield (kg/ha) at the 2nd harvest (mean of 3 years).

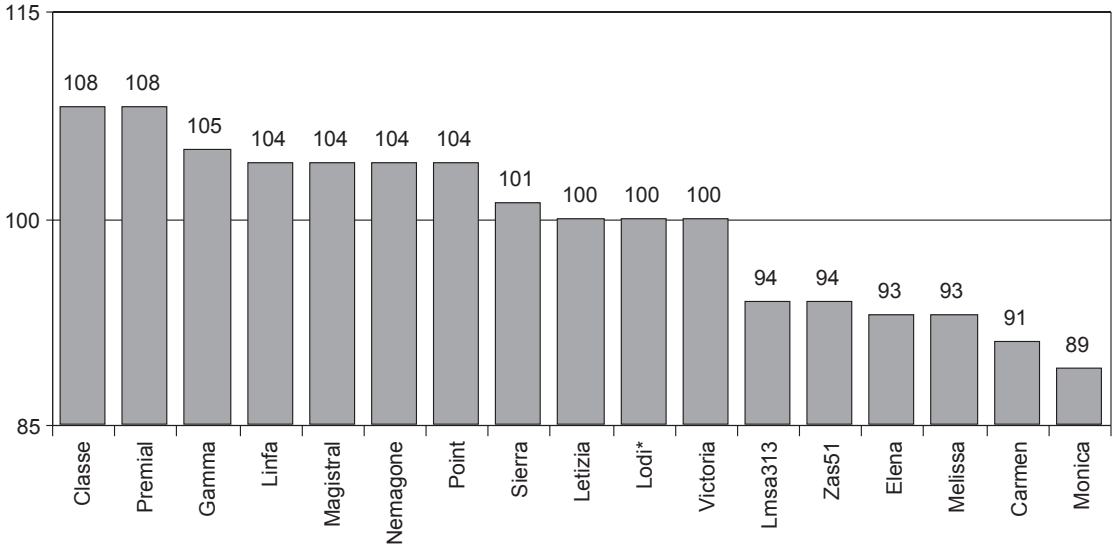

Fig. 2. Ranking of the 16 new lucerne cultivars and the control cv. Lodi* in terms of total DMY (% of the mean value) over a 3 year period in 3 contrasting locations of Northern Italy.

References

Chase, L.E. (1981). *Energy Prediction Equations in USA at NY Hydhia Forage Laboratory.* Production Agricultural Training School, Ithaca, USA.

Goering, H.K. and Van Soest, P.J. (1970). *Forage Fibre Analysis,* Agric. Handbook 379. USDA/ARS, Washington, DC, USA.

Jones, D.I.H. and Hayward, M.V. (1975). The effect of pepsin pre-treatment of herbage on the prediction of dry matter digestibility from solubility in fungal cellulase solutions*. J. Sci. Food Agric*., 26: 711-718.

Tomasoni, C., Borrelli, L., Onofrii, M., Bozzo, F., Magro, F. and Piazza, C. (1999). Le nuove varietà di erba medica iscritte al Registro Varietale nel 1997*. Sementi Elette*, 45(5): 11-15.