EFFECT OF RATE AND TIMING OF NITROGEN APPLICATIONS ON FORAGE SORGHUM BIOMASS YIELD

S. Sawatzky, M.Thomas, S. Akin, W. R. Raun, D. B. Arnall
Oklahoma State University, Stillwater, Oklahoma
steven.sawatzky@okstate.edu

ABSTRACT

Forage Sorghum (Sorghum-Sudan grass) is a forage crop harvested in the form of silage or dry-hay and is intended to distribute to livestock as feed. The research objective for this study is to observe how nitrogen timing plays a role in crop total biomass yield. Observations and data were collected during the 2021 growing season, with a total of two harvests allowed due to weather conditions in the area. This trial was conducted at two locations: Lake Carl Blackwell near Stillwater, Oklahoma and Cimarron Valley Research Station in Perkins, Oklahoma. This research study was established with eight nitrogen (N) treatments replicated three times. The N treatments were an application of urea-ammonium nitrate (UAN) applied to seven of the eight total treatments at pre-plant, with one un-fertilized check. A top-dress application of urea-ammonium nitrate (UAN) is performed on three of the seven pre-plant treatments after the first harvest. Treatments range from 50 lbs ac^{-1} to 200 lbs ac^{-1} of total nitrogen applied. Silage was the harvest method used to collect biomass from each treatment and all forage harvests were performed at the first observation of heading stage. After analysis, data results show nitrogen has a positive effect on biomass production, with some split applications of pre-plant and top-dress producing more overall biomass compared to pre-plant only applications.

INTRODUCTION

Forage sorghum can produce multiple biomass harvests in a single growing season, the biomass can then be used to supplement livestock feed. Forage sorghum production acres in Oklahoma have been steadily increasing since 2018 (NASS, 2022).In Oklahoma, 16,000 acres of forage sorghum harvested in 2020, increasing to 23,000 acres harvested during the 2021 growing season (NASS, 2022). . When used correctly, nitrogen timing can be beneficial to forage sorghum biomass production, such as by increasing biomass production. However, due to the increasing price of nitrogen, the need to understand how nitrogen timing can effect production is essential. The objective of this study is to evaluate the impact of nitrogen application rate and timing on the biomass production of forage sorghum.

MATERIALS AND METHODS

The study was established during the 2021 growing season in north central Oklahoma to evaluate how N timing influences forage production across multiple biomass collections. This research study was conducted in a randomized complete block design with 8 total treatments, replicated three times (Table 1.). The forage sorghum was planted at 45,000 seeds ac^{-1} on a 7.5 inch row spacing. Urea ammonium nitrate (28-0-0) was applied at pre-plant and top-dress with SJ3 streamer nozzles. The data collected includes: pre-plant soil samples, NDVI readings, and wet biomass yields. There was a total of two biomass harvests, which were conducted at the first sign of the heading stage, and the crop was harvested 6 inches from the ground surface. The top-dress application was applied four days after the first biomass harvest.

Treatment	Preplant Nitrogen (lbs N ac^{-1})	Topdress Nitrogen (lbs N ac^{-1})	Total Nitrogen (lbs N ac^{-1})
1	**0**	**0**	**0**
2	**50**	**0**	**50**
3	**100**	**0**	**100**
4	**150**	**0**	**150**
5	**200**	**0**	**200**
6	**50**	**50**	**100**
7	**75**	**75**	**150**
8	**100**	**100**	**200**

Table 1. Treatment Structure of the Nitrogen use Effect on Forage Sorghum research study.

RESULTS AND DISCUSSION

The forage sorghum study located at the Cimarron Valley Research station in Perkins, Oklahoma was planted on April 26th, 2021. The first biomass collection was taken on July 23rd, 2021, and the second biomass collection was taken on September 22nd, 2021. The data collected from this research study observed the increase in production with both pre-plant and top-dress applications. For the Perkins first harvest, N application above the check statistically maximized yield at $\alpha=0.05$ (Figure 1). The second harvest timing suggested value in split N applications over traditional pre-plant applications. Harvest 2 yields were greatest with split applications of N. Among pre-plant only application, only the 200-0 lbs ac^{-1} rate was statistically greater than the check at 13.5 tons for the 200-0 lbs ac^{-1} pre-plant rate over approximately 5 tons per acre for the 0-0 N check.

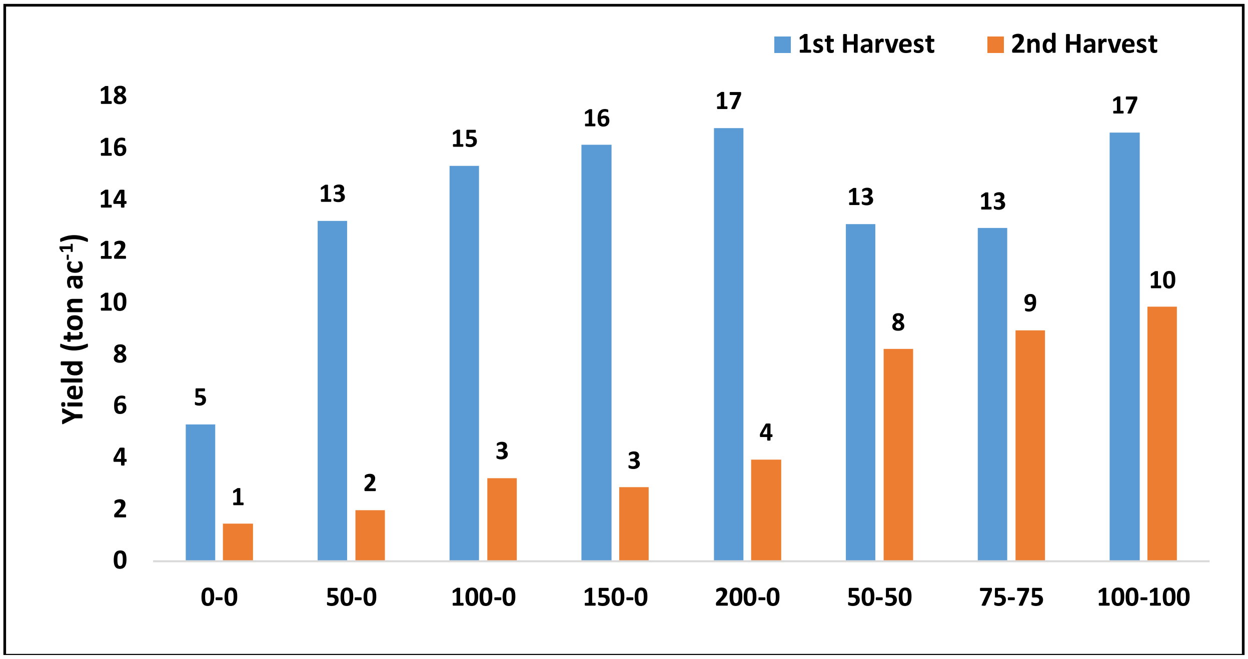

Figure 1. Mean wet biomass yields observed from the Nitrogen use Effect on Forage Sorghum research study conducted at the Cimarron Valley Research Station in Perkins, Oklahoma.

The forage sorghum study located at the Lake Carl Blackwell research farm near Stillwater, Oklahoma was planted on April, 26th 2021. The first biomass collection was taken on July 22nd 2021, and the second biomass collection was taken on September 23rd 2021. The observations from this study show that nitrogen application influenced biomass yield (Figure 2). In this analysis yield was significantly impacted by nitrogen application at both locations. At lake Carl Blackwell in 2021 N application was significant $\alpha=0.05$. When analyzed by harvest time a pre-plant application at 200 lbs ac^{-1} of N maximized yield at 15.7 tons of biomass per acre. However, the 200-0 lbs ac^{-1} rate did not statistically differ from any pre plant application greater than 75 lbs N ac^{-1}. In the second harvest plots receiving only pre-plant applications were significantly decreased when N was applied at less than 200 lbs ac^{-1} compared with similar split applications.

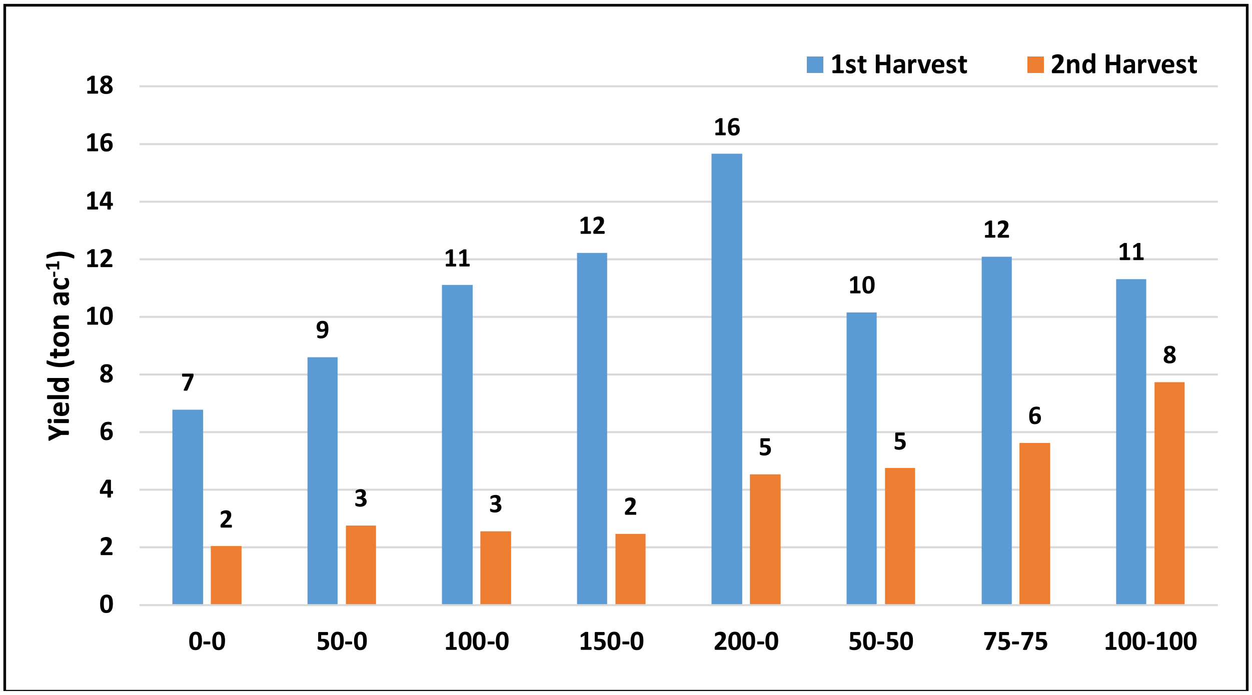

Figure 2. Mean wet biomass yields observed from the Nitrogen use Effect on Forage Sorghum research study conducted at the Lake Carl Blackwell research farm near Stillwater, Oklahoma.

Analysis of the total production of biomass harvested throughout the growing season, at each location show yields were significantly impacted by the influence of nitrogen α=0.05 (Figure 3). At the Lake Carl Blackwell location the application of 200 lbs N ac^{-1}, regardless of timing, was the only nitrogen rate that reported a significant increase of the 0 N check and 50 lbs N ac^{-1} pre-plant rates by 10 and 8 tons ac^{-1}, respectively. The split application of 75 lbs N ac^{-1} at pre-plant and 75 lbs N ac^{-1} at top-dress also yield a 9 ton ac^{-1} increase over the 0 N check. At the Perkins location all N treatments reported yield increases significantly greater than the 0 N check (7 tons ac^{-1}). The split application of 100 lbs N ac^{-1} pre-plant and 100 lbs ac^{-1} at top-dress yielded the highest numerically with 26 tons ac^{-1} which was greater than the 150, 100, and 50 lb pre-plant rates by at least 7 tons ac^{-1}.

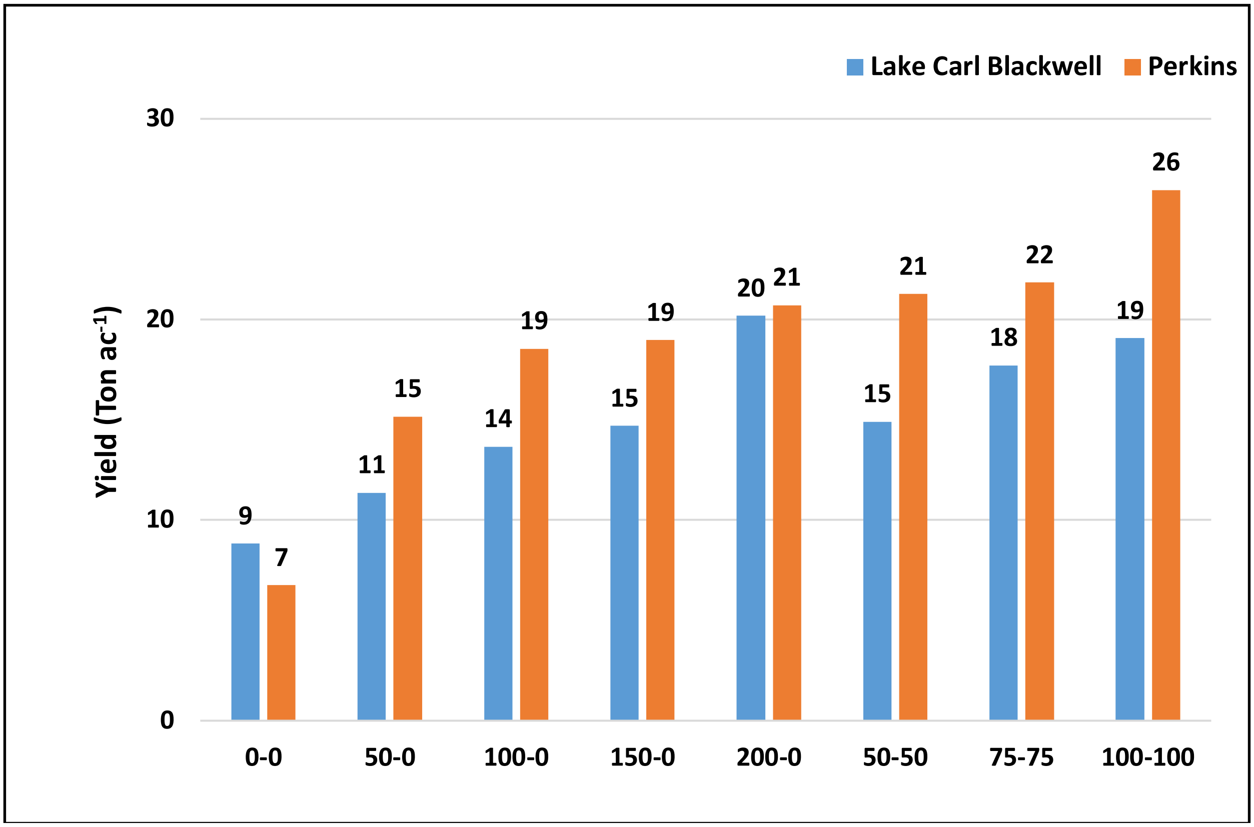

Figure 3. Total harvest mean wet biomass production by treatment at both locations, the Cimarron Valley research station in Perkins, Oklahoma, and the Lake Carl Blackwell research farm near Stillwater, Oklahoma.

SUMMARY

The evaluation of nitrogen rate and timing on forage sorghum conducted in north central Oklahoma during 2021 conclude positive impacts of nitrogen in forage sorghum. Both pre-plant and top-dress applications are significant to biomass yields. Both locations in this study reported greatest increases of biomass yield when N was applied at a 200 lbs ac^{-1}, regardless if applied all at pre-plant or as a split application of 100 lbs ac^{-1} at pre-plant and again at top-dress. Due to the increasing nitrogen price, using a split application method can be economically beneficial to producers in the great plain's region. By utilizing a split application a producer could mitigate losses of applied nitrogen that could potentially occur with a pre-plant application.

REFERENCES

NASS, U. (2022). United States Department of Agricultural National Agricultural Statistics Service. Retrieved from https://quickstats.nass.usda.gov/results/1DB68F09-4D46-3ED8-A80B-E3DD63C4ADDA