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Harvest Management Effects on Alfalfa Quality

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INTRODUCTION

To produce dairy quality hay, alfalfa should be cut at an early maturity (pre-bud stage). Harvest management such as the time of day the forage is cut and the rate of hay dry-down can also affect forage quality. Alfalfa accumulates total nonstructural carbohydrates (TNC) during daylight because photosynthesis produces TNC more rapidly than they are exported and utilized for new growth and maintenance. Total nonstructural carbohydrates are composed of starch, fructans, sucrose, glucose, and fructose. Continued plant respiration during darkness depletes TNC concentration. After hay is cut, plant and microbial respiration will continue to consume TNC until the hay reaches less than about 16% moisture. Therefore it is important to dry the hay as quickly as possible to retain as much TNC as possible, as well as avoiding rain showers and allowing the next crop to grow. New developments in conditioners and forming a wider windrow were evaluated for the effects on hay quality. Our objectives in Study 1 were to: 1) determine daily variation of carbohydrate concentrations and accumulation rates in Alfalfa (*Medicago sativa* L.), 2) predict a time interval to maximize for TNC levels in hay, and 3) estimate the impact of PM cutting on TNC yield. Study 2 objectives were to evaluate the effects of windrow width and conditioner type on alfalfa hay moisture and forage quality.

Daily cycling of TNC in alfalfa has been reported (1, 2), however, the application of this knowledge to producing higher forage quality and improved palatability is largely ignored. Cattle, sheep, and goats can distinguish between alfalfa hay harvested at sundown versus the next morning (3) and they eat up to 30% more PM- than AM-harvested hay. The PM-harvested hay also translates into increased milk production (4).

PROCEDURES

Study 1: Germain 'WL 322HQ' alfalfa was sampled at 3-hour intervals during the 24-hour period prior to cutting. A 10-acre grower's field near Kimberly, ID was sampled along a transect midway in the field and perpendicular to irrigation furrows. Sampling by compositing 10 grab-samples per plot immediately preceded first and fourth cuttings in 1997. Samples were freeze-dried and ground in a cyclone abrasive mill. The TNC concentrations were predicted by Near Infrared Reflectance Spectroscopy (NIRS). The calibration of TNC was determined by an adaptation (5) of the wet chemistry method described by Smith (6).

Study 2: Drying rates of alfalfa cut by identical swathers with a standard conditioner versus a "super conditioner" were compared as well as 48- versus 60-inch windrow widths. 'Pioneer 5364' alfalfa (third year of production) was grown at the Northwest Irrigation and Soils Research Laboratory, USDA-ARS, Kimberly, ID. Swathers were 1475 New Holland 'Haybine' on hydro-swing frames, and model 2300 header 14-ft cut. Swathers were puled at 5 mph and powered by a minimum of 88 hp tractors with 540-rpm PTO hydraulic pumps. The standard conditioner has twin rubber chevron rollers, 8.5 ft wide.

[1] Presented at Idaho Hay Association Annual Meeting on March 1-3, 2000 at Twin Falls, Idaho.

The "super conditioner"[2] (Circle C Equipment, Hermiston, OR) has the same width rollers but the surface is flatter and not interwoven compared to the standard conditioner. Air cells apply high pressure to the rollers of the "super conditioner" and flatten the entire stem. First cutting was swathed from 3:30 to 6:00 pm (PM treatment) on 11 June 1999 and from 6:30 to 8:00 am (AM treatment) on 12 June 1999. The "super conditioner" had a 9-inch diameter air cell with 35 psi producing about 2,500 lbs of force on each side of the rollers. There were no PM vs AM treatments for the third cutting. Third cutting was swathed from 3:45 to 5:10 pm 13 Sept. 1999. The "super conditioner" used for third cutting had a 7-inch diameter air cell with 65 psi producing about 2,230 lbs of force on each side of the rollers. Each block was cut within 1 hour to minimize time of day effect on total nonstructural carbohydrates (TNC).

An initial fresh sample was taken from each block, weighed, frozen, and stored in a plastic bag. A minimum of 8 grab samples (10 paces apart) per windrow was taken from the windrow at 3 pm each day following until baled. The 100 ft of windrow adjacent to each end of the field was avoided to allow the swathers to reach consistent conditioning and ground speeds. The conditioner and width treatments were completely randomized with four blocks.

Moisture content of each sample was determined by comparison of fresh weight with the weight after drying by freeze-drying (initial and final samples) or oven drying at 140° F for 48 hours or until samples did not change in weight. The formula used was: (fresh weight - dry weight)/(fresh weight).

RESULTS

Study 1

The TNC curves were sinusoidal over a 24-h period (Figure 1), but linear between 0900 MDT (Figure 2) and about 1800 h. On May 26 the TNC increased linearly from 5.8 % of plant dry matter (DM) at 0900 (harvest hour = 0) to 2100 MDT at the rate of 0.29 % TNC per hour. On Sept. 22 the TNC increased linearly from 5.4 % at 0900 (harvest hour = 0) to 1930 MDT at the rate of 0.5 % per hour, an increase of 193 %.

The dry matter concentration, the reciprocal of moisture percentage, was not significantly affected by whether the alfalfa was cut in the PM or AM (Figure 1). Hay should not be cut with a heavy dew at any time of day.

From these results, we conclude that TNC concentrations in alfalfa can increase linearly during the day. To maximize the TNC concentration in alfalfa, center your cutting time on 6 pm. If you need to cut 12 hours per day, begin cutting at noon and quit at midnight to capture the most TNC in the hay. If you have to cut in the morning, cut a field that is already too mature for dairy quality hay and keep the lots separate. Many dairymen are aware of the better quality of PM-cut hay and you should market this advantage. The increased forage quality can be determined as a 1% reduction in acid detergent fiber (ADF) concentration.

[2] Mention of a trade name does not imply an endorsement or recommendation by the University of Idaho or USDA or similar companies or products not mentioned.

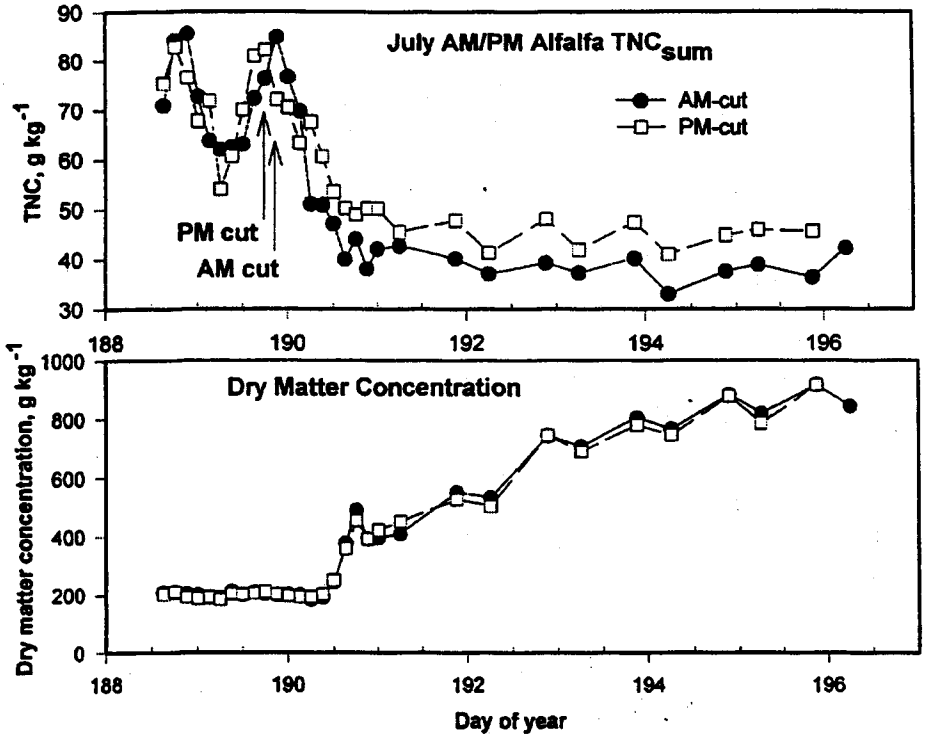

Figure 1. Daily variation in total nonstructural carbohydrate concentration and dry matter concentration and effects of PM- versus AM-cutting. The study was conducted near Kimberly, ID during July 1997.

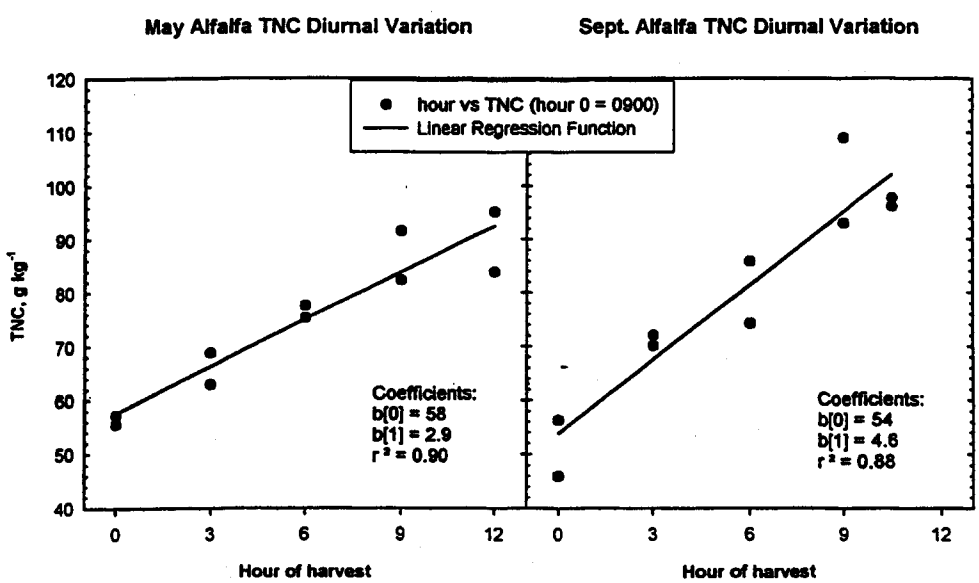

Figure 2. Daily variation of total nonstructural carbohydrates (TNC) in 'WL 322HQ' alfalfa at Kimberly, ID in May and September of 1997. The curves are sinusoidal over a 24-h period, but linear between 0900 (harvest hour = 0) and about 1800 MDT.

Study 2

Alfalfa hay moisture was unaffected by conditioner type in first cutting (Figure 3), however the "super conditioner" reduced hay moisture significantly over the standard conditioner in third cutting (Figure 4). The 60-in wide swath allowed hay to dry faster than the 48-in wide swath during first cutting, but swath width was not significant in third cutting. It should be noted that both first and third cuttings were done at bloom stage because the buyer's goals were to maximize yield and have feeder quality hay for wintering beef cows. Thus first cutting yields were about 3 ton/ac and windrow width was significant even after hay was rained on two days after cutting. Third cutting yields were about 1 ton/ac and temperatures were unusually warm with no dews, so there was no advantage to extending the windrow width to 60 inches.

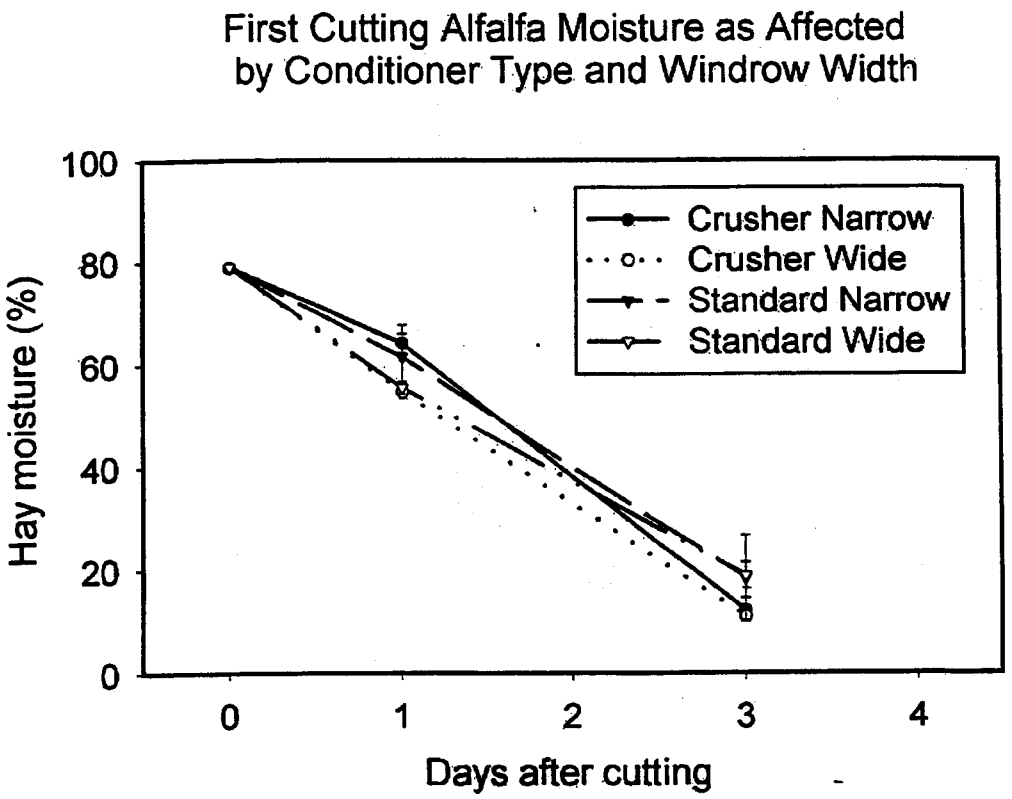

Figure 3. First cutting alfalfa moisture as affected by conditioner type ("crusher" or super conditioner by Circle C Equipment, Hermiston, OR, or standard New Holland 2300 header) and windrow width (narrow = 48 inches wide, wide = 60 inches wide). Study conducted near Kimberly, ID 11-15 June 1999. Swathers were New Holland 1475 haybine swathers with 14-ft cut.

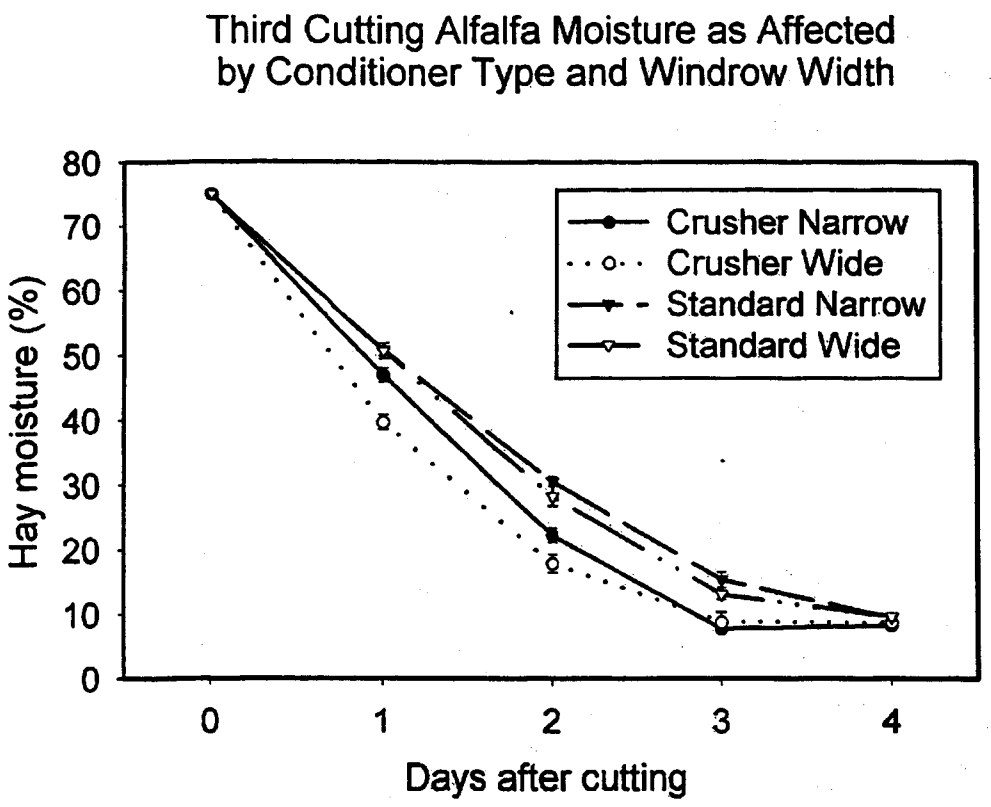

Figure 4. Third cutting alfalfa moisture as affected by conditioner type ("crusher" or super conditioner by Circle C. Equipment, Hermiston, OR, or standard New Holland 2300 header) and windrow width (narrow = 48 inches wide, wide = 60 inches wide). Study conducted near Kimberly, Idaho Sept. 13-20, 1999. Swathers were New Holland 1475 Haybine swathers with 14 ft cut.

CONCLUSIONS

- There is daily cycling in forage quality and this is important to consider when testing forage or testing animal preference or intake of forage.
- The PM-cut hay quality is greater than AM-cut.
- We estimate 136 (first cutting) and 81 lbs TNC/ac (fourth cutting) increase by PM- versus AM-cutting.
- Ruminants prefer and eat more PM- than AM-cut hays.
- More milk is produced when fed 40% of a totally mixed ration as PM-cut alfalfa versus AM-cut alfalfa.
- Increasing windrow width in heavy hay from 48 to 60-inch windrow allows for faster dry-down, however in light hay increased windrow width is not necessary.
- The "superconditioner" may provide faster dry-down of alfalfa hay in some conditions.
- Increased forage quality appears on forage test.
- A decrease of 1% ADF is worth @ $10 to 15/ton at today's prices for premium alfalfa hay.

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