Field response and quality evaluation of alfalfa varieties for dehydrated forage production

Corsi G., Dal Re L., Laffi G., Ligabue M.

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 225-229

Field response and quality evaluation of alfalfa varieties for dehydrated forage production

G. Corsi*, L. Dal Re*, G. Laffi and M. Ligabue*****
*Azienda Agraria Sperimentale "M. Marani", via Romea Nord 248, 48100 Ravenna, Italy
**SO.PR.E.D. Soc.Coop a r.l., via Faentina 106, 48100 Ravenna, Italy
***C.R.P.A. S.p.A., corso Garibaldi 42, 42100 Reggio Emilia, Italy

SUMMARY – A field trial has been carried out during the three year period 1998-2000 around Ravenna (Adriatic coast), to examine: (i) alfalfa cultivar response to climatic and soil characteristics, with a cutting schedule based on a fixed number of days (28); and (ii) forage quality changes caused by high temperature drying. Seven cultivars were included in the experiment: Selene, Superba, Triade, Zenith, Classe, Zenith and Prosementi (test), arranged in a randomized block design in small plots. Dry matter yield was determined. The same cultivars were sown also in large plots, to produce for each variety such quantities of forage sufficient for the dehydrator. Crude protein and fiber, total ash, NDF, ADF, ADL were determined before and after conservation. In this paper yield data and quality evaluation of the three year period are presented.

Key words: Alfalfa, dehydration, forage quality, cultivar adaptation.

RESUME – *"Comportement au champ et mesure de la qualité de variétés de luzerne destinées à la production de luzernes déshydratées". Nous avons effectué un essai près de Ravenne (côte Adriatique) pendant trois ans – de 1998 à 2000 – pour examiner : (i) la réaction des cultivars de luzerne aux caractéristiques du climat et du sol, selon un programme de fauchage basé sur un nombre de jours fixe (28) ; et (ii) les changements dans la qualité du fourrage provoqués par la déshydratation à haute température. L'expérience comprenait sept cultivars : Selene, Superba, Triade, Zénith, Classe, Zénith et Prosementi (test), disposés en blocs aléatoires en petites parcelles. Nous avons défini la récolte de matière sèche. Les mêmes cultivars ont été semés également sur de grandes parcelles afin de produire, pour chaque variété, des quantités de fourrage suffisantes pour le déshydratant. Nous avons défini, avant et après la conservation, la teneur en protéine brute, fibre brute, cendres totales, NDF, ADF, ADL. Ce document présente les données de récolte et l'évaluation qualitative pour cette période de trois ans.*

Mots-clés : *Luzerne, déshydratation, qualité du fourrage, adaptation de variétés.*

Introduction

The production of dehydrated forage at elevated temperatures has become widespread in European countries for many years. Rapid or very rapid drying can be obtained with different types of dehydrators. The fundamental principle is to avoid gradual warming of the forage. Instead they stimulate a rapid evaporation of water from the vegetable tissue. In this way the temperature inside the leaves and stems does not exceed the level which would provoke phenomenas of denaturalizing proteins and other nutritional substances.

The cost of forage production is without doubt definitely more costly than the traditional hay or silo making but is effective because of its minimum losses during the entire process. In fact the nutritive value of the forage remains essentially constant compared to the green forage while the N quality shows an increase thanks to heat treatment which modifies the proteins, protecting them from rumen degradation (Mauriès, 1991).

The best vegetative stage for harvesting is at the bud stage (Demarquilly, 1982). At this stage the percentage of raw protein on the dry matter of the plant exceeds 18% and can reach up to 20-22% (Mauriès, 1988).

On the other hand, declining productivity of alfalfa (*Medicago sativa* L.) stands under an intensive cutting regime has an important impact on farm income, above all in the need to sustain the cost of new alfalfa stand seeding. In the past, recommendations for the achievement of the best alfalfa management

system were based on the idea of delaying cutting until full flowering to assure the long-term maintenance of stands. It is well documented that the dry matter yield and the forage quality are inversely related, and that the best compromise is generally obtained at the 10% flowering stage (Sheaffer *et al*., 1988). Moreover, there is much evidence that frequent harvests do not permit a sufficient restoration of the carbohydrate reserves, resulting in reduced alfalfa persistence, which is related to variety behaviour in non-structural carbohydrate (NSC) storage patterns (Gossen *et al*., 1994). Recently, a more intensive management of the stand is becoming widespread, due to the availability of new cultivators adapted to frequent cutting (Ligabue and Tabaglio, 1996).

The field trial reported in this paper has been carried out to evaluate: (i) the agronomic performances of the newer alfalfa cultivars under a medium-frequent cutting regime; and (ii) the forage quality changes caused by high temperature drying process.

Materials and methods

A field experimentation has been carried out during the three year period 1998-2000 around Ravenna, to examine: (i) alfalfa cultivars response to climatic and soil characteristics, with a medium-frequent cutting schedule based on a fixed number of days (28); and (ii) forage quality changes caused by high temperature drying.

Seven varieties were included in the experiment: Classe, Prosementi (test), Selene, Triade and Superba – italian types; Legend (multifoliolate) – United States; and Zenith – France.

The cultivars were arranged in a randomized block design with small plots and three replicates to test yield performances: fresh matter yield, dry matter content and dry matter yield were determined. The same cultivars were sown also in large plots without replicates, to produce for each variety such quantities of forage sufficient for the dehydrator. Crude protein and fiber (Met. Weende), total ash, NDF, ADF and ADL (Met. Van Soest) were determined before and after conservation.

The trial was established on 27 March 1998 in Ravenna (Northern Italy, Emilia-Romagna region, near the Adriatic coast), on a silty clay loam soil, with pH 7.4 ($CaCl_2$ 0.01 M); the seeding rate was 40 kg/ha.

The cutting schedule, 28 days between each cut, gave rise to a variable number of harvests: 3 harvests in the first year, 5 in the second and third year.

The yield data were analyzed using analysis of variance and, where appropriate, the treatment means separation was made in accordance with the Duncan test. The quality data were not processed due to the different number of samples before and after conservation and to the absence of replicates.

In this paper yield data and quality evaluation of the three year period are presented.

Results and discussion

Dry matter yield

Table 1 shows cultivar performances, reported both as yield data and index (mean = 100). All the cultivars tested show a very high productive level (field mean on the three year period = 53.28 t/ha). This behaviour is due to the good soil fertility and the availability of groundwater; besides the stand was harvested, due to cutting schedule applied, at the beginning of the flowering stage, that permits a sufficient restoration of the carbohydrate reserves.

The cultivars are significantly different in the three year period ($P \leq 0.001$). The Duncan test is able to separate out two productivity groups. The first one, that includes Prosementi, Superba and Classe, was shown to be more productive (110, 109 and 102% of the field mean respectively). The second group includes Zenith, Selene, Triade and Legend and produce less than the field mean (Zenith is quite close the mean).

In the first year the Duncan test does not separate any group in spite of a 5% probability level: Superba and Classe show the highest production (index = 115 and 107% of the field mean) and Zenith and Prosementi are near the field mean.

Table 1. Dry matter yield (t/ha and index-mean = 100): 3 year period 1998-2000†

Rank position	Cultivar	Total yield			1st year 1998			2nd year 1999			3rd year 2000		
		t/ha	Index		t/ha	Index		t/ha	Index		t/ha	Index	
3	Classe	54.596	102	A	12.516	107	A	21.69	101	A	20.391	102	B
7	Legend	47.782	90	B	11.206	96	A	18.91	88	B	17.669	88	B
1	Prosementi	58.385	110	A	11.603	99	A	23.90	111	A	22.883	114	A
5	Selene	50.777	95	B	9.981	85	A	20.77	96	B	20.029	100	B
2	Superba	58.017	109	A	13.422	115	A	23.19	108	A	21.404	107	A
6	Triade	50.314	94	B	11.259	96	A	20.19	94	B	18.867	94	B
4	Zenith	53.136	100	B	11.801	101	A	22.23	103	A	19.107	95	B
Field mean		53.287			11.684			21.553			20.050		
Probability		**			*			**			**		
C.V.%	5.34		7.80			6.64			5.65				

†Means separated by Scott-Knott's test ($p \leq 0.05$).

In the second year the cultivars are significantly different for $P \leq 0.001$: the first group separated by Duncan test includes Prosementi, Superba, Zenith and Classe with index of 111, 108, 103 and 101 respectively.

In the last year the analysis of variance shows a high probability level ($P \leq 0.001$) and the Duncan test separates two groups: in the first one Prosementi and Superba are included (with index of 114 and 107); Classe, even if included in the second group, has an annual yield higher than the field mean.

This has led to the belief that, while influencing production, the degree of cultivation intensity chosen was not such as to have a negative influence on the stand density over the three year period considered in the present study.

Forage quality

For the sake of brevity only the crude protein and NDF before and after dehydration are presented.

In Table 2 the data of crude protein and NDF content of the seven cultivars, averaged across years before and after the drying process, are presented.

Table 2. Crude protein and NDF content of the cultivars (% on dry matter)

Cultivar	Crude protein		NDF	
	Before dehydration	After dehydration	Before dehydration	After dehydration
Classe	18.28	17.58	46.04	46.99
Legend	19.56	18.87	45.21	48.35
Prosementi	17.96	18.03	47.63	47.40
Selene	18.28	18.22	47.42	46.60
Superba	18.10	17.87	48.40	47.89
Triade	18.27	17.90	47.72	47.54
Zenith	18.19	17.48	46.89	46.97
Average	18.38	17.99	47.02	47.39

The cultivars are quite similar for both protein and NDF content: before conservation only Legend (multifoliolate) show a higher protein content (+1.18 on the mean) and a lower NDF content (-1.81 on the mean); after the drying process all the cultivars tested seem to have the same quality, as the small differences pointed out have no evidence after conservation.

The protein and NDF data for the three year period and each year and cut are presented in Tables 3 and 4.

Table 3. Crude protein content (% on dry matter yield) – years and cuts

	1998 - 2000		1998		1999		2000	
	Before drying	After drying	Before drying	After drying	Before drying	After drying	Before drying	After drying
First cut	17.47	16.55	20.49	20.09	15.62	14.84	16.73	15.36
Second cut	18.65	18.12	18.70	17.79	17.98	19.41	19.14	17.42
Third cut	18.44	17.78	18.37	17.84	17.06	16.14	19.83	19.36
Fourth cut	19.75	20.22	24.39	22.66	19.51	20.48	19.05	19.66
Fifth cut	18.54	19.48			18.42	18.62	18.64	20.16
Total	18.38	17.99	19.50	18.82	17.38	17.47	18.51	17.91

Table 4. NDF content (% on dry matter yield) – years and cuts

	1998 - 2000		1998		1999		2000	
	Before drying	After drying	Before drying	After drying	Before drying	After drying	Before drying	After drying
First cut	48.86	49.90	42.20	46.28	53.54	53.45	50.08	51.02
Second cut	47.44	48.88	44.66	48.71	50.60	48.64	47.61	49.25
Third cut	47.61	47.14	46.42	45.69	50.12	51.87	45.84	45.05
Fourth cut	42.92	40.78	34.97	39.90	47.36	42.77	43.18	39.35
Fifth cut	43.20	43.43			48.19	50.32	39.19	37.90
Total	47.02	47.39	43.68	46.90	50.57	50.15	46.25	45.96

The comparison between data before and after conservation confirm that forage quality is not negatively influenced by the drying process. The means averaged over years of the two parameters are respectively 18.38-17.99 and 47.02-47.39: only in the sowing year, due to the high water content and leaf/stem ratio. Forage quality is lower after drying, even if data show small differences.

In Table 5 the water content of the forage at the beginning of the drying process is presented.

Table 5. Water content (%) of the forage at the dehydrator

	1998	1999	2000
First cut	61	58.2	46.8
Second cut	59.1	40.1	59.2
Third cut	58.3	39.3	33.8
Fourth cut	53	27	34
Fifth cut	-	70.9	64.1

Conclusions

A clear difference between the cultivars was obtained with respect to dry matter yield. The three Italian cultivars Prosementi, Superba and Classe confirm their good adaptation to soil and climate conditions of the east part of the region. Zenith achieved an intermediate level, while Selene and Legend showed a lower yield potential. The latter one is characterized by a good forage quality, that do not compensate the low production.

The quality data before and after the drying process show that with the technique applied in this trial forage dehydration do not affect the forage quality.

The choice of varieties seems to be very important to improve the forage yield, while the small differences between cultivar quality lead to conclude that the agronomic technique, harvest frequency and weed control in particular, is the major factor to improve forage quality.

Acknowledgements

Research funded by Regione Emilia-Romagna.

References

Demarquilly, C. (1982). Valeur alimentaire des légumineuses (luzerne et trèfle violet) en vert et modifications entrainées par les differentes méthodes de conservation. *Fourrages*, 90: 181-202.

Gossen, B.D., Horton, P.R., Wright, S.B.M. and Duncan, C.H. (1994). Field response of alfalfa to harvest frequency, cultivar, crown pathogens and soil fertility. I. Survival and yield. *Agron. J.,* 86: 82-88.

Ligabue, M. and Tabaglio, V. (1996). Field response of alfalfa cultivars to harvest frequency on yield, forage quality and survival. Grassland and land use systems. In: *Proceedings of the 16th General Meeting of the European Grassland Federation,* Grado, 15-19 September, pp. 489-494.

Mauriès, M. (1988). *Utilisation des légumineuses dans les systèmes fourragers pour vaches laitières de Rhone-Alpes.* Thèse de Doctorat, Université des Sciences et Techniques du Languedoc, Montpellier, 568 pp.

Mauriès, M. (1991). Utilisation de la luzerne déshydratée par les vaches laitières. Revue bibliographique. *Fourrages*, 128: 455-464.

Sheaffer, C.C., Lacefield, G.D. and Marble, V.L. (1988). Cutting schedules and stands. In: *Alfalfa and Alfalfa Improvement*, Hanson, A.A. *et al.* (eds). Agron. Monogr., 29. ASA, CSSA & SSSA, Madison, WI, pp. 411-437.