ALFALFA YIELD, QUALITY AND PERSISTENCE

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INTRODUCTION

Alfalfa management in complex because it requires the simultaneous consideration of factors that affect the yield of the crop, forage quality for ruminants and the persistence of the stand. Considerable research has demonstrated the importance of agronomic factors such as soil pH, drainage and soil fertility in successful alfalfa production. Beyond soil factors and cultivar selection, selection of harvest date is one the most important management factors that influence yield, quality and stand persistence.

HISTORICAL ASPECTS

Initially after alfalfa introduction into the eastern U.S., due to its marginal winterhardiness and disease resistance, only two harvests were routinely made each season (Smith, 1972). Infrequent harvests were necessary to insure plant survival due to the absence of resistance to important diseases and inability to survive cold winter temperatures. Smith and Rohweder (1977) discussed the role of nonstructural carbohydrates in survival and productivity of alfalfa. A portion of the carbohydrates produced from photosynthesis during growth are moved to the taproot for storage. This source of energy is available for regrowth after cutting and after dormancy during winter. Since carbohydrate storage continues up to advanced maturity stages, the late harvests used for the older alfalfa cultivars gave them ample energy reserves and allowed for acceptable survival in spite of their shortcomings in other characteristics.

Considerable effort by plant breeders resulted in the development of alfalfa cultivars that had resistance to bacterial wilt, anthracnose and some other diseases that reduced yields and stands of the original cultivars. Selection and introduction also allowed development of cultivars with good winterhardiness characteristics. These changes have allowed expansion of alfalfa acreage and have changed management practices.

MATURITY EFFECTS ON YIELD AND PERSISTENCE

Early alfalfa cultivars yielded best when cut infrequently (Miller and Rohweder, 1987). Early work indicated that seasonal yields were maximized by delaying the harvest until the full bloom stage (Table 1).

More recent cultivars are less subject to environmental stresses and diseases than earlier cultivars and can therefore tolerate earlier cutting with less impact on yield (Table 2). When four harvests were made with the first cut at the early bud stage, dry matter yield was near 4 tons/acre for Cimarron, Saranac AR and Vernal. Delay of the first harvest until the mid bud stage increased yield of all cultivars by amounts ranging from 0.3 to 0.6 tons/acre. All subsequent harvests were taken at the mid bud stage for both of the two treatments described above. Taking three harvests, all at first flower, did not increase yield at all for Cimarron but increased yield from 0.3 to 0.4 tons/acre for the other two cultivars.

Stand persistence affects the profitability of alfalfa and therefore is an important consideration in harvest management. Harvest frequency influences the number of plants per unit area and also the number of shoots on each plant (Table 3). Nelson (1986) measured the response of alfalfa cut at 2, 4 and 6 week intervals in Missouri. The plots for this experiment were established in 1972 and harvesting at the intervals described above began in 1973. After three seasons of harvests, the number of plants per square foot of soil area was 3.2 for plots cut at 2 week intervals, 4.1 for plots cut at 4 week intervals and 3.9 for plots cut at 6 week intervals. These data indicate that, at that stage of the stand, a very short harvest interval had reduced the number of plants but an interval of 4 weeks did not. The very frequent interval also reduced the number of shoots on each crown, by 1.0 to 1.7 shoots per plant (Table 3). Dry matter yields were reduced for the 2 week interval even in 1983, the first year of differential harvests. However, the 4 week interval was generally similar in yield to the 6 week interval until the third year of harvesting and thereafter yielded about one-half ton per acre less than the 6 week interval.

MANAGEMENT EFFECTS ON QUALITY

Although forage yield generally increases as the plant matures, the quality of the forage decreases. First harvest alfalfa was cut at mid bud, first flower, 25% bloom and 50% bloom and analyzed for crude protein, in vitro digestibility and fiber concentrations (Table 4). Alfalfa crude protein concentration decreased from its high of 23% on the first date to only 15% on the last date. Across the same dates, digestibility declined from 76% on the first date to 67% 3 weeks later. Neutral detergent fiber concentrations increased from 30 to 40% across the same dates. The latter data indicate that the more advanced maturity alfalfa would result in a lower intake level for that forage and would slow the rate of passage of the forage through the digestive tract.

One important reason alfalfa quality delcines as the shoot matures is that the ratio of leaf to stem decreases. As a general rule, alfalfa will be about one-half leaf and one-half stem. Alfalfa leaf has over twice as much crude protein as stem, therefore any increase in stem content will reduce the overall crude protein concentration (Collins, 1988). The concentration of protein in the stem also decreases as the

stem ages, from 14% in the young portion of the stem to as little as 9% in the oldest portion of the stem. Neutral detergent fiber concentration is less than 30% in the leaf, but is 68% in the stem tissue. The fiber of alfalfa leaf was more digestible than the fiber in alfalfa stem. Leaf had an NDF digestibility of 66%, very high for fiber. Stem, on the other hand, had a fiber digestibility of only 31%. These data demonstrate clearly that quality is sacrificed by delaying harvest of alfalfa.

RECOMMENDATIONS

Based upon recent research, the best compromise between the yield, persistence and quality of alfalfa is gained by harvesting between mid bud and first flower. Some results do indicate that stands under stress from very frequent harvesting or a severe winter might benefit from having one of the harvests delayed until about 10% bloom. This practice would allow the plant to accumulate higher levels of carbohydrates in the root system to be used for regrowth. The maturities recommended above allow for near maximum yields while providing a high quality, high value forage.

Table 1. Harvest management effects on yields of older, first generation alfalfa cultivars.

Maturity and number of cuts	DM yield
	--tons/acre--
bud, 3 cuts	1.8
1/10 bloom, 3 cuts	2.4
full bloom, 2 cuts	3.2
seed pod, 2 cuts	2.8

Source: Adapted from Miller and Rohweder, 1987.

Table 2. Harvest management effects on yields of recent cultivars.

Cutting trt. and maturity	Cultivar Cimarron	Saranac AR	Vernal
	--------tons/acre---------		
4 cuts, Early bud	4.1	4.0	4.0
4 cuts, Late bud	4.7	4.3	4.3
3 cuts, first fl.	4.7	4.6	4.7

Source: Collins and Rohweder (unpublished research).
For the 4 cut systems, the first harvest was made at either early or mid bud. All other harvests were at mid bud.

Table 3. Harvest frequency effects on alfalfa stand density, shoot numbers per plant, and yield.

Harvest frequency	Stand density	Shoot number	Forage yield
	-pl/sq.ft.-	-#/pl-	-tons/ac-
2 weeks	3.2	4.1	3.2
4 weeks	4.1	5.8	5.1
6 weeks	3.9	6.8	5.6

Source: Nelson et al. (1986).
Stand density data are from Nov. 1975; shoot number data are from 1976; forage yield data are from 1977.

Table 4. Quality of alfalfa harvested at different maturity stages.

Maturity stage	Crude protein	In vitro digestibility	Neutral detergent fiber
	----------%----------		
Mid bud	23	76	30
First flower	21	72	36
Early bloom	19	70	38
Mid bloom	16	67	40

Source: Collins, 1988.

REFERENCES

Collins, M. 1988. Quality of whole crop and pressed forage from mechanically dewatered alfalfa, red clover, and birdsfoot trefoil. Agron. J. 80(In press).

Miller, L., and D. Rohweder. 1987. The influence of alfalfa cutting schedules on yield of dry matter and livestock products per acre. p. 175-181. In Proc. Amer. Forage and Grassl. Conf. 2-5 March 1987 Springfield, IL.

Nelson, C.J., D.D. Buchholz, D.L. Rausch, and J.H. Coutts. 1986. Managing alfalfa and alfalfa-grass mixtures for persistence. p. 12-29. In Proc. 16th. National Alfalfa Symp. 5-6 March 1986. Fort Wayne, Indiana.

Smith, D. 1972. Cutting schedules and stands. p. 481-496. In C.H. Henson (ed.) Alfalfa Science and Technology. American Society of Agronomy.

Smith, D., and D.A. Rohweder. 1977. Establishing and managing alfalfa. Wisconsin Agr. Exp. Sta. Bull. R-1741.