PLANT POPULATIONS AND SEEDING RATES

Pawel J. Wiatrak[1]*, David L. Wright[1], Wayne Hanna[2], Jerzy A. Pudelko[1], Jan Spitalniak[1], I. D. Teare[1]

ABSTRACT

Pearl Millet [Pennisetum glaucum (L.) R. Br.] is an important grain crop in many countries. In the southern USA, pearl millet is grown for forage and grain. This study was conducted to compare different row widths and seeding rates of the millet for the silage and grain. The research was conducted in 1988 and 1989 in Tifton (GA), and in 1993 and 1994 on Norfolk sandy loam soil at The North Florida Research Center, Quincy, Florida using hybrid grain millet HGM™100 developed by W. W. Hanna, Tifton, GA. In Tifton (GA), grain yield of millet in 1988 and 1989 was the highest at the lowest seeding rate (1.0 lb/A = 1.7 T/A), but was not significantly different in 1989 except for the 3.7 lb/A (1.2 T/A) seeding rate which was lower. In Quincy, highest grain yields in 1993 were obtained at the five inch row spacing with 4 and 6 lb/A seeding rates (2.8 T/A and 2.6 T/A). In 1994, the highest grain yield was again achieved in the 5 inch row spacing at 6 lbs seed/A (1.3 T/A), but it was not significantly different from 15 inch rows at 4 or 6 lb/A of seed (0.9 T/A and 1.3 T/A). Fresh silage yield in 1994 was generally lower than 1993 due in part to the excessive rainfall and, yields were similar for all row widths and seeding rates except in 5 inch rows at 4 lb/A (11.8 T/A), which was lower than only the 15 inch row at 4 lbs seed/A. Plant height or head length were not different in 1994. Number of grain heads were highest for the 6 lbs seeding rates at all row spacing in 1994, and had significantly less heads at the lowest seeding rates in 5 and 15 inch rows.

INTRODUCTION

Pearl millet is one of the most important crops in the semi-arid regions of the world (Rachie and Majmudar, 1980). Pearl millet has been shown to be highly digestible by swine (Dove and Myer, personal communition), beef cattle (Hill and Hanna, 1990), poultry (Smith et al., 1989), and catfish (Burtle et al., 1992).

In the USA, pearl millet has been grown mainly as a forage crop but it has potential as a grain crop for dryland areas (Christensen et al., 1984, 1987; Ibrahim et al., 1986). Results obtained in areas where pearl millet is traditionally grown as grain have indicated that its optimum seeding date depends on environmental conditions and plant photoperiodism (Carberry et al., 1985; Craufurd and Bidinger, 1989). M'Khaitir (1992) showed that population had no effect on millet yield and yield components, particularly head number per plant because tillers compensated for lower populations. Bationo et al. (1990) showed that increasing fertilization and plant density, increase grain yield of pearl millet in average or wet years and slightly reduces yield in a drought year. The objectives of this study were to compare row widths and seeding rates of millet to silage and grain yield and yield components.

MATERIALS AND METHODS

Studies were conducted in 1988 and 1989 on the Forage and Turf Research Unit Coastal Plain Experiment Station in Tifton (GA), and also in 1993 and 1994 on a Dothan sandy loam (fine, loamy siliceous, thermic Plinthic Kandiudult) located on the North Fla. Res. and Educ. Ctr., Quincy, FL. Soils of the Coastal Plain have a compacted layer located 6 to 14 inches below the surface. The pearl millet hybrid used in this study was the W.W. Hanna developed hybrid from Georgia, Agra Tech HGM™100.

In Tifton, GA, the field was fertilized with 250 lbs of 5:10:15 and seedbed prepared prior to planting millet. Millet was planted on June 14, 1988, and on June 15 in 1989 with four replications with plots 2 row by 18 feet long using seeding rates in 36 inch rows. The Quincy, FL experiments were planted on a winter fallow field. The experimental design was a split-plot with 4 replications. Preplant cultivation and fertilization included chisel-plowing, s-tine harrowed and fertilization with 500 lb/A of 5:10:15 (N:P:K). Millet was planted on 28 June 93 and on 26 May 94 with a H & N cone drill designed for 5 inch row increments. Three row widths and 3 seeding rates used each year were 5, 15, 30 inch rows at 2, 4, and 6 lbs seed/A. Seeds of millet were planted 1/2 to 3/4 inch deep. The row widths were an effect of using 13 rows, 4 rows and 2 rows from the planter in plots 5 feet wide by 25

[1]North Fla. Res. & Educ. Ctr., Quincy, FL 32351. University of Florida, Fla. Agric. Exp. Stn. Journal Series No. R-03949.
[2]Coastal Plain Expt. Stn., Agronomy, Univ. of Georgia, Tifton, GA 31793.
*Corresponding author.

feet long. During the planting of 4 and 2 rows, seed from other seed tubes were collected in small plastic buckets.

No herbicides were used at Tifton. At Quincy in 1993, the experiment was sprayed with Prowl @ 1.0 pt/A + Aatrax @ 1.5 lb/A preemergence. In 1994, Aatrax @ 1.0 lb/A and Prowl @ 1.5 pt/A were applied postemergence when millet was 5-6" high (8-9 leaf stage); 150 lb/A of N was applied in 1993 in 3 equal rates (at 5th leaf stage - 10 July; boot stage - 31 July and milk stage - 27 Aug.). In 1994 100 lb/A of N was applied when the millet was 6" high (9-10 leaves) and 50 lb/A at boot stage (before the heads became visible).

At both locations there was a problem with birds eating the grain from the heads at maturity. Tifton grain was harvested for yield. At Quincy, the regression equation (Wright, et al., 1994) was used to calculate the theoretical grain yield.

Lodging percentage was estimated from 0 % (no lodging) to 100 % (all plants lodged). All results of experiment were analyzed for variance and separated means using Fisher's Least Significant Difference Test at the 5% probability level.

RESULTS AND DISCUSSION

The number of plants per foot in Tifton (Table 1) was highest in both 1989 and 1989 at 4.6 lb/A seeding rate (65.5); but not different from the 4.6 lb/A (33.7) and 1.7 lb/A (30.3) in 1989. Plant heights were highest (Table 1) at higher and were shortest both years at the lowest seeding rate (1.0 lb/A) probably due to in less row competition for light and nutrients. No significant differences were noted in head length from the different seeding rates in 1988, however there was a significant shorter head length at the 3.7 lb/A seeding rate (11.2 inch) in 1989. Grain yield was highest at the lowest seeding rate in both 1988 and 1989 (1.7 T/A grain yield in 1988), but was only significantly higher than the 3.7 lb/A seeding rate (1.2 T/A grain yield) in 1989. Protein analysis on the grain were done only at Tifton. Lower protein levels were noted at the highest seeding rate 4.6 lb/A, 12.2% protein in 1988 and

Table 1. Agronomic Characteristics (plants/3 ft. row, plant height, head length, grain yield and % protein) for pearl millet at four seeding rates

Seeding Rate (lb/A)	Agronomic Characteristics	1988	1989
1.0	Plants/3 ft. row	15.8c	7.7c
1.7		20.8c	30.3ab
3.7		50.8b	24.0b
4.6		65.5a	33.7a
1.0	Plant height	69.6c	65.2c
1.7	(inch)	71.2bc	68.8ab
3.7		73.2a	69.2a
4.6		72.0ab	68.8ab
1.0	Head length	13.0a	11.7a
1.7	(inch)	12.5a	11.7a
3.7		13.1a	11.2b
4.6		12.8a	11.3ab
1.0	Grain yield	1.7a	1.5a
1.7	(T/A)	1.5b	1.4ab
3.7		1.1c	1.2b
4.6		1.1c	1.3ab
1.0	% Protein	12.7ab	10.8a
1.7		13.0a	10.1ab
3.7		12.6ab	10.0ab
4.6		12.2b	9.8b

Numbers followed by the same letter are not significantly different according to the LSD test ($P \leq 0.05$).

9.8% protein in 1989, and were significantly lower from only the 1.7 lb/A seeding rate in 1988 and 1.0 lb/A seeding rate in 1989.

Plant numbers, tillers and tillering index was obtained in 1994 from Quincy. In 1994 (Table 2) plant numbers were highest at the seeding rate of 6 lb/A and at the widest row space of 30 inches (253,700 pl/A), and lowest at lowest seeding rates. Number of plants were dependent on the seeding rates (6 lb/A = 240,800 pl/A; 4 lb/A = 199,200 pl/A, and at 2 lb/A = 114,000 pl\A), but there were no significant differences between the row widths. The number of stems/A (Table 2) was highest at the seeding rates of 6 and 4 lb/A (443,700 and 376,000 stems and tillers/A) and the 6 lb/A rate was significantly higher than 2 lb/A (302,900 stems and tillers/A). There were no significant differences between stem or tiller number for the row widths. The tillering index (Table 2), or number of stems per plant was highest at the 2 lb/A seeding rate and 5 and 15 inch row widths (3.169 and 2.703 tillering index). This was significantly lower at the higher seeding rates (4 lb/A = 0.824 and 6 lb/A = 1.860 tillering index), but there was no significant difference between the row spacings.

Table 2. Plant of seed and stems population plus tillering index (Quincy, FL) in 1994.

Row widths (inch)	Agronomic Charactistics		Seeding Rates (lb/A)			Mean
			2	4	6	
5	Pl/A (x 1000)		94.3c	190.4b	219.5ab	168.2a
15			122.7c	215.7b	228.9ab	189.1a
30			124.2c	191.6b	253.7a	196.6a
		mean	114.0b	199.2a	240.8a	
5	Stems and tillers/A (x 1000)		300.2c	346.5abc	449.4a	365.4a
15			318.0bc	432.8ab	424.2ab	391.6a
30			288.2c	348.8abc	457.6a	364.9a
		mean	302.9b	376.0ab	443.7a	
5	Tillering index (stems/plant)		3.169a	0.804c	2.055bc	2.376a
15			2.703ab	2.022bc	1.855c	0.994a
30			2.350bc	1.846c	1.669c	0.855a
		mean	2.741a	0.824b	1.860b	

Numbers followed by the same letter are not significantly different according to the LSD test ($P \leq 0.05$).

In 1993, there were little differences in the height of plants (Table 3) except for the two lower seeding rates in 5 inch rows (59.2 and 56.1 inches), which were shorter than the higher seeding rate and lower seeding rate in 15 inches rows and two lower rates in 30 inch rows. In 1994 there were not any significant differences between treatments in plant height. Grain head length (Table 3) in 1993 was without noticeable differences in the narrow rows at lower seeding rates and the wide rows at the low seeding rate. Head lengths were shorter at the highest seeding rate (6 lbs/A) in 15 and 30 inch rows (10.2 and 10.7 in. head length) agreeing with Tifton data. This might be expected because of more stems and tillers resulting in shorter heads. In 1994, there were no significant differences between treatments which was influenced by excessive rainfall.

Table 3. Plant heights, head lengths and grain heads per acre (Quincy, FL).

Row width (inch)	Agronomic Characteristics	Seeding rate (lb/A)	1993	1994
	Plant height (inch)	2	59.2b	62.4a
5		4	56.1b	58.5a
		6	62.3a	63.4a
		2	62.1a	61.8a
15		4	61.0ab	61.6a
		6	60.4ab	60.8a
		2	62.6a	61.8a
30		4	62.5a	63.5a
		6	60.8ab	61.9a
	Head length (inch)	2	12.2a	9.6a
5		4	11.9ab	9.4a
		6	12.0ab	8.7a
		2	11.7ab	9.7a
15		4	11.9ab	9.0a
		6	10.2d	9.2a
		2	11.6ab	9.0a
30		4	11.5b	9.3a
		6	10.7c	8.6a
	Grain heads/A (x 1000)	2	148.8b	96.1d
5		4	193.1a	109.8bcd
		6	190.9a	154.4abc
		2	138.7bc	103.0cd
15		4	149.6b	162.3ab
		6	147.4b	201.2a
		2	124.1c	117.1bcd
30		4	124.1c	157.5ab
		6	139.4bc	189.2a

Numbers followed by the same letter are not significantly different according to the LSD test ($P \leq 0.05$).

Table 4. Percent lodging, yield of fresh silage and grain yield of millet (Quincy, FL).

Row width (inch)	Agronomic Characteristics	Seeding rate (lb/A)	1993	1994
	Lodging %	2	5.0f	0.0a
5		4	22.5e	0.0a
		6	57.5c	0.0a
		2	36.3d	0.0a
15		4	47.5cd	0.0a
		6	70.6b	0.0a
		2	48.8cd	0.0a
30		4	76.3b	0.0a
		6	92.5a	0.0a
	Fresh silage (T/A)	2	22.2a	11.8ab
5		4	22.2a	11.8b
		6	23.4a	15.4ab
		2	19.8abc	15.2ab
15		4	21.0ab	17.6a
		6	17.0bc	12.2ab
		2	19.5abc	11.6ab
30		4	17.2bc	16.8ab
		6	16.4c	16.7ab
	Grain yield	2	2.2b	0.9abc
5	(T/A at moisture 15.5 %)	4	2.8a	0.9abc
		6	2.6a	1.3a
		2	0.9b	0.8bc
15		4	2.2b	0.9abc
		6	1.6c	1.3a
		2	1.7c	0.6c
30		4	1.7c	0.9abc
		6	1.6c	0.8bc

Numbers followed by the same letter are not significantly different according to the LSD test ($P \leq 0.05$).

The number of grain heads (Table 3) in 1993 was highest in 5 inch rows at two higher seeding rates 4 and 6 lb/A (193,100 and 190,900 grain heads/A). Other treatment values were lower with least number of heads occurring in wide rows. In 1994 the most heads were at the highest (6 lb/A seeding rate) at each row spacing (15 inches = 201,200; 30 inches = 189,200; 5 inches = 154,400 heads/A), (Table 3). Head numbers decreased with seeding rate and seeding rate had more influence on number than row width. The lowest numbers of grainheads in 1994 were at the low seeding rate, independent of row widths.

Lodging (Table 4) in 1993 was the lowest in 5 inch row spacing and 2 lb/A seeding rate (5.0 lodging %); and the highest in 30 inches row width and 6 lb/A of seed (92.5 lodging %). However, in 1994 there were not any lodged plants probably due to water logged soils and shorter plants. The yield of fresh silage (Table 4) in 1993 was the highest in 5 inch rows and 6 lb/A seeding rate (23.4 T/A fresh silage), 4 lb/A (22.2 T/A fresh silage) and 2 lb/A (22.2 T/A fresh silage); and the lowest in 36 rows and 6 lb/A seeding rate (16.4 T/A fresh silage). In 1994, there was tendency for highest yields in 15 inch rows spacing and 4 lb/A seeding rate (17.6 T/A fresh silage), and in 30 inch rows at 4 and 6 lb/A seeding rate (16.8 T/A fresh silage and 16.7 T/A fresh silage), but there were no significant differences. The grain yield of millet (Table 4) in 1993 was the highest at 5 inch rows and 4 and 6 lb/A seeding rates

(2.8 T/A and 2.6 T/A fresh silage), respectively. Yields were lowest at the widest row spacing with no significant differences for seeding rates. Grain yield of millet was also low in 15 inches row and 6.7 lb/A of seeding rate (1.6 T/A grain yield). In 1994 the highest grain yield was at 6 lb/A seeding rate in 5 inch (1.3 T/A grain yield) and 15 inch (1.3 T/A grain yield) wide rows, and the lowest in 30 inch rows at 2 lb/A seeding rate (0.6 T/A grain yield).

REFERENCES

Bationo, A., C.B. Christianson, and W.E. Baethgen. 1990. Plant density and nitrogen fertilizer effects on pearl millet production in Niger. Agron. J. 82:290-295

Burtle, G.J., G.L. Newton, and W.W. Hanna. 1992. Pearl millet replaces corn in channel catfish diets. In Abstracts of Annual meetings of the An. Soc. of An. Sci. & Intl. Soc. of Ethology. 8-11 Aug 1992. Pittsburg, PA.

Carberry, P.S., L.C. Campbell, and F.R. Bilinger. 1985. The growth and development of pearl millet as affected by plant population. Field Crops Res. 11:193-205.

Christensen, N.B., J.C. Palmer, H.A. Praeger, Jr., W.D. Stegmeier, and R.L. Vanderlip. 1984. Pearl millet, a potential crop for Kansas. Kansas Ag. Exp. Station. Keeping Up With Res 77.

Christensen, N.B., R.L. Vanderlip, and G.A. Milliken. 1987. Response of pearl millet to grain sorghum environments. Field Crops Res. 16:337-348.

Craufurd, P.Q., and F.R. Bidinger. 1989. Potential and realized yield in pearl millet (Pennisetum americanum) as influenced by plant population density and life cycle duration. Field Crops Res. 22:211-225.finishing pigs. J. Anim. Sci. 69:719-725.

Haydon, K.D. and S.E. Hobbs. 1991. Nutritive digestibilities of soft wheat, improved triticale cultivars, and pearl millet for

Hill, G.M. and W.E. Hanna. 1990. Nutritive characteristics of pearl millet grain in beef diets. J. Anim. Sci. 68:2061-2066.

Ibrahim, Y.M., V. Marcarian, and A.K. Dobrenz. 1986. Drought tolerance aspects in pearl millet. J. Agron. Crop. Sci. 156:110-116.

Rachie, K.O., and J.V. Majmudar. 1980. Pearl millet. Pennsylvania State University Press. College Park, PA.

Smith, R.L., L.S. Jensen, C.S. Hoveland, and W.W. Hanna. 1989. Use of pearl millet, sorghum and triticale grain in broiler diets. J. Prod. Agric. 2:78-82.

Virmani, S.M. and M.K.V. Sivacumar (ed.) Agrometeorology of sorghum and millet in the Semi-Arid Tropics: Proceedings, International Symposium, ICRISAT Center, Patancheru, India. 15-20 Nov. 1982. ICRISAT, Pancheru, India.

Wright, D.L., I.D. Teare, and J.A. Pudelko. 1994. Adjusting grain yield of bird damaged pearl millet. Fl. Acad. of Sci. Abstr. 57:8.