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EFFECT OF VARIETY AND NITROGEN LEVELS ON THE p^H OF SORGHUM SILAGE

[1]Zakka, T., [1]Musa, A., [1]Yashim, S.M., [2]Hassan, M.R., [3]Aruna, U.L., [4]Munza, B.M., [1]Yilwatda, B.M., [2]Lawan, S.K. and [5]Sadiq, A.

[1]Department of Animal Science, Ahmadu Bello University, Zaria
[2]National Animal Production Research Institute Shika, Zaria
[3]Department of Agronomy, Ahmadu Bello University, Zaria
[4]Department of Animal Science University of Maiduguri
[5]College of Education Zuba, Niger State
Correspondence: zakkatimothy@gmail.com, 07061512846

ABSTRACT
This study evaluated the effect of sorghum variety and nitrogen fertilization on the fermentation characteristics of sorghum silage, with particular focus on silage pH. Field experiments were conducted during the 2023 and 2024 rainy seasons at the National Animal Production Research Institute (NAPRI), Shika, Nigeria. Two sorghum varieties, sweet sorghum and samsorgh-17, were cultivated under four nitrogen levels (0, 60, 120, and 180 Nkg/ha) and harvested for ensiling at 14 weeks after sowing. Silage samples were assessed for pH after 21 days of ensiling. Results revealed significant varietal differences ($p < 0.05$), with Samsorgh-17 consistently producing lower silage pH values than sweet sorghum, indicating a more efficient fermentation process. Nitrogen application showed variable effects across years; in 2024, moderate nitrogen fertilization (60 Nkg/ha) reduced silage pH most effectively, while higher rates (120–180 Nkg/ha) slightly increased pH. These findings highlight the potential of samsorgh-17 as a promising forage variety for silage production under variable nitrogen regimes in the Northern Guinea Savannah.

Keywords: Sorghum, Variety, Nitrogen and p^H

DESCRIPTION OF PROBLEM

Silage production plays a pivotal role in ensuring high-quality, year-round forage for livestock, particularly in regions where climatic challenges limit forage options. Sweet sorghum is increasingly valued for silage due to its adaptability to warm, arid environments and its high sugar content, which supports effective fermentation and improved nutritional quality compared to many conventional forage (1). Nitrogen fertilization have shown to have significantly influences sorghum's agronomic and biochemical traits, including plant height, dry matter yield, crude protein content, and energy values which are key factors that determined silage quality (2). In particular, nitrogen rates of 90–120 Nkg/ha have been identified as optimal for maximizing biomass yield and farmer income without causing detrimental lodging, especially in semi-arid tropical settings (2).

Despite these insights, research on Samsorgh-17 an emerging sorghum variety remains limited in the scientific literature. To fill this gap, comparative studies evaluating the silage characteristics of Samsorgh-17 and traditional sweet sorghum under varied nitrogen regimes are critical. Understanding how Samsorgh-17 responds to different nitrogen levels could reveal its potential advantages of having a higher biomass, improved nutritional traits, or greater environmental resilience thus guiding fertilizer recommendations for sustainable forage production systems.

MATERIALS AND METHODS

Experimental Site and Location

The research was carried out in 2023 and 2024 at NAPRI, Shika, located in the Northern Guinea Savannah of Nigeria. The area experiences distinct wet (April–September) and dry

(October–April) seasons. Annual rainfall ranges between 748.6–1156.7 mm, with an average of about 1058.6 mm. Temperatures peak at 35.1°C in May and drop to 11.5°C in December/January, with about 70% relative humidity during the rainy season (3).

Silage preparation and Sampling

In 2023, forage materials were harvested at 14 weeks after sowing and then chopped with a forage chopper. The chopped forage materials was allowed to wilt for 24 hours and ensiled in glass jars labeled A, B, C and D to correspond with silages of the two varieties and four nitrogen levels (V_1= 0, 60, 120 and 180 Nkg/ha) and (V_2= 0, 60, 120 and 180 Nkg/ha) respectively and this was replicated tree times. Samples of the silage were opened at twenty-one (21) days after ensiling. The pH of the silage were measured with pH meter. This was repeated in 2024 to validate the results.

Statistical Analyses and Models

Data collected were analyzed using General Linear Model Procedure of (4). Means were compared using the Duncan's Multiple Range Test (5). The model as follows:

$Y_{ijk} = \mu + A_i + B_j + (A*B)_{ij} + E_{ijk}$

Where:

Y_{ijk} = is the record of observations for dependent variables

μ= is the population mean

A_i = effect of variety (i = sweet sorghum and SAMSORG-17);

B_j = effect of nitrogen levels (j = 0 Nkg/ha, 60N kg/ha, 120N kg/ha and 180N kg/ha;

$(A*B)_{ij}$ = Interaction effect of variety and nitrogen level;

E_{ijk} = random error assumed to be normally and independently distributed.

RESULTS AND DISCUSSION

Effect of Variety on pH of Sorghum Silage

Variety had a significant effect on silage pH across both years and in the overall mean (P < .05). In 2023, Sweet sorghum recorded a higher silage pH (4.66) compared with Samsorgh-17 (4.45). Similarly, in 2024, Sweet sorghum maintained a higher pH (3.89) than Samsorgh-17 (3.56). When averaged across years, sweet sorghum produced a mean pH of 4.27, than Samsorgh-17 4.01. These results demonstrate that samsorgh-17 consistently supported a more rapid acidification process than sweet sorghum, leading to lower terminal pH values. Samsorgh-17 exhibited lower silage pH than sweet sorghum, suggesting genotypic variation in fermentation efficiency. Final silage pH reflects the balance between water-soluble carbohydrates, lactic acid bacteria activity, and buffering capacity of the forage (6). Varieties with higher water soluble carbohydrates and lower buffering capacity generally reach a lower terminal pH, promoting better preservation (7). The variations observed from this study could be due to the differences in maturity rate, fiber content, and nutrient partitioning which can influence ensiling outcomes (8).

Effect of Nitrogen Fertilization on pH of Sorghum Silage

Nitrogen fertilization had variable effects across years. In 2024, the effect of nitrogen levels was highly significant (P<0.05), with silage pH decreasing from 3.92 at 0 Nitrogen level to 3.58 at 60 Nitrogen level, before rising slightly to 3.74 and 3.67 at 120 and 180 Nitrogen levels, respectively. Across years, the overall mean pH differed significantly (P<0.05) among treatments. Silage with (0 N) recorded the highest mean pH (4.27), while 60 N produced the lowest (4.07). Treatments at 120–180 Nitrogen levels were intermediate (4.11–4.12), indicating that moderate Nitrogen fertilization had the greatest impact in reducing silage pH. In 2024, 60 Nkg/ha produced the lowest silage pH. Nitrogen fertilization have shown to have influences both crude protein and Water Soluble Carbohydrate dynamics in sorghum, often raising crude protein and buffering capacity (9; 10). Elevated buffering capacity can slow the rate of pH decline during ensiling (7). In this study, the marked reduction in silage pH at 60 Nkg/ha in 2024 suggests that moderate Nitrogen levels improved substrate–microbe balance, enabling Lactic Acid Bacteria to dominate fermentation and reduce pH more efficiently.

CONCLUSION AND APPLICATION

The research revealed that sorghum variety and nitrogen levels significantly affected silage fermentation quality. Samsorgh-17 outperformed sweet sorghum by achieving lower pH values, which enhanced preservation efficiency. A nitrogen rate of 60 kg/ha proved most effective in supporting rapid acidification, while higher rates (120–180 kg/ha) slowed pH reduction due to increased buffering capacity. Environmental factors also influenced the results, but overall, Samsorgh-17 with 60 kg N/ha is recommended for producing high-quality silage.

Table 1: Effect of variety and nitrogen levels of P^{H} of sorghum silage

	2023	2024	MEAN
Variety			
Sweet sorghum	4.66^{a}	3.89^{a}	4.27^{a}
Samsorgh-17	4.45^{b}	3.56^{b}	4.01^{b}
SEM	0.03	0.07	0.04
P Value	0.001	0.002	0.001
Nitrogen level (Nkg/ha)			
0	4.62	3.92^{a}	4.27^{a}
60	4.56	3.58^{c}	4.07^{b}
120	4.50	3.74^{b}	4.12^{ab}
180	4.54	3.67^{bc}	4.11^{ab}
SEM	0.07	0.05	0.10
P-Value	0.088	0.001	0.001
Interactions			
V x NL	*	*	*

^{abc}Means with different superscripts along the same row are significantly (P<0.05) different, SEM: standard error of means, LOS: levels of significance, NL: Nitrogen Level*: Significant, NS: Not significant.

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