JOURNAL OF THE NACAA

ISSN 2158-9459

VOLUME 16, ISSUE 1 – JUNE, 2023

Editor: Linda Chalker-Scott

Wiseman, T.[1], Lima, D.[2], Penrose, C.[3], McCutcheon, J.[4], Landefeld, M.[5]

[1]Extension Educator, Ohio State University Extension, Ohio, 43764
[2]Extension Educator, Ohio State University Extension, Ohio, 43950
[3]Extension Educator, Ohio State University Extension, Ohio, 43756
[4]Director, Operations, Ohio State University Extension, Ohio, 43724
[5]Extension Educator, Emeritus, Ohio State University Extension, Ohio, 43793

Nitrogen Options to Increase Yield in Fall Stockpiled Cool Season Grass in Eastern Ohio

Abstract

The objective of this three-year study was to determine the effects of yield and quality by adding urea, urea with Agrotain®, and ammonium sulfate by applying them to cool season grass, primarily tall fescue (*Festuca arundinacea* Schreb) and orchardgrass (*Dactylis glomerata* L.). The study was a randomized complete block design with four treatments (control, 100 pounds per acre (lb/ac) urea, 100 lb/ac urea plus Agrotain®, and 219 lb/ac ammonium sulfate) four replications of each treatment at three locations in Eastern Ohio for three years. Nitrogen (N) treatments were applied in early August, all plots were harvested in early November. Average forage yields increased for each of the three N applications, yields ranged from 2497 lb dry matter (DM)/ac for the control, 3101 lbs DM/ac with urea alone, 3381 lbs DM/ac urea with Agrotain®, and 3252 lbs DM/ac using ammonium sulfate. In summary, N applied in early August increased forage yield regardless of source with no differences in quality.

Introduction

Stockpiling forages during late summer and fall is a common practice throughout southeastern Ohio. The application of nitrogen (N) to increase forage dry matter (DM) is well documented (Collins and Balasko, 1981; Gerrish et al., 1994; Riester et al., 2000; Scarbrough et al., 2004; Teutsch et al., 2011). Urea is the most common form of N used in the area due to availability of product and equipment available for making applications. Grass plants use N to maximize growth, produce proteins, and build up sugars for growth. Livestock are then permitted to graze the “stockpile” at a later date when other forages no longer are growing or available. This practice extends the grazing season, reduces the need for stored feed and labor costs (Hitz and Russell, 1998; Cherney and Kallenbach, 2007).

One of the problems with this practice, however, is the possibility of losing broadcast N due to volatilization because of inadequate rainfall in a timely manner. Vitosh et al. (1996) recommends that urea-containing fertilizer should receive ½ inch or more of rainfall before hydrolysis occurs to reduce or eliminate volatilization losses. Urease inhibitor products such as Agrotain® are advertised to reduce such volatilization by lengthening the amount of time before such loss occurs. The most common urease inhibitor is NBPT (N-(n-butyl) thiophosphoric triamide) sold under the trade name Agrotain® (Schwab and Murdock, 2010).

In a previous study (Penrose et al., 2015) concluded, stockpiling cool season grasses, and in particular tall fescue (*Festuca arundinacea Schreb)* can reduce the need for stored forages and in many cases it is higher quality than the hay producers make. There was a positive statistical difference ($P<0.05$) in the amount of crude protein above the control plots when adding Agrotain® to the urea before application. The purpose of that study was to determine the effects of yield and quality by adding fertilizer stabilizing (urease inhibitor) products to urea, at the labeled rate, before applying to tall fescue and orchardgrass (*Dactylis glomerata L.)* (Landefeld and Penrose, 2016).

In Southeast Ohio, studies and demonstrations have been conducted to evaluate quality and quantity of stockpiling cool season grasses. The objective of this study was to determine if yields and quality of stockpiled cool season grasses with the use of urea, urea with the addition of a urease inhibitor, ammonium nitrate, or no additional nitrogen.

Materials and Methods

In 2016, a three-year study was initiated at three locations in Eastern Ohio. Each of the sites’ soils were identified using the Natural Resource Conservation Service Web Soil Survey (USDA-NRCS, 2015). Soil samples were taken at each location at a depth of four inches and analyzed at the Penn State Agricultural Analytical Services Laboratory. The sites are described below:

- Site One was in Monroe County (39°49’24”N, 81°09’12”W). Soil type is a Zanesville Silt Loam with a predominant orchardgrass cover. Soil pH was 6.2, P-26 ppm, K-69 ppm.
- Site Two was in Noble County (39°47’15”N; 81o31’16”W. The soil type is a Lowell Silt Loam with a predominant fescue grass cover. Soil pH was 6.6, P-18 ppm, K-130 ppm.
- Site Three was in Morgan County (39°35’21”N, 81o49’53”W). Soil type is a Westgate Silt Loam with a predominant fescue grass cover. Soil pH was 7.0, P-4 ppm, K-135 ppm.

Each location (Monroe, Noble, and Morgan Counties) had a randomized complete block design with four treatments, and four replications. This study was repeated for three years. Plot dimensions were six feet by 20 feet. The fields were mechanically cut with forage equipment prior to treatments to a height of three inches. The control plots received no urea (46-0-0), urease inhibitor (Agrotain®), or ammonium sulfate (21-0-0). The remaining treatments included: 100 lbs/ac urea; 100 lbs/ac urea plus Agrotain® added at the label rate of one gallon/ton of fertilizer; and 219 lbs/ac ammonium sulfate which was applied early August. The plots were harvested in early November each year to a height of three inches above ground level utilizing 2 feet x 2 feet subsamples from each plot. Each sample was weighed to the nearest ounce and dry matter was determined using laboratory moisture analysis. The samples were analyzed at a Spectrum Analytic Incorporated Laboratory utilizing wet chemistry forage tests. Each of the 48 samples were quality tested for crude protein (CP), acid detergent fiber (ADF), and total digestible nutrients (TDN). Analysis for CP was done using the combustion method, ADF using Ankom Technology Method 5 (Ankom200 Fiber Analyzer, Ankom Technology, Fairport, NY) and TDN was calculated using ADF values. Statistics were calculated using the Proc Mixed procedure in SAS 9.3 (SAS Institute, Cary, NC), location, and treatment by location, with random variable of replicate within location. The PDIFF function was used for mean separation.

Results

Table 1. Results from nitrogen applications for three years at three sites in Southeastern Ohio.

Treatment	Lbs. DM/A	Lbs. DM/A above control	CP%	ADF%	TDN%
Control	2497 a*	-	11.5	37.1	62.7
Urea	3102 b	605	11.7	38.8	61.7
Urea+Agrotain®	3381 b	884	12.0	36.6	63.0
Ammonium sulfate	3252 b	756	11.9	38.4	61.9

LSD = 335 ($P < 0.05$)

*Means with the same letter are not significantly different.

Rainfall

- 2016: Rainfall after N was applied was nearly non-existent (0.1 in. at two of the three sites, the other had none) for twelve days making potential for N volatilization. On day twelve, there was a rain event (0.7 in. Monroe County, 0.74 in. Noble County, 2.0 in. Morgan County).
- 2017: Rainfall after the N treatments were applied within 96 hours of the treatments (0.7 in. Monroe County, 0.75 in. Noble County, 1.3 in. Morgan County) reducing the potential to lose N to volatilization. For the month of August, rainfall at the three sites ranged from 3.18 in. to 3.2 in.
- 2018: Rainfall occurred within 30 hours after the fertilizer treatment (0.11 in. Monroe County, 0.22 in. Noble County, 0.25 in. Morgan County). For the month of August, rainfall at the three sites ranged from 3.21 in. to 3.73 in.

Discussion

Pasture grass's ability to obtain the nutrients from the soil, strongly influence their productivity, and ability to compete with other plants. Many nutrients are needed for maximum growth which include boron calcium, carbon, chlorine, copper, hydrogen, iron, magnesium, manganese, molybdenum, nitrogen, oxygen, phosphorus, potassium. sulfur, and zinc. Nitrogen normally appears as the first limiting factor for grasses. It is often the most difficult nutrient to manage due to leaching, volatilization, evapotranspiration, or was unavailable because it was being used by soil microbes.

Applying N to pasture fields in late summer is a good strategy for extending the grazing season for livestock producers. Utilizing additional N to increase yields in late fall has been demonstrated in previous studies (Kallenbach, et al., 2017; Landefeld, et al., 2018). The timing of N application is critical to the response of forages to increase productivity. In this study using N with a form of a stabilizer did result in statistical increases in forage yield for all treatments. Each of the three N treatments using urea, urea+Agrotain® and ammonium sulfate averaged 604, 884 and 756 DM/ac of forages above the control respectively. The average price for each additional pound of stockpiled forage was $0.05 /lb urea, $0.04 /lb urea plus Agrotain®, and $0.07 /lb ammonium sulfate. This would suggest that harvested forages prices would need range between $80.00 to $140.00 dollars per ton to be competitive, labor and machinery costs would also need to be considered. No statistical differences in forage CP, ADF, or TDN were observed.

Other studies have shown little to no differences in CP with similar levels of N applied in late summer (Nave et al., 2016; Payne et al., 2021; Teutsch et al., 2005). With N rates above that used in the treatments, other studies have shown increased CP levels for stockpiled forages as N rates increased (Taylor and Templeton, 1976; Singer et al., 2003). The Monroe location contained a mixture of tall fescue and orchardgrass, but the grass species were not separated for comparison. In Wisconsin, (Riesterer, et al., 2000) showed that tall fescue, early maturing orchardgrass, and reed canarygrass (*Phalaris arundinacea L.)* could be effectively grazed into late winter. Late maturing orchardgrass and timothy (*Phleum pratense L.)* was recommended to be grazed by December due to more rapid decline in standing forage organic matter.

Conclusions

Stockpiling cool season grasses can reduce the need for stored forages and in many cases, it is higher quality than much of the first cutting hay produced. The problems known to tall fescue, fungal endophyte which produces alkaloids that are toxic to animals and causes various animal health problems, are not encountered with orchardgrass. While orchardgrass may not be as good as fescue to hold its quality characteristics for late winter use or heavy grazing, it is a very palatable forage and produces sufficient tonnage for stockpiling when weather conditions permit. Studies consistently indicate stockpiling with N profitably increases yield and quality, however in this study the costs of adding fertility were higher than purchasing equivalent amounts of hay when labor and machinery costs are considered. More studies are needed to provide clear answers about using fertilizer additive products on various forage species in stockpiling situations. Future studies will include additional forms of N and harvesting at an earlier date since orchardgrass is known to lose quality and quantity sooner than fescue.

Adding N, approximately 50 pounds per acre when stockpiling is initiated, can increase yields and potentially quality. These data suggest that Agrotain® is a good option if there is any doubt about rainfall after applying urea. Several cattle producers in our area have tried it with success and research from University of Kentucky confirms it improves yields. Research will continue to determine how the addition of a urease inhibitor will impact yield and quality during extended periods of no rain (Penrose et al., 2015). One needs to calculate the application costs, consider the costs and time to feed stored feed, and the utilization of the stockpiled forages and the stored feed. In many cases, stockpiling is a viable option to reduce costs and save time.

Literature Cited

Cherney, J.H., and R.L. Kallenbach. 2007. Forage systems for the temperate humid zone, pp. 277-290. In: R.F. Barnes, C.J. Nelson, K.J. Moore, and M. Collins (eds.), *Forages Volume II: The Science of Grassland Agriculture, 6th ed*. Blackwell Publishing, Ames, IA.

Collins, M., and J.A. Balasko. 1981. Effects of N fertilization and cutting schedules on stockpiled tall fescue. I. Forage yield. *Agronomy Journal* 73:803-807. https://doi.org/10.2134/agronj1981.00021962007300050014x

Gerrish, J.R., P.R. Peterson, C.A. Roberts, and J.R. Brown. 1994. Nitrogen fertilization of stockpiled tall fescue in the midwestern USA. *Journal of Production Agriculture* 7:98-104. https://doi.org/10.2134/jpa1994.0098

Hitz, A.C., and J.R. Russell. 1998. Potential of stockpiled perennial forages in winter grazing systems for pregnant beef cows. *Journal of Animal Science* 76:404-415.

Kallenbach, R., C. Roberts, J. Lory, and S. Hamilton. 2017. Nitrogen fertilization rates influence stockpiled tall fescue forage through winter. *Crop Science* 57:1732-1741. https://acsess.onlinelibrary.wiley.com/doi/10.2135/cropsci2016.02.0097

Landefeld, M., D. Lina, J. McCutcheon, and C. Penrose. 2018. Results of 2017 fertilizer options for stockpiling cool season grass. *Proceedings of the American Forage and Grassland Council Annual Conference*, Louisville, KY.

Landefeld, M.A., and C.D. Penrose. 2016. Comparing fertilizer additives applied to urea for stockpiling orchardgrass. *Journal of the NACAA* 9(2). https://www.nacaa.com/journal/72f32e35-5e4d-4bec-9fc0-e429d41a13f8

Nave, R.L., R.P. Barbero, C.N. Boyer, M.D. Corbin, M.D., and G.E. Bates. 2016. Nitrogen rate and initiation date effects on stockpiled tall fescue during fall grazing in Tennessee. *Crop, Forage and Turfgrass Management* 2:1-8. https://doi.org/10.2134/cftm2015.0174

Payne, K.M., S.R. Smith, and B.M. Goff. 2021. Enhanced efficiency nitrogen formulations on stockpiled tall fescue production. *Agronomy Journal, 113, 1596-1606.* https://acsess.onlinelibrary.wiley.com/doi/10.1002/agj2.20553

Penrose, C.D., J.S. McCutcheon, and M.A. Landefeld. 2015. Utilizing urease inhibitors with urea to stockpile fescue. *Journal of the NACAA* 8(2). https://www.nacaa.com/journal/ee374342-83db-4411-ad64-f78c1c2a8ab0

Riesterer, J.L., D.J. Undersander, M.D. Caskler, and D.K. Combs. 2000. Forage yield of stockpiled perennial grasses in the upper Midwest USA. *Agronomy Journa*l 92:740-747. https://acsess.onlinelibrary.wiley.com/doi/10.2134/agronj2000.924740x

Scarbrough, D.A., W.K. Coblentz, K.P. Coffey, K.F. Harrison, T.F. Smith, D.S. Hubell III, J.B. Humphrey, Z.B. Johnson, and J.E. Turner. 2004. Effects of nitrogen fertilization rate, stockpiling initiation date, and harvest date on canopy height and dry matter yield of fall stockpiled bermudagrass. *Agronomy Journal* 96:538-546. https://doi.org/10.2134/agronj2004.5380

SAS Institute. 2020. *SAS/STAT user's guide, version 9.4*. SAS Inst. Inc., Cary, NC.

Schwab, G., and L. Murdock. 2010. Nitrogen transformation inhibitors and controlled release urea. http://www2.ca.uky.edu/agc/pubs/agr/agr185/agr185.pdf

Singer, H., R.L. Hintz, K.J. Noore, M.H. Wiedenhoeft, and E.C. Brummer. 2003. Tall fescue response to nitrogen and harvest date for stockpiled grazing in Upper Midwest. *Crop Management* 2:1-5. *https://doi.org/10.1094/CM-2003-0904-01-RS.*

Taylor, T.H., and W.C. Templeton, Jr. 1976. Stockpiling Kentucky bluegrass and tall fescue forage for winter pasturage. *Agronomy Journal* 68:235-239. https://doi.org/10.2134/agronj1976.00021962006800020006x

Teutsch, C.D., W.M. Clapham, J.M. Fedders, G. Groover, and W.M. Tilson. 2011. Nitrogen rate and application timing affect the yield and risk associated with stockpiling tall fescue for winter grazing. *Forage and Grazinglands* 9:1-11. https://doi.org/10.1094/FG-2011-0513-01-RS

Teutsch, T.H., J.H. Fike, G.E. Groover, and S. Aref. 2005. Nitrogen rate and source effects on the yield and nutritive value of tall fescue stockpiled for winter grazing. *Forage and Grazinglands* 3:1-9. https://acsess.onlinelibrary.wiley.com/doi/full/10.1094/FG-2005-1220-01-RS

USDA-NRCS. 2015. *Web Soil Survey*. https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Vitosh, M.L., J.W. Johnson, and D.B. Mengel. 1996. Tri-state fertilizer recommendations for corn, soybeans, wheat and alfalfa. *Extension Bulletin E-2567.* Michigan State University Extension.