Drought Stress Increases Densities but Not Populations of Two-spotted Spider Mite on *Buddleia davidii* ‘Pink Delight’

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Abstract. Two experiments were conducted to determine the effect of drought stress on the susceptibility of *Buddleia davidii* Franch. ‘Pink Delight’ to the two-spotted spider mite (*Tetranychus urticae* Koch). In the first experiment, drought stress was imposed by withholding water until predawn xylem pressure potential fell below –1 MPa. Shoot growth was 75% less in drought-stressed than in nonstressed plants. Mite population densities were not affected, but noninfested leaf area was 14% higher, and degree of mite damage was lower, in nonstressed plants. Evidently, the greater amount of new growth in nonstressed plants leads to lower spider mite densities by diluting populations. In a second experiment, nonstressed *B. davidii* ‘Pink Delight’ plants were watered every 1 to 2 days and drought-stressed plants were watered every 3 days. Spider mite populations were monitored by sampling newly expanded and mature foliage. Mite populations on mature foliage were not affected by stress, but stressed plants grew less and had larger spider mite populations on their newly expanded foliage than did nonstressed plants.

*Buddleia davidii*, butterfly bush, is a popular ornamental shrub grown in nurseries and gardens throughout the United States. The most significant debilitating pest of *B. davidii* is the two-spotted spider mite (*Maunier, 1987*). Spider mites cause aesthetic damage and increase production costs because of the need for miticide applications. Cultural factors such as temperature (Boudreaux, 1958), nutritional stress (Mellors and Propts, 1983), and drought stress affect two-spotted spider mite populations.

Conflicting results regarding the effects of drought stress on populations of two-spotted spider mite and related species in horticultural crops have been reported (Klubertanz et al., 1990; Smitley and Peterson, 1991). Many studies, primarily on agronomic crops, have indicated an increase in spider mite populations associated with an increase in drought stress (Hollingsworth and Berry, 1982; Kattes and Smitley, 1984). Higher nutritional value of nonstressed plants (Ferree and Hall, 1980; Hare et al., 1989; Mellors and Propts, 1983; Smitley and Peterson, 1991). English-Loeb (1990) suggested that a drought stress level exists at which mites will perform best and that stress above or below this level reduces mite performance.

Drought stress negatively affects many plant functions, the most significant of which is plant growth (Hsiao et al., 1973). This reduces the area available for spider mites to infest. Drought stress may increase the suitability of a plant as a nutritional source (White, 1984) as well as reduce the plant’s defensive ability (English-Loeb, 1990; Rhoades, 1979, 1983). Higher nutritional value of nonstressed plants has, however, also been reported to be beneficial to growth and development of the two-spotted spider mite (Wrensch and Young, 1975).

No consensus exists as to the effect of drought stress on population growth of two-spotted spider mite. Each plant species must be evaluated separately when studying the effect of drought stress on this pest. This study examined the effects of water stress on infestations of two-spotted spider mite on *Buddleia davidii* ‘Pink Delight’.

Materials and Methods

Expt. 1, 1996. Twenty *Buddleia davidii* ‘Pink Delight’ plants were propagated and grown in 11.3-L (3 gal) containers under greenhouse conditions at Athens, Ga., from Jan. to June 1996. Plants were grown in 100% pine bark and topdressed with Nutricote Total 17–7–8 (17N–3.0P–6.7K plus micronutrients) (PlantCo, Brampton, Ont., Canada). Plants were arranged in a completely randomized design on a greenhouse bench; 10 were drought-stressed and 10 were not. Water was added to plastic trays placed under each container. One liter of water was supplied to nonstressed plants every 2 d, and soluble fertilizer [200 mg·L⁻¹ N as 10–20–20 (20N–4.0P–17K)] (Scotts-Sierra Horticultural Products Co., Marysville, Ohio) was added to the water every 4 d. Predawn xylem pressure potentials of all plants were monitored every 3 d using a pressure chamber (Scholander et al., 1965). Drought-stressed plants were watered individually when their xylem pressure potential fell below –1 MPa, the point at which slight wilting occurs. Watering was alternated with fertilizer solution as with nonstressed plants. Effects of water stress on growth were assessed by measuring shoot length of two young shoots from each plant over the course of the experiment.

Treatments began 26 June. To control mites already present, all plants were treated on 14 June and 1 July with Dinocap (2,4-dinitro-6-octyl-phenyl-crotonate) (Diacem, Bergamo, Italy), a contact miticide with short residual activity (Briggs, 1992). Natural two-spotted spider mite infestations, originating from other *Buddleia* sp. present in the greenhouse, were allowed to develop from the last miticide spray until the end of the experiment on 24 July, when plant growth, mite damage, and mite infestation were recorded.

Mite populations at the end of the experiment were determined by randomly taking five leaves from each plant and counting the number of eggs, adults, and nymphs on an area 71 mm² located at the central, basal portion of the leaf. The percentage of noninfested leaf area was calculated by dividing the number of samples that had no spider mite stages present by the total number of samples for each plant.

At the conclusion of the experiment, mite damage symptoms were calculated for each of the 20 plants independently by five people familiar with the visible characteristics of spider mite feeding. These individuals were asked to mark a tag 10 cm long, without gradients, at a point where they judged visible two-spotted spider mite damage to lie. The top of the tag indicated extreme mite damage (≥10) and the bottom of the tag no mite damage (≤0). The distance from the bottom of the tag to each mark represented an individual damage rating.

Statistical analyses of treatment differences between shoot growth, mite population variables, percentages of uninsected area, and damage ratings were performed using Student’s *t* test (SAS Institute, Cary, N.C.).

Expt. 2, 1997. To assess two-spotted spider mite foliar infestations on drought-stressed plants in a production setting, and to corroborate results from Expt. 1, 20 *B. davidii* ‘Pink Delight’ plants were grown in 11.3-L (3 gal) containers, outdoors at Athens, Ga., from March until the initiation of treatment. On 10 July all plants were stripped of their foliage,
Expanding foliage appeared to be less infested with spider mites than was mature foliage across both treatments. Percentage of noninfested area was significantly less and mite damage, as assessed by survey, was significantly greater in drought-stressed plants than in nonstressed plants. Numbers of adults, nymphs, and eggs did not differ statistically between treatments (Table 1).

The lack of significant differences in mite populations between drought-stressed and nonstressed plants is consistent with data reported by other researchers (Ferree and Hall, 1980; Hare et al., 1989; Mellors and Propts, 1983; Smitley and Peterson, 1991; Wrensch and Young, 1975). This indicates that similar populations of two-spotted spider mites develop on drought-stressed and nonstressed B. davidii. Spider mites feed on the older leaves of infested plants and disperse to new leaves as the old leaves become resource-deficient (Wrench and Young, 1975). If, due to some environmental factor, no new growth develops, the plant will not be able to outgrow an exploding mite population (Smith, 1989). This results in a higher percentage of damage per unit leaf surface area on a drought-stressed than on a nonstressed plant, even though populations are similar. This is corroborated by greater noninfested area in nonstressed plants.

Table 1. Total shoot growth, two-spotted spider mite populations, noninfested leaf area, and damage ratings in drought-stressed and nonstressed Buddleia davidii ‘Pink Delight’ (Expt. 1).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Shoot growth (cm)</th>
<th>Mite population (mean no./71 mm²)</th>
<th>% Noninfested leaf area</th>
<th>Damage rating (0–10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought-stressed</td>
<td>0.80 a</td>
<td>15.50 a 3.16 a 0.94 a 2.0 a</td>
<td>6.61 a</td>
<td></td>
</tr>
<tr>
<td>Nonstressed</td>
<td>3.37 b</td>
<td>20.94 a 1.86 a 0.98 a 16.0 b</td>
<td>5.36 b</td>
<td></td>
</tr>
</tbody>
</table>

*Mean separation within columns by Student’s t test (P ≤ 0.05).

Results and Discussion

Expt. 1, 1996. Shoot growth of nonstressed plants was significantly greater than that of drought-stressed plants (Table 1). Drought stress caused slight wilting between irrigations. Leaves of severely drought-stressed plants abscised toward the end of the experiment because of extreme water stress and mite infestation. Drought-stressed plants probably received less fertilizer than nonstressed plants, but neither treatment should have been deficient in any nutrient, given the high rate of fertilizer applied.

Expanding foliage appeared to be less infested with spider mites than was mature foliage across both treatments. Percentage of noninfested area was significantly less and mite damage, as assessed by survey, was significantly greater in drought-stressed plants than in nonstressed plants. Numbers of adults, nymphs, and eggs did not differ statistically between treatments (Table 1).

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Fig. 1. Effects of drought stress on Buddleia davidii ‘Pink Delight’ (Expt. 2). (A) Shoot length; (B) xylem pressure potential; (C) number of motile mite stages on newly expanded foliage; and (D) number of mite eggs on newly expanded foliage. Asterisks indicate significant (P ≤ 0.05) differences between means within each date.

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The increased growth of nonstressed plants prevents the mites from infesting expanding foliage as rapidly as they would infest the more slowly expanding foliage of a drought-stressed plant.

**Literature Cited**


