PREFERENTIAL ATTRACTION OF THE TWIG GIRDLER, *ONCIDERES CINGULATA TEXANA* HORN[1], TO MOISTURE-STRESSED MESQUITE

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ABSTRACT

A positive relationship was found between moisture stress in honey mesquite, *Prosopis glandulosa* Torr., and degree of infestation by the twig girdler, *Oncideres cingulata texana* Horn, in north central Texas. Individual mesquite trees were subjected to several soil moisture treatments and levels of intraspecific competition to produce differential moisture stress among trees. Predawn leaf petiole water potential was measured in late August 1989, just prior to the adult, twig girdling stage, which occurred in September. Observations of girdling damage in November revealed that trees which had greater water stress (*i.e.*, lower predawn leaf water potential) had a greater number of girdled twigs per unit canopy volume.

INTRODUCTION

In arid and semi-arid regions of the southwestern USA and Mexico, adult females of a long-horned beetle known as the twig girdler, *Oncideres cingulata* (Say) or *Oncideres rhodosticta* Bates, consume portions of small branches and twigs of the woody legume, honey mesquite, *Prosopis glandulosa* Torr. (Linsley 1940, Whitford et al. 1978). These beetles oviposit beneath the bark above the girdle site (Polk and Ueckert 1973, Rogers 1977, Forcella 1982).

Infestations of the twig girdler occur in localized areas of Texas (Watts et al. 1989), but little is known concerning physiological qualities of mesquite which may attract the twig girdler. Forcella (1984) suggested tree size and density influenced twig girdling intensity of *Oncideres cingulata* (Say) on black hickory, *Carya texana* Buckl., in Oklahoma. The purpose of this paper is to document the potential relationship between levels of water stress in mesquite and degree of twig girdler infestation.

MATERIALS AND METHODS

Study Site and Species. The study was conducted within a 2 ha. pasture on the W. T. Waggoner Estate located 30 km south of Vernon in the northern Rolling Plains ecological area of Texas (33°52'N, 99°17'W; elevation 368 m). Average annual precipitation is 665 mm, which occurs in a bimodal pattern, with peak rainfall in May (119 mm) and October (77 mm). The region supports a herbaceous understory of grasses and forbs dominated by a moderate overstory (<30% canopy cover) of mesquite. Components of the understory include the warm-season buffalograss, *Buchloe dactyloides* (Nutt.) Engelm., and sideoats grama, *Bouteloua curtipendula* (Michx.) Torr., and the cool-season Texas wintergrass, *Stipa leucotricha* Trin. & Rupr. Soils of the study area are Typic Paleustolls of the Deandale and Kamay series (Koos 1962). Both soils are clay loams developed from sandstone and shale parental material. Slopes are less than three percent.

Specimens of the mesquite twig girdler were collected on the site and identified as *Oncideres cingulata texana* Horn. We did not find the other species of

[1] Coleoptera: Cerambycidae

mesquite twig girdler, *Oncideres rhodosticta* Bates, or other subspecies of *Oncideres cingulata* (Say) at the site.

Treatment Installation. The study included five treatments of four trees each which were designed to create different levels of moisture stress in mesquite. Trees were multistemmed, 2.5-3.5 m in height, and 4-6 m in canopy diameter. Treatments were identified as irrigated (IR), no moisture or rainout (RO), control (CT), low intraspecific competition (LC), and high intraspecific competition (HC) (Table 1). Treatments were arranged in the field in a randomized complete block design with one tree from each treatment in each block. Root systems of trees in the first three treatments were containerized with metal and plastic barriers placed in the ground. Root systems of trees in the LC and HC treatments remained intact. Treatments involving root containerization were initiated in 1986 while the LC and HC treatments were added in 1988. Details of treatment installation were given by Ansley et al. (1988) and Jacoby et al. (1988). Precipitation was measured at the site with a rain gauge.

TABLE 1. Moisture Stress Treatments on Honey Mesquite Trees.

Treatment	Roots Contained	Level of Intra-specific Competition	Water Treatment
Irrigated (IR)	Yes[a]	None	Precip. + Irrig.[b]
Rainout (RO)[c]	Yes	None	No Water
Control (CT)	Yes	None	Precipitation
Low Comp. (LC)[d]	No	Low	Precipitation
High Comp. (HC)	No	High	Precipitation

a See Ansley et al. (1988) for details of root containerization. Bottoms of containers were open.
b Surplus trees were irrigated with 25-35 mm once every 3-4 wk during the mesquite growing season (April-October).
c See Jacoby et al. (1988) for rain shelter design.
d Average distance of neighboring mesquite trees in LC and HC treatments was 14.9 and 4.8 m, respectively.

As part of a long-term evaluation of mesquite water relations on the site, leaf petiole water potential was measured before sunrise (predawn) during the 1986 through 1989 mesquite growing seasons. Two leaves (as subsamples) were excised from the center of each canopy at 1.5-2 m height to determine water potential using a Scholander-type pressure bomb, as outlined by Turner (1981).

The current study involving twig girdler responses to plant stress was conducted during 1989. In November 1989, all girdled stems were removed from each tree and counted. Because trees differed slightly in canopy size, twig girdler infestation in each tree was compared on the basis of girdled stems per unit canopy volume. Canopy volume was determined by visually bisecting the canopy at the widest point, taking length measurements, and determining volumes of the top portion (V_{top}) and the bottom portion (V_{bot}) using standard geometric equations so that:

$$\text{Total Volume} = V_{top} + V_{bot}$$

where,

$$V_{top} = (4/3\, h_1 \pi ab) / 2$$

and,

$$V_{bot} = 1/3\ h_2 \pi (ab + \sqrt{abcd} + cd)$$

where, h_1 = height from top of canopy to widest part of the canopy, h_2 = height from widest part of canopy to the ground, a = width of widest part of canopy along the north-south axis, b = width of widest part of canopy along the east-west axis, c = width of base of canopy along the north-south axis, and d = width of base of canopy along the east-west axis.

Regression techniques were used to determine a functional relationship between plant moisture stress and degree of twig girdler infestation. Means of water potential and infestation level for each treatment were used for the regression (n = 4 trees per treatment). Water potential values of leaf subsamples were pooled prior to determination of means and standard error.

RESULTS AND DISCUSSION

During 1986 and 1987 predawn leaf water potential was generally highest in irrigated, and lowest in rainout trees (Fig. 1). Control trees had predawn water potentials between the irrigated and rainout trees until late 1987 when water potential decreased in control trees to levels similar to rainout trees. By 1988, rainout trees exhibited greater predawn water potential than control trees, suggesting that rainout trees had accessed deeper soil moisture below the bottom of the root container (Ansley et al. 1991). This trend was interrupted in July 1988 when heavy rains caused

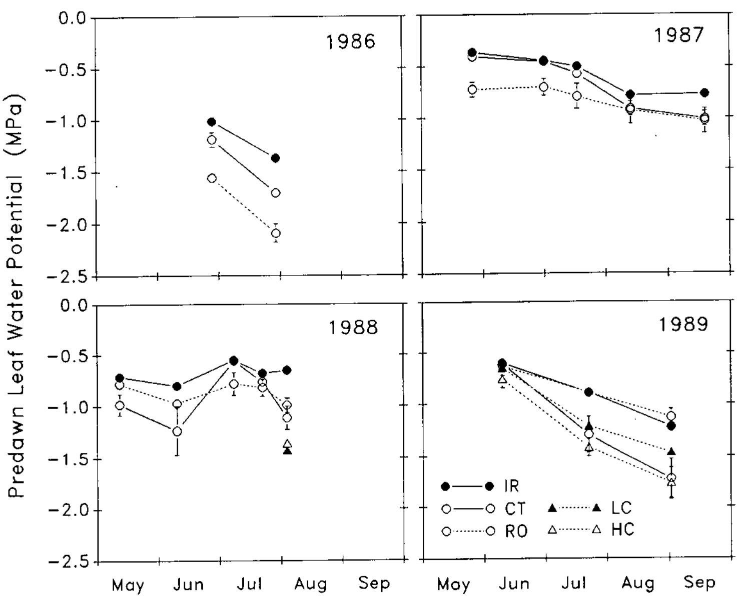

FIG. 1. Predawn leaf water potential in honey mesquite exposed to different moisture treatments during four years. Circles indicate root containerized trees; filled circles are irrigated (IR), open circles and solid lines are control (CT), and open circles and dashed lines are rainout (RO) trees. Triangles indicate trees with undisturbed root systems; filled triangles are low intraspecific competition (LC), and open triangles are high intraspecific competition (HC). Vertical bars indicate ± 1 standard error (when not visible, error bars are smaller than mean symbol).

predawn water potential to increase in control trees to levels above rainout and similar to irrigated trees. In August 1988, evaluation of all five treatments indicated a wide differentiation of predawn leaf water potential among treatments, ranging from -.65 MPa in irrigated trees to -1.42 MPa in low competition trees.

By 1989, responses of rainout trees had increased to levels very similar to the irrigated trees (Fig. 1). Trees in these two treatments had greater predawn water potential (*i.e.*, less moisture stress) than trees in the other three treatments during July and August 1989. By late August 1989, trees exhibiting the greatest moisture stress were in the control and high competition treatments.

Adult twig girdlers were first observed on mesquite trees at the study site during the first 2 wk of September 1989. This is consistent with the life cycle of the insect, as described by Rogers (1977). Adult twig girdler activity ceased by mid-October 1989.

A positive linear relationship was found between increasing moisture stress in honey mesquite and infestation by the twig girdler. Trees which expressed greater levels of moisture stress (*i.e.*, lower predawn leaf water potential) had more twigs girdled per unit canopy volume (Fig. 2).

A storm during 12-14 September 1989 produced 151 mm at the study site which undoubtedly increased predawn water potential in all treatments except the rainout, although no measurements were made at this time. However, no rain greater than 8 mm occurred for 35 days prior to or 45 days following this storm. Previous studies on the site indicated that differential stress between treatments returned within 1 wk after a major precipitation event (Ansley et al. 1989). We assume, therefore, that for much of the adult stage of the twig girdler, stress levels in mesquite were similar to what was measured on 30 August.

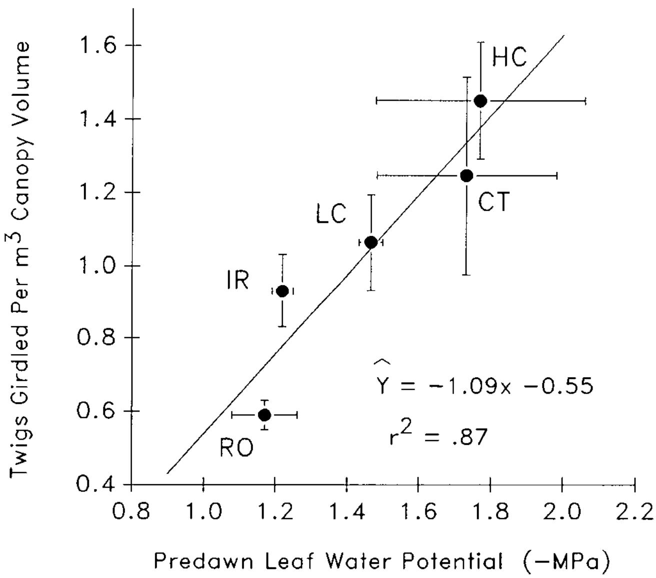

FIG. 2. Linear regression of twig girdling density as a function of predawn leaf water potential. Vertical and horizontal bars represent ± 1 Standard error of girdling density (vertical) and leaf water potential (horizontal) for each moisture stress treatment (n = 4).

Mattson and Haack (1987) and Larsson (1989) noted several problems in relating plant stress to insect activities. In many studies, environmental factors which caused plant stress were the same as those which favored insect growth. Thus, in these studies, plant stress could not be clearly associated with increased insect populations. In our study, field-grown mesquite trees were differentially moisture-stressed under a uniform ambient environment, allowing insect performance (*i.e.*, girdling) to be directly related to plant stress.

In other studies where moisture stress of trees was manipulated, colonization success of naturally occurring herbivorous insects increased in stressed trees (Lorio and Hodges 1977, Ferrell 1978, Waring and Pitman 1985, Mulock and Christiansen 1986, McCullough and Wagner 1987). An opposite relationship has been found in other studies, however. For example, Price and Clancy (1986) found that moisture-stressed arroyo willow, *Salix lasiolepis* Benth., in Arizona provided lower food resources which reduced populations of the stem-galling sawfly, *Euura lasiolepis* Smith. Bultman and Faeth (1987) found greater densities of an undescribed species of *Cameraria* leaf miners on irrigated rather than drought-stressed Emory oak, *Quercus emoryi* Torr.

Various hypotheses have been proposed to explain why stressed trees are more attractive to insects, including a reduced resistance to attack (Ferrell 1978, Rhoades 1983, Price et al., 1987). Others have found that moisture stress creates biochemical changes, such as increased soluble proteins, in the host tissue which attract insects (Miles et al. 1982, White 1984). In Kulman's (1971) review of effects of insect defoliation on trees, it was suggested that unfavorable water balance resulted in increased sugar content of foliage which attracted foliverous insects. Thus, stems on moisture-stressed mesquite may have been more palatable to the twig girdler because of higher protein or sugar content than other stems, although we did not measure this. Alternatively, the twig girdler may have selected drier tissues in moisture-stressed trees to provide a more suitable habitat for overwintering eggs. Thus, drier stems may stimulate girdling activity and subsequent oviposition. This conclusion concurs with Price et al. (1987) who found that the bud-galling sawfly, *Euura mucronata* (Hartig) Man. (Churchill), attacked long shoots of its host, *Salix cinerea* L., more frequently than short shoots because it established and survived better in the long shoots.

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