

## PEARL MILLET HEAD LENGTH IN RELATION TO INDUCED STRESS

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### ABSTRACT

Pearl Millet [Pennisetum glaucum (L.) R. Br., hybrid HGM-1001 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 Kandudult) 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 half for conventional tillage-planting and the other for no-tillage-planting. The conventional half 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.

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

Treatment	Rate per A	Till System Head Length <sup>1</sup>		No-Till System Head Length <sup>1</sup>	
1. Atrazine without oil	1.5 lbs	0.918	FGHI	0.875	FG
2. Atrazine without oil	2.0 pt	0.930	FGH	0.900	FG
3. Atrazine with oil	1.0 lb + 1 qt	0.870	HI	0.878	FG
4. Atrazine with oil	1.5 lbs + 1 pt	0.870	HI	0.945	EF
5. Dual + 2,4 D	1.0 pt + 0.5 lb (a.i.)	1.072	BC	1.100	AB
6. Dual + 2,4 D	1.5 pts + 0.5 lb (a.i.)	1.070	BC	1.120	AB
7. Dual + 2,4 D	2.0 pts + 0.5 lb (a.i.)	0.948	EFG	1.085	B
8. Ramrod (42%) + 2,4 D	3.0 qt + 0.5 lb (a.i.)	1.010	CDE	0.990	DE
9. Ramrod (42%) + 2,4 D	4.5 qt + 0.5 lb (a.i.)	1.017	CD	1.005	CDE
10. Prowl + 2,4 D	1.0 pt + 0.5 lb (a.i.)	0.910	GHI	0.882	FG
11. Prowl + 2,4 D	1.5 + 0.5 lb (a.i.)	0.880	HI	0.938	EFG
12. Dual + Atrazine with oil	1.0 pt + 1.0 lb	1.253	A	1.075	BC
13. Dual + Atrazine with oil	1.5 pt + 1.0 lb	1.058	BC	1.173	A
14. Ramrod + Atrazine with oil	3.0 qt + 1.0 lb	1.102	B	0.888	FG
15. Ramrod + Atrazine with oil	4.5 qt + 1.0 lb	0.948	EFG	1.058	BCD
16. Prowl + Atrazine with oil	1.0 pt + 1.0 lb	0.918	FGHI	0.865	G
17. Prowl + Atrazine with oil	1.5 pt + 1.0 lb	0.975	DEF	0.900	FG
18. Check hand weed control		0.858	I	0.889	FG
19. Check without weed control		0.900	GHI	0.897	FG
20. Check without weed control		0.908	GHI	0.905	FG
Mean <sup>2</sup>		0.971 z		0.968 z	
21. On till only Ramrod + Atrazine with oil and Prowl postemer 4.5 qt + 1.0 lb		0.895	GHI		
22. On till only Prowl + Atrazine with oil and Prowl postemer 1.0 pt + 1.0 lb		0.898	GHI		

<sup>1</sup> Mean values in columns followed by the same letter are not significantly different at the 5% level of significance.

<sup>2</sup> 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 systems were: 1) the application of 500 lb/A of 5-10-15 fertilizer 21 June, 2) pearl millet seed treatment with Concep to "safen" herbicide application (particularly Dual). 3) planting on 23 June followed by irrigation with 3/4 inch of water on the day of planting, 4) seeding rate of 4 lb/A in plots 12 feet by 25 feet in 36" rows (plant density of 166 000 plants per acre), 5) band application of 80 lb N/A as ammonium nitrate applied two inches to the side of row on 21 July, 6) spraying with Lannate for control of corn earworm on 8 July, and 7) all plots were sprayed with 2.4-D for broad leaf weed 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.

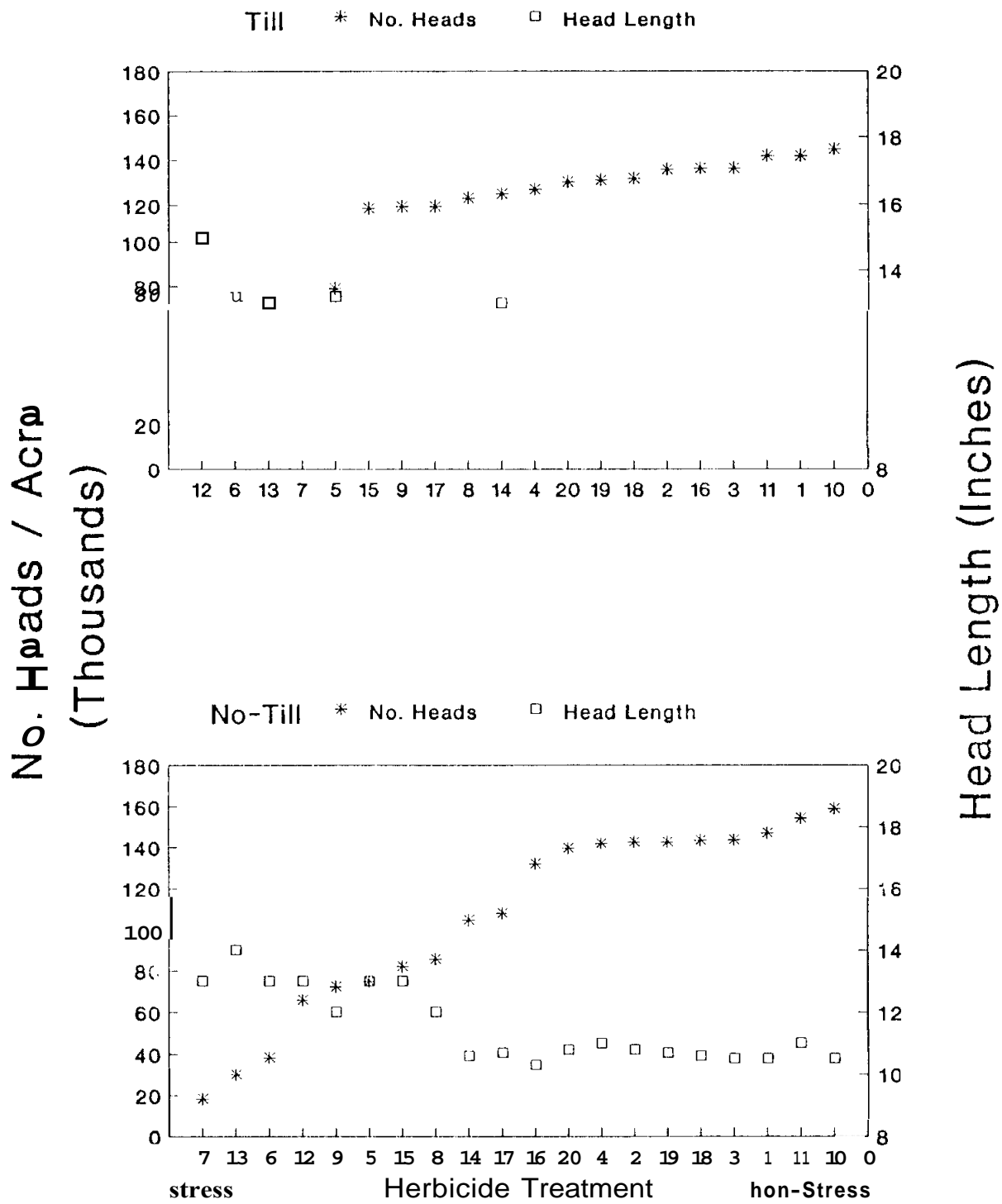


Figure 1. Herbicide stress indicated by number of heads/A in relation to herbicide treatment and head length (inches) of till and no-till systems.

### 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 seeding 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 ( $P < 0.051$ ) (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 ( $P < 0.05$ ) 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 ( $P < 0.05$ ) 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 ( $P < 0.05$ ).

### 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 ( $P < 0.051$ ). 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 ( $P < 0.05$ ).

## 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 ( $P < 0.05$ ).
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 ( $P < 0.051$ ).
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 ( $P < 0.05$ ).

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<sup>1</sup> are shown for each combination seeding rate and row width.

Row width (inches)	Seeding Rate <sup>1</sup> (lb/A)		
	2	4	6
5	<b>89,000</b> (0.85)	<b>172,000</b> (1.65)	<b>264,000</b> (2.53)
15	<b>88,000</b> (2.54)	<b>176,000</b> (5.06)	<b>266,000</b> (7.64)
30	<b>88,000</b> (5.08)	<b>177,000</b> (10.16)	<b>265,000</b> (15.23)

<sup>1</sup>Plants/linear foot of row in brackets

<sup>1</sup>Emergence rate approximately 55% of seeding rate

Table 3. Pearl millet head lengths<sup>1</sup> in relation to row width and seeding rate.

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

<sup>1</sup> 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.

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