Pearl Millet for Ethanol Production in North Alabama: Response to Different Rates of Nitrogen and Pest Survey

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ABSTRACT

There is a worldwide campaign advocating the use of environmentally safe fuels because of the hazards associated with fossil fuel emissions. Hence, there is the need to determine which agricultural feedstock can satisfy this pressing need. Pearl millet (*Pennisetum glaucum* [L.] R. Br) has the requisite characteristics of a crop for ethanol production in comparison to traditional crops that are currently being used for ethanol. An advantage of pearl millet as a feedstock is that, in the United States pearl millet is not a food crop. In this study 4 genotypes of pearl millet were evaluated for superior agronomic traits suitable for feasible economic production of ethanol. The genotypes were treated with 4 different nitrogen rates: 0, 40, 80 and 120 kg ha^{-1}, and evaluated for booting, number of tillers, plant height, number of panicles, panicles size, yield, insect pest and disease infestations. Nitrogen rates 0 and 40 kg ha^{-1} had an initial spurt in vertical growth of 87.03cm and 80.60cm respectively at 8 weeks after planting (8WAP); however the average plant height at 8WAP for the four nitrogen rates was 78.64 cm, but there was no significant difference among treatments at maturity. The 120 kg ha^{-1} nitrogen rate had the highest number of plants booting at 8WAP. The tillering capacity was similar across all treatments. The highest seed yield of 3,937 kg ha^{-1} resulted from the 0 kg ha^{-1} nitrogen rate. Among insect pest species found feeding on the plants include corn earworm, leaf-footed bug, May beetle and grasshoppers. Beneficial insects (e.g., bees, predators) were also noted. Seed borne fungi were also isolated from some of the harvested seeds. The study shows that, nitrogen fertilizer can decrease yield in conditions of late planting, drought conditions and higher rates of nitrogen application.

INTRODUCTION

•**Pearl millet** (*Pennisetum glaucum* [L.] R. Br) is the sixth most important cereal in the world (Singh *et al.*, 2002; Henry and Kettlewell, 1996).

•**Production Estimate:** 64 million acres (26 million hectares) grown in Africa and India as a food grain (Guila *et al.*, 2007) and 1.5 million acres (607,000 hectares) in the United States (Sedivec and Schatz, 1991).

•**Uses** – Human consumption source (Africa and Asia), poultry, livestock and bird feed (U.S).

•Its has the ability to withstand environmental stress and to give appreciable yield under unfavorable growing conditions.

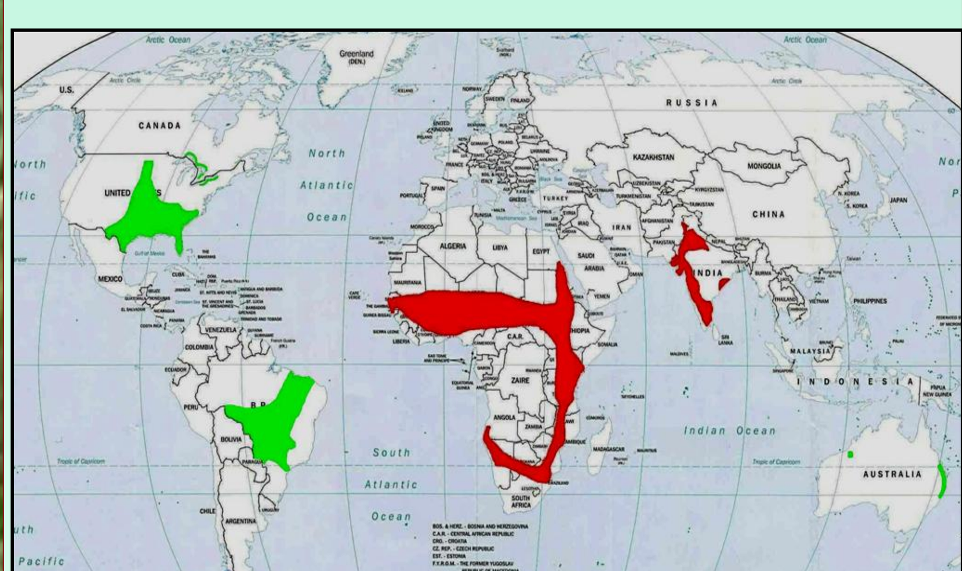


Figure 1. Pearl millet production areas.
(Source: Personal comm.: J.P. Wilson, 2010).

Keyword: Peal millet is mainly used as a food source at the red colored zones, while it is used as animal feed at the green zones.

Why Pearl millet for ethanol production?

•There are health hazards associated with exhaust emissions (i.e. cancer (Cammer *et al.*, 1988), auto-immune disorders (Yoshino *et al.*, 1999), heart disorders (Schwatz *et al.*, 1996), allergic reactions, asthma, inflammation of airways (Kagawa, 2002).

•Amount of fossil fuel reserves are finite and pearl millet has been identified as a potential feedstock to supplement maize (*Zea mays*) to produce ethanol in the Southeastern United States (Wilson *et al.*, 2006).

•Growing pearl millet for ethanol production gives more financial return compared to corn (Wang *et al.*, 2006).

OBJECTIVES

•To screen diverse pearl millet germplasm for their yield, seed quality and potential use as feedstock for biofuel.

•To determine the response of different pearl millet varieties to different nitrogen regimes and how it translates into yield and the overall ethanol produced.

•To recognize the prevailing diseases and insect pests accompanying the production of this crop.

MATERIALS AND METHOD

•**Location:** Winfred Thomas Agricultural Research station, Alabama A&M University, Hazel Green, Alabama (34N56, 86W34).

•**Soil type:** Decatur silty clay loam (Clayey, Kaolinitic, thermic Rhodic Paleudults). The pearl millet varieties that were planted in this experiment were received from the

•**Pearl millet germplasm lines:** 2304, LHB08, 606A1x2304, 707A1x4280), source: Pearl Millet Germplasm Bank (USDA-ARS) Tifton, GA, USA.

•**Plot size:** 3.05m long, 1.14 wide, with 12.7cm and 0.69m intra row and inter row spacing respectively.

•**Treatment**: Four(4) nitrogen rates i.e. 0, 40, 80 and 120 kg ha^{-1}, designated as N-1, N-2, N-3 and N-4 respectively.

•**Experimental Design**: The plots for this experiment were arranged in a Randomized Complete Block Design (RCBD) with four replications.

•**Data Collection**: Data was collected on heads/plot, head size, booting, plant height, disease and insect infestation .

•**Data Analysis:** Data was subjected to the analysis of variance (ANOVA) procedure & General Linear Model (GLM) of the Statistical Analysis System (SAS). Means were separated using Tukey's Honestly Significant Difference test at p=5% .

RESULTS AND DISCUSSION

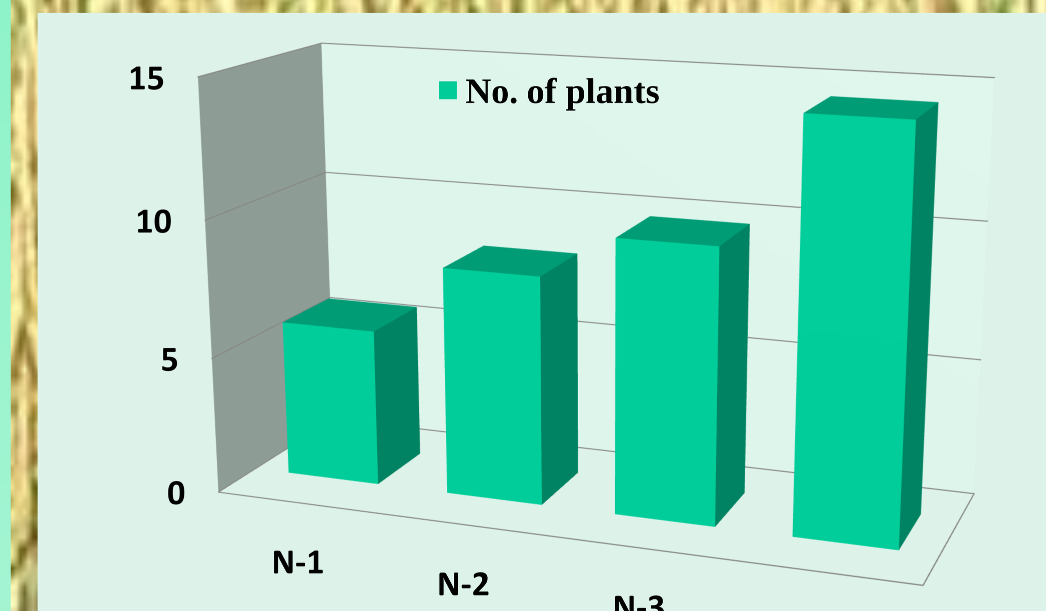


Figure 2. Number of Plants Booting at 8WAP
*No significant difference between treatments

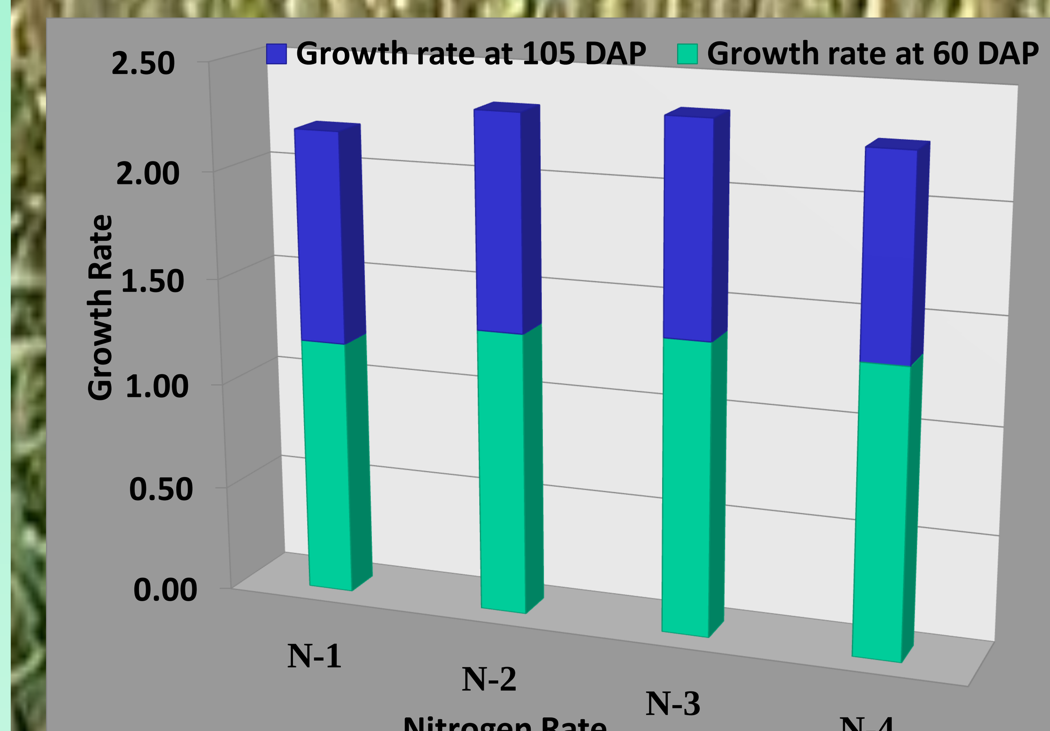


Figure 3. Plant Growth Rate
*Significant difference between treatments

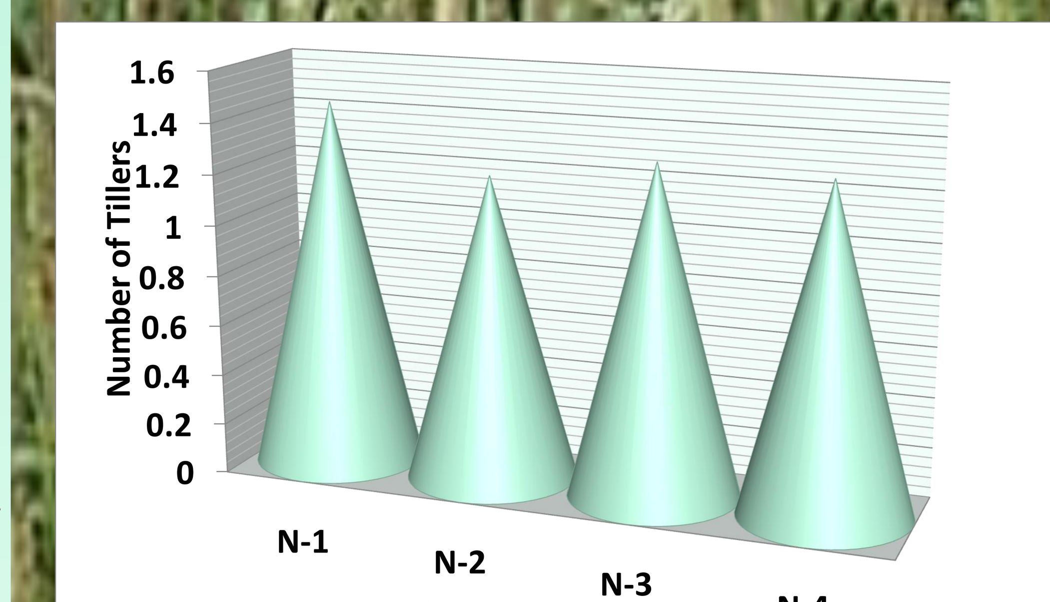


Figure 4. Tillering capacity of pearl millet in response to different nitrogen rates.

Table 1. Mean separation of plant height at 8 and 15 weeks after planting (WAP) using Tukey's Honestly Significant Difference

Nitrogen Rate (kg/ha)	Plant Height at 8 WAP (cm)	Plant height at 15 WAP (cm)
0	87.038 ᵃ	116.60 ᵃ
40	80.600 ᵃ	124.58 ᵃ
80	74.694 ᵇ	124.03 ᵃ
120	72.263 ᵇ	124.61 ᵃ

There is no significant different between means with the same letter at p=5%

Table 2. Correlation between the Measured Variables

	Boot 8wks	Ht 15wks	GR 8wks	GR 15wks	Tillers	No. Heads	Head size	Yield
Ht 8wks	**0.44195 0.0003**	0.05937 0.6412	**0.99994 <.0001****	**-0.68362 <.0001****	-0.22426 0.0748	**0.28173 0.0253**	-0.16117 0.2070	-0.1546 0.2342
Boot 8wks		0.09647 0.4482	**0.44330 0.0002**	**-0.25155 0.0450**	-0.03551 0.7806	**0.63562 <.0001**	0.17696 0.1653	0.17038 0.1893
Ht 15wks			0.06222 0.6253	**0.68793 <.0001**	0.13945 0.2718	-0.00780 0.9516	0.11045 0.3888	0.08653 0.5073
GR 8wks				**-0.68150 <.0001**	-0.22166 0.0784	**0.28375 0.0242**	-0.16104 0.2073	-0.1547 0.2339
GR 5wks					**0.26568 0.0338**	-0.21058 0.0976	0.19785 0.1201	0.17641 0.1738
Tillers						0.04001 0.7555	0.00890 0.9448	-0.0519 0.6914
No. heads							-0.04729 0.7151	-0.0579 0.6601
Head size								**0.9990 <.0001**

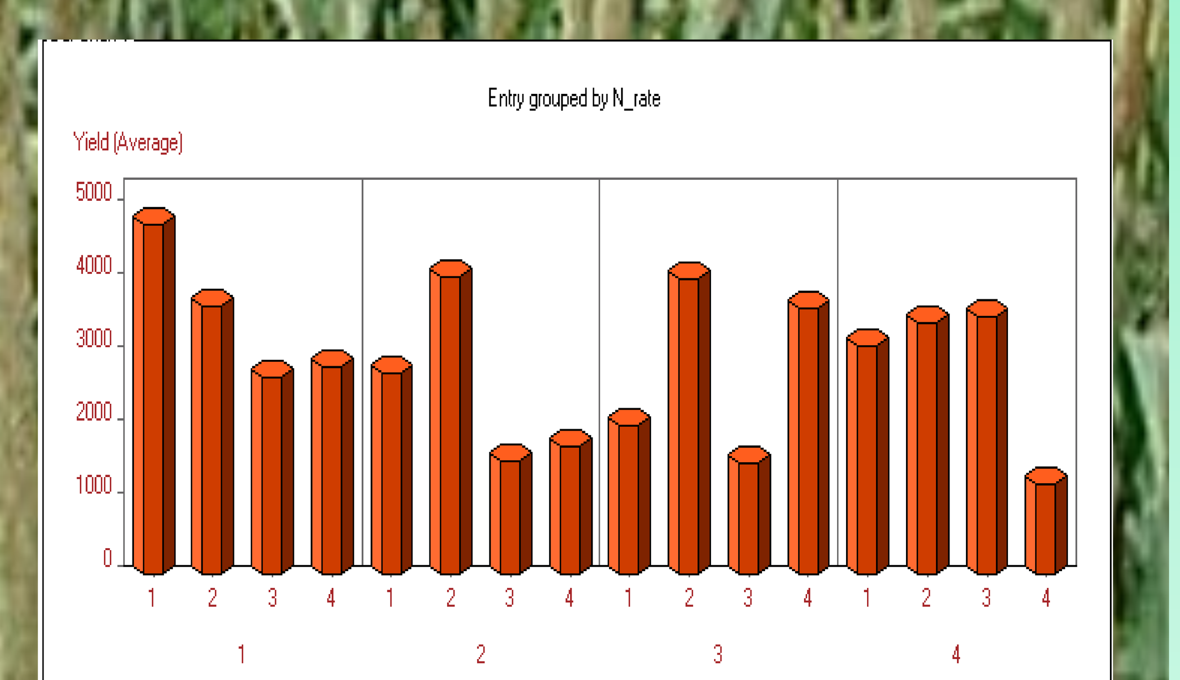


Figure 5. Grain Yield (kg) in response to different nitrogen treatment

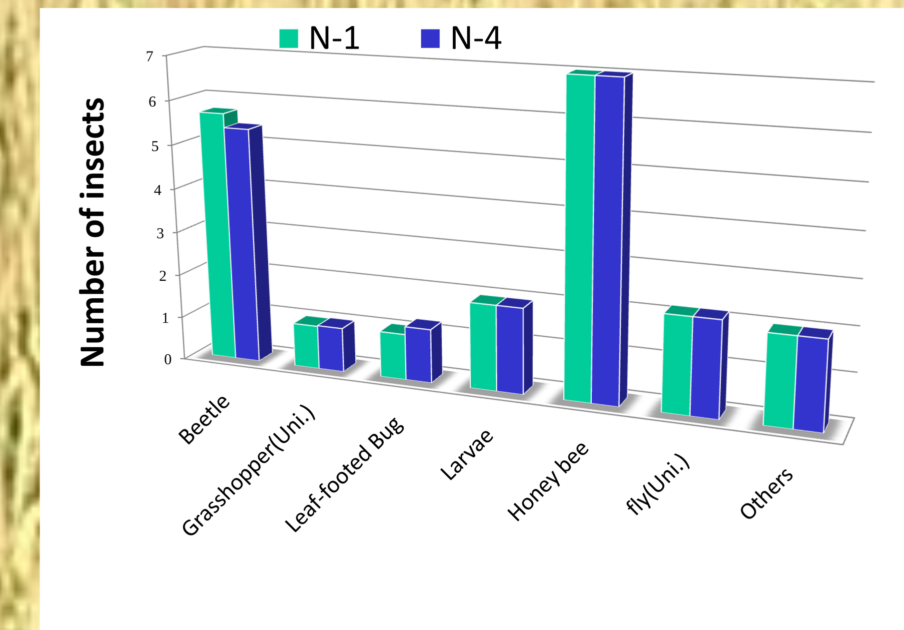


Figure 6. Insect Count at 13 WAP

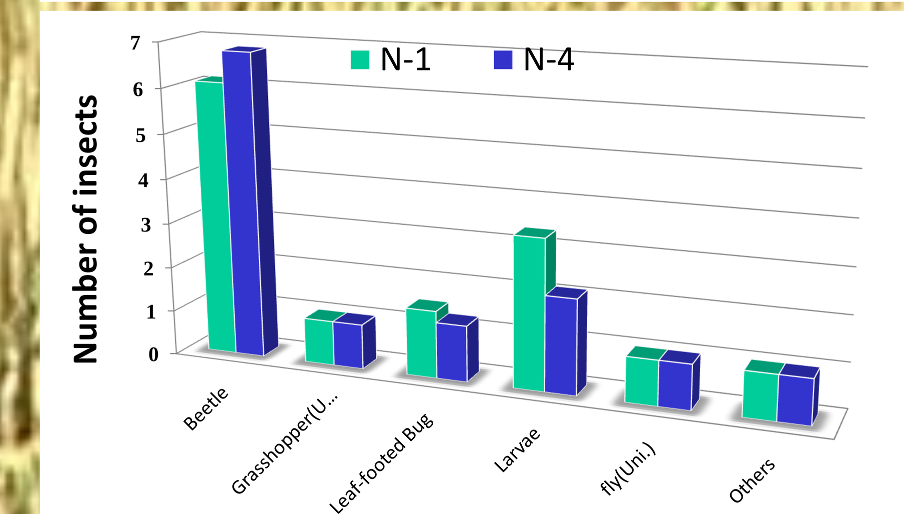


Figure 7. Insect Count at 15 WAP

DISCUSSION AND CONCLUSION

•Increasing the rate of nitrogen does not result in an increase in grain yield.

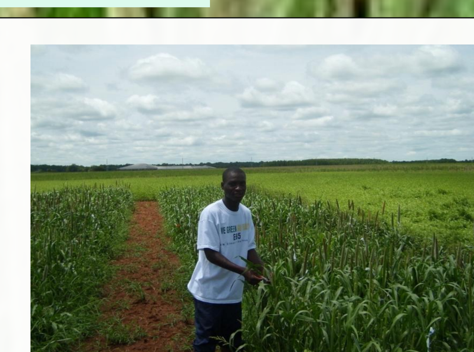
•The theoretical yield of ethanol for pearl millet is estimated to be 0.43L/kg of seeds.

•Planting pearl millet during the growing window is very crucial in obtaining the optimum yield.

•The insects population was not at a threshold that could cause economic damage.

•No natural infestation of disease pathogens occurred.

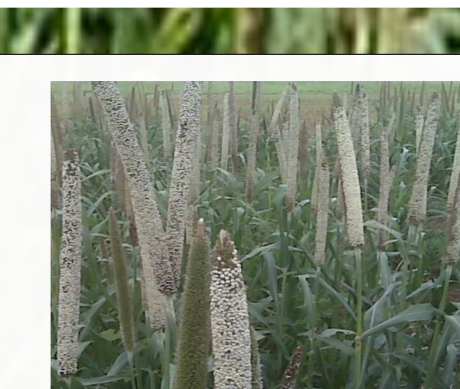
Planting of Pearl Millet using a grain drill planter



Pearl millet at early stages of growth.

Grasshopper feeding on pearl millet leaves.

Dr. David Mays (Agronomist), Dr. Rufina Ward (Entomologist) and Eric Obeng (Grad. Student) making an assessment of pearl millet plants.



Matured peal millet heads with seed

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