Kansas Agricultural Experiment Station Research Reports

Volume 3
Issue 3 *Kansas Fertilizer Research*

Article 1

6-2017

Nitrogen and Phosphorus Application Effects on Pearl Millet Forage Yield and Nutritive Value

D. D. Serba
Kansas State University, ddserba@k-state.edu

A. Obour
Kansas State University, aobour@ksu.edu

Recommended Citation

Serba, D. D. and Obour, A. (2017) "Nitrogen and Phosphorus Application Effects on Pearl Millet Forage Yield and Nutritive Value," *Kansas Agricultural Experiment Station Research Reports*: Vol. 3: Iss. 3. https://doi.org/10.4148/2378-5977.1392

Nitrogen and Phosphorus Application Effects on Pearl Millet Forage Yield and Nutritive Value

D.D. Serba and A.K. Obour

Summary

There is limited information on the nitrogen (N) and phosphorus (P) fertilizer requirement of pearl millet forage in dryland systems. Determination of optimum N and P rates for pearl millet forage production in dryland environments of the Great Plains will have economic advantage for farmers and ranchers growing pearl millet for forage. A field experiment was conducted in 2016 at the Agricultural Research Center-Hays, KS, to investigate N and P fertilizer application effects on forage yield and nutritive value of pearl millet. Factorial combinations of five levels of N (0, 30, 60, 90, and 120 lb/a) and three levels of P (0, 15, and 30 lb/a) were evaluated in randomized complete block design with four replications. A forage-hybrid cultivar, TifLeaf 3, released by U.S. Department of Agriculture, Agricultural Research Service (USDA-ARS) unit at the University of Georgia (Tifton, GA) was used for the experiment. The seed was drilled in six rows at 15 lb/a in individual plot sizes of 5 ft wide × 30 ft long. The results indicate that N fertilizer application increased forage yield, crude protein content, and *in vitro* dry matter digestibility. Although increase in N rate increased the protein content and digestibility of the forage, this single season on-station experiment indicates that N rate of 30 lb/a is adequate for pearl millet forage production under rain-fed conditions. Application of P fertilizer had no effect on forage yield. However, applying 15 lb P/a did increase *in vitro* dry matter digestibility compared to the check treatment.

Introduction

Pearl millet is a drought and heat tolerant warm season cereal crop used by livestock producers as a summer forage in the United States. With the increased threatening of sorghum forage production from sugarcane aphid (*Melanaphis sacchari*) in the Great Plains, non-host pearl millet would be an alternative forage species with great drought tolerance and insect resistance characteristics. Several hybrid and open pollinated forage cultivars have been released by USDA-ARS at Tifton, GA and are available commercially to growers. A renewed effort is also being made at the Kansas State University Agricultural Research Center-Hays to develop improved cultivars of pearl millet for the drought prone areas of western Kansas.

There is limited information available on N and P fertility requirement of pearl millet forage, particularly in dryland environments in the Great Plains. Most of the farmers growing pearl millet forage in the region are applying fertilizer rates recommended for forage sorghum or practice blind application. This may affect the productivity, the economics of forage production, and/or the quality of the forage produced. This study was, therefore, conducted to determine N and P fertilizer rates and their interaction effects on pearl millet forage yield and nutritive value. The goal is to determine the economic optimum N and P rates for pearl millet forage production in dryland systems.

Procedures

The experiment was conducted at the Kansas State University Agricultural Research Center-Hays in the summer of 2016 under rain-fed conditions. Treatments were factorial combinations of five levels of N (0, 30, 60, 90, and 120 lb/a) and three levels of P (0, 15, and 30 lb/a) arranged in randomized complete blocks with four replications. The experiment was planted on June 13, 2016 and harvested at heading stage on August 26, 2016. Individual plot sizes were 5 ft wide × 30 ft long (6 rows at 10 inches spacing). The experiment was conducted using pearl millet forage hybrid, TifLeaf 3, at a seeding rate of 15 lb/a. An area of 3 ft wide (4 middle rows) was harvested from each plot at heading using a Carter small plot forage harvester (Carter Manufacturing Company, Inc. Grand Haven, MI). Fresh weights were recorded immediately and subsamples were collected, weighed and dried in forced air oven at 115°F for 5 days. The weight of the subsamples was determined and the dry matter yield was calculated based on the moisture content of the subsamples. The dried samples were ground to 1 mm particle size (mesh size 20) using Wiley Mill, Standard Model No. 3 (Thomas Wiley, Inc., Swedesboro, NJ). The forage nutritive values were determined using Near Infra-red Spectrometry (NIRS) at Ward Laboratories, Inc. (Kearney, NE). The data obtained were analyzed using Generalized Linear Model on SAS 9.4 (SAS Institute Inc., Cary, NC).

Results

Results showed that N fertilizer application had a significant effect on biomass yield, crude protein, and *in vitro* dry matter digestibility of the forage (Table 1). However, application of P fertilizer did not affect biomass yield and crude protein but had an effect on *in vitro* dry matter digestibility. The interaction effect of N and P was also significant on biomass yield and crude protein content.

Biomass Yield

Greater biomass yields were obtained at 90 and 30 lb/a N rates (Figure 1). Application of N fertilizer at 120 lb/a did not improve biomass yield. Although an increase in N rate increased the protein content and digestibility of the forage, this single season on-station experiment indicates that an N rate of 30 lb/a is adequate for pearl millet forage production under rain-fed conditions.

The application of P fertilizer had no effect on biomass yield as the control (P0) plots yielded 6590 lb/a compared to the 6384 lb/a from 15 lb/a and 6540 lb/a from 30 lb/a P rates plots. Therefore, the application of P fertilizer in pearl millet forage has no effect on forage yield.

Protein Content and Digestibility

Forage crude protein concentration increased linearly with N fertilizer application (Figure 2). Crude protein concentration ranged from 13.15% with the control to 16.78% when N was applied at 120 lb/a. The unfertilized plots (N0) had significantly lower crude protein content than the fertilized plots. Among the fertilized plots, increasing N fertilizer rates significantly increased the crude protein content of the forage. As summarized in Figure 2, 120 lb/a N significantly increased the crude protein content compared with the 30 and 60 lb/a N.

The N × P rate interaction effect was significant on crude protein content. Phosphorus fertilizer application at 30 lb/a significantly increased crude protein concentration at the 30 to 90 lb/a N rates (Figure 3). The P0 showed high effect at N at 120 lb/a probably due to the compensation effect of the high N fertilizer.

However, *in vitro* dry matter digestibility increased with an increase in N fertilizer rates (Figure 4). Mean forage digestibility was 77.1% at N0 while it was 78.3% at 120 lb/a N. This increase in digestibility with an increase in N rate is closely related to the increase in protein concentration with N fertilizer application voiding the effect of phosphorus fertilizer.

Simple scatterplot matrix analysis was also performed to depict the correlation of the three important traits: biomass yield, protein content, and forage digestibility (Figure 5). The result indicated that protein content and *in vitro* dry matter digestibility were positively and linearly correlated. However, there was not a defined relationship between biomass yield and crude protein concentration as well as biomass yield and *in vitro* dry matter digestibility. The independence of forage yield and forage nutritive values imply the difficulty of simultaneous improvement of these traits in pearl millet.

Table 1. Analysis of variance (ANOVA) for biomass yield, protein content, and *in vitro* dry matter digestibility of pearl millet forage in 2016 at Hays, KS

Source	df	Dry biomass yield	Crude protein content	*In vitro* digestibility	Phosphorus content
Replication	3	NS	NS	NS	NS
Nitrogen (N)	4	**	***	*	NS
Phosphorus (P)	2	NS	NS	*	NS
N × P	8	***	*	NS	NS
Error	42	NS	NS	NS	NS

Df = degree of freedom; *, **, *** = Significant at 0.05. 0.01, and 0.001 probability levels;
NS = Not significant at 0.05 probability level.

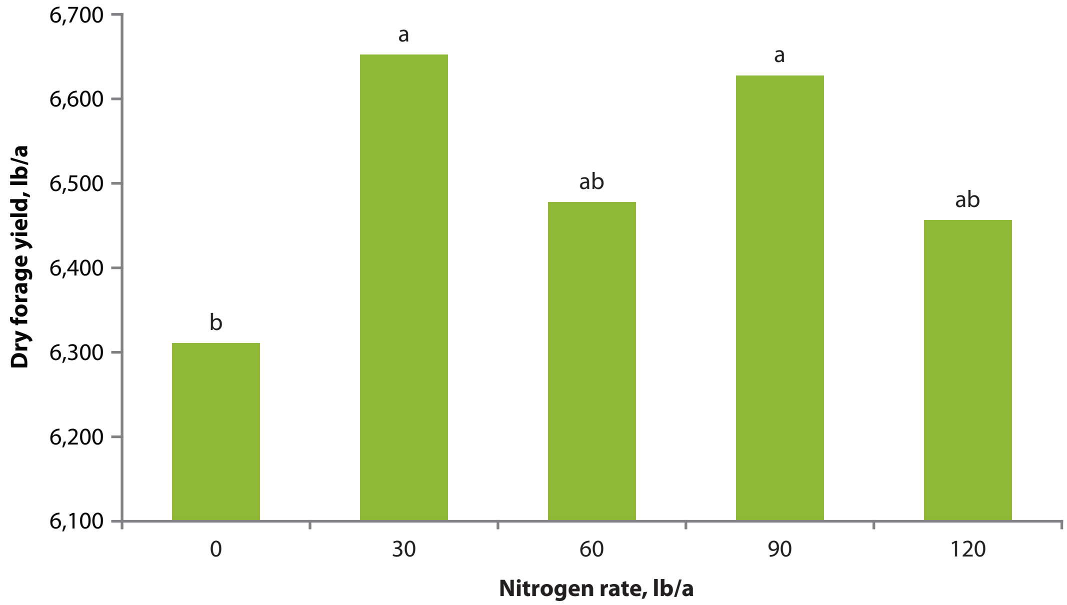

Figure 1. Dry pearl millet forage yield as affected by nitrogen fertilizer rates.

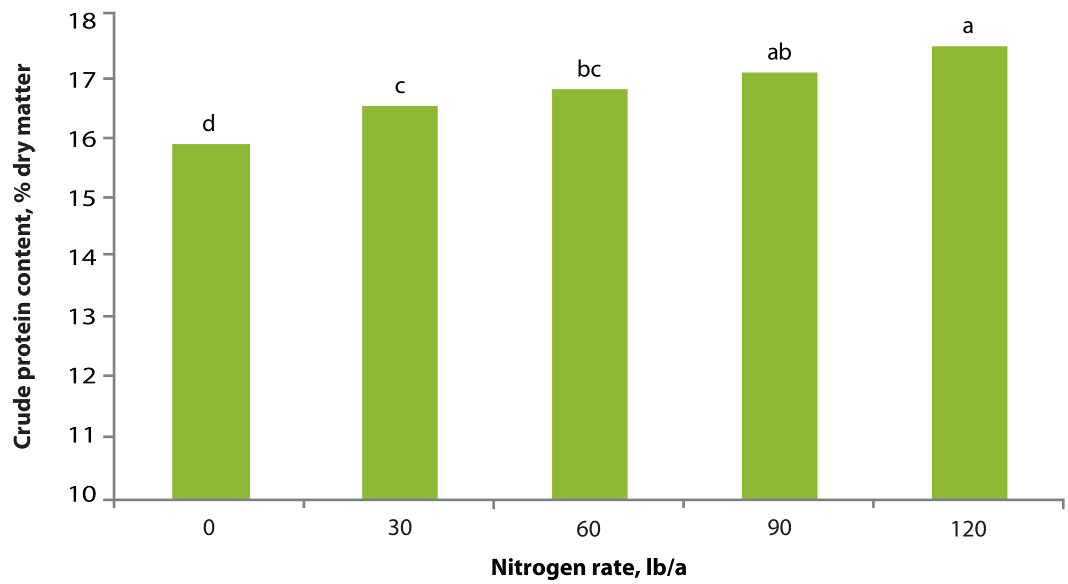

Figure 2. Mean crude protein content as affected by nitrogen fertilizer rates (bars with the same letter are not significantly different from each other).

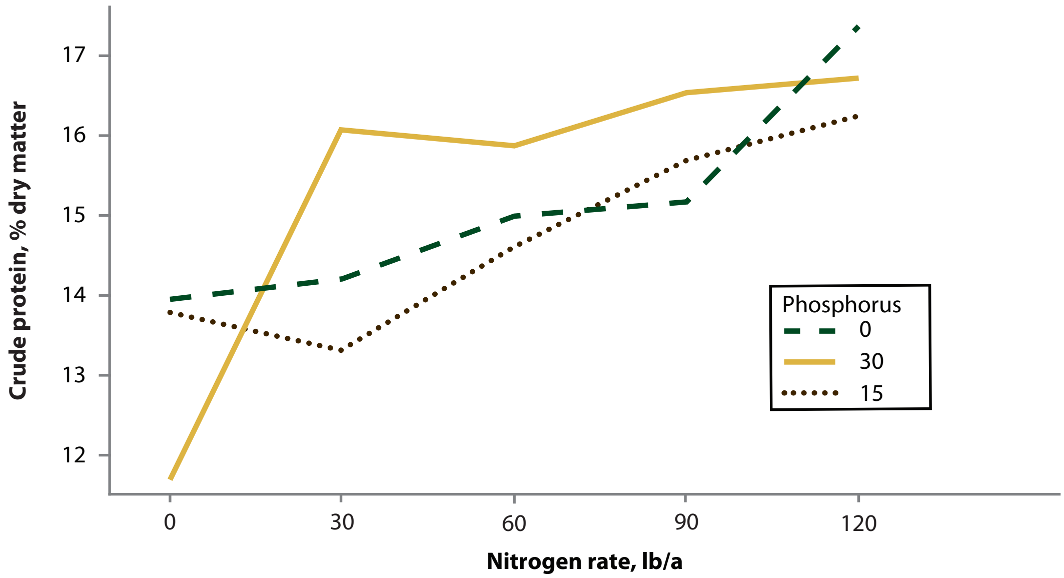

Figure 3. The nitrogen and phosphorus interaction effect on the crude protein content of pearl millet forage.

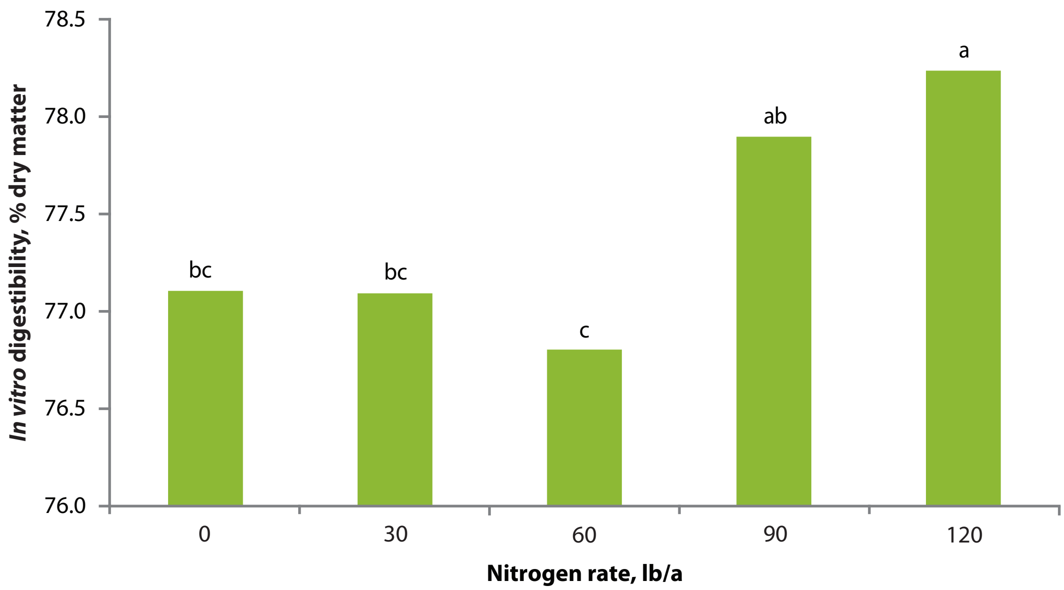

Figure 4. Effect of nitrogen fertilizer levels on *in vitro* dry matter digestibility of the forage.

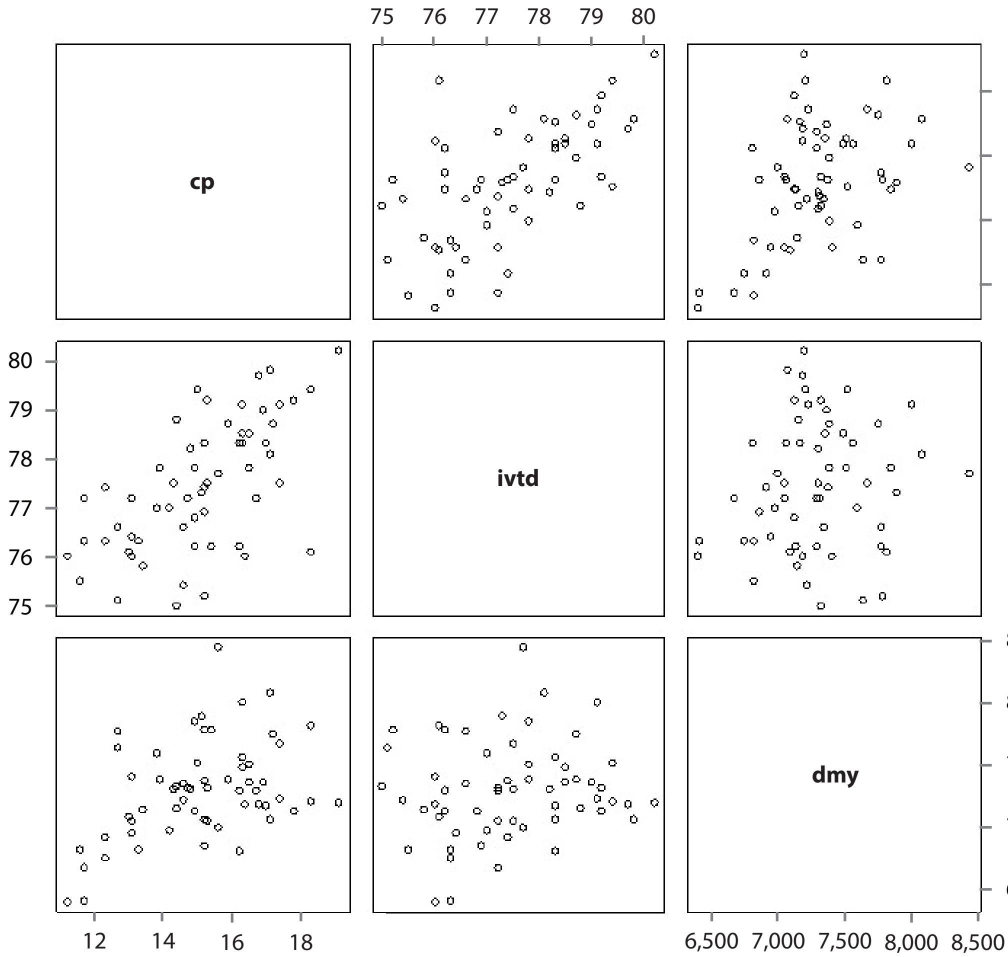

Figure 5. Correlation matrix of crude protein content (cp), *in vitro* dry matter digestibility (ivtd), and dry biomass yield (dmy) of the forage.