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RESPONSE TO DAYLENGTH OF NONCONVERTED AND CONVERTED SELECTIONS OF FORAGE SORGHUM MILLO BLANCO (Sorghum bicolor (L.) Moench) IN PUERTO RICO

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ABSTRACT

Information on the effect of daylength on nonconverted and converted selections of sorghum is very limited. This study was designed to evaluate the effect of daylength on plant height (PHt), days to anthesis (DA), and other agronomic traits of local Millo Blanco nonconverted (MBNC) and three Millo Blanco converted (MBC) selections of forage sorghum (*Sorghum bicolor* (L.) Moench) and BTx406 (a 4-dwarf photoperiodinsensitive temperate grain sorghum used as the control) during an eight-month period in Puerto Rico. The MBC selections were based on approsimately plant height of 50, 120 and 170 cm. Plantings were made on the 21st day of each month from May through December, 1991. After an initial 30-day growth period, plants were evaluated every 15 days until harvest. Days to anthesis of MBNC decreased from 175 (May planting) to 61 (October planting), then increased to 70 and 75 (November and December plantings, respectively). The mean plant height of MBNC followed a similar trend ranging from 278 cm (August planting) to 138 cm (November planting). Although a significant correlation was observed between days to anthesis and plant height in MBNC, the MBC selections and BTx406 (the control) were unaffected by planting date. Mean days to anthesis of the three MBC selections was similar throughout the year (61 days). This study demonstrated the possibility of making selections for height from converted sorghums prior to their formal release having by this way an excellent opportunity for its utilization in a year round breeding program.

INTRODUCTION

The World Sorghum Collection has been the source of new germplasm of which most lines are of tropical origin (4, 6, 8, 10, 11). These sorghums possess many desirable genes which have contributed to the improvement of temperate-adapted sorghums (7, 11). Since most tropical sorghums are sensitive to daylength, the Sorghum Conversion Program (SCP) was started in 1963; as a cooperative venture of the Tesas Agricultural Experimet Station and the U.S. Department of Agriculture (USDA). The SCP makes available new germplasm sources from the World Collection by converting tall, late flowering, photoperiod-sensitive sorghums from the tropics into short, early flowering, photoperiod-insensitive strains (10, 11). Plants fully converted and selected after four backcrosses are theoretically 1/32 temperate and 31/32 tropical material, although they can contain arrays of height and maturity genes resulting sometimes in unstable germplasm in terms of these traits (5, 7). The SCP makes these sorghums indeterminate over a wide range of daylenghts showing little or no photoperiodic response. This study was designed to evaluate the effect of daylength on days to anthesis (DA), plant height (PHt) and a series of agronomic traits of Millo Blanco (MBNC), a local photoperiod-sensitive (nonconverted) sorghum (*Sorghum bicolor* (L.) Moench), three converted Millo Blanco (MBC) selections of different height from the SCP, and BTx406 (control), during an 8-month period.

MATERIALS AND METHODS

The experiment was conducted at the Isabela experimental farm of the Tropical Agriculture Research Station (TARS), USDA-ARS at an elevation of 128m and ambient temperatures ranging from 18.8 to 29.4° C. The soil is a Coto clay (Tropeptic Haplorthox, clayey Kaolinitic, isohyperthermic) with an organic matter content of 2.5% and pH of 5.5. The experimetal design was a randomized block arranged in split-split plots, replicated four times. The main plots consisted of planting dates (PD) made the 21st day of each month from May through December, 1991; the subplots were MBNC, three MBC selections and BTx406. The selections were obtained from the last cycle of conversion of MB (-14E) at Isabela during June 1990, and

based on 50, 120 and 170 cm plant height; later they were identified as MB-4Dw, MB-3Dw and MB-2Dw, respectively.

Each subplot consisted of two rows 600 cm long spaced 100cm apart with plants thinned to a distance of 36.5 cm apart within rows. Before sowing, and four weeks after planting, all plots received 560 kg/ha of a 15-5-10 fertilizer. Weeds were controlled with propazine (2-chloro-4,6,- bis(isopropylamino-s-triazine) at a rate of 2.5 kg ai/ha. Overhead irrigation was applied to all plots as needed.

Measurements were made of plant height (from the ground to the midpoint of the upper leaf blade) and total leaf blade area (using the second leaf blade from the top and multiplying its masimum length x masimum width x 0.747 x number of leaves/plant x tillers). This calculation is based on the procedure developed by Sticker et al., (12). Number of internodes, leaf number/main stem, and days to anthesis were measured simultaneously. All data were subjected to analysis of variance, and significant differences were identified with Duncan's multiple range test.

RESULTS AND DISCUSSION

The analysis of variance showed that F values for planting dates (PD), selections (S), and sampling intervals (I) were significant for most traits (Table 1). Previous studies indicated that individual cultivars of sorghum have different critical photoperiods that inhibit floral development (1-4, 6, 8, 9, 11). Our results indicated that days to anthesis of MBNC decreased from 175 (May planting) to 61 days (October planting), but increased to 70 and 75 days for the November and December plantings, respectively (Fig. 1). Floral initiation of MBNC was delayed by the cool temperatures prevailing at the Isabela farm during November and December. When planted in October, MBNC had the same growth pattern as that of the remaining selections, which indicates that its critical photoperiod is less than 11.21 hours. In Puerto Rico (latitude 18° N), daylength ranges from 11.02 (December 21) to 13.13 hours (June 21), factor which is determinant in the flowering response of short-day plants. Although the MBC selections showed minor visual differences in terms of DA, their means were similar to BTx406 at all planting dates (61 days). The MBC selections

and BTx406 flowered 6 to 8 days earlier when planted in June as compared to the December planting. It appears that the critical photoperiod of the MBC and BTx406 is above 13.13 hours.

The plant height of MBNC (Fig. 2) diminished significantly from 278 cm (August planting) to 138 cm (November planting); then increased to 194 cm (December planting). During November planting the plant height of MBNC was similar to that of the MBC selection MB-2Dw. Previous studies have demonstrated a similar and consistent trend of MBNC across planting dates (13). The stability in terms of height of the MB-4Dw selection was comparable to that of BTx406 , but better than in the MB-3Dw and MB-2Dw selections. The last two selections responded very similar to the effect of temperature and daylength, although both flowered at approsimately 61 days. In general, the long days and high temperatures had an equal effect on all MBC selections as well as on BTx406 .

Mean leaf number (Fig. 3) and total leaf area (Fig. 4) of MBNC showed similar trends to those of days to anthesis and plant height across planting dates. Plants had more leaves (over 13) and more total leaf area (over 132,000 cm^2) when planted from May to August, and significantly fewer leaves (10 or less) and less total leaf area (less than 48,000) when planted from September to December. On the other hand, PD did not affect the leaf number and the total leaf area of the MBC selections and BTx406 . They all had an average of 9 leaves > plant. Lower number of leaves were obtained in the November and December plantings. The number of internodes/plant (Fig. 5) showed a similar tendency to those of days to anthesis, plant height, leaf number and total leaf area.

Miller, et al. (6) found that plant height and days to anthesis were closely correlated in sorghum. In this study, a significant correlation was observed between days to anthesis and plant height in MBNC but not in its converted selections and BTx406 as shown in the following tabulation:

Genotype	Correlation coefficient
MB-1DW (Non converted Tropical)	.86**
MB-2DW (Converted selection)	-.72
MB-3DW (Converted selection)	-.36
MB-4DW (Converted selection)	.21
BTx406 (temperate)	.09

** Significant at 1% level.

Significant correlations were also found between daylength/month and most of the agronomic traits studied in MBNC:

Character	Correlation cofficient
Plant height	.85*
Internodes/plant	.62
Leaves/plant	.94**
Days to anthesis	.71*
Total leaf area	.92**

** Significant at 1% level.
* Significant at 5% level.

Excellent selections for height can be easily made from the conversion program prior to their formal release. At the same time, these selections are day-neutral which offer excellent opportunities for their utilization in a year round breeding program.

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Table 1. Analysis of variance for planting dates and selections for Millo Blanco, three of its converted selections and BTx406 at Isabela, Puerto Rico.

SOURCE	CHARACTERS				
	PLANT HEIGHT	NO. OF INTERNODES	LEAVES/ PLANT	DAYS TO ANTHESIS	TOTAL LEAF AREA
PLANTING DATE (PD)	**	**	**	*	**
REPLICATION (R)	**	**			
SELECTION (S)	**	**	**	*	**
PD X S	**	**	**		**
R X S X PD	**	**	**	*	**
MEAN	130	8	9	81	45,292

** -Significant at 1% level.

* - Significant at 5% level

Fig. 1: Effect of eight planting dates on days to anthesis of Sorghum Millo Blanco, three of its converted selections, and BTx406 at Isabela, P.R.

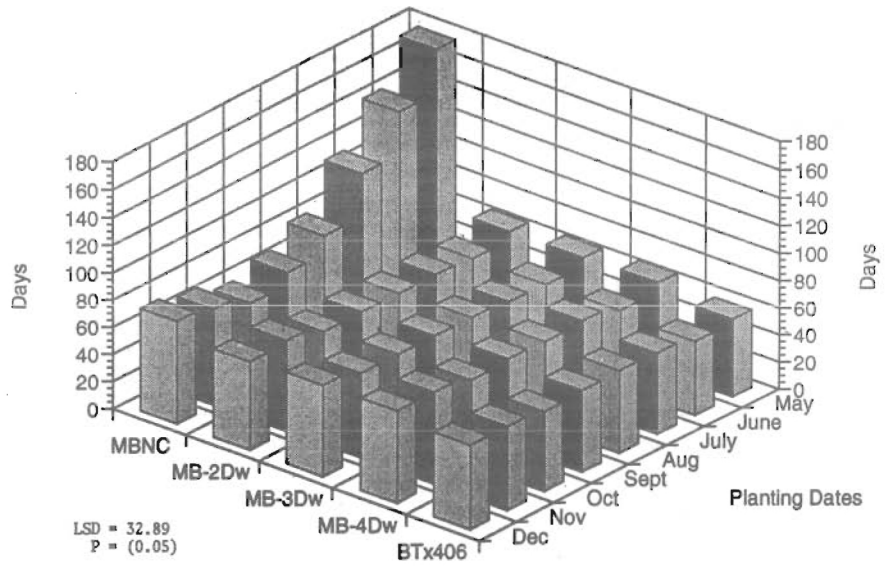

Fig. 2: Effect of eight planting dates on plant height of Sorghum Millo Blanco, three of its converted selections, and BTx406 at Isabela, P.R.

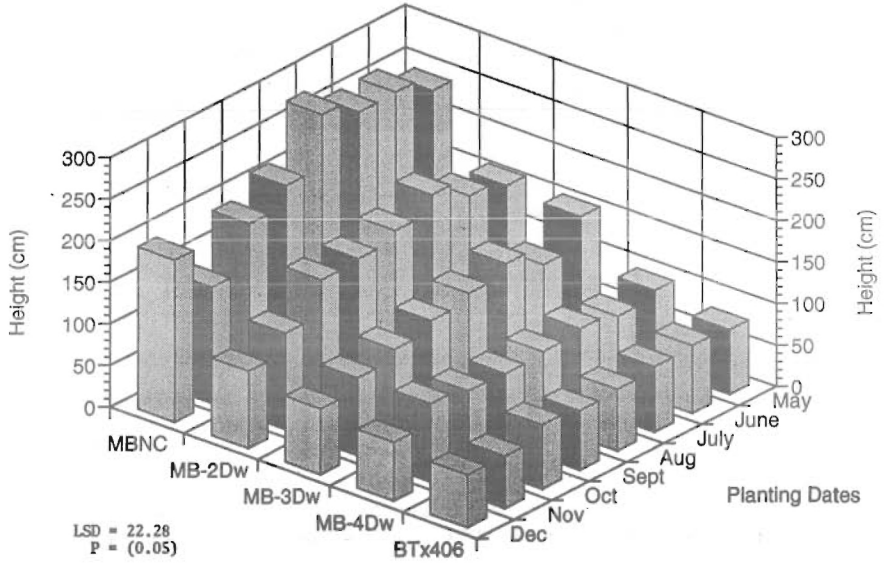

Fig. 3: Effect of eight planting dates on mean leaf number of Sorghum Millo Blanco, three of its converted selections, and BTx406 at Isabela, P.R.

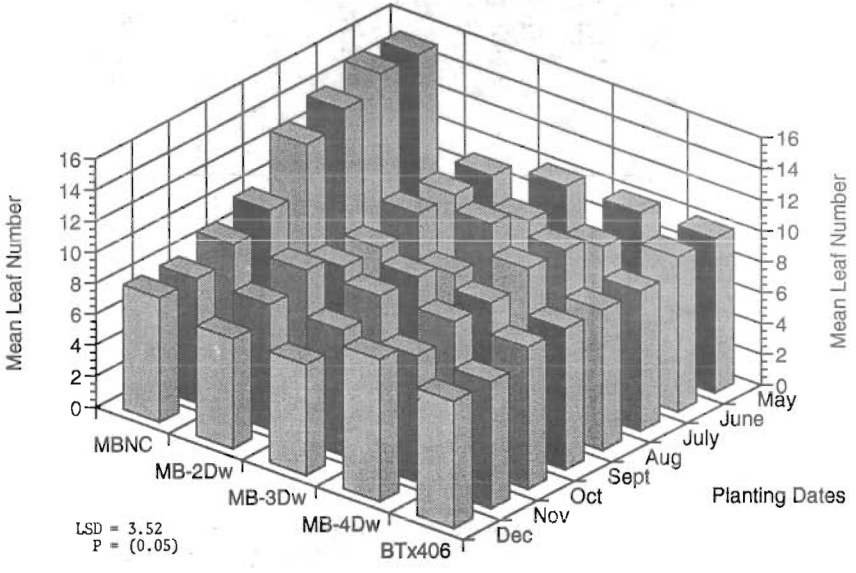

Fig. 4: Effect of eight planting dates on mean total leaf area of Sorghum Millo Blanco, three of its converted selections, and BTx406 at Isabela, P.R.

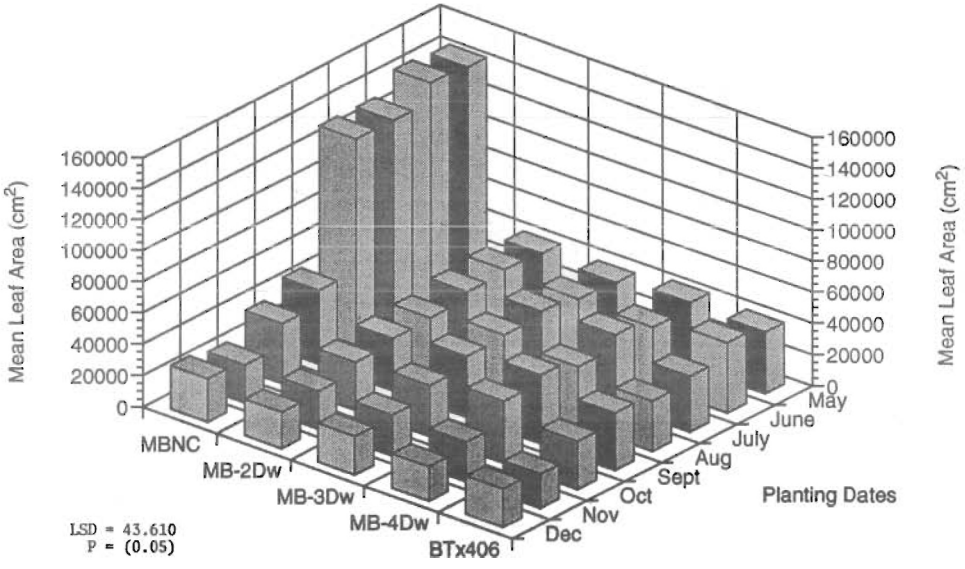

Fig. 5: Effect of eight planting dates on number of internodes of Sorghum Millo Blanco, three of its converted selections, and BTx406 at Isabela, P.R.