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The effect of wide swathing on wilting times and nutritive value of alfalfa haylage

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ABSTRACT

On 3 consecutive cuttings, alfalfa from a single field was mowed with a John Deere 946 mower-conditioner (4-m cut width; Moline, IL) to leave narrow swaths (NS) ranging from 1.2 to 1.52 m wide (30–37% of cutter bar width) and wide swaths (WS) ranging from 2.44 to 2.74 m wide (62–67% of cutter bar width). Samples were collected from windrows and dry matter (DM) was monitored during wilting until a target of 43 to 45% DM was obtained. Forage from random windrows (n = 4–6) was harvested by hand, chopped through a forage harvester before being packed in replicated vacuum-sealed bags, and allowed to ensile for 65 d. There was no swath width × cutting interaction for any parameter tested. Over all cuttings, the resulting silage DM was not different between the NS silage (43.8%) and the WS silage (44.9%). However, wide swathing greatly reduced the time of wilting before making silage. The hours of wilting time needed to reach the targeted DM for the NS silage compared with the WS silage at cuttings 1, 2, and 3 were 50 versus 29, 54 versus 28, and 25 versus 6, respectively. At the time of ensiling, the WS silage had more water-soluble carbohydrates (5.1%) than did the NS silage (3.7%). The WS silage had a lower pH (4.58) than did the NS silage (4.66), but swath width did not affect fermentation end products (lactic acid, acetic acid, and ethanol). The NS silage had more NH_3-N (0.26%) than did the WS silage (0.21%). Wide swathing did not affect the concentration of ash or the digestibility of NDF, but it lowered the N content (NS = 3.45%; WS = 3.23%) and increased the ADF content (NS = 39.7%; WS = 40.9%) of the resulting silage. Wide swathing can markedly reduce the time that alfalfa must wilt before it can be chopped for silage, but under good conditions, as in this study, the resulting silage quality was generally not improved.
Key words: alfalfa silage, wide swath, forage

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To minimize the risk of clostridial fermentation, alfalfa should be wilted to achieve a DM greater than 30% before it is ensiled. Clostridia are less likely to dominate the ensiling process in drier forages because they do not tolerate high osmotic pressures. However, during wilting in narrow windrows, a large portion of the plant material is shaded from exposure to wind and solar radiation, which slows the loss of moisture from the plant. Prolonged wilting expends water-soluble carbohydrates and increases the risk of the crop being rained on. Swath inversion (Rotz and Savoie, 1991) and chemical drying agents (Panciera and Krause, 1997) are among the methods that have been used to reduce the time that alfalfa lies in the field before being harvested. Past research has also shown that laying alfalfa in wide swaths can reduce the time of wilting before harvest (Shearer and Turner, 1989; Jahn et al., 2003). Recent interest has centered on laying mowed alfalfa into wide swaths to minimize the time plants are respiring in the field (Kilcer, 2006; Undersander, 2006). The objective of this experiment was to determine the effects of wide swathing on drying time in the field and on the subsequent nutritive value of the crop ensiled as haylage.

Alfalfa (*Medicago sativa*) was mowed, wilted, and harvested from the same field (>90% alfalfa) at 3 successive cuttings (June, July, and August, 2006) on days without rain at the University of Delaware Farm (New Castle County, DE). The alfalfa was mowed in the morning after the dew was visibly gone (between 0900 and 1100 h) with a John Deere 946 Center-Pivot Rotary Disk mower (Moline, IL) with an impeller conditioner and a 4.16-m cutter bar to achieve narrow swaths (**NS**) ranging from 1.2 to 1.52 m in width (30–37% of cutter bar width) and wide swaths (**WS**) ranging from 2.44 to 2.74 m in width (62–67% of cutter bar width). Between 4 and 6 rows (each about 100 m in length) for each swath width were mown at each cutting with a residual stubble height of approximately 5.6 cm. The narrow width was the widest between the tractor tires without driving over the windrow. Immediately after mowing, 4 to 5 samples were randomly and manually collected from the windrows. Samples from each treatment were composited and chopped, and the DM content was estimated using a microwave oven. Periodic samples were

Table 1. Weather conditions during wilting[1]

Item	Mean temperature (°C)	Maximum temperature (°C)	Mean relative humidity (%)	Mean solar radiation (MJ/m^2 per day)	Average wind speed (km/h)
Cutting 1					
Day 1	16.11	23.17	73.0	17.6	3.22
Day 2	14.61	19.78	78.4	14.2	12.07
Day 3	13.28	20.06	84.9	12.4	5.63
Cutting 2					
Day 1	16.50	22.11	62.6	15.5	1.61
Day 2	20.33	27.17	63.9	29.2	3.70
Cutting 3					
Day 1	28.56	34.72	65.7	27.1	2.57
Day 2	28.00	35.39	70.6	26.0	3.54

[1]Data obtained from a weather station on the Newark, Delaware, farm (39°40′N, 75°45′W; elevation = 32.3 m). http://www.deos.udel.edu/agirrigation_retrieval.html; Accessed Nov. 30, 2009.

taken in the same manner until representative samples reached a target of about 43 to 45% DM. At the targeted DM, 4 (cut 1) to 6 (cuts 2 and 3) representative samples were harvested by hand and fed through a field chopper. There was no mechanical raking or merging of windrows during harvest. Approximate yields of DM in cutting 1, 2, and 3 were 3.58, 5.82, and 2.26 t/ha. Chopped forages (about 400 g) were packed in 3.5-mil nylon–polyethylene standard barrier micro-layered pouches (15.2 × 30.5 cm; Doug Care Equipment Inc., Springville, CA) and vacuum-sealed with a Best Vac vacuum machine (distributed by Doug Care Equipment Inc.). The samples were stored between 23 and 25°C and ensiled for 65 d.

The DM content of forages and silages was determined by drying duplicate samples in a 60°C forced-air oven for 48 h. Dried samples of fresh forage and silages were ground with a UDY Cyclone Sample Mill (UDY Corporation, Fort Collins, CO) through a 1-mm screen. Samples were analyzed for ADF and NDF using sulfite and heat-stable amylase (Robertson and Van Soest, 1981) with an Ankom[200] Fiber Analyzer (Ankom Technology, Fairport, NY). Total N was determined by combustion of the sample (Leco CNS 2000 Analyzer, St. Joseph, MI).

A water extract was collected by filtering the homogenized silage mixture through Whatman 54 filter paper (Florham Park, NJ). A portion of the filtered water extract (10 mL) was acidified with 50 μL of 50% (wt/vol) H_2SO_4 to reduce the pH of the extract to <2.0 before freezing (−20°C). Water extracts were analyzed for lactic acid, VFA, and ethanol by HPLC (Dairyland Laboratories, Arcadia, WI) as described by Muck and Dickerson (1998). Water extracts were also analyzed for water-soluble carbohydrates (**WSC**; Nelson, 1944) and ammonia-N (Weatherburn, 1967). The digestibility of NDF was determined on samples after 65 d of ensiling using the in vitro procedure described by Goering and Van Soest (1970) with some modifications. Those modifications included 1) incubation of samples in 100-mL polypropylene tubes, each sealed with a rubber stopper fitted with a glass tube and a rubber policeman (14–105A, Fisher Scientific, Pittsburg, PA) with a 5-mm slit to allow for venting of gas pressure; 2) gentle manual swirling of the tubes at 3, 6, 9, 20, and 26 h; and 3) incubation for 30 h.

The data were analyzed using the GLM procedure of SAS (version 9.1, SAS Institute, Cary, NC) according to a randomized complete block design with main effects of swath width, cutting number, and swath width × cutting number. Significance was declared at $P <$ 0.05 unless stated otherwise. Means were tested using Tukey's test.

There were differences among cuttings for some variables, but they are not shown or discussed because they were not the primary interest of this study. Only main effects between swath width are shown and discussed because there were no interactions between treatment and cutting for any variable.

Dry matters determined by microwave drying from wilting samples are shown in Table 1. A DM content of about 35% was obtained for NS alfalfa at about 29, 28, and 12 h and for WS alfalfa at about 26, 25, and 4 h for cuttings 1, 2, and 3, respectively. The savings in time between the NS and WS alfalfas would have been relatively small for first and second cuttings. Our target DM was 43 to 45%, which was achieved in about 21, 12, and 19 h less time for the WS alfalfa than for the NS alfalfa for cuttings 1, 2, and 3, respectively. Shearer et al. (1992) reported that alfalfa dried down significantly faster in a 2-m swath compared with a 1-m windrow. In the current study, the extremely short wilt time of 6 h for wide-swathed alfalfa during the third cutting suggests that caution should be taken when wide-swathing under hot conditions so as to not mow too much ahead of the capacity of the chopping operation.

The WSC content of the fresh crop at ensiling and the nutritive contents of the resulting ensiled alfalfas