SARE Project LS93-53

Quincy NFREC Research Report 94-5

HERBICIDE EFFECTS ON PEARL MILLET IN RELATION TO WEED CONTROL AND CROP DAMAGE

J.A. Pudelko, D.L. Wright, I.D. Teare*

J.A. Pudelko; Agric. Univ. Inst.of Soil Cult. and Plant Prod.,Mazowiecka 45/46, 60-623 Poznan', Poland:
D.L. Wright, I.D. Teare; North Florida Res. and Educ. Ctr. Quincy, FL 32351 (Dept of Agronomy, Inst. of Food and Agric. Sci., Univ. of Florida, FL 32611). *Corresponding author.

ABSTRACT

Pearl Millet [Pennisetum glaucum (L.)] is a potentially-productive, high-quality grain or silage crop. The objective of the 1993 study was to characterize the effects of various herbicides on pearl millet injury over time on grain and silage yield in relation to herbicide concentration, tillage system, and weed control. This research was conducted on a Norfolk sandy loam located on the North Florida Res. and Educ. Ctr., Quincy FL with HGM-100 (W.W. Hanna, Tifton, GA) pearl millet hybrid. Herbicide control for grass and broadleaf type weeds were similar between no-till and till systems. Pearl millet injury in relation to herbicide treatment and three dates after treatment are shown. The three herbicide combinations that gave the lowest grain yields were Dual with either 2,4-D or Atrazine. Atrazine (alone) and Prowl treatments resulted in higher grain yields. The interaction of number of heads/A and head length with herbicide treatment are shown. 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. Silage yield was affected by herbicide treatments more than plant height.

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).

Timing, intensity and duration of water stress accounted for 70 to 85 % of the variation in pearl millet grain yields within and across years (Mahalakshmi et al., 1988). Critical growth stages receiving water stress were flowering and grain filling.

Two preplant herbicides, Pursuit and Accent, were reported to reduce grain yield of pearl millet (HGM-100) 60 and 100 percent, respectively, compared to the handweeded check (Wright et al., 1993), but the specific effects of herbicide stress on pearl millet have only been reported in relation to head length (Pedulko, et al.,1993).

The objective of this study was to characterize the effects of various herbicides on pearl millet injury over time and on both grain and silage yield in relation to concentration, tillage systems, pearl millet injury, and weed control (grass and broadleaves).

MATERIALS AND METHODS

The study was 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 a weed fallow field with a Brown Ro-Til implement with KMC planters.

A herbicide study on pearl millet was conducted on a field where weeds had not been controlled for a year. The field was very weedy (crab grass, Texas panicum, purple nutsedge, sicklepod, morning glory, pigweed, cocklebur). Before it was planted, the field was mowed and divided into two equal parts. One part for conventional tillage-planting and the other for no-tillage-planting. The conventional part was subsoiled at 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.

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), 4. band application of 80 lb ammonium nitrate/A two inches to the side of row on 21 July, 5. spraying with Lannate for control of corn earworm on 8 July, and 6. all plots were sprayed with 2,4-D for broadleaf weed control on 16 July.

Pre-emerge herbicide treatments (1-17) were applied on 25 June in 17 different herbicide combinations (Dual, Ramrod, Prowl, Atrazine, and 2,4,-D) (Table 1). Two postemergence treatments (21,22) of prowl were applied on 3 July following pre-emerge applications of Atrazine, Ramrod and Prowl on 25 June in the no-till system only. One hand weeded treatment (18) and two treatments without weed control (19, 20) completed the 22 treatments used in this study (Table 1).

Herbicide injury on pearl millet for treatments 1-20 was estimated by eye as percent (%) injury on 12, 21 July and 2 Aug. Percent broadleaf control was estimated on 2 July and percent grass control was estimated on 21 July. Plant height, head length, and number of heads per acre were measured in the late dough stage.

Bird damage to pearl millet grain during the soft dough stage made it necessary to predict grain yield by regression analysis from head lengths as reported by Pudelko et al., 1993.
and reported in bu/A. Fresh silage yields were harvested with a tractor pulled silage harvester 12 Sept and reported in tons/A (weight of fresh silage).

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.

RESULTS AND DISCUSSION

When herbicide treatments are ordered on the x axis in relation to a response on the y axis with the highest response to the right and the lowest response at the left, then severity of herbicide treatment and interactions can be observed by the reader.

Percent weed control for grass and broadleaf weed types were not significantly different between no-till and till systems (Fig. 1). LSD's for percent pearl millet injury are shown in subfigures of Fig. 1 for each weed type and tillage system. There was a 40% difference in control of weedy grasses and broadleaves between the checks with no weed control (19 and 20) and the check that was hand weeded. Treatments 9,8,7,5,6 gave the poorest control of broadleaves and treatments 2 and 1 gave the poorest control of grasses. Herbicide treatments and their numerical codes are shown in Table 1.

Wright et al. (1993) reported herbicide injury to pearl millet by Dual and Ramrod in 1992. In 1993, herbicide treatments were expanded to 20 in no-till and 22 in the till systems (Table 1). Percent injury to pearl millet is shown in Fig. 2. LSD's for percent pearl millet injury are shown in subfigures of each date/tillage combination. No-till treatments were not different from till treatments at the 0.05% level of significance. Percent injury decreased slowly with time.

Grain yield:

Predicted grain yield is shown in relation to herbicide treatment in Fig. 3 The three lowest grain yielding treatments were Dual +2,4-D or Atrazine combinations. Atrazine and Prowl treatments were in the higher grain yields with the checks. Two treatments that changed positions radically in the till compared to the no-till were treatment 9 (Table 1) [Atrazine (1.5 lb) + oil (1 pt)] and treatment 4 (Table 1) [Ramrod (4.5 qt) + 2,4-D (0.5 lb)].

Components of grain yield:

Yield/one head is shown at the top of Fig. 4 for no-till and till. It appears to be more like head length than like number of heads/A (note the interaction of treatments 9 and 4. Number of heads/A appears to be more affected by herbicide treatments than either yield/one head or head length. The interaction of number of heads/A and head length with herbicide treatments are shown in Fig. 5.

Length of heads:

In the till system (Fig. 4), seed head lengths were significantly longer (P = 0.05) with Dual and 2,4-D treatment (trt) 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 rates (trt 13), Prowl and Atrazine (trt 17) than no herbicide application trt (18, 19, 20). In the no-till system (Fig. 4) 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 no herbicide application in the no-till system. 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 of Ramrod and Atrazine (trt 21) and Prowl and Atrazine (trt 22) had no effect on pearl millet head length (P = 0.05).Silage Yield:

Silage yield and plant height:

Wright et al. (1994) reported that plant height was not related to fresh silage yield and suggested that stalk diameter and leaf area index may be better predictors of fresh silage yield. We found that herbicides did affect silage yield and to a lesser extent plant height. Treatments 7,13,6,5, and 12 were always in the lowest treatments for silage yield and plant height.

CONCLUSIONS

1. Herbicide control for grass and broadleaf types were similar between no-till and till systems.
2. Percent injury curves in relation to herbicide treatment and three dates after treatment are shown.
3. The herbicide treatments that gave the lowest grain yields were Dual with either 2,4-D or Atrazine. The Atrazine and Prowl treatments resulted in higher grain yields.
4. The interaction of number of heads/A and head length with herbicide treatment are shown.
5. Tillage systems had no significant effect on head length.
6. 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.
7. Post emergence treatments of Ramrod and Atrazine and Prowl and Atrazine had no effect on head length ($\underline{P}$ = 0.05).
8. Silage yield was affected by herbicide treatments more than plant height.

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.

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Table 1. Pearl millet mean head length (inches) in relation to herbicide treatments on Till and No-Till system (1993).

Treatment		Rate per A	Till System Head Length[1]		No-Till System Head Length[1]	
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[2]			0.971 z		0.968 z	
21.	On till only;postemerge Prowl (1.0 lb) following preemerge Ramrod + Atrazine with oil (4.5 qt + 1.0 lb)		0.895	GHI		
22.	On till only;postemerge Prowl (1.0 lb) following preemerge Prowl + Atrazine with oil 1.0 pt + 1.0 lb		0.898	GHI		

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

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

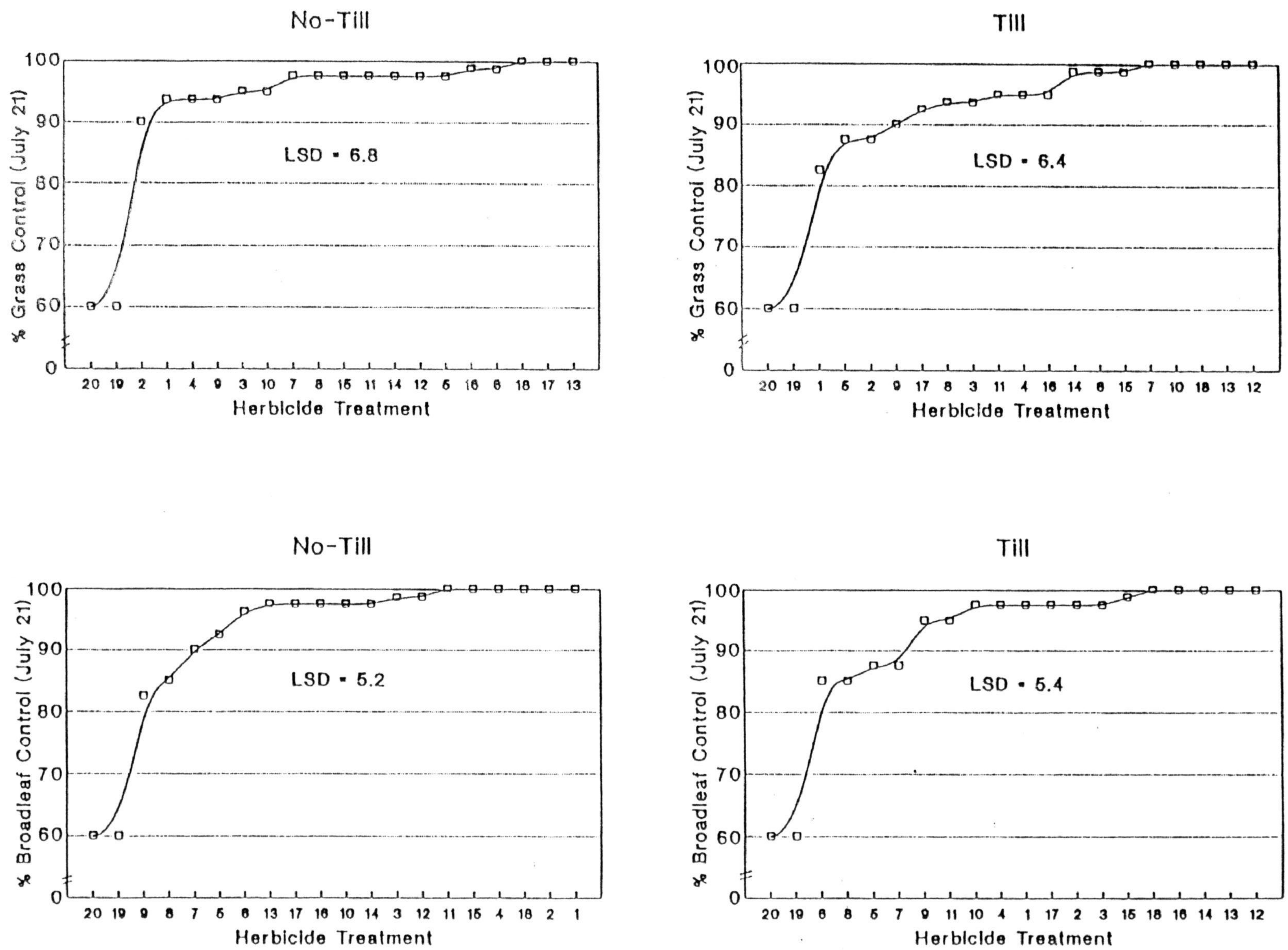

Figure 1. Percent grass and broadleaf control (evaluation 21 July) in relation to herbicide (applied preemerge 25 June) and tillage treatments on pearl millet (1993).

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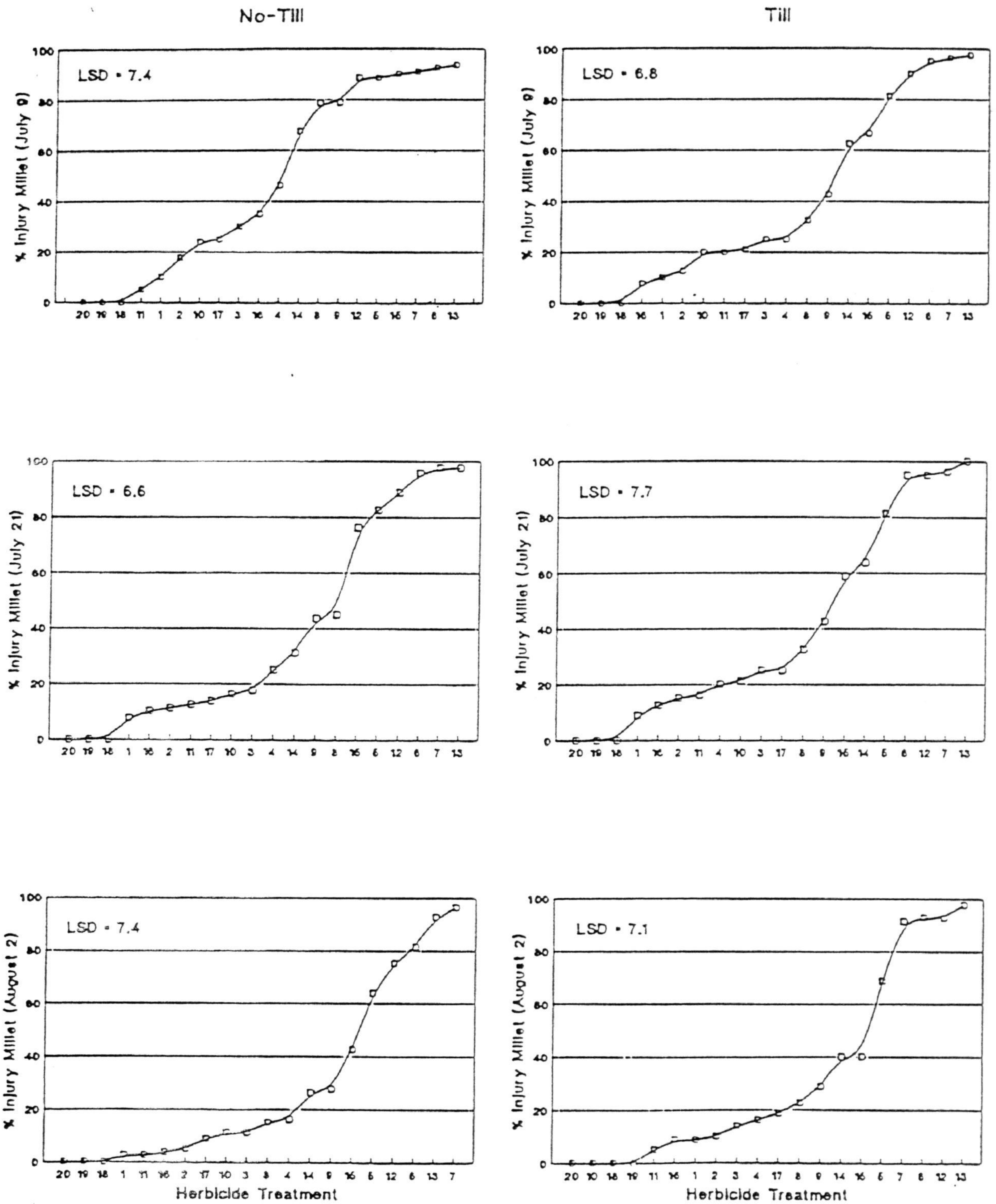
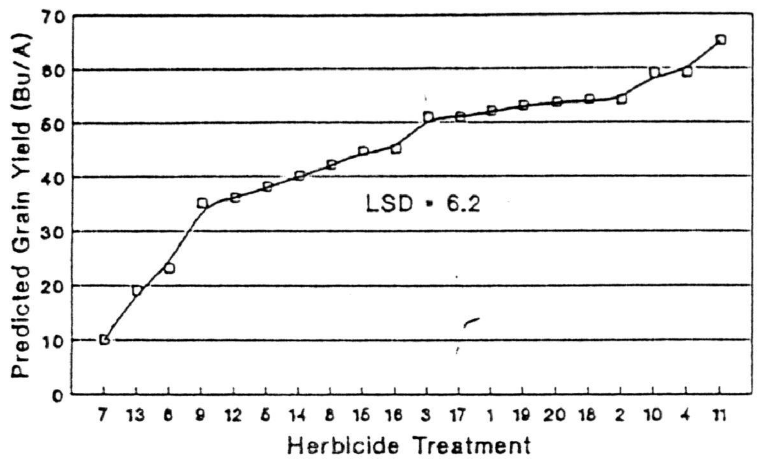


Figure 2. Percent (%) herbicide (applied preemerge 25 June) injury to pearl millet in relation to evaluation dates, herbicide and tillage treatments 91993). LSD for pearl millet injury due to herbicide treatment for date after treatment and tillage combination.

No-Till



Till

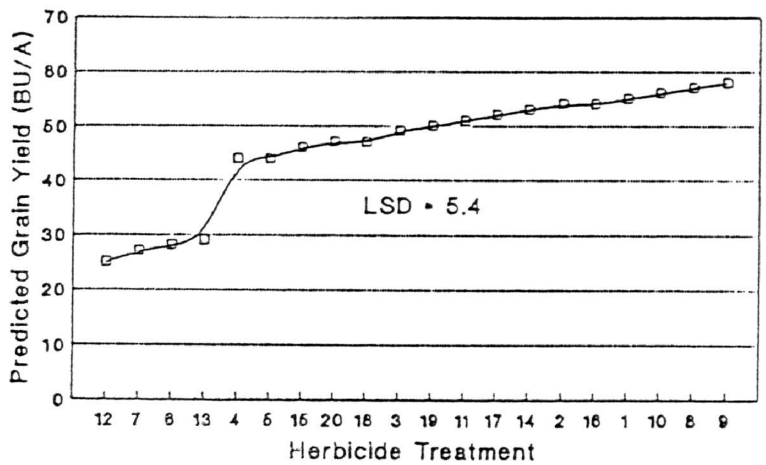


Figure 3. Pearl millet harvested grain yield and predicted grain yield in relation to herbicide and tillage treatments (1993).

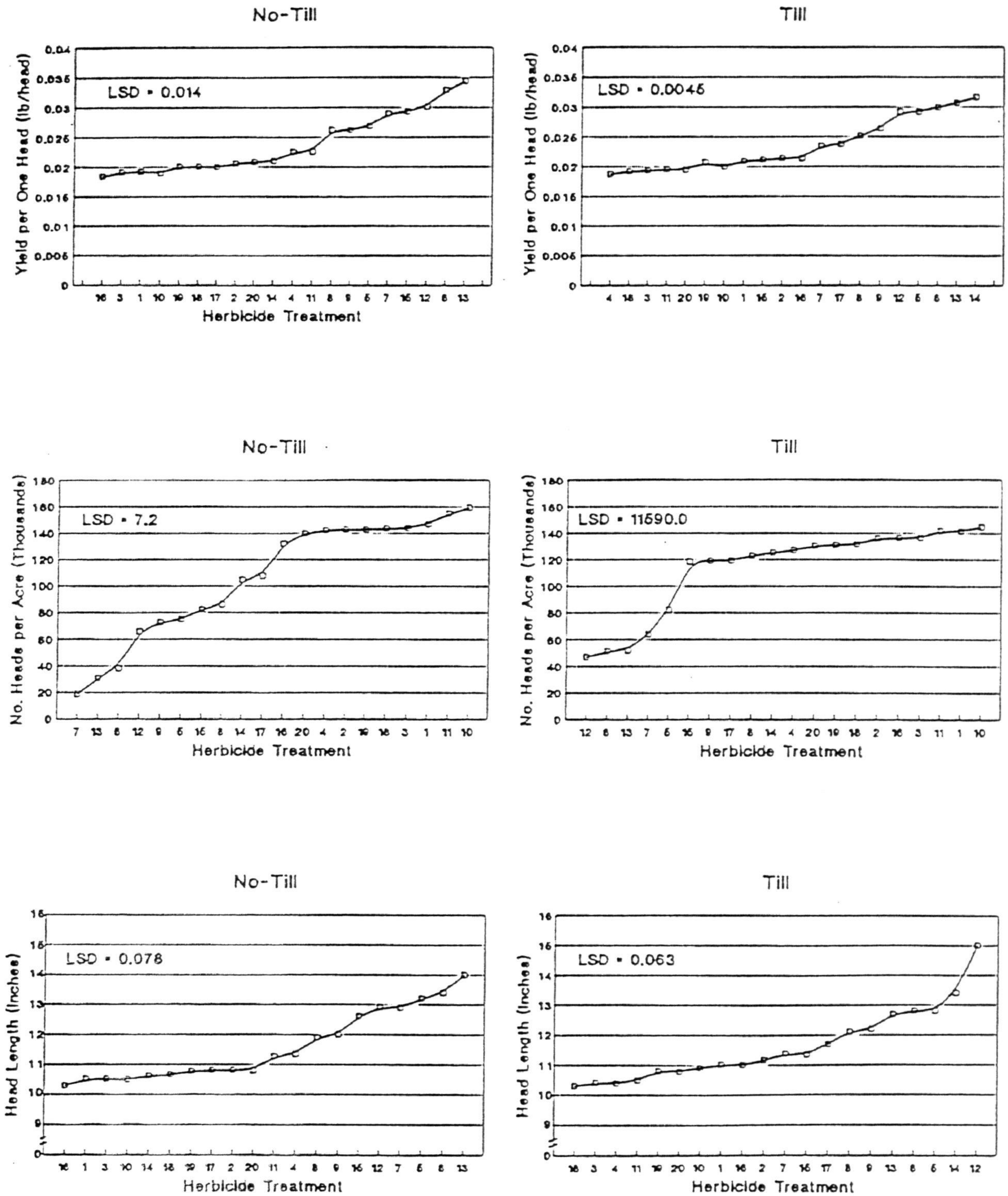


Figure 4. Components of pearl millet grain yield (yield/head, no. heads/A, length of head) in relation to herbicide and tillage treatments (1993).

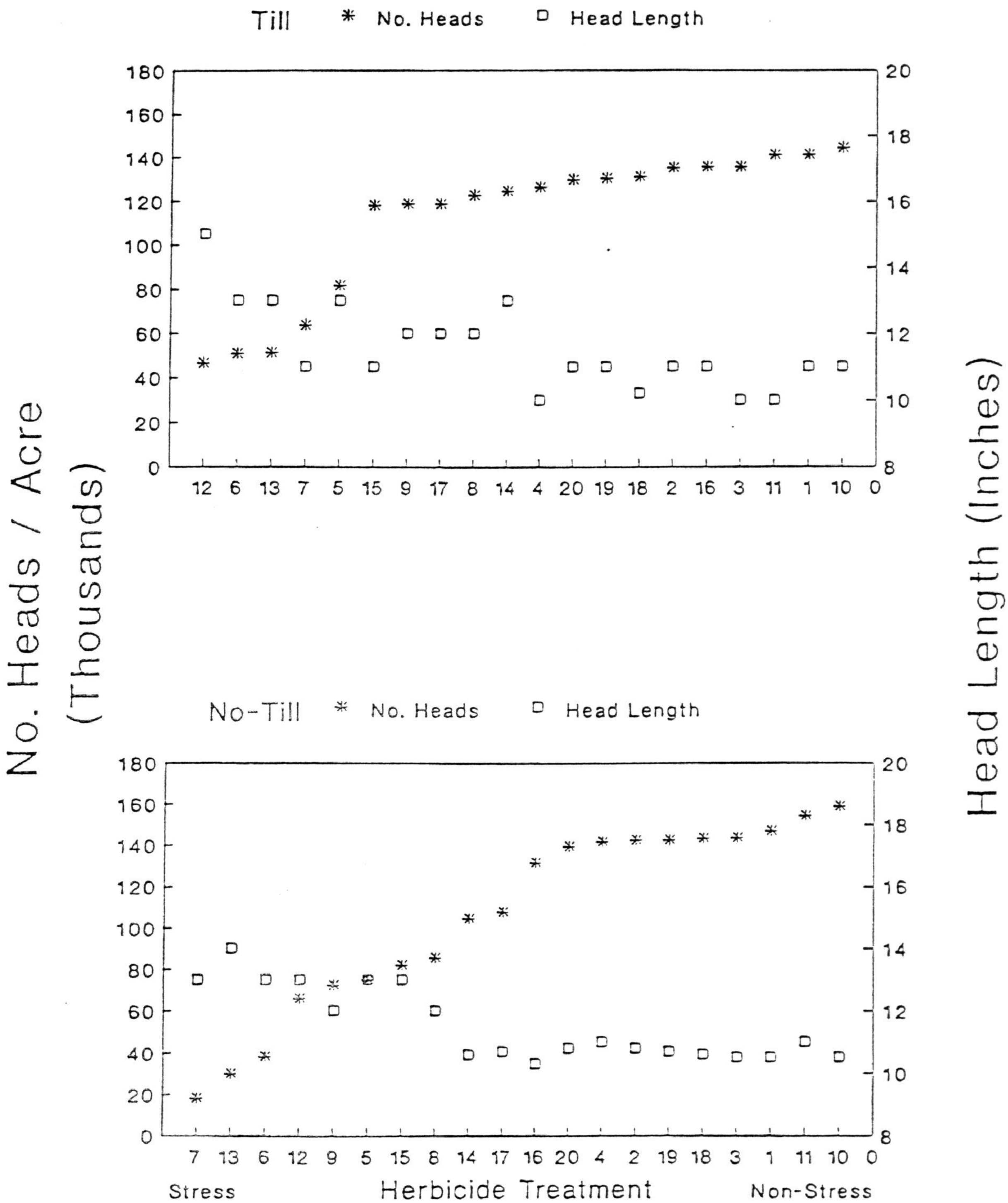


Figure 5. Herbicide stress indicated by number of heads/A in relation to herbicide treatment and length (inches) of till and no-till systems.

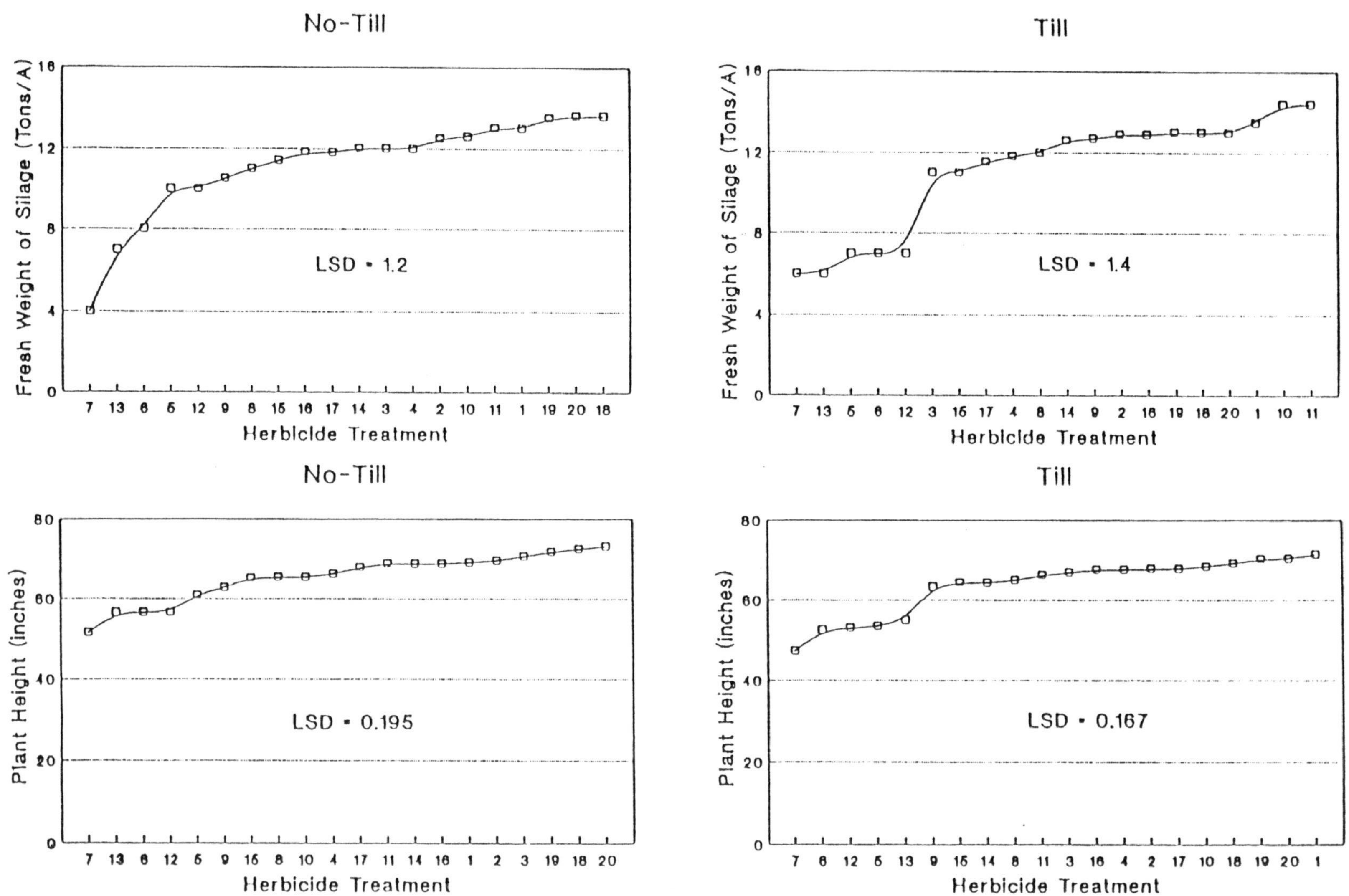


Figure 6. Pearl millet fresh weight silage yield and plant in relation to herbicide and tillage treatments (1993).