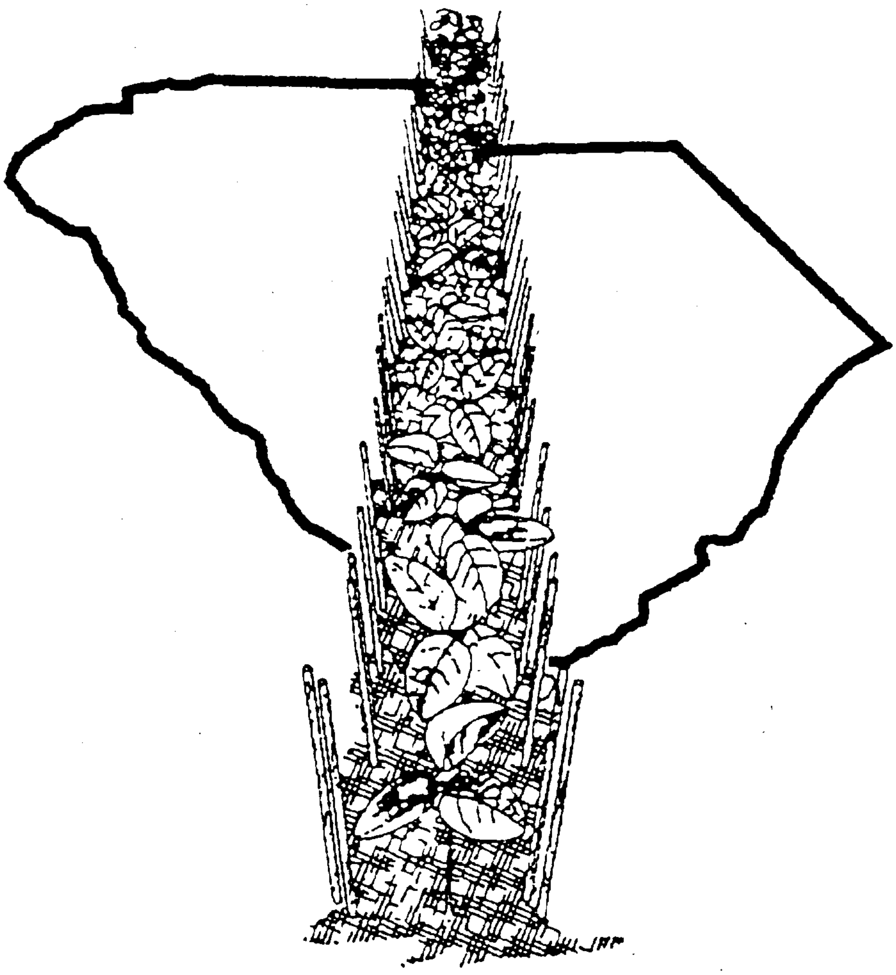
SARE Project LS93-53

David Wright

Proceedings of the

1994 Southern Conservation Tillage Conference for Sustainable Agriculture

Conservation Tillage for Improving Profitability



Columbia, South Carolina June 7-9, 1994

PEARL MILLET HEAD LENGTH IN RELATION TO INDUCED STRESS

J.A Pudelko[1], I.D. Teare[2], and D.L. Wright[3]

ABSTRACT

Pearl Millet [Pennisetum glaucum (L.) R. Br., hybrid HGM-100] panicle length is highly correlated with grain yield. Our objective was to relate pearl millet head length with two induced stressors: 1) herbicide stress, and 2) plant density stress (row width/seeding rate). This research was conducted on a Norfolk sandy loam located on the North Florida Res. and Educ. Ctr., Quincy FL. Preplant applications of Dual with 2,4-D or Atrazine, Ramrod alone or with Atrazine significantly ($P < 0.05$) increased head length in till and no-till treatment. Prowl and Atrazine increased head length in till treatment only. The mean head length across row widths for the 6 lb/A seeding rate was significantly shorter than the 2 and 4 lb/A seeding rate. The mean head length across seeding rates for the 5 inch row width was significantly greater than the 15 and 30 inch row width. This information helps evaluate whether pearl millet head lengths should be used to predict grain millet yield under certain imposed stress treatments.

INTRODUCTION

Pearl millet is a potentially-productive high-quality grain or silage crop (Burton et al.,1986 and Kumar et al., 1983). It is grown under low-input management conditions (noncrusting sandy soils) with little fertilizer and limited water (Payne et al., 1990).

Teare et al., 1994, describe physiological stage of development for each of four planting dates and related planting date and water availability to predicting grain yield from head length measurements. They found that head lengths for 5 May, 17 May, and 15 June plantings accurately predicted grain head yields, but 15 July planting produced less seed and smaller seeds with moderately long heads which was probably related to absence of pollinators (bumble bees, Bombus spp.) and lateness of the season. Timing, intensity and duration of water stress accounted for 70 to 85 % of the variation in pearl millet grain yields within and across years in other studies (Mahalakshmi et al., 1988). Critical growth stages identified as being sensitive to water stress were flowering and grain filling.

Two preplant herbicides, Pursuit and Accent, have been reported to reduce grain yield of pearl millet (HGM-100) 60 and 100 percent compared to a handweeded check (Wright et al., 1993). However, the effect of herbicide stress has not been reported in relation to head length [suggested by Pudelko et al. (1993) for estimating pearl millet grain yields in small research plots after bird predation].

The objective of this study was to determine the impact of certain induced-stresses [herbicide stress, and plant density stress (row width/seedling rate)] on pearl millet to head length, which has been used for predicting pearl millet head yields.

MATERIALS AND METHODS

These studies were conducted in 1993 on a Norfolk sandy loam (fine, loamy siliceous, thermic Typic Kandiudult) located on the North Florida Research and Education Center, Quincy, Florida. The soil has a compacted layer located 8 to 14 inches below the surface.

The pearl millet hybrid used in this series of experiments was HGM-100, developed as a grain pearl millet by W.W. Hanna (1991), Tifton, Georgia. Pearl millet seed was no-till planted (in-row subsoiled strip tillage) in a weed fallow field with a Brown Ro-Til implement with KMC planters.

Herbicide Study

A herbicide study on pearl millet was conducted on a very weedy field. Before it was planted, the field was mowed and divided into two equal parts. One halve for conventional tillage-planting and the other for no-tillage-planting. The conventional halve was subsoiled to 12-inch depth on 12 May and S-tine harrowed 2 June. The no-till part was sprayed with Gramoxone on 2 June at the rate of 3.0 pt/A primarily for nutsedge control.

[1] Agric. Univ. Inst. of Soil Cult. and Plant Prod., Mazowiecka 45/46, 60-623 Poznan' Poland.
[2] N. Florida Res. and Educ. Ctr., Quincy, FL 32351.
[3] Dept. of Agron., Inst. of Food and Agric. Sci., Univ. of FL, Gainesville, FL 32611.

ble 1. Pearl millet head length in relation to weed control on Till and No-Till system.

eatment	Rate per A	Till System Head Length[1]		No-Till System Head Length[1]	
Atrazine without oil	1.5 lbs	0.918	FGHI	0.875	FG
Atrazine without oil	2.0 pt	0.930	FGH	0.900	FG
Atrazine with oil	1.0 lb + 1 qt	0.870	HI	0.878	FG
Atrazine with oil	1.5 lbs + 1 pt	0.870	HI	0.945	EF
Dual + 2,4 D	1.0 pt + 0.5 lb (a.i.)	1.072	BC	1.100	AB
Dual + 2,4 D	1.5 pts + 0.5 lb (a.i.)	1.070	BC	1.120	AB
Dual + 2,4 D	2.0 pts + 0.5 lb (a.i.)	0.948	EFG	1.085	B
Ramrod (42%) + 2,4 D	3.0 qt + 0.5 lb (a.i.)	1.010	CDE	0.990	DE
Ramrod (42%) + 2,4 D	4.5 qt + 0.5 lb (a.i.)	1.017	CD	1.005	CDE
Prowl + 2,4 D	1.0 pt + 0.5 lb (a.i.)	0.910	GHI	0.882	FG
Prowl + 2,4 D	1.5 + 0.5 lb (a.i.)	0.880	HI	0.938	EFG
Dual + Atrazine with oil	1.0 pt + 1.0 lb	1.253	A	1.075	BC
Dual + Atrazine with oil	1.5 pt + 1.0 lb	1.058	BC	1.173	A
Ramrod + Atrazine with oil	3.0 qt + 1.0 lb	1.102	B	0.888	FG
Ramrod + Atrazine with oil	4.5 qt + 1.0 lb	0.948	EFG	1.058	BCD
Prowl + Atrazine with oil	1.0 pt + 1.0 lb	0.918	FGHI	0.865	G
Prowl + Atrazine with oil	1.5 pt + 1.0 lb	0.975	DEF	0.900	FG
Check hand weed control		0.858	I	0.889	FG
Check without weed control		0.900	GHI	0.897	FG
Check without weed control		0.908	GHI	0.905	FG
ean[1]		0.971 z		0.968 z	
On till only Ramrod + Atrazine with oil and Prowl postemer 4.5 qt + 1.0 lb		0.895	GHI		
On [illegible] only Prowl + Atrazine with oil and Prowl postemer 1.0 pt + 1.0 lb		0.898	GHI		

Mean values in columns followed by the same letter are not significantly different at the 5% level of significance.

Mean values in row followed by the same letter are not significantly different at the 5% level of significance.

Cultural practices common to both tillage ystems were: 1) the application of 500 lb/A of 5-0-15 fertilizer 21 June, 2) pearl millet seed eatment with Concep to "safen" herbicide pplication (particularly Dual), 3) planting on 23 une followed by irrigation with 3/4 inch of water n the day of planting, 4) seeding rate of 4 lb/A in lots 12 feet by 25 feet in 36" rows (plant density f 166 000 plants per acre), 5) band application of 0 lb N/A as ammonium nitrate applied two inches o the side of row on 21 July, 6) spraying with annate for control of corn earworm on 8 July, and) all plots were sprayed with 2,4-D for broad leaf veed control on 16 July.

Seventeen pre-emerge herbicide treatments were applied in different herbicide combinations (Dual (Metolachlor), Ramrod (Propachlor), Prowl (Pendimethalin), Atrazine, and 2,4,-D) on 25 June (Table 1). Two postemergence treatments of Prowl were applied following pre-emerge applications of Atrazine, plus either Ramrod or Prowl in the till system only. One hand weeded treatment and two treatments without weed control completed the 22 treatments used in this study (Table 1).

The experiment was a split plot design with tillage systems as whole plots and herbicide treatments as sub-plots. All treatments were replicated four times. Results were subjected to analysis of variance and means were separated using Fishers Least Significant Difference Test at the 5 % level of probability.

Row Width/Seeding Rate Study

The row width-seeding rate study was planted on 28 June. Row widths and seeding rates used in the study are shown in Table 2. Plot size was 5 feet wide X 25 feet long.

Cultural practices common across all row widths and seeding rates were: 1) application of 500 lb/A of 5-10-15 before planting on 25 June; 2) application of ammonium nitrate banded beside row at 50 lb N/A at 5th leaf stage (10 July), boot stage (31 July), and milk stage (27 Aug) (total N applied, 150 lb/A); and application of Prowl + Atrazine at 1.0 and 1.5 lb/A, respectively on 30 June after planting and before emergence (3 July).

Plant population density (plants per acre and plants per linear foot of row) are shown in Table 2 for each seedling rate and row width. Note the uniform plant population density across row widths (columns) and the increased number of plants within the row as row width increased for each seeding rate.

RESULTS AND DISCUSSION

Herbicide Study

Tillage systems had no effect on pearl millet head length ($\underline{P} < 0.05$) (Table 1). Number of heads/A is an indication of herbicide treatment stress. Figure 1, with herbicide treatments ordered in relation to number of heads/A, shows the lowest number of heads/A or greatest herbicide stress at the left of the X axis and least herbicide stress at the right of the X axis. Herbicide treatments and their numerical codes are shown in Table 1. In the till system (Fig. 1), head lengths were significantly longer ($\underline{P} < 0.05$) with Dual and 2,4-D treatment at the two lower rates (trt 6 and 7), Ramrod and 2,4-D (trt 8 and 9), Dual and Atrazine (trt 12 and 13), Ramrod and Atrazine at the lower rate (trt 13), and Prowl and Atrazine (trt 17) than with the no-herbicide application trt (18, 19, 20). In the no-till system (Fig. 1) seed head lengths were significantly ($\underline{P} < 0.05$) longer for Dual and 2,4-D at all rates (trt 5, 6, and 7), Ramrod at all rates (trt 8 and 9), Dual and Atrazine (trt 13 and 14), and Ramrod and Atrazine (trt 15) than for the no-herbicide application. With the exception of trt 14 (Ramrod @ 4 qt/A and Atrazine with oil @ 1 lb/A), Dual and Ramrod increased head lengths and reduced number of heads/A.

The two post emergence treatments in the till system, of Ramrod and Atrazine (trt 21) and Prowl and Atrazine (trt 22), had no effect on pearl millet head length ($\underline{P} < 0.05$).

Row Width/Seeding Rate Study

The effect of pearl millet population density (plants/A and plants/linear foot of row) for each combination row width/seeding rate are shown in Table 2. Population density increased in rows from left to right according to seeding rate, but population density in columns from top to bottom across row widths remained constant. Plants/linear foot of row increased for each row width from left to right and from top to bottom for all seeding rates across row widths (Table 3). Population density effects on pearl millet head lengths are shown in Table 3. The mean head length across row widths (Table 4) for the 6 lb/A seeding rate was significantly shorter than the 2 and 4 lb/A seeding rate ($\underline{P} < 0.05$). The mean head length across seeding rates (Table 4) for the 5 inch row width was significantly greater than the 15 and 30 inch row widths ($\underline{P} < 0.05$).

CONCLUSIONS

1. Tillage systems had no significant effect on head length.

2. Pre-emerge applications of Dual and 2,4-D; Ramrod; Dual and Atrazine; Ramrod and Atrazine increased head length in till and no-till systems. The Prowl and Atrazine treatment increased head length in the till system only.

3. Post emergence treatments of Ramrod and Atrazine and Prowl and Atrazine had no effect on head length ($\underline{P} < 0.05$).

4. The mean head length across row widths for the 6 lb/A seeding rate was significantly shorter than the 2 and 4 lb/A seeding rates ($\underline{P} < 0.05$).

5. The mean head lengths across seeding rates for the 5 inch row width was significantly greater than the 15 and 30 inch row widths ($\underline{P} < 0.05$).

This knowledge is useful for assessing the value of the predictive equation (Pudelko et al., 1993) for estimating pearl millet head yield of small

Table 2. Plant population density (plants/A) and plants/linear foot of row[1] are shown for each combination seeding rate and row width.

Row width (inches)	Seeding Rate[2] (lb/A) 2	4	6
5	89,000 (0.85)	172,000 (1.65)	264,000 (2.53)
15	88,000 (2.54)	176,000 (5.06)	266,000 (7.64)
30	88,000 (5.08)	177,000 (10.16)	265,000 (15.23)

[1]Plants/linear foot of row in brackets

[2]Emergence rate approximately 55% of seeding rate

Table 3. Pearl millet head lengths[1] in relation to row width and seeding rate.

Row Width (inches)	Seeding Rate (lb/A) 2	4	6	$\bar{x}$
5	1.013	0.995	0.998	1.002 A
15	0.975	0.992	0.848	0.938 B
30	0.970	0.955	0.895	0.940 B
$\bar{x}$	0.986 A	0.981 A	0.913 B	

[1] Mean values followed by the same letter are not significantly different at the 5% level of significance.

research plots after bird predation. In the decision making process, it is important to know that Dual and Ramrod increase head length more than Prowl,that high seeding rates shorten head lengths, and that narrow rows lengthen heads lengths.

ACKNOWLEDGEMENTS

Our thanks to E. Brown Agricultural Technician IV; North Fla. Res. and Educ. Ctr. Univ. of Fla., Quincy, FL; for plot preparation and management, data collection, computer processing, and data illustration.

REFERENCES

Burton, G.W., A.T. Primo, and R.S. Lowrey. 1986. Effect of clipping frequency and maturity on the yield and quality of four pearl millets. Crop Sci. 26:79-81.

Hanna, W.W. 1991. Pearl millet-a potentially new crop for the U.S. In Abstracts of Technical Papers, No. 18, Southern Branch ASA, 2-6 Feb 1991, Ft. Worth, TX.

Kumar, K.A., S.C. Gupta, and D.J. Andrews. 1983. Relationship between nutritional quality characters and grain yield in pearl millet. Crop Sci. 23:232-234.

Mahalakshmi, V., F.R. Bidinger, and G.D.P. Rao. 1988. Timing and intensity of water deficits during flowering and grain-filling in pearl millet. Agron. J. 80:130-135.

Pudelko, J.A., D.L. Wright, and I.D. Teare. 1993. A method for salvaging bird damaged pearl millet research. Fla. Agric. Exp. Stn. Res. Rep. No. NF 93-12:1-11.

Teare, I.D., D.L. Wright, and J.A. Pudelko. 1994. Pearl millet stages of development in relation to planting date and available water. Fla. Agric. Exp. Stn. Res. Rep. No. NF-94-11:1-12.

Wright, D.L., I.D. Teare, F.M. Rhoads, and R.K. Sprenkel. 1993. Pearl millet production in a no-tillage system. p. 152-159. In P. Bollich (Ed.) 1993 Southern Cons. Tillage Conf. for Sustainable Agric. June 15-17, Monroe, LA. SB 93-1.