ARTIFICIAL DEW TO IMPROVE BALING: CAN YOU BEAT MOTHER NATURE?

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Abstract: Dew, or high relative humidity, is required to bale alfalfa hay without significant leaf shatter and loss. These conditions do not frequently occur during the spring and summer months in many areas of the high desert because of low relative humidity, wind, and high ground temperatures. Trials were duplicated on four dates/times during the summer of 1988 to determine if spraying the windrows with water could simulate natural dew. Windrows were sprayed with water at the rate of 72 gallons per mile of windrow while other windrows were left dry. The sprayed windrows produced bales that were more leafy in appearance, produced superior flakes, and had a higher percentage leaf than the windrows that were baled dry. Dry matter yield was increased by 13 percent as well. Spraying alfalfa windrows with water was found to be an advisable practice when dry conditions prevail.

Keywords: Alfalfa, spraying windrows, leaf retention, alfalfa quality

INTRODUCTION

The baling operation is certainly one of the most crucial stages in producing high quality alfalfa hay. If alfalfa is not baled under the correct conditions ("put up" properly), all the effort that has been put forth into other cultural practices becomes immaterial. Under favorable conditions, the alfalfa is allowed to cure fully (i.e. moisture content is reduced from approximately 80 percent to less than 25 percent) and then baled with dew on the hay. Dew serves to soften and toughen the leaves, protecting them from substantial shattering and leaf loss. Dry-matter losses during baling under good moisture conditions are approximately five to ten percent, depending on the type of baler and other factors. However, dry-matter losses under dry conditions increase to approximately 15 to 20 percent. Leaves dry about five times faster than the stems, making the leaves considerably drier than the stems at the time of baling. Therefore, the dry-matter loss when baling dry hay is primarily leaves - the most nutritious part of the alfalfa. When hay is baled under these dry conditions,the leaves become separated from the stems and further leaf loss occurs as the bales are broken open and fed to livestock.

In some areas of the high desert, there is insufficient dew to bale hay without considerable leaf loss. For dew or condensation to occur, the air temperature must be at or near the dew point. Three factors work to make dew unlikely in the high desert during many of the spring and summer months. The high desert is an arid environment and therefore, for dew to appear, the air temperature must drop even lower than in most other areas which have a higher relative humidity. Many of the alfalfa fields are isolated and surrounded by only desert, keeping the humidity low. Secondly, the high desert is typically warm (minimum temperatures are well above the dew point) in the summer months. Lastly, winds are a commonplace in the high desert. These winds sweep across the desert, serving to keep the humidity low. Wind also prevents the formation of an inversion layer which would allow cooler air to settle near the ground surface. These factors combine to make for possibly the worst baling conditions in the state.

Because there is high demand for quality horse hay, high-desert alfalfa growers can receive a premium for their summer hay. This hay is usually sold to retail feed stores, a market that demands weed-free, well-cured hay with a bright green color. High-desert alfalfa retains its brilliant green color because there is very little sun bleach associated with higher humidities. However, when the alfalfa is baled dry, the price drops at least $5-10 per ton, or it may even be difficult to sell. Baling conditions

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in portions of the high desert (particularly the Newberry Springs and Daggett area of San Bernardino County) are so poor that they approximate baling had it been done in the middle of the day in other alfalfa production regions. There is excessive leaf loss and the leaves that are packaged into the bale are shattered and not attached to the stem.

Growers have adopted several practices to help compensate for these dry baling conditions. A center pivot irrigation system is used on most ranches, making irrigations with a small amount of water possible. The alfalfa is cut the day after an irrigation, thus laying the windrows onto moist ground. The soil moisture helps add some humidity to the windrow. The windrow formed by the swather/windrower is baled directly without raking. The rationale is that excessive leaf loss would occur during the raking operation, a raked windrow would be more susceptible to scattering from wind, and the ground moisture under the windrow would be lost if two windrows were combined. In the summer, alfalfa is baled approximately 60 to 70 hours after cutting (the third morning after cutting). In the driest areas, growers do not wait an extra day for moisture, as more "stem moisture" would be lost and the baling conditions would be even worse. Alfalfa is ordinarily baled between 5:00 and 8:00 a.m. because this is the time when the likelihood of moisture is greatest. Despite all these practices, excessively dry, stemmy, shattered-leaf hay prevails during most of the spring and summer months. Cubing alfalfa may be the best option, but most growers do not have the acreage nor the income to justify purchasing a cuber.

Field trials were established to determine if spraying alfalfa windrows with water could substitute for natural dew when baling to 1) enhance the appearance of the baled alfalfa, 2) improve the nutritional quality of the hay, and 3) prevent excessive leaf loss and thereby increase yields.

MATERIALS AND METHODS

Field-scale trials were conducted during the summer of 1988 in Newberry Springs, located in the high desert of San Bernardino County. The trial was replicated on four dates: July 28 (5:00 a.m.), July 28 (9:00 p.m.), July 29 (6:00 a.m.) and August 15 (6:00 a.m.). Environmental data for the test dates was obtained from the closest weather station (table 1). The experimental site for the first three dates was an alfalfa field in its fourth year of production, and the fourth date was a first-year alfalfa field. Both fields were circular with a center pivot irrigation system. The field was mowed with a conventional 16-foot swather/windrower. The plots were concentric windrows in the last two spans toward the end of the pivot. The length of the windrow varied depending upon its distance from the center point. The exact length of each windrow was measured with a surveyor's wheel and averaged approximately 1,000 feet in length. Each windrow was considered a plot or a replicate. The alfalfa was allowed to dry thoroughly until the third morning after cutting, when the treatment was applied and the alfalfa baled.

Two adjacent windrows were randomly sprayed with water or left untreated. These treatments were replicated through the field four to five times each date. The water was applied with a three-tiered boom sprayer equipped with seven nozzles. (Figure 1.) The three booms were each 18 inches apart. Two Spray Systems, Inc. 5500-X22 adjustable hollow cone nozzles were mounted on the first boom 27 inches apart. Two more of the same nozzles were mounted on the second boom nine inches apart and centered between the two front nozzles. The result was that each of the four front nozzles were each nine inches apart. Three standard Spray Systems, Inc. TX-26 nozzles were mounted on the trailing boom. One nozzle was centered and the two outside nozzles were 24 inches apart. The outside nozzles were on eight inch drops and the spray was directed in toward the windrow using swivels. The leading four nozzles were adjusted to narrow the spray angle. Only two nozzles were mounted on each boom so that the sprays would not intersect and deposit an excessive amount of water at the intersection points. The concept for this boom and nozzle configuration was to obtain penetration into the windrow with the first four nozzles, and the trailing three nozzles would apply a mist over the entire windrow, including the edges. A surfactant (manufactured by Amway) was added to the water at 0.25 percent by volume. During pilot studies conducted earlier in the summer, it appeared that a surfactant improved coverage and enhanced water penetration into the leaf. The water was applied at a rate of 72 gallons per mile of windrow (or in other terms approximately 40 gallons per acre which equates to 175 gallons/acre concentrated on the windrow, assuming a 44-inch wide windrow). A spray pressure of 50 psi was used. The spray rig was equipped with a 300 gallon capacity tank and was pulled through the field ahead of the baler.

Baling commenced when the alfalfa leaves felt soft and moist but not wet to the touch, between 5 and 20 minutes (an average of 10 to 12 minutes) after spraying depending on the weather conditions that day. The plots were baled with a New Holland Hayliner 500 baler. All bales were visually evaluated for appearance after baling. Core samples were taken from several bales in each treatment to determine physical and chemical properties using NIRS analysis. One bale from each treatment was stored in an open barn, except for the 7/29 trial date when one bale from each replication, or a total of four bales per treatment, were stored. Yield data were collected for the August 12 study. Every bale within a plot was weighed using a hanging spring scale. The bales were left in storage for approximately two months, allowing time for the moisture content of the bales to stabilize. The bales were then cut open and a slice (flake) was removed and placed in a plastic bag. The bag containing the alfalfa flake was then dropped with the flake oriented horizontally from a height of six feet. This provided a measure of the integrity of the flake and an estimate of the losses that might occur during feeding. The flake was then removed from the bag; the leaves remaining in the bag were weighed and classified as "loose leaf." Stems and leaves in the remaining sample were then separated by hand, and the percentage of each was calculated.

RESULTS AND DISCUSSION

The effect of watering the windrows was readily observed by the baler operator. The hay entered the baler more uniformly, less leaves were tossed by the pick-up mechanism on the baler, and the bale tension had to be reduced to maintain the same bale weight as in the dry-windrow plots. Also, there was noticeably more leaf left on the ground and surrounding the bales in the plots where the windrows were baled dry.

The physical appearance of the the baled alfalfa was vastly improved by spraying the windrows with water: more leaf was visible on the outside of the bale, the bales from watered windrows were less dusty, and felt softer. The physical appearance and the degree of improvement from watering varied somewhat depending upon the environmental conditions of the day the trials were conducted. Wind was the greatest obstacle. Under windy conditions, evaporation of the applied water was accelerated, and the hay had to be baled much sooner, even before the water had sufficient time to completely penetrate the leaves.

While the moisture content results were consistent, there was variability in the chemical analysis results. The moisture content of the baled alfalfa was increased an average of approximately three percent by spraying the windrows with water (table 2). The moisture increase was the least on the July 28 a.m. baling period. In disagreement with the weather service data, we observed this to be the windiest of the four baling periods. Also, there was little to no wind during the p.m. baling time on the 28th. The weather station was approximately 15 miles from the test site, and microclimate can be extremely important when dealing with wind velocities and relative humidity. This may account for the discrepancies. Crude protein and TDN tended to be slightly higher for the watered treatments, but this difference was not statistically significant. This trend was reversed for the July 28 a.m. baling time. Perhaps more attention should have been placed on the exact location in the bale where the core samples were taken; under dry conditions shattered leaves will sift downward to the bottom of the bale. This may explain the inconsistency.

Spraying the windrows had a highly significant effect on the integrity and composition of the alfalfa flakes (table 3). Bales from windrows that were dry averaged more than five times (16.2 compared to 5.1 percent) as much loose leaf, or leaf that did not adhere to the flake, as the watered-windrow bales. There was the least amount of loose leaf at the August 12th baling session. The relative humidity was highest at this date, 40 percent, and this the first-year alfalfa field, therefore having fine stems and a higher leaf-to-stem ratio. There was also more total leaf in the hay that was watered prior to baling. Total leaf increased 7.5 percent by spraying the windrows with water.

Yield, evaluated on the August 12 baling date, was significantly higher in the windrow-watered plots (table 4). Yields in the high desert are not typically this low. But the alfalfa field was in its first year of production. Also, this cutting followed an especially hot period. Dry-matter yield was increased by 13 percent.

CONCLUSIONS

The practice of spraying alfalfa windrows prior to baling to simulate natural dew was found to be very effective. Spraying windrows with water prior to baling under dry conditions 1) increased the moisture content of the bales, 2) resulted in a higher percentage of attached and total leaf, and 3) reduced losses during baling, thereby increasing total yield per acre. Perhaps the greatest improvement was in the visual appearance of the alfalfa. More leaf was visible on the outside of the bale. Even under the driest and windiest conditions, the windrow-watered bales formed a good flake, a characteristic that is very important to horse-hay buyers. Hay brokers that were previously disinterested in the dry hay produced in some areas of the high desert are now impressed with these results.

This method has several potential uses/advantages:

1) Improved yields and hay quality in dry areas.
2) Extend the time period each day that alfalfa can be baled with moisture.
3) Permit the baling of alfalfa nearly any day to facilitate the scheduling of other cultural operations (i.e. irrigation, swathing, etc.)

More research is needed to further define the yield increase that could be anticipated under various weather conditions, as well as the optimum water application rate in various climates. Further study is also warranted to determine the best nozzle/boom configuration.

In the title of this article, the question was posed, "Artificial Dew to Improve Baling: Can You Beat Mother Nature"? The answer is not simple. Spraying alfalfa windrows with water in an extremely arid and often windy environment does not equal natural dew. However, the effect does approach that of natural dew even in the most parched environments. In instances where the moisture conditions are better, yet still less than optimum, improvements can also be made with this technique.

LITERATURE CITED

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Table 1. Environmental data for the test dates.

Date	Time	Temp.(°F)	Dew Point(°F)	Relative Humidity(%)	Wind Velocity (Knots)
7/28	5:00 am	81	49	24	8
7/28	9:00 pm	99	44	9	16
7/29	6:00 am	80	40	16	9
8/12	6:00 am	63	44	40	10

Table 2. The effect of spraying windrows with water on the moisture concentration, quality, and composition of baled alfalfa hay.

Treatment	Date	Time	Moisture %	Crude[1/] Protein %	MCF[1/] %	TDN[1/] %
Check	7/28	5:00 am	7.0	16.6	23.8	52.6
Watered	"	"	8.8	15.5	24.7	51.8
Check	7/28	9:00 pm	7.6	16.3	24.8	51.8
Watered	"	"	10.1	16.6	23.2	53.1
Check	7/29	6:00 am	6.4	15.9	25.0	51.6
Watered	"	"	10.5	16.1	22.7	53.5
Check	8/12	6:00 am	10.6	17.5	21.1	54.9
Watered	"	"	13.6	18.1	21.3	54.7

1/ Values reported on a 90 percent dry matter basis

Table 3. The effect of spraying windrows with water on the leaf characteristics and leaf to stem ratio of baled alfalfa hay.

Treatment	Date	Time	Leaf (%) Loose	Leaf (%) Retained	Leaf (%) Total	Stem (%)
Check	7/28	5:00 am	13.9	41.6	55.5	44.5
Watered	"	"	4.3	58.6	62.9	37.1
Check	7/28	9:00 pm	16.1	42.5	58.6	41.4
Watered	"	"	4.5	61.7	66.2	33.8
Check	7/29	6:00 am	19.7	40.5	60.1	39.9
Watered	"	"	6.3	62.7	68.9	31.1
Check	8/12	6:00 am	4.8	63.1	67.9	32.1
Watered	"	"	1.6	69.5	71.1	28.9
Averages 1/						
Check			16.2	44.2	60.4	39.6
Watered			5.1	62.9	67.9	32.1

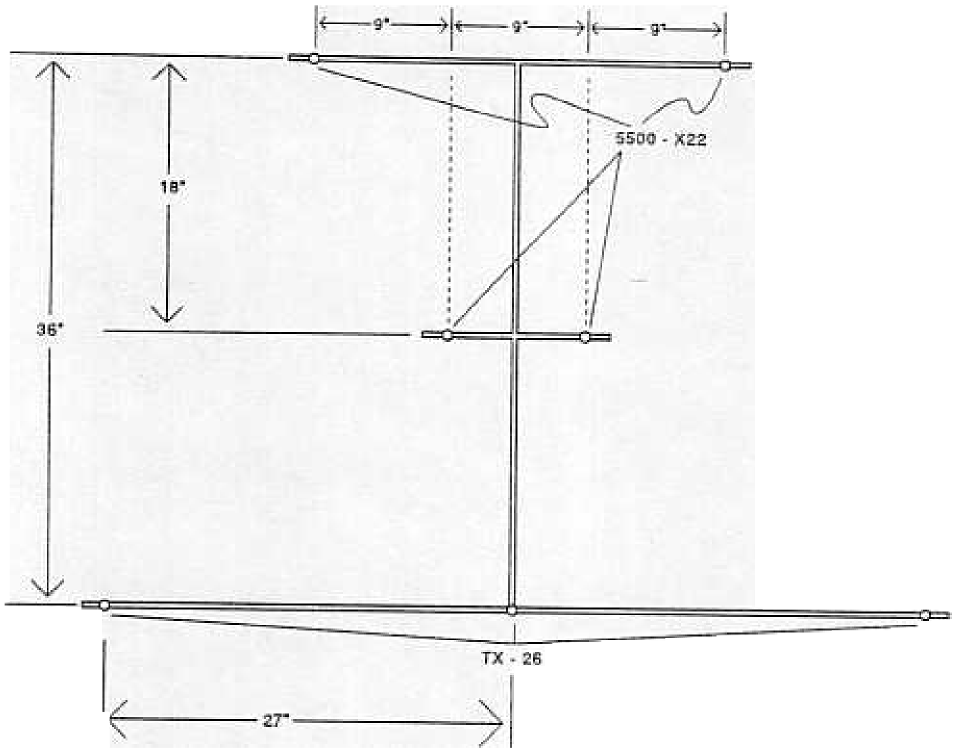
1/ Means within a column are significantly different at the 0.01 probability level

Table 4. The effect of spraying windrows with water on the yield of baled alfalfa hay, August 12, 1988.

Treatment	Yield (tons) 1/ Field Weights	Yield (tons) 1/ 100% DM
Check	0.76	0.68
Watered	0.91	0.78

1/ Means within a column are significantly different at the 0.05 probability level.

Figure 1. The spray system used to water alfalfa windrows.



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