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PLANTING DATE, RUST, AND CULTIVAR MATURITY EFFECTS ON AGRONOMIC CHARACTERISTICS OF PEARL MILLET

Wayne W. Hanna* and David Wright

ABSTRACT

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] has the potential to become an important grain crop in the U.S. However, agronomic information is needed on maturity of cultivars to plant and effects of planting dates and rust on grain yield. A two-year replicated study was conducted in 1990 and 1991 comparing grain yields and agronomic characteristics of three hybrids [an early rust susceptible (ERS), an early rust resistant (ERR) and a late rust resistant (LRR)] planted at six dates from the middle of April to the end of July. Genetic resistance to rust (*Puccinia substriata* Ellis and Barth. var. *indica* Ramachar & Cummins) generally gave stability to grain yields and seed size for all planting dates in both years. Grain yields were reduced by 89% from the April to end of July planting date if the hybrid had no rust resistance. Percent protein increased, plants became shorter, and plants flowered earlier with later planting dates. April and May plantings produced the highest grain yields for ERR, followed by July plantings. The middle of June planting produced the lowest yields in both years. LRR produced the highest grain yields at the latest planting date in both years.

INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] has been an important forage crop in the United States for a number of years (Burton, 1983). More recently, interest has developed in growing it as a high quality grain crop, especially on the sandy, acid and droughty soils in the southeastern U.S. Parents for the first pearl millet hybrid in the U.S. were released in March, 1991 (Hanna, 1993).

Francis et al. (1984) conducted research that suggested "planting time may affect genotype yield stability" in sorghum (*Sorghum bicolor* L. Moench). They observed less interaction for yield between genotypes and environment when hybrids were planted late than when planted early. This observation was attributed to more rapid development and less exposure to stress conditions in later plantings.

Wayne Hanna, USDA-ARS, Univ. of GA, Coastal Plain Expr. Stn., Tifton, GA. 31793. David Wright, North Fla. Res. and Educ. Ctr., Quincy, FL 32351. *Corresponding author.

Pfeiffer and Pilcher (1987) reported a 9% decrease in yield of soybean (*Glycine max* L.) with delayed plantings. Grain yield was reduced 4 to 6% for maize (*Zea mays* L.) planted May 30 instead of May 1 (Bauer and Carter, 1986). Maize kernal breakage also increased in later planting dates but showed maturity group effects.

Agronomic information is needed to assist farmers to successfully produce grain crops, especially a new crop such as pearl millet.

The objectives of this study were to determine the effects of six dates of planting on grain yields and agronomic characteristics of early and late maturing grain hybrids with and without rust resistance.

MATERIALS AND METHODS

Three F_1 hybrids were planted in a six dates of planting (DOP) study in 1990 (20 Apr., 5 and 30 May, 21 June and 10 and 27 July) and 1991 (22 Apr., 14 and 30 May, 17 June , 5 and 22 July and 8 Aug.) on a Tifton l.s. (Plinthic Kandudults). Each DOP was consecutively numbered 1 through 6 for the April through last planting in July, respectively. Data from the 8 Aug., 1991 planting will not be included in the means to give a more balanced comparison between years.

Hybrids included HGM™100 (Tift $90D_2A_1E_1$ x Tift 8677, early and rust resistant (ERR)], Tift $H23D_2A_1E_1$ x Tift 8677 [early and rust susceptible (ERS)] and Tift $85DA_1$ x Tift 8677 [late and rust resistant (LRR)]. The ERR (HGM™ 100) and ERS hybrids are near-isogenic except for rust resistance and flower in about 55 days after planting. The LRR hybrid is near-isogenic to ERR except for lateness and flowers in about 75 days after planting.

Each plot consisted of four rows, 36 inches wide and 17 feet long. Data were taken from the two center rows. The experiments had four replicates. Fertilization consisted of 250 lbs. of 5-10-15 ($N-P_2O_5-K_2O$) banded preplant in the center of the row. Plots received 50 lb N from ammonium nitrate at 25 days after planting. Plots were sprayed immediately after planting with 2 lb (a.i.) per acre milopro* to control weeds.

Grain yields were estimated from the center 14 feet of each row. Days to 50% anthesis was determined from planting to when 50% of the heads in a plot were shedding pollen. Plant height was measured from the base of the plant to the top of the head of the majority plants in a plot. Rust ratings were based on a scale of 1 to 5 where 1 = no rust and 5 = pustules on greater than 80% of leaf area. Nitrogen content of seeds was determined with a Leco Corporation nitrogen combustion analyzer by the Georgia Department of Agriculture at Tifton, GA. Protein content was determined by multiplying nitrogen content by 6.25.

RESULTS AND DISCUSSION

Significant year effects on grain yield were caused by difference in rainfall during the growing seasons of 1990 and 1991, 12.5 and 25.4 inches, respectively. Mean grain yields across planting dates were 2290 and 1487 lb. for 1990 and 1991. Pearl millet grain yields tend to be significantly lower in high rainfall season, probably because this species evolved under very low soil moisture conditions. We observed a similar decrease in average grain yields in our yield trials in 1991 and 1994 due to high rainfall (see Hanna, this Proceedings).

The DOP x hybrid effect was highly significant (P = 0.01) for all characters measured in both years except for a significant (P = 0.05) effect for % protein in 1991. The DOP x hybrid effects are probably influenced mainly by maturity and the rust susceptibility of ERS.

Date of Planting

Date of planting significantly (P = 0.05) affected grain yield, plant height, days to 50% anthesis, % protein and 1000-seed weight (Table 1).

Average grain yields began to drop with the June planting in both years (Table 1). Most of the reduced yield due to late DOP can be attributed to ERS. Grain yields of ERS were reduced 89 and 88% from DOP 1 to DOP 6 in 1990 and 1991, respectively. Grain yields of ERR and LRR were reduced less than 7% for the same time period except for ERR in 1990 which showed a 30% yield reduction. The major cause of reduced yields in later plantings can be attributed to rust on ERS. Rust ratings in DOP 5 and 6 were above 4.0 in both years for plants of ERS at anthesis, whereas, no rust was observed on ERR and LRR. Rust can significantly reduce forage yields and quality (Hanna et al., 1988 and Monson et al., 1986). Rust resistance in the grain hybrids is essential for plantings after the middle of June. ERR produced the highest grain yields (3832 and 1859 lb/acre in 1990 and 1991, respectively, in DOP 1 and LRR produced the highest grain yields in DOP 6 (3163 and 1288 lb/acre in 1990 and 1991, respectively.

Table 1. Effects of date of planting on agronomic characteristics of three pearl millet grain hybrids at Tifton, GA†

Dates of planting‡	Grain yield (lb/A)		Plant height (inches)		50% anthesis (days)		Protein (%)		1000-seed weight (oz)	
	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
1	2642	1732	62	63	72	67	7.1	10.9	0.22	0.26
2	2866	1257	60	72	69	64	7.2	10.3	0.23	0.23
3	2449	1789	64	74	68	62	8.8	9.2	0.18	0.22
4	1643	1154	65	67	61	61	11.9	9.2	0.16	0.21
5	1934	1619	55	63	56	64	14.1	12.9	0.18	0.31
6	2203	1373	56	60	57	54	20.3	12.6	0.22	0.29
LSD (0.05)	397	355	2	2	1	1	1.1	1.0	0.02	0.02

†Each value is the mean of three hybrids - ERR, ERS and LRR.
‡Planting dates are numbered consecutively from April (1) through July (6).

Plants became significantly shorter with all successive planting dates in both years except between DOP 3 and DOP 4 in 1990 and DOP 1 and DOP 2 in 1991.

*Trade or company names are included for the benefit of the reader and do not imply endorsement or preferential treatment of the product.

Days from planting to 50% anthesis also became successively less with each planting date from DOP 1 to DOP 6 in both years. The decrease in both height and days to 50% anthesis are a response of the hybrids to day length.

Protein content of the seeds were similar for DOP 1 and DOP 2 and highest for DOP 5 and DOP 6 in both years. Percent protein progressively increased from DOP 1 to DOP 6 in 1990 which is what we have typically observed in other studies (Hanna, unpublished). However, seeds from DOP 3 and DOP 4 had similar protein content but less protein than seeds from DOP 1 or DOP 2 in 1991. This was probably related to high rainfall in 1991 during plant and/or seed development.

The means for 1000-seed weight in Table 1 do not show consistent trends, mainly because the rust susceptible hybrid, ERS and the rust resistant hybrids, ERR and LRR, responded differently. Seed size decreased by 54% and 30% from DOP 1 to DOP 6 in 1990 and 1991, respectively for ERS. Much of this decrease in seed size is due to rust infection beginning with DOP 3 but with major effects on DOP 4 to DOP 6. ERR produced the smallest seeds on plants from DOP 4 in both years while LRR produced the smallest seeds on plants from DOP 3 and DOP 4 in 1990 and 1991, respectively. These effects on seed size of ERR and LRR are probably related to a combination of day length, moisture and/or temperature during plant and seed development and deserve further study.

Cultivars

Mean grain yields for the six planting dates were higher for ERR and LRR than for ERS in both 1990 and 1991 (Table 2). These data again confirm that rust resistance is very important in the pearl millet hybrids. Above average rainfall in 1991 reduced yields compared to 1990 by 48% for ERR and by 17% for LRR. However, ERR has significantly higher grain yield potential in average rainfall years.

ERR averaged the same height in both years while ERS and LRR tended to be taller in 1991 compared to 1990 which is probably related to cloudy weather during the rainy 1991 summer. ERR and ERS flowered about 12 days earlier than LRR in both years.

Percent seed protein and 1000-seed weight were similar for ERR and LRR in both years. Protein content of ERS was higher than of ERR and LRR in both years and was partially related to the smaller seed size of ERS compared to the other two hybrids (Table 2).

CONCLUSIONS

In this study, a rust resistant hybrid that flowered in 56 to 66 days after planting (DAP) depending on DOP showed more yield potential than a rust resistant hybrid that flowered 58 to 84 DAP. However, the later maturing hybrid showed a significant yield advantage in both years for the end of July planting or DOP 6.

Table 2. Agronomic characteristics of early and late pearl millet hybrids†.

	Grain yield (lb/A)		Plant height (inches)		50% anthesis (days)		Protein (%)		100-seed weight (oz)	
Hybrid‡	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
ERR	2859	1495	62	62	59	58	11.3	10.9	0.23	0.27
ERS	1632	1045	59	64	59	57	12.5	11.5	0.15	0.21
LRR	2296	1906	60	72	73	70	11.3	10.1	0.21	0.27
LSD (0.05)	398	178	1	2	1	1	0.7	0.9	0.02	0.01

† Each value is the mean of six dates of planting.

‡ ERR = early rust resistant; ERS = early rust susceptible and LRR = late rust resistant.

Highest grain yields can be expected from April and May planting (DOP 1 to 3) followed by July plantings (DOP 5 to 6). The lowest yields were observed for the middle of June plantings in both years for all three hybrids.

Rust resistance in pearl millet grain hybrids is essential for planting dates after June 15. Rust will significantly reduce grain yield. It will also increase percent protein of seeds due to significantly reduced seed size. Rust resistance is needed in hybrids to stabilize grain yields and seed quality.

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