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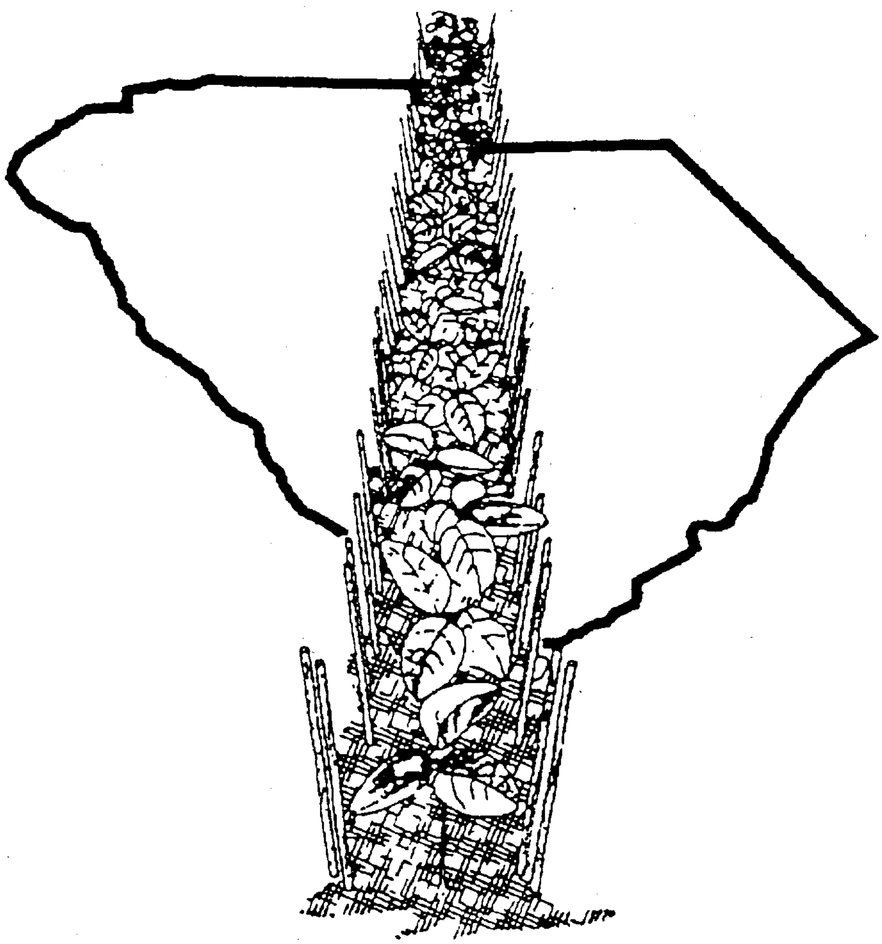

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PHYSIOLOGICAL DEVELOPMENT OF HGM-100 TO PLANTING DATE AND AVAILABLE WATER

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ABSTRACT

Physiological status in plants is dynamic with soil water, atmospheric conditions, and ontogeny of the plant (indicated by stage of growth). Pearl Millet [Pennisetum glaucum (L.) R. Br., hybrid HGM-100] is a new crop in the Southeast suitable for grain or silage. Our objective was to describe stage of development of HGM-100 in relation to date of event and available water for four planting dates through the summer growing season. This research was conducted on a Norfolk sandy loam located on the North Florida Res. and Educ. Ctr., Quincy FL with HGM-100. Stage of development and rainfall/irrigation events and amounts are described for four planting dates in 1993 for HGM-100. Seed size and predicted grain yields were related to amount of available water and planting date. The 17 May planting date produced the highest predicted grain yield (19.1 inches) and the 15 June planting date produced the lowest grain yield. The low yield may have been due to lack of pollinators (bumble bees, Bombus spp.) and not lack of water (18.2 inches). The 5 May planting recieved the least water (16.4 inches).

INTRODUCTION

Knowledge of plant, insect and disease ontogeny in relation to date of planting date as a function of growth stages and environmental parameters make it possible to compare or to combine limited bits of knowledge from all over the world to explain yield phenomena.

HGM-100 pearl millet synchrony with date of planting and expected environmental changes, such as, available water, day length and temperature; and the interactions with insect and disease cycles must be understood to obtain successful crop yields. These interactions have been defined as Systems Agriculture (Teare et al., 1992) in recent years.

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).

Hattendorf et al. (1988) report that pearl millet had the greatest daily water use rate of the crops studied {pearl millet, sunflower [Helianthus annuus L.], sorghum [Sorghum bicolor (Moench), corn [Zea mays L.], and soybean [Glycine max (Merr.)]}. This and the knowledge that pearl millet also had the greatest leaf area index of these crops suggest that pearl millet has the capacity for deep rootedness, a greater number of roots and/or the attribute for increased rooting density (Davis-Carter, 1989).

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., 1985, 1987, and 1988). Critical growth stages identified as being sensitive to water stress were flowering and grain filling.

The objective of this study was to determine the impact of date of planting on HGM-100 pearl millet phenological events in relation to insect activity and available water during the 1993 summer growing season.

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) with a Brown Ro-Til implement with KMC planters.

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Table 1. Planting date, stage of development, and 1/2" irrigation for calendar date and day of year at Quincy, FL, 1993.

Stage	Description	Calendar date	Day of year	Amount Irrigation (inches)
PI	Preirrigation	30 April	120	1/2
PD_1	Planting date	5 May	125	
I	Irrigation	7 May	127	1/2
O	50% Emergence	10 May	130	
I	Irrigation	14 May	134	1/2
1	Third leaf visible	15 May	135	
I	Irrigation	17 May	137	1/2
2	Fifth leaf visible	21 May	141	
I	Irrigation	27 May	147	1/2
3	Panicle initiation[1]	30 May	150	
4	Flag leaf visible	5 June	156	
		8 June	159	1/2
5	Boot stage	12 June	163	
I	Irrigation	17 June	168	1/2
I	Irrigation	22 June	173	1/2
6	50% stigma emerged	25 June	176	
7	Milk stage, 1/2 length	10 July	191	
8	Dough stage, 1/2 length	19 July	200	
9	Black layer, 1/2 length	30 July	211	—
			86[2]	4.0[3]
TR	Total rainfall			12.4[4]
				16.4[5]

[1] Panicle initiation occurs when fifth leaf fully extended.
[2] Days from planting to black layer formation at 1/2 length.
[3] Total irrigation.
[4] Total rainfall during growing period: PD_1 (1 May to 30 July), PD_2 (14 May to 16 Aug), PD_3 (11 June to 5 Sept), PD_4 (12 July to 30 Sept)
[5] Total water during growing period.

Table 1. Continued

Stage	Calendar date	Day of year	Amount Irrigation (Inches)
PI	14 May	134	1/2
PD_2+1	17 May	137	1/2
O	22 May	142	
I	27 May	147	1/2
1	30 May	150	
I	8 June	159	1/2
2	9 June	160	
3	14 June	165	
I	17 June	168	1/2
4	21 June	172	
I	22 June	173	1/2
5	25 June	175	
6	14 July	195	
7	3 Aug	215	
8	12 Aug	224	
9	16 Aug	226	—
		89[2]	3.0[3]
TR			16.1[4]
			19.1[5]

Table 1. Continued.

Stage	Calendar date	Day of year	Amount Irrigation (inches)
PI	8 June	159	1/2
PD_3	15 June	166	
O	20 June	171	
I	22 June	173	1/2
1	26 June	177	
2	30 June	181	
3	4 July	185	
4	14 July	195	
5	20 July	201	
6	5 Aug	217	
7	17 Aug	229	
8 & I	24 Aug	236	1/2
9	2 Sept	245	—
		86[2]	1.5[3]
TR			17.2[4]
			18.7[5]

Table 1. Continued.

Stage	Calendar date	Day of year	Amount Irrigation (inches)
PD_4	15 July	196	
O	21 July	202	
1	26 July	207	
2	30 July	211	
3	5 Aug	217	
4	12 Aug	224	
5	19 Aug	231	
I	24 Aug	236	1/2
6	27 Aug	239	
7	15 Sept	258	
8	21 Sept	264	
9	28 Sept	271	—
		79[2]	0.5[3]
TR			17.7[4]
			18.2[5]

arl m date of planting study was a esign planting dates as whole plots s of development determined for six s in relation to calendar date, nt period, and total water for each plot. tes, stages of development, and date of re shown in Table 1. Plots were eight (rows were 36 inches apart) and 30 feet d of pearl millet were planted 3/4" deep (302 667 seeds/A). This resulted in ely 166 467 plants/A, or 55 % .

er (5-10-15 at 500 lbs/A) was applied s before planting. Nitrogen was d to the side of the row at 120 lbs/A at Prowl @ 1 qt/A + Atrazine @ 2 qt/A for weed control (Wright et al.,1993). Atrazine were applied between stage 1 e 1, 10 to 15 days after planting when was 3 to 5 inches tall).

ainfall occurred throughout the early ason for this experiment. One half inch s of irrigation were scheduled in paucity of rainfall (Table 1). Rainfall amo are shown in Fig. 1.

RESULTS AND DISCUSSION

Four pearl millet planting dates, maturity dates and water (rainfall/irrigation) events are shown in Fig. 1 in relation to time. Note the lack of rainfall throughout the season. Total water available (rainfall and irrigation) from planting to maturity for each planting date (PD) was: PD_1 = 16.4 inches, PD_2 = 19.1 inches, PD_3 = 18.7 inches, and PD_4 = 18.2 inches (Table 1). Physiological stage of development for each planting date is shown in relation to calendar date and day of year (Table 1). Days between stages 0 to 3 were 20, 23, 14, and 15; stages 3 to 6 were 26, 30, 32, and 22; and stages 6 to 9 were 35, 31, 28, 32 for PD1, PD2, PD3, and PD4, respectively (Table 1).

Pearl millet head lengths; shown to be related to grain yield by Pudelko et al., 1994; are shown for each planting date (Fig. 2) (columns topped with the same letter are not significant at the 5 % level of significance). Head lengths for 5 May, 17 May, and 15 June plantings accurately predicted grain head yields $\underline{P} < 0.0001$) by the equation: $Y = -0.0317 + 0.0048\,X$ (Pudelko et al., 1993). However, the 15 July planting date produced very little seed. The average number of

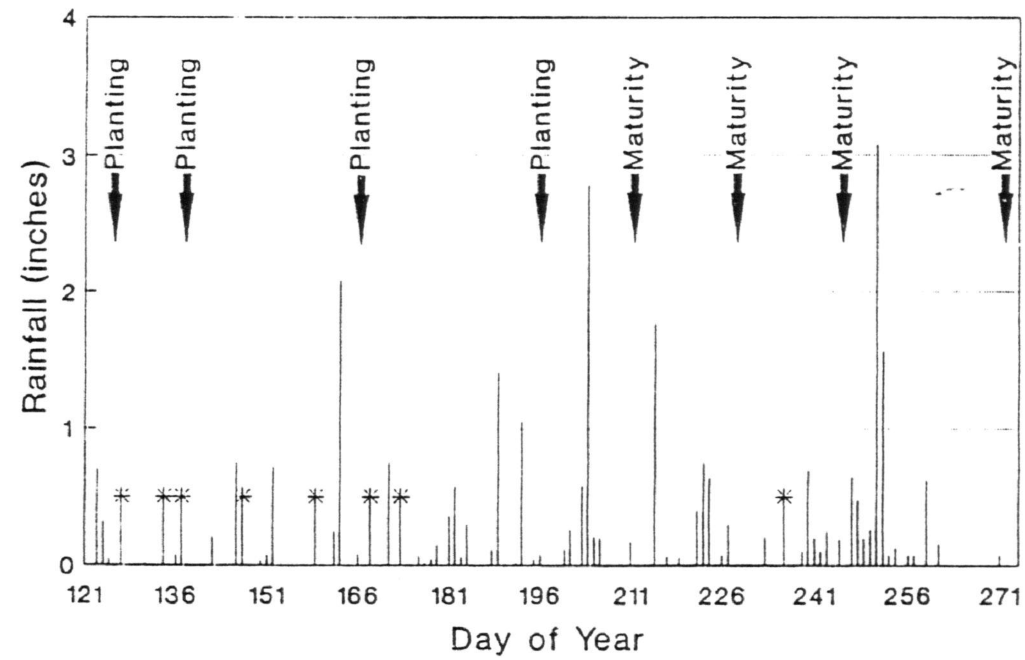

Figure 1. Rainfall during the 1993 pearl millet growing season for four planting dat n relation to rainfall amounts and dates of events.

seeds per 20 non-bird damaged heads was only 105. This may have been related to environmental changes, i.e., reduced length of day, or paucity of pollinators. Bumble bees, the primary pollinators for the first three planting dates, were essentially absent during flowering of PD_4. It probably wasn't lack of available water (18.2 inches compared to 16.4 inches for PD_1).

Contrary to Mahalakshmi et al. (1988), we found differences in seed size (lb/1000 seed) due to planting date (Fig. 3). Seed size in relation to planting date indicates that environment affected grain yield. One would expect that the 15 July planting date, with only 105 seeds per 20 heads, should have large seeds like PD_2 or at least seeds the same size as PD_1 and PD_3, but the seed size was smaller than the earlier plantings. Grain yield (predicted by head length, Fig 2.) and seed size (lb/1000 seed, Fig. 3) are increased by increased water (19.1 inches for PD_2, Table 1) (Mahalakshmi et al., 1987 and 1988). Thus, PD_2 (17 May) may be the optimum planting time for pearl millet in the Southern Coastal Plain.

CONCLUSIONS

1. Physiological growth stages from planting to black layer formation are shown in relation to calendar date and date of year for four planting dates.

2. The 17 May planting date recieved the most rainfall (19.1 inches) and produced the highest grain yields.

3. Head lengths for 5 May, 17 May, and 15 June plantings accurately predicted pearl millet head yields ($P < 0.05$) with equation $Y = -0.0317 + 0.0048 X$.

4. The 15 July planting date produced very little seed although head lengths averaged over 12 inches long.

5. Bumble bee pollinators were essentially absent during flowering of the 15 July planting date.

6. The 17 May planting produced grain with the largest seed size and 15 July, the smallest seed size.

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