Ital. J. Agron., 6, 1, 27-33

Effect of Cutting Frequency on Dry Matter Yield and Quality of Lucerne (*Medicago sativa* L.) in the Po Valley

E. TABACCO [1], G. BORREANI [1], M. ODOARDI [2], and A. REYNERI [1]

[1] *Dipartimento di Agronomia, Selvicoltura e Gestione del Territorio, Università di Torino, Italy*
[2] *Istituto Sperimentale per le Colture Foraggere, Lodi, Italy*

Corresponding author: G. Borreani, Dipartimento di Agronomia, Selvicoltura e Gestione del Territorio, Università di Torino, via L. da Vinci 44, 10095 Grugliasco (TO), Italy. Tel.: +39 011 6708783, Fax: +39 011 6708798, E-mail: borreani@agraria.unito.it

Received: 21 November 2001. Accepted: 19 March 2002.

ABSTRACT

BACKGROUND. Harvesting schedules that optimise nutrient concentrations and yield in lucerne (*Medicago sativa* L.) are now more frequently based on the high nutrient requirements of dairy cows.
METHODS. Three different harvest schedules (VB first cut at late vegetative, following cuts at early bud; VF first cut at late vegetative, following cuts at early flowering; BF first cut at early bud, following cuts at early flowering), and two cultivars (Equipe, Multiking II), were compared in the Po Valley (northern Italy), during 1996-1998, to evaluate dry matter (DM) yield, leaf to stem ratio, crude protein (CP), neutral detergent fibre (NDF), acid detergent lignin (ADL) and organic matter digestibility (OMD). The morphological stage by weight (MSW) was also determined at each cut.
RESULTS. VB annual DM yield was significantly lower than VF (-17%) and BF (-18%) yields. The OMD declined linearly with advancing maturity and resulted as being 140 g kg^{-1} OM higher at the late vegetative (MSW = 2) than at the flowering (MSW = 6) stage. When cultivars were compared at the same stage of development, Multiking II showed a higher OMD (+ 17 g kg^{-1} OM) than Equipe.
CONCLUSIONS. The VF harvest gave the same yield as the traditional schedule (BF), with improved quality in terms of CP, NDF and OMD. The VB treatment greatly enhanced the forage quality but reduced crop yield by about 20%.

Key-words: morphological stage, crude protein, digestibility, multifoliolate trait.

INTRODUCTION

There is constant progress in forage production systems for dairy farms due to the high nutrient requirements of lactating cows and the reduction of dairy farm profits. Furthermore, the variability of the hay market pushes farmers into making great efforts to obtain constant high quality forages to feed dairy cows.

Lucerne is a reliable source of forage due to its good potential for producing high value livestock feed under many environmental conditions. Traditional haymaking at flowering results in a high DM yield, good persistency of the crop (Sheaffer et al, 1988; Gossen et al., 1994), but also in a forage with a high fibre content and low OM digestibility (Gervais and Girard, 1987; Borreani et al., 1996). In areas of high spring rainfall such as the Po Valley, good hay curing weather usually occurs too late to produce high-quality forage. Therefore many dairy farmers re-evaluate current harvesting strategies and conservation methods as alternatives to traditional haymaking. Successful ensiling provides an opportunity to maintain the high quality forage of the early cut herbage, and to avoid the rapid quality decline associated with the advancing crop maturity (Kalu and Fick, 1981).

Improved forage quality can be obtained in 3 ways: cutting at an early stage, growing cultivars specifically selected for their quality and increasing the cutting height.

It has been well documented that lucerne forage quality decreases as the plant matures from the bud stage to full flowering (Marten et al., 1988). At the same time, the DM yield increases with the age of the plant. Early cutting is the best way of achieving high quality forage. Furthermore, some new cultivars characterised by rapid re-growth after cutting are now available on the market and offer the possibility of increasing the cutting frequency without compromising the yield and persistence of the crop (Gossen et al., 1994; Ligabue and Tabaglio, 1996). On the other hand, new varieties, including multifoliolate strains, have been released that were specifically selected to improve feed

quality (Hall et al., 2000). Multifoliolate cultivars show a higher leaf to stem ratio than trifoliolates when compared at the same growth stage (Onofrii et al., 1996).
Methods to improve forage quality have normally been tested separately and there is little information on the effects of cutting frequency, multifoliolate trait, and their interrelationships in harvesting systems at farm scale in the Po Valley.
The aim of this research was to evaluate, over a 3-year period, the effects of different cutting schedules and the multifoliolate trait on DM yield and forage quality of lucerne in the Po Valley.

MATERIALS AND METHODS

The research was carried out over 1996-1998 at the Research Centre of the University of Turin, in the western Po Valley (44° 50' N, 7° 40' E, 232 m a.s.l.) on recent alluvium soil, Typic Udifluvents (USDA, 1997) with a sandy-loam texture. The main soil characteristics are reported in Table 1. Stands of lucerne were sown on 4 April 1996, at 35 kg ha^{-1} of full viable seed, with 10 cm row spacing. All plots were fertilised before seeding with 100 kg P_2O_5 ha^{-1} and 150 kg K_2O ha^{-1}. No fertiliser was applied over the subsequent years. On 16 May 1996 a pre-cut was done to contrast weed development and no sampling was done on this cut.
Three different cutting schedules were compared:
a) VB – first cut at late vegetative with a crop height of 50–60 cm; following cuts at bud stage, according to the 10-stage classification (Kalu and Fick, 1981);
b) VF – first cut at late vegetative, as VB, and following cuts at early flowering;
c) BF – first cut at late bud (since the first cut normally flowers too late) and following cuts at early flowering.
Two cultivars were compared: *Equipe* (medium autumn dormancy, early spring growth, rapid re-growth after cutting, selected in the Po Valley) and *Multiking II* (early-medium autumn dormancy, medium spring growth after cutting, multifoliolate, medium re-growth, selected in northern USA).
Different re-growth rates after cutting and cutting regimes according to the phenological stage determined different harvesting intervals for each treatment and cultivar when the prefixed growth stage was reached.
The treatments were assigned to experimental units using a randomised complete block design and three replicates. Total plot size, including pathways, was 10 m × 2 m. Forage yield and samples were taken with a Haldrup forage plot harvester, on subplots of 12 m^2 to avoid border effects.

Table 1. Main soil characteristics (0-60 cm layer).

Soil parameters	
Gravel	absent
Sand	48%
Silt	43%
Clay	9%
pH (in water)	7.6
Organic matter	1.2%
Total N	0.11%
C/N	6.3
P_2O_5 exchangeable (Olsen)	43 ppm
K_2O exchangeable	92 ppm
Bulk density (dry basis)	1.3 g dm^{-3}
Available water	16.1%

Measurements

The forage yield was determined at each sampling date. Forage samples were taken from each plot to determine the DM content. The composition of the harvested herbage was also determined on 50 stems, dividing the plants into leaves, stems, and inflorescences. The leaf to stem ratio was calculated on the dried material. Samples were dried in a forced-draft oven to constant weight at 90 °C. Morphological stage (Kalu and Fick, 1981) was determined on 50 stems per plot. The method assigns a stage number from 0 to 9 to each individual stem (Table 2) and the mean stage by weight (MSW) is derived from the following equation:

$$MSW = \Sigma (S \times D) / W$$

where S = stage number, D = dry weight of stems in stage S, and W = total dry weight of stems in all stages.
For each treatment and harvest, a herbage subsample of 150-200 stems was dried in a forced-draft oven to constant weight at 65 °C, air equilibrated, weighed, ground in a Cyclotec mill (Tecator, Herndon, VA, USA) to pass a 1 mm screen, and stored for qualitative analyses.
The dried samples were analysed for crude pro-

Table 2. Codification of development stages for lucerne (Kalu and Fick, 1981).

Code	Stage name	Stage definition
0	Early vegetative	stem length < 15 cm; no buds, flowers or seed pods
1	Mid vegetative	stem length 16 to 30 cm; no buds, flowers or seed pods
2	Late vegetative	stems > 30 cm, no buds, flowers or seed pods
3	Early bud	1 to 2 floral buds, no open flowers or seed pods
4	Late bud	> 2 floral buds, no open flowers or seed pods
5	Early flower	1 node with open flowers; no seed pods
6	Late flower	open flowers, no seed pods
7	Early seed pod	1 to 3 nodes with green seed pods
8	Late seed pod	> 3 nodes with green seed pods
9	Ripe seed pod	Nodes with mostly brown mature seed pods

tein (CP), neutral detergent fibre (NDF) and acid detergent fibre (ADL) contents by an NIR Systems 5000 scanning monochromator (NIRSystems Inc., Silver Spring, MD, USA), applying the Near Infrared Reflectance Spectroscopy (NIRS) methodology (Shenk and Westerhaus, 1991; Berardo et al., 1997) and for enzymatic organic matter digestibility (OMD) (Aufrère, 1982). One third of the samples were also analysed for CP using Kjeldahl N × 6.25 and for NDF and ADL, as described by Goering and Van Soest (1970) to test and validate the NIRS equations.

Statistical analysis

The variation in annual yield and the total 3-year DM yield, leaf to stem ratio and MSW were analysed by least square means analysis using the general linear model of the SPSS program. Means were separated using the Student Newman Keuls test at a $P \leq 0.05$ significance level.

The qualitative traits were regressed on the MSW. Linear and quadratic regressions were compared using the Draper and Smith (1981) stepwise selection procedure to select the best regression model at the 0.05 probability level. The MANOVA analysis of covariance was used to verify the equivalence of the equations for the three years (Norusis, 1992). This procedure allowed the hypothesis of parallelism of the regression equations to be verified and, when these were not rejected, analysis of covariance was used to evaluate the differences between the adjusted means. The regression lines for each treatment and cultivar are reported in the figures when no equivalence of regressions over the treatment and cultivar was found.

RESULTS AND DISCUSSION

The weather conditions were characterised by a cool and rainy season in 1996; an early spring and warm September in 1997, and a cool spring and early warm summer in 1998 (Table 3). No frost damage was recorded during winter over the years. No irrigation was supplied, due to soil reserves and good rainfall distribution.

Table 3. Monthly and annual mean temperatures and cumulated rainfall for the study period and long-term average.

Month	Temperature (°C)				Rainfall (mm)			
	1996	1997	1998	1976-99	1996	1997	1998	1976-99
March	6.6	10.1	8.0	7.6	27	1	3	53
April	11.8	11.3	10.6	10.8	81	12	121	99
May	16.2	16.9	17.2	15.9	95	19	96	108
June	20.4	19.3	21.0	19.5	60	253	32	76
July	20.9	21.2	22.7	22.0	33	39	36	36
August	20.8	22.2	22.6	21.3	108	40	38	65
September	14.5	19.2	16.9	17.3	75	50	49	66
October	12.0	12.6	12.1	12.1	136	3	43	94
November	7.0	6.2	4.1	5.6	79	45	11	53
Annual	11.6	12.4	12.0	11.5	954	530	502	751

Cutting schedule and DM yield

Harvesting at specific phenological growth stages was successfully carried out in spring and summer, while autumn harvests were at an earlier stage because of the slow rate of plant morphological development. Cutting at early bud allowed 14 days earlier harvesting in spring than cutting at flowering. In the seeding year, there were 4 cuts for all the scheduled regimes, while there were 7, 6 and 5 cuts in 1997 and 6, 5 and 4 in 1998 for the VB, VF, and BF treatments, respectively. In 1997 an additional cut was done for all the cutting schedules due to earlier spring re-growth. The first cut was on 22 April 1997 and 8 May 1998 for VB and VF, and on 21 May 1997 and 3 June 1998 for BF treatment. *Equipe* confirmed its early re-growth by about 4 days compared to *Multiking* II. This allowed an extra cut for *Equipe* for the VB treatment in 1998. In the full productive years (1997-98) the first cut at vegetative stage led to a better and more uniform distribution of DM yield over the year. The first cut accounted for 26% of the total annual DM yield for the VB and VF treatments and 35% for the BF harvest regime. A reduction of the total mean DM yield was observed in early cut treatments (VB and VF) as already observed by Sheaffer et al. (1988) and Reyneri et al. (1995). The mean DM yields of the first cut were 3.2 t ha^{-1} for VB and VF and 4.8 t ha^{-1} for BF, while the other cuts yielded on average 1.8, 2.5 and 2.8 t ha^{-1} for VB, VF and BF, respectively.

Significant interaction effects were found between cultivars and cutting treatments in cumulated annual and total three-year DM yields (Table 4). The VB treatment determined a significant three-year yield reduction of about 17 and 18% compared to VF and BF, respectively. When only the first cut was at the vegetative stage (VF) the cumulated annual DM yield was similar to the BF treatment for both cultivars. *Equipe* yielded 14% more than *Multiking* II with the VB treatment, while no significant differences were found for VF and BF.

Leaf to stem ratio and forage quality

The leaf to stem ratio resulted as inversely related to the morphological stage at cutting and it was consequently higher in the VB treatment (Figure 1). Albrecht et al. (1987) reported that the leaf to stem ratio of lucerne decreased from 1.5 in the vegetative stage to around 0.5 when plants were mature, and Nordkvist and Aman (1986) reported that the leaf fraction declined from 72.9 to 18.4% as lucerne advanced in maturity. The codified stage MSW resulted as the key factor to explain the differences in forage digestibility and quality between treatments. This system, defined by Kalu and Fick (1981),

Table 4. Total annual dry matter (DM) yield and cumulated three-year yield (t DM ha^{-1}).
VB = first cut at late vegetative and following cuts at bud stage; VF = first cut at late vegetative and following cuts at flowering; and BF = first cut at late bud and following cuts at flowering.
S = schedule effect; C = cultivar effect.
NS, not significant; *, **, *** = $P < 0.05$, $P < 0.01$ $P < 0.001$, respectively.

Schedule	Cultivar	Year			Total
		1996	1997	1998	1996-98
VB	Equipe	9.7	15.0	9.9	34.6
	Multiking II	9.0	13.5	7.7	30.3
	average				32.5
VF	Equipe	11.6	18.1	10.0	39.7
	Multiking II	12.0	15.6	10.9	38.5
	average				39.1
BF	Equipe	12.1	16.6	11.9	40.6
	Multiking II	12.7	15.2	11.8	39.7
	average				40.2
LSD		1.48	1.19	1.67	2.68
S		***	***	***	***
C		NS	***	NS	**
S × C		NS	NS	**	NS

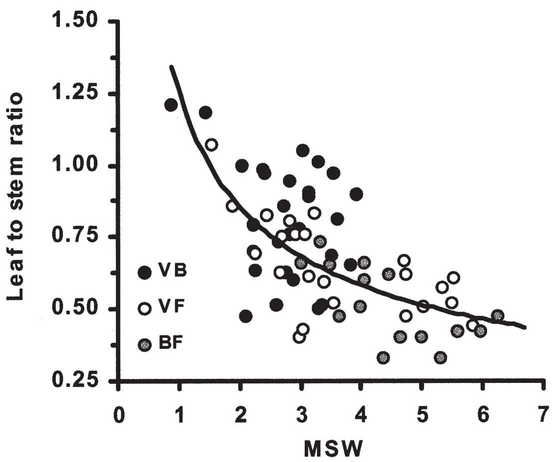

Figure 1. Leaf to stem ratio related to mean stage by weight (MSW) according to harvest schedule. Regression equation of the pooled data:
Leaf to stem ratio = 2.53 $MSW^{-0.186}$ – 1.35
$R^2 = 0.48$ s.e. = 0.15 n = 76

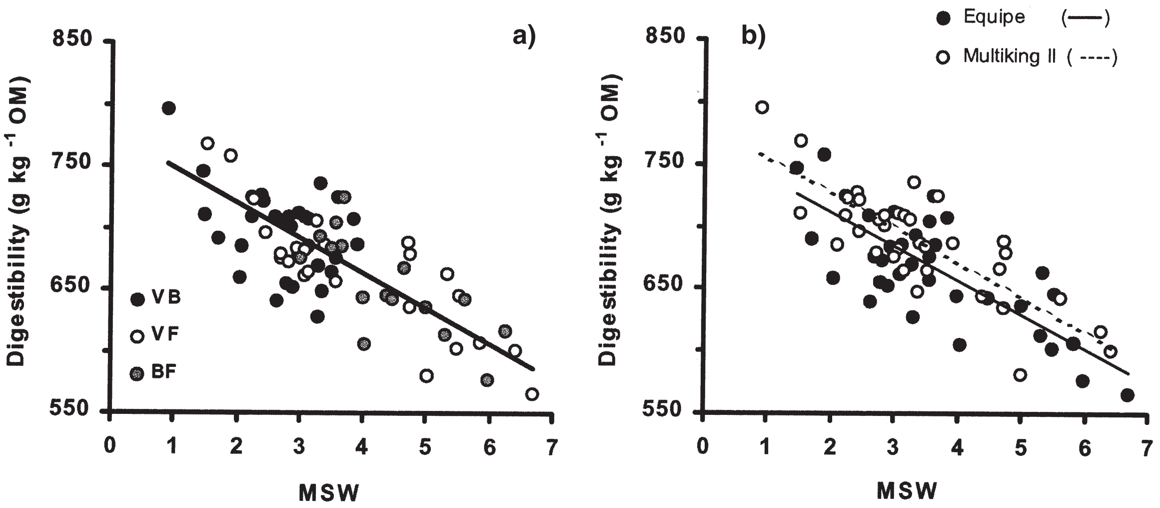

Figure 2. Organic matter digestibility related to mean stage by weight (MSW) according to harvest schedule (a) and cultivar (b). Regression equations of the pooled data:
a) OMD (g kg^{-1} OM) = – 28.3 MSW + 776 R^2 = 0.62 s.e. = 28.4 n = 76
b) OMD $_{Equipe}$ (g kg^{-1} OM) = – 27.4 MSW + 766 R^2 = 0.58 s.e. = 30.0 n = 38
OMD $_{Multiking}$ (g kg^{-1} OM) = – 28.2 MSW + 783 R^2 = 0.67 s.e. = 25.4 n = 38

based on the weighted average of a random sample of stems, has become the basis for most of the current procedures for predicting forage quality from development stage (Fick et al., 1994). All quality parameters from the three cutting schedules during the three years were therefore pooled and correlated to MSW. The OMD linearly decreased with advancing plant maturity, being 140 g kg^{-1} OM lower at flowering (MSW = 6) than at late vegetative (MSW = 2) stage (Figure 2a). The VB cutting schedule revealed higher OMD than the other schedules and ranged from 796 to 627 g kg^{-1} OM. The OMD values for the BF treatment ranged from 724 to 576, while for the VF they spread from 758 to 566 g kg^{-1} OM because the cuts were performed over a wide range of growth stages. *Multiking II* showed a significantly higher digestibility than *Equipe*, by about 17 g kg^{-1} OM in all stages (Figure 2b).

The increase in the NDF and ADL contents with advancing maturity resulted in decreasing forage quality with no differences between cultivars (Figure 3a and 3b). The CP content decreased with increasing stages of maturity from 260 to 172, from 235 to 156, and from 220 to 154 g kg^{-1} DM for VB, VF and BF, respectively, with no differences between cultivars (Figure 3c).

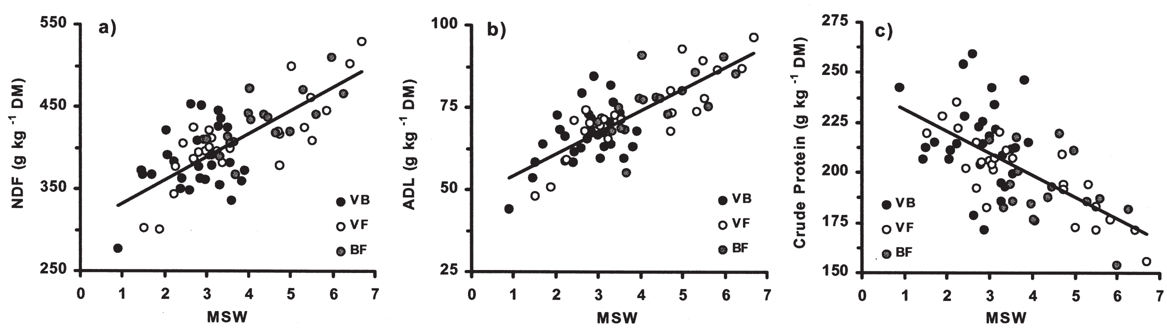

Figure 3. NDF, ADL and crude protein related to mean stage by weight (MSW). Regression equations of the pooled data:
a) NDF (g kg^{-1} DM) = 28.3 MSW + 304 R^2 = 0.56 s.e. = 32.4 n = 76
b) ADL (g kg^{-1} DM) = 6.59 MSW + 47.6 R^2 = 0.60 s.e. = 6.9 n = 76
c) CP (g kg^{-1} DM) = – 10.9 MSW + 243 R^2 = 0.41 s.e. = 16.9 n = 76

CONCLUSIONS

Lucerne maturity at time of harvest strongly influenced forage quality and DM yield. Early cuttings resulted in a reduction of the DM yield and an improvement in the nutritive value and quality traits. The VF cutting schedule gave the same DM yield as the traditional schedule (BF) but improved the feed value, particularly at the first cut, in terms of CP, NDF and OMD.

In order to satisfy the nutrient requirements of high performing dairy cows, forages should have high OMD (> 680 g kg^{-1} OM) and NDF of 370 g kg^{-1} DM or less (Broderick, 1995; Nelson and Satter, 1992). For this reason the only way to obtain high quality forage over the whole season is to harvest lucerne at early stages (as with VB). This cutting schedule determined about an 18% reduction of the annual DM yield and increased harvesting and conservation costs, due to the higher number of harvests and their lower yield per season. It can nevertheless be justified by the high quality forage. The cultivar *Equipe*, characterised by a rapid re-growth after cutting, in the Po Valley resulted as being more suitable for the application of the VB schedule, since the yield reduction was only about 12% compared to 25% in the cultivar *Multiking II*. The multifoliolate cultivar *Multiking II*, characterised by a low regrowth rate after cutting and by a higher nutritive value in terms of OMD over the whole growing cycle, performed well only in the VF schedule, when the improvement in forage quality was not coupled with a DM yield reduction.

The results confirm that farmers can influence the DM yield and forage quality of a lucerne stand by using a cutting regime and cultivar to obtain the most adequate forage for livestock feeding requirements.

ACKNOWLEDGEMENTS

The authors wish to thank Mario Gilardi (Dipartimento di Agronomia, Selvicoltura e Gestione del Territorio) and Davide Casassa Mont for technical assistance in the field, and Barbara Pintus (Istituto Sperimentale Colture Foraggere, Lodi) for the chemical analyses.

This work was funded by the Ministero della Università e della Ricerca Scientifica e Tecnologica (MURST). The work is attributable in equal parts to the authors.

REFERENCES

Aufrère J., 1982. Étude de la prevision de la digestibilité des fourrages par una methode enzymatique. Ann. Zootech., 31, 111-130.

Albrecht K.A., Wedin W.F., Buxton D.R., 1987. Cell-wall composition and digestibility of alfalfa stems and leaves. Crop Sci., 27, 735-741.

Berardo N., Boccardi F., Piccinini E., Ursino A., Odoardi M., 1997. La spettroscopia nel vicino infrarosso (NIRS) per l'analisi qualitativa dei foraggi. Riv. Agron., 31, 208-211.

Borreani G., Valente M.E., Peiretti P.G., Canale A., Ciotti A., 1996. Evolution of ensilability characteristics, nutritional values, and yield in the first and second growth cycles of lucerne cv. Equipe and Boreal. In: Parente G., Frame J., Orsi S. (eds.): Grassland and Land Use Systems, Vol. 1, 383-387. Proceedings 16th General Meeting EGF, 15-19 September, Grado, Italy,

Broderick G.A., 1995. Performance of lactating dairy cows fed either alfalfa silage or alfalfa hay as the sole forage. J. Dairy Sci., 78, 320-329.

Draper N.R., Smith H., 1981. Applied regression analysis. 2nd ed. John Wiley & Sons, New York.

Fick G.W., Wilkens P.W., Cherney J.H., 1994. Modeling forage quality changes in the growing crop. In: Fahey G.C., Collins M., Mertens D.R., Moser L.E. (eds.): Forage quality, evaluation and utilization, 757-795. ASA-CSSA-SSSA, Madison, WI.

Gervais P., Girard J.M., 1987. Influence de la hauteur et de la frequence des coupes sur le rendement, le peuplement, la composition chimique et les reserves nutritives de la luzerne. Can. J. Plant Sci., 67, 735-746.

Goering H.K., Van Soest P.J., 1970. Forage Fiber Analyses (Apparatus, Reagents, Procedures and Some Applications). Agric. Handbook No. 379. ARS, USDA, Washington, DC.

Gossen B.D., Horton P.R., Wright P.R., 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.

Hall M.H., Smiles W.S., Dickerson R.A., 2000. Morphological development of alfalfa cultivars selected for higher quality. Agron. J., 92, 1077-1080.

Kalu B.A., Fick G.W., 1981. Quantifying morphological development on alfalfa for studies of herbage quality. Crop Sci., 21, 267-271.

Ligabue M., Tabaglio V., 1996. Field response of alfalfa cultivars to harvest frequency on yield, forage quality and survival. In: Parente G., Frame J., Orsi S. (eds.): Grassland and Land Use Systems, Vol. 1, 489-494. Proceedings 16th General Meeting EGF, 15-19 September, Grado, Italy.

Marten G.C., Buxton D.R., Barnes R.F., 1988. Feeding value. In: Hanson A.A., Barnes D.K., Hill R.R. (eds.): Alfalfa and alfalfa improvement, 465-492. Agronomy n. 29, ASA, Madison, WI.

Nelson W.F., Satter L.D., 1992. Impact of alfalfa maturity and preservation method on milk production by cows in early lactation. J. Dairy Sci., 75, 1562-1570.

Nordkvist E., Aman P., 1986. Changes during growth in anatomical and chemical composition and in vitro degradability of lucerne. J. Sci. Food Agric., 37, 1-7.

Norusis M.J., 1992. Statistical Package for the Social Sciences. McGraw-Hill, New York.

Onofrii M., Bozzo F., Tomasoni C., Borrelli L., Magro F., Dossi P., Piazza C., 1996. Le nuove varietà di erba medica iscritte al registro varietale nel 1994. Sementi Elette, 42, (5), 15-20.

Reyneri A., Borreani G., Ciotti A., 1995. Effetto dell'epoca di esecuzione del primo taglio e dell'altezza di taglio su tre varietà di erba medica (*Medicago sativa* L.). Riv. Agron., 29, 574-581.

Sheaffer C.C., Lacefield G.D., Marble V.L., 1988. Cutting schedules and stands. In: Hanson A.A., Barnes D.K., Hill R.R. (eds.) Alfalfa and alfalfa improvement, 411-438. Agronomy n. 29, ASA, Madison, WI.

Shenk J.S., Westerhaus M.O., 1991. New standardization and calibration procedures for NIRS analytical system. Crop Sci., 31, 1694-1696.

USDA, 1997. Keys to soil taxonomy. 7th ed. Soil Survey Staff, USDA-SCS. Pocahontas Press, Pocahontas, VA.

EFFETTO DELLA FREQUENZA DI UTILIZZAZIONE SULLA PRODUZIONE E QUALITÀ DI UN PRATO DI ERBA MEDICA (*Medicago sativa* L.)

RIASSUNTO

SCOPO. Per l'allevamento della vacca da latte sono necessari foraggi di eccellenti caratteristiche qualitative. L'utilizzazione dell'erba medica mediante l'insilamento, in sostituzione della fienagione, concede ora l'opportunità di modificare la frequenza di utilizzazione per migliorare la qualità del foraggio.
METODI. Nel triennio 1996-98, a Carmagnola (44° 50' N, 7° 40' E) in un ambiente di pianura, sono state poste a confronto 3 frequenze di taglio (VB: primo taglio allo stadio vegetativo avanzato e successivi alla comparsa dei bottoni fiorali; VF primo taglio allo stadio vegetativo avanzato e tagli successivi a inizio fioritura; BF primo taglio alla comparsa dei bottoni fiorali e successivi a inizio fioritura) con 2 varietà (*Equipe*: a rapido ricaccio; *Multiking* II: a medio ricaccio, multifogliolata). Sono stati misurati: la resa areica di sostanza secca, la ripartizione della fitomassa al taglio, lo stadio morfologico per pesata (MSW) secondo Kalu e Fick (1981), il contenuto in proteina grezza (CP), le componenti fibrose (NDF e ADL) e la digeribilità della sostanza organica (OMD) per via enzimatica.
RISULTATI. L'anticipo del taglio (VB) ha determinato una riduzione significativa della produzione annuale cumulata del 17 e 18% rispetto a VF e BF. Nei due anni di piena produzione (1997-98) il numero di tagli è stato di 7 e 6 per VB, di 6 e 5 per VF e solo di 5 e 4 per BF. La produzione media dei tagli è stata di 2,0, 2,6 e 3,0 t s.s. ha^{-1} rispettivamente per VB, VF e BF. Lo stadio quantificato MSW è risultato il miglior parametro per descrivere l'evoluzione della digeribilità e della qualità. OMD è risultata superiore di 140 g kg^{-1} s.o. allo stadio vegetativo avanzato (MSW = 2) rispetto alla fioritura (MSW = 6). *Multiking II* ha presentato, a parità di stadio, un rapporto foglie - steli più elevato e una OMD superiore di 17 g kg^{-1} s.o.
CONCLUSIONI. La ricerca ha evidenziato che l'anticipo del taglio migliora la qualità del foraggio soprattutto in termini di digeribilità ma riduce la produzione. Il trattamento VF che prevedeva l'esecuzione anticipata del solo primo taglio è quello che ha permesso di ottenere una produzione di s.s. analoga a BF ma con un foraggio di migliore qualità. Il trattamento VB ha migliorato ulteriormente le caratteristiche qualitative dell'erba raccolta ma a scapito di una riduzione della produzione del 20% circa e di un aumento dei costi di raccolta e di conservazione dovuti al più elevato numero di tagli (6-7 vs. 4-5).

Parole chiave: *Medicago sativa* L., stadio morfologico, proteina grezza, digeribilità, carattere multifogliolato.