Response of Guar to Drought Conditions

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ABSTRACT

Plants with greater drought tolerance will increase crop production in many areas of the world. The purpose of this study was to examine the physiological responses of guar, a drought tolerant plant, under water stress. The dry treatment received only one irrigation and yielded respectably. This treatment maintained turgor and metabolic functions throughout the study by decreasing transpiration rate and increasing diffusive resistance.

INTRODUCTION

Guar, Cyamopsis tetragonoloba (L.) Taub, is a drought tolerant, summer annual legume grown primarily for the galactomannin gum in the endosperm of its seed. Principally grown in India and Pakistan, it is also cultivated on the high plains of Texas and Oklahoma under natural rainfall conditions, and in areas of south Texas and Arizona under various irrigation regimes.

The development of plants with greater tolerance to drought conditions offers considerable promise for increasing crop production on marginal lands. Guar is a classic drought avoider with a large, deep tap root system which is able to extract soil water efficiently as long as there is moisture in the soil contacting the roots. This study was initiated in order to examine the physiological responses of guar plants to water stress.

MATERIALS AND METHODS

Four guar cultivars (Kinman, Lewis, Santa Cruz, Mesa) were planted June 19, 1985 at the Maricopa Agricultural Research Center. The experimental design was a split plot with 8 replications. The subplots were well watered and water stressed. All plots received a post-planting irrigation after 5 days to ensure stand establishment. The well watered plots were irrigated every 3 weeks (July 15, August 5, August 26, September 16) through maturity in September. The water stressed plots received no further irrigation after establishment.

Transpiration rate, diffusive resistance, and leaf temperature were measured in all plots 4 days after the August 5, August 26, and September 16 irrigations. Plant height and yield were measured at harvest in December.

RESULTS AND DISCUSSION

Yield differences were observed among cultivars and water treatments (Table 1). Mesa yielded the least with 790 kg ha-1. Mesa was developed as a green manure crop, thus it is much more vegetative than the other 3 lines which were developed for seed production. This is reflected in the differences of height at harvest with Mesa being significantly taller than the other cutlivar (Table 1).

Kinman and Santa Cruz were the high yielders with 1145 and 1040 kg ha-1, respectively. The dry water treatment, which only received one irrigation for stand establishment, yielded significantly less (453 kg ha-1) than the well watered plants (1498 kg ha-1). Although the wet treatment outyielded the dry

treatment by a significant margin, 453 kg ha-1 is a respectable yield, and the economic input for the dry treatment is much less than the wet treatment.

Transpiration rates were significantly higher in the wet treatment for all three sampling dates (Table 2). The reciprocal was found for diffusive resistance, with the dry treatment being significantly higher at all three sampling dates (Table 2). Throughout the study, neither water treatment was visibly wilted, so apparently leaf water potentials were kept relatively high. This shows that guar has a prolific or efficient root and conductive system so when water is present the transpiration rate is high, allowing normal metabolic reactions. Also, the lack of wilting and respectable seed yield in the dry treatment shows that by increasing diffusive resistance, the plant is effectively retarding water loss.

Leaf temperatures (Table 2) were significantly different between the two water treatments and reflected an increase in temperature due to the lower transpiration rate in the dry water treatment. However, the increase in temperature was not great enough to inhibit metabolic functions.

Drought resistance is a complex of many morphological, physiological, and biochemical characteristics. The measurements we make only indirectly measure the efficiency of a plant's root system and metabolic activities. However, we believe them in combination to be an adequate selective device to estimate the overall status of drought avoidance and tolerance within a crop species.

Table 1. Guar yield (kg ha-1) and height (cm) by cultivar and water treatment at Maricopa, AZ, 1985

Cultivar	Yield*	Height
Mesa	790 a	100 c
Lewis	925 ab	75 a
Santa Cruz	1040 bc	86 b
Kinman	1145 c	87 b
Water Treatment		
Dry	453 a	55 a
Wet	1498 b	119 b

* Means within a column followed by a different letter are significantly different at P = 0.05.

Table 2. Transpiration rate (ug cm-2s-1), diffusive resistance (s cm-1) and leaf temperature (oC) of guar by water treatment at three sampling dates at Maricopa, AZ, 1985

Water	August 9a			August 30			September 20		
Treatment	TRb	DRc	LTd	TR	DR	LT	TR	DR	LT
Dry	20.0 a	1.9 b	37 b	6.9 a	7.1 b	41 b	4.4 a	7.4 b	30.4 b
Wet	39.9 b	0.4 a	33 a	30.5 b	0.7 a	38 a	7.8 b	3.4 a	29.8 a

a) Means within a column followed by a different letter are significantly different at P = 0.05.

b) Transpiration rate.

c) Diffusive resistance.

d) Leaf temperature.