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Growth and Grain Yield of Pearl Millet (*Pennisetum glaucum*) Genotypes at Different Levels of Nitrogen Fertilization in the Southeastern United States

Eric Obeng[1], Ernst Cebert[1], Bharat P. Singh[2], Rufina Ward[1], Leopold M. Nyochembeng[1] & David A. Mays[1]

[1] Alabama A & M University, Department of Biological & Environmental Sciences, 4900 Meridian Street, USA

[2] Fort Valley State University, 1005 State University Drive, Fort Valley, Georgia 31030, USA

Correspondence: Ernst Cebert, Alabama A & M University, Department of Biological & Environmental Sciences, 4900 Meridian Street, USA. Tel: 1-256-372-4243. E-mail: ernst.cebert@aamu.edu

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Abstract

Pearl millet (*Pennisetum glaucum* [L.] R. Br) has the requisite characteristics for dry land production in the southeastern USA in comparison to the traditional grain crops while requiring less input. The purpose of this study was to identify the genotypes that produce the highest yield and seed quality at different rates of nitrogen. Four pearl millet genotypes (2304, LHB08, 606A1*2304 and 707A1*4280) were cultivated on secondary land and treated with 4 different nitrogen rates: 0, 40, 80 and 120 kg ha^{-1}. The genotypes were evaluated for agronomic parameters including booting, number of tillers, plant height, plant weight, number of heads, head length and yield. Nitrogen rate did not have any significant effect on the head length, number of tillers and plant (dry) weight among the genotypes. Plant height ranged between 96 and 111 cm and was significantly different among the genotypes. However, numerically, genotype LHB08 produced the longest heads (42 cm) and highest seed yield (6,159 kg ha^{-1}) across all treatments. Overall, nitrogen rate did not produce significant difference in yield among the genotypes. Since grain yield obtained in this study is comparable to those reported elsewhere, it can be inferred that pearl millet has the potential as a new grain crop for the southeastern United States. Furthermore, results demonstrated that pearl millet can be grown with limited N-input. As N-fertilization is the major cost of producing any crop, pearl millet offers special opportunity for large number of limited resource farmers in the region.

Keywords: dry land, pearl millet growth, yield and Nitrogen fertilization

1. Introduction

Pearl millet is the sixth most important cereal in the world after wheat (*Triticumaestivum*), rice (*Oryza sativa*), maize (*Zea mays* L.), barley (*Hordeumvulgare*) and sorghum (*Sorghum bicolor*) (Singh, Singh, & Tyagi, 2003; Henry & Kettlewell, 1996). It is a major crop in the semi-arid dry land regions in Southeast Asia and Africa (Baltensperger, 2002). In the United States, pearl millet is grown as a summer annual forage crop, as seed for the bird feed industry and for wildlife. Increasingly, it is being regarded as an alternative feed grain for poultry (Timper & Hanna, 2005). Pearl millet possesses the unique genetic predisposition to withstand environmental stress and produce appreciable yield when grown on marginal soils. Because of these favorable characteristics, pearl millet has been projected as a potential feedstock for biofuels (Wilson et al., 2006). Improving crop performance to obtain appreciable economic yields requires a clear understanding of the crop including management of nutrients during the production cycle for newly developed cultivars.

Realizing the multiple use potential of pearl millet grain, several research projects are underway to develop new pearl millet varieties and hybrids for high grain yield. Agronomic variations among pearl millet genotypes have been reported earlier by Khairwal et al. (2007), which may serve as a guide for breeding and selection depending on the purpose for which pearl millet is being grown, such as for forage (Sedivec & Schatz, 1991) or as a grain (Dewey et al., 2009). Research on pearl millet for grain has been centered on developing dwarf hybrids (Rajewski & Andrews, 1995), proper row spacing (Pale, 2002), controlling weeds (Limon-Ortega, Mason, & Martin, 1998), date of planting (Pale et al., 2003) and adaptability to local conditions (Maman, Lyon, Mason, Galusha, & Higgins, 2003). The tall hybrids are high yielding while the dwarf varieties are excellent for grazing

but with lower grain yields (Hancock, 2009). Several limiting nutrients, including nitrogen (N), potassium (K) and phosphorous (P), reduce the optimum performance of grain production. According to Pandey, Maranville, & Bako (2001), N is considered the most important limiting nutrient for many economically important crops. Nitrogen use efficiency (NUE) of pearl millet is higher than many other crops (Muchow, 1988) because increasing the rate of N fertilization does not always accompany a corresponding increase in grain yield.

Pearl millet is well suited for the southeastern US climate and soil characteristics. It is the second most popular type of summer annual grass in Alabama and is mostly used for grazing or hay (Baker, 1993; Davis, Dale, & Ferreira, 2003; Sedivec & Schatz, 1991). Mullins and Reeves (1994) reported pearl millet grain yields exceeding 5,700 kg ha^{-1} in slightly acidic soil condition with high residual phosphorus in southern Alabama. Grain and biomass yield of 5.3 and 16.7 Mg ha^{-1}, respectively have been reported in Nebraska (Maman et al., 2003). Therefore, pearl millet in rotation with other crops such as wheat and canola, or if grown on non prime agricultural lands can supply both seeds and biomass as feedstock for biofuels, and serve as a supplement to maize. The objective of this study was to determine the response of four (4) of the most promising and advanced type grain lines of pearl millet available at the USDA-ARS (United States Department of Agriculture, Agricultural Research Service) Pearl Millet Breeding Program, Tifton, Georgia to different rates of N-Fertilization under environmental conditions in southeastern United States.

2. Materials and Methods

During the growing seasons of 2009 and 2010, pearl millet production experiments were conducted at the Winfred Thomas Agricultural Research Station of Alabama A&M University in Hazel Green, Alabama (latitude: 34° 54' 57.6", longitude: 86° 38' 49.6", elevation: 248.1 meters on a Decatur silty clay loam soil (Clayey, Kaolinitic, and thermic RhodicPaleudults). Four pearl millet lines (2304, LHB08, 606A1*2304 and 707A1*4280) with wide genetic variability were selected for this study by the pearl millet breeder at the Crop Genetics and Breeding Research Unit, USDA-ARS, Tifton, Georgia. Two of the lines, 2304 and LHB08, are open pollinated inbreds, while the other two lines, 606A1*2304 and 707A1*4280, are hybrids. These four lines were used in this study to evaluatepearl millet response to N fertilization rates of 0, 40, 80 and 120 kg ha^{-1}as well as for genotype x N rate variations. The seeds were planted on June 4th and June 7th for 2009 and 2010, respectively. For both seasons, the land was appropriately prepared two days prior to planting. Seeds were sown at a rate of 5 kg ha^{-1} on plots measuring 3.05 m x 1.14 m. The plots were arranged in a Randomized Complete Block Design (RCBD) with four replications. Ammonium nitrate fertilizer (34-0-0; NH_4NO^{3-}-P-K) treatments was applied to appropriate plots manually after crop establishment. Experimental plots were rain-fed and weeds were removed manually throughout the growing season.

Pre-harvest data collected included plant stand (number of plants per plot), number of plants booting at different dates, plant height and seeding development (percentage seed formed in relationship to head length). At maturity, 5 randomly selected plants per plot and post-harvest agronomic data were taken for number of tillers per plant, head length, vegetative dry weight and seed weight. The plots were harvested to estimate grain yield.

Data were analyzed using general Analysis of Variance (ANOVA) procedure in General Linear Model (GLM) to determine statistical significance. Means were separated using Duncan's Multiple Range Test at p=0.05. Correlation was also carried out based on statistical significance. Statistical Analysis System (SAS) package ver. 9.2 was used for all analyses.

3. Results and Discussion

3.1 Tillering

According to Andrews, Majumdar and& Doggett (1975) there are three types of tillering in pearl millet: synchronous, non-synchronous basal tillering and sub-terminal tillering. With sub-terminal tillering, the tillers arise from the auxiliary buds, whereas in the synchronous and non-synchronous tillering, the tillers arise from the basal leaf bud axils. Based on the sub-terminal tillers, genotype 606A1 x 2304 produced significantly more tillers than all the other genotypes for both 2009 and 2010. Number of tillers for all the four nitrogen rates in both 2009 and 2010 did not differ significantly (Table 1). In 2009, wetter (precipitation 13.0 cm during the growing period) and warmer (mean temperature of 18ºC) growing conditions resulted in more tillers, the order of tiller number for the four lines being in the following order: 606A1*2304>707A1*4280>LHBO8>2304. In 2010, with total precipitation during growing season of 8.0 cm and mean temperature of 17.5ºC, genotype 606A1*2304 produced the maximum number of tillers, 2304 the second largest , followed by LHBO8 and 707A1*4280 (Table 1). It was clear from the difference in the tiller number count between the two years that rainfall during the period of tiller formation significantly affected the total tiller number formed by the plant.

Table 1. Averages for head length, number of heads, number of tillers, plant weight and grain yield for four Pearl millet genotypes and four nitrogen rates

Nitrogen rate (kg ha^{-1})	Head length (cm)		By Nitrogen rate Number of heads plant^{-1}		Number of tillers plant^{-1}		Plant weight (kg)	
	2009	2010	2009	2010	2009	2010	2009	2010
N0	27.8^{a}	28.9^{ab}	1.6^{a}	1.4^{a}	2.7^{a}	1.1^{a}	0.05^{a}	0.05^{a}
N40	28.2^{a}	27.7^{b}	1.2^{a}	1.5^{a}	3.0^{a}	1.2^{a}	0.15^{a}	0.06^{a}
N80	28.7^{a}	28.5^{ab}	1.6^{a}	1.6^{a}	3.0^{a}	1.3^{a}	0.06^{a}	0.06^{a}
N120	27.9^{a}	29.8^{a}	1.9^{a}	1.5^{a}	3.1^{a}	1.2^{a}	0.07^{a}	0.06^{a}
			By Genotype					
2304	17.0^{c}	19.0^{c}	1.5^{b}	1.4^{b}	2.5^{b}	1.2^{ab}	0.18^{a}	0.05^{a}
LHBO8	42.0^{a}	38.0^{a}	0.7^{b}	1.2^{b}	2.6^{ab}	1.1^{b}	0.03^{a}	0.06^{a}
606A1*2304	17.0^{c}	18.0^{d}	2.2^{a}	1.9^{a}	3.3^{a}	1.3^{a}	0.04^{a}	0.06^{a}
707A1*4280	27.5^{b}	26.0^{b}	0.9^{b}	1.2^{b}	2.9^{ab}	1.1^{b}	0.06^{a}	0.06^{a}

Treatment means followed by the same letter(s) within the same column are not significantly different at $P \leq 0.05$.

The onlysignificant interaction observed was between genotype 606A1*2304 and 80 kg ha^{-1} that produced greater number of tillers per plant than other N levels. The other interactions of genotypes LHBO8, 707A1*4280, 606A1*2304 and 2304 with 0, 40, 80 and 120 kg ha^{-1}N did not show any significant statistical difference in the number of tillers in 2009 and 2010 (Table 2). However, it was noted that tiller progression and transition into the reproductive growth stage was closely related to the timing of its emergence. Largest heads resulted from tillers which emerged earliest in comparison to smaller heads derived from late emerging tillers. A similar observation was reported in rice by Raghunatha, Jagannath, Krishnamurthy, and Rajashekara (1972) that early appearing tillers produce larger heads.

Table 2. Averages for head length, number of heads, number of tillers and plant dry weight for four Pearl millet genotypes and their interaction with four nitrogen rates

Genotype x Nitrogen Rate	Head length (cm)		Number of heads		Number of tillers		Plant weight (kg)	
	2009	2010	2009	2010	2009	2010	2009	2010
2304 x N0	22.00^{d}	22.50^{de}	1.7^{cd}	1.7^{bcde}	2.7^{ab}	1.2^{abc}	0.16^{a}	0.08^{ab}
2304 x N40	19.50^{d}	22.50^{de}	1.3^{cd}	1.6^{cde}	2.5^{ab}	1.0^{abc}	0.14^{a}	0.04^{ab}
2304 x N80	21.00^{d}	21.50^{de}	1.2^{d}	1.4^{cde}	1.6^{a}	1.1^{abc}	0.09^{a}	0.04^{b}
2304 x N120	16.00^{d}	24.50^{d}	2.3^{bcd}	1.8^{abcde}	2.6^{ab}	1.2^{abc}	0.09^{a}	0.08^{ab}
LHBO8 x N0	46.50^{a}	42.00^{a}	1.3^{cd}	1.2^{de}	2.1^{ab}	1.0^{bc}	0.08^{a}	0.07^{ab}
LHBO8 x N40	49.00^{a}	37.00^{bc}	1.4^{cd}	1.4^{cde}	3.0^{ab}	1.1^{abc}	0.09^{a}	0.09^{ab}
LHBO8 x N80	37.00^{b}	40.00^{ab}	1.7^{cd}	1.6^{cde}	2.6^{ab}	1.3^{abc}	0.08^{a}	0.07^{ab}
LHBO8 x N120	47.00^{a}	42.00^{a}	1.8^{cd}	1.1^{e}	2.6^{ab}	1.0^{bc}	0.07^{a}	0.07^{ab}
606A1*2304 x N0	18.00^{d}	19.00^{e}	2.5^{abc}	2.2^{ab}	3.1^{ab}	1.3^{abc}	0.07^{a}	0.06^{b}
606A1*2304 x N40	17.50^{d}	22.50^{de}	2.2^{bcd}	2.0^{abc}	2.5^{ab}	1.1^{abc}	0.07^{a}	0.08^{ab}
606A1*2304 x N80	22.00^{d}	21.50^{de}	3.5^{a}	2.3^{a}	3.5^{a}	1.5^{a}	0.07^{a}	0.10^{ab}
606A1*2304 x N120	21.50^{d}	18.50^{e}	3.2^{a}	1.8^{abcd}	3.5^{a}	1.2^{abc}	0.06^{a}	0.06^{ab}
707A1*4280 x N0	29.00^{c}	26.00^{d}	1.5^{cd}	1.2^{de}	2.3^{ab}	0.9^{c}	0.06^{a}	0.10^{ab}
707A1*4280 x N40	30.00^{c}	25.00^{d}	2.0^{cd}	1.7^{bcde}	2.8^{ab}	1.5^{ab}	0.30^{a}	0.07^{ab}
707A1*4280 x N80	33.00^{b}	25.50^{d}	1.4^{cd}	1.3^{de}	3.1^{ab}	1.1^{abc}	0.03^{a}	0.06^{ab}
707A1*4280 x N120	32.00^{bc}	33.50^{c}	2.2^{bcd}	1.9^{abcd}	3.0^{ab}	1.3^{ab}	0.02^{a}	0.11^{a}

Treatment means followed by the same letter(s) within the same column are not significantly different at $P \leq 0.05$.

3.2 Head Length

There was no significant difference in head length for all the four nitrogen rates in 2009, but in 2010 differences existed between 40 and 120kg ha^{-1}N (Table 1). However, the difference in head length between N40 and N120 appears to be an aberration because while a decline occurred from 0N to 40 N, head length again became similar between 0N and 80 N and 0N and 120 N. This result is in contrast to the observation by Maas and Hanna (2006), whereby an increase in nitrogen rate of up to 112 kg ha^{-1} led toa boost in head length. Genotypes were easily separable into three separate categories based on head size: 1) shortest head- 2304 and 606A1*2304, 2) intermediate head- 707A1*4280, and 3) longest head- LHBO8. Head length for both years ranged between 20.7 and 48.1 cm. Teare, Wright, and Pudelko (1994) has emphasizedof head length being the primary factor in pearl millet productivity.

3.3 Number of Heads

The number of heads and head length has been found to be positively correlated to grain yield (Singh, 1969; Pudelko, Wright, & Teare, 1993). Nitrogen rates 0 kg ha^{-1}, 40 kg ha^{-1}, 80 kg ha^{-1} and 120 kg ha^{-1} did not show any significant difference for number of heads for both years (Table 1). The number of heads at the time of harvest for genotypes 2304, LHBO8 and 707A1*4280 was not statistically different, but there was a significant difference between these three genotypes and 606A1*2304; the latter produced the highest number of heads per plant both in 2009 and 2010 (Table 1). Genotype 606A1*2304 which produced the highest number of heads, also had the highest tiller density. The interaction of genotype 606A1*2304 and all the four nitrogen rates performed better than their competitors, and overall, genotype 606A1 x 2304 at nitrogen rate 80 kg ha^{-1} had the maximum number of heads (Table 2).

3.4 Plant Height

In 2010, the highest rate of 120 kg ha^{-1} nitrogen produced the tallest plants at 56 DAP. Plant heights at nitrogen rates 40 and 80 kg ha^{-1} were not significantly different at 56 DAP. At 105 DAP; plant height for the four nitrogen rates did not differ statistically among the treatments (Figure 1). These results are consistent with the findings by Maas, Hanna, and Mullinix (2007), in which plant height did not differ for nitrogen rates.

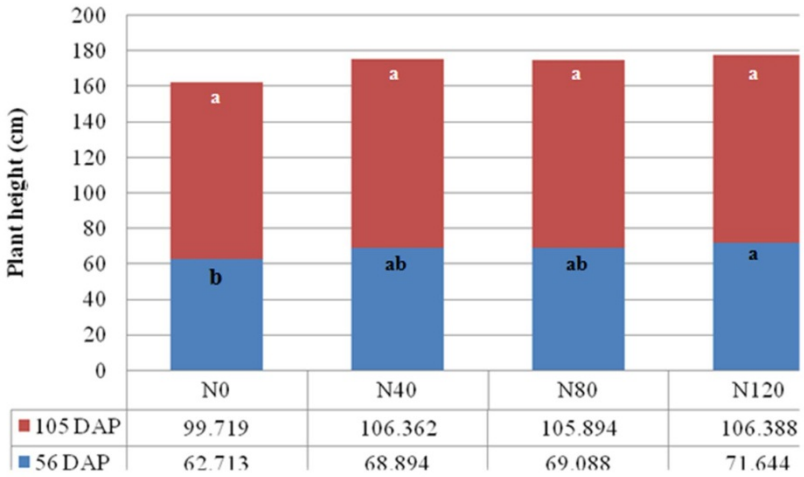

Figure 1. Average plant height for four pearl millet genotypes in response to four nitrogen rates at 56 and 105 DAP in 2010

Plant height measured before booting and at maturity showed significant variation among the genotypes. Average plant height at 56 days after planting (DAP) during the first year showed the following sequence from tall to short: 2304>606A1*2304>LHBO8> 707A1*4280. At 105 DAP, the sequence of cultivars for height shifted to LHBO8> 2304>707A1*4280>606A1*2304 from tallest to lowest. Genotype 606A1*2304 produced the highest number of tillers (Table 1) on average but plants were short (Figure 2), a characteristic that may be a desirable for grazing and mechanized harvesting.

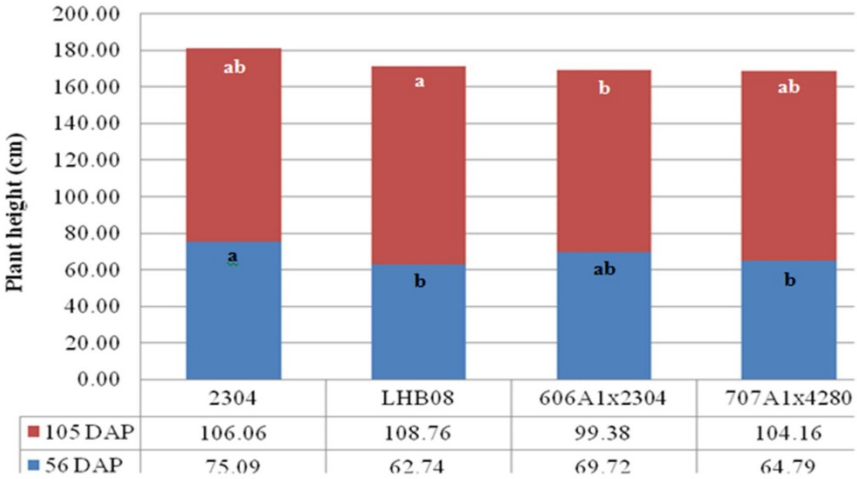

Figure 2. Average plant height of four pearl millet genotypes in response to four nitrogen rates at 56 and 105 DAP in 2009

There was a negative correlation between the number of tillers and plant height in all genotypes, which is similar to findings by Tchala (1989). Plant height at 63 and 77 DAP were positively correlated. Plant height at 49, 63 and 77 days after planting had a direct correlation with grain yield produced (Table 3); the taller the plants, the higher the yield. Among the test cultivars, plant height was consistent during the growth process; however, differences in height at harvest were due to head length.

Table 3. Plant height, number of plants booting and estimated yield for four genotypes of pearl millet treated with four nitrogen rates

Genotype x Nitrogen Rate	Plant height at 56 DAP(cm)	Heads booting at 63 DAP	Plant height at 105 DAP (cm)	Head length (cm)	Estimated Yield (kg ha^{-1})
2304 x N0	69.9^{abcd}	8.0^{cd}	96.5^{b}	23.00^{de}	1314.7^{defg}
2304 x N40	78.1^{abc}	11.5^{bcd}	111.1^{ab}	22.5^{de}	808.6^{efg}
2304 x N80	69.9^{abcd}	10.8^{bcd}	105.4^{ab}	22.00^{de}	979.7^{efg}
2304 x N120	82.6^{a}	17.5^{abc}	111.2^{ab}	19.00^{d}	1305.7^{defg}
LHB08 x N0	64.1^{bcd}	3.8^{d}	105.5^{ab}	42.00^{a}	6226.4^{ab}
LHB08 x N40	66.7^{abcd}	6.8^{cd}	104.8^{ab}	36.50^{bc}	6386.3^{ab}
LHB08 x N80	62.3^{dc}	6.3^{cd}	118.8^{a}	40.00^{ab}	4805.1^{bc}
LHB08 x N120	57.9^{d}	10.3^{cd}	106.1^{ab}	42.00^{a}	7218.9^{a}
606A1*2304 x N0	62.2^{dc}	11.3^{bcd}	98.4^{b}	19.00^{e}	562.2^{g}
606A1*2304 x N40	66.7^{abcd}	15.0^{abcd}	102.2^{ab}	23.00^{de}	496.0^{g}
606A1*2304 x N80	82.6^{a}	26.0^{a}	97.8^{b}	21.50^{de}	1190.7^{efg}
606A1*2304 x N120	67.4^{abcd}	22.8^{ab}	99.1^{ab}	21.00^{de}	1036.8^{efg}
707A1*4280 x N0	54.6^{d}	NA	98.5^{b}	26.50^{d}	2801.7^{cdef}
707A1*4280 x N40	64.1^{bcd}	NA	107.3^{ab}	25.00^{d}	3063.4^{cd}
707A1*4280 x N80	61.7^{d}	NA	101.6^{ab}	26.00^{d}	3598.1^{c}
707A1*4280 x N120	78.8^{ab}	2.3^{d}	109.3^{ab}	34.00^{c}	3394.4^{cd}

Treatment means followed by the same letter(s) within the same column are not significantly different at $P \leq 0.05$.

3.5 Plant Weight

According to Chohan, Naeem, Khan, & Kainth (2006), tall genotypes produce higher fodder than shorter ones. Mean plant dry weight for the four genotypes was not significantly different for both 2009 and 2010 (Table 1).

Statistically four nitrogen rates used did not result in any difference in plant weight for both years. This indicates that nitrogen rate had no direct effect on plant biomass of four pearl millet genotypes used in this study. During the 2009 growing season, there was no significant difference in plant dry weight across all interactions among four genotypes and their corresponding nitrogen rates (Table 2). However, during the 2010 season, there were significant differences among the nitrogen rates. Genotype 707A1 x 4280 at nitrogen rate 120 kg ha^{-1}produced more plant dry weight, andhad significantly greater plant dry weight than 606A1*2304 at N0 kg ha^{-1} and 2301 at N80 kg ha^{-1} (Table 2).

3.6 Grain Yield

Due to the high seed loss from insect feeding and bird damage, optimum yield potential was estimated using a regression formula by Pudelko et al. (1993) based on head length. Because of similarities in yields obtained in 2009 and 2010, the yields were pooled. Genotype LHB08 at 0 kg ha^{-1} and 120 kg ha^{-1} nitrogen gave the highest yield, followed by LHB08 at 40 kg ha^{-1} and 80 kg ha^{-1} nitrogen (Table 3). It can be concluded that genotype LHB08 have better overall genetic potential for yield (average yield 6,159 kg ha^{-1}) across all treatments in comparison to the other three genotypes that were used in the nitrogen rate experiment. This high yield is similar to findings by Sarr et al. (2008) where peal millet achieved a yield of 6,041 kg ha^{-1}. It can further be concluded that pearl millet possesses high N use efficiency as a result of which it can produce high yields with N supplementation.

Although it is traditionally known that pearl millet yields appreciably with low nutrient availability, there are conflicting reports of yield response to high fertilizer application rates (Gascho, Menezes, Hanna, Hubbard, & Wilson, 1995). In Eastern Nebraska, a significant increase in grain yield of pearl millet with application rate of 78 kg N ha^{-1} was observed by Maman, Mason, Galusha, and Clegg (1999) and Limon-Ortega et al. (1998). According to Menezes, Gascho, and Hanna (1999), highest pearl millet yield resulted from N rate of 112 kg ha^{-1}. On the other hand, N-fertilizer applications have also been reported to be associated with decreased grain yield under late planting situations, drought conditions or high levels of mineral N in soil. Residual nitrate has been reported to account for the inconsistencies in the response of pearl millet to nitrogen fertilization (Maranville & Sirifi, 1995). Kennedy et al. (2002) also reported inconsistencies in pearl millet yield in response to nitrogen application in Louisiana (USA).

3.7 Correlations

Plant height at 63 and 77 days after planting were positively correlation. Plant height at 49, 63 and 77 days after planting had a direct reflection on the grain yield produced (Table 4). This means that the taller the plants, the more yield they produced and vice versa.

Table 4. Correlation among plant height, number of plants booting, number of heads and estimated yield

	Plant height at 49 DAP	Number of plants booting at 49 DAP	Plant height at 63 DAP	Number of heads at 63 DAP	Plant height at 77 DAP	Estimated yield
Plant height at 35 DAP	0.42638 0.0004 64	0.00498 0.9799 28	0.54996 <.0001 64	0.29716 0.0171 64	0.15647 0.2169 64	0.23926 0.0611 62
Plant height at 49 DAP		-0.12266 0.5341 28	0.63310 <.0001 64	0.01551 0.9032 64	0.35595 0.0039 64	0.49544 <.0001 62
Number of plants booting at 49 DAP			-0.12703 0.5195 28	0.64393 0.0002 28	-0.34674 0.0707 28	-0.44627 0.0196 27
Plant height at 63 DAP				0.07528 0.5544 64	0.49266 <.0001 64	0.55257 <.0001 62
Number of heads at 63 DAP					-0.21212 0.0924 64	-0.30577 0.0157 62
Plant height at 77 DAP						0.49007 <.0001 62

Head length and the number of heads at the time of harvest were found to be negatively correlated. Previous work reporting a negative correlation between head length and number of heads in sorghum has been reported by Ezeaku and Mohammed (2006). Plants with fewer heads produced longer heads resulting in higher grain yield. Number of heads and the number of tillers were positively correlated. Therefore the higher thenumber of tillers, the higher the number of heads produced by each genotype. Also, the number of heads was positively correlated to the plant dry weight (Table 5).

Table 5. Pearson's correlation for number of heads, tiller and plant weight for pearl millet genotypes and combined nitrogen treatments for 2009 and 2010

	Number of heads	Number of tillers	Plant weight
Head length	-0.11668 <0.0001 1171	0.10792 0.0002 1193	0.00364 0.8999 1195
Number of heads		0.49646 <0.0001 1175	0.38643 <0.0001 1175
Number of tillers			-0.03296 0.2544 1198

4. Conclusion

Field production of pearl millet for grain in the southeastern United States is feasible based on the results of this study. Although, agronomic response varied significantly based on seasonal climatic conditions, pearl millet production in this region is still advantageous due to pearl millet's genetic pre-disposition to perform under stressful growing conditions including drought and low nitrogen.

We observed in this study that an increase in nitrogen rate did not increase the head length and the number of heads produced. Since these variables are primary contributors to grain yield, therefore, lack of response to increased nitrogen rates means this input can be eliminated, thus reducing cost of production while achieving optimal yields, provided that an appropriate cultivar is selected. Cultivars with higher number of heads and tillers were associated with high plant density and shorter plants. These characteristics are desirable for forage and grazing. However, genotypes with larger head size such as LHB08 would be more favorable for grain production. Increasing rates of nitrogen did not have significant impact on plant biomass and grain yield, but positively affected plant height of specific cultivars. Selection of genotypes for specific location and response to fertility should preclude other management inputs in wide-scale production of pearl millet based on needs for either biomass or grain yield.

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Notes

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