EFFECT OF SILVERLEAF WHITEFLY ON COTTON PHOTOSYNTHESIS

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Introduction

The silverleaf whitefly (SLW), *Bemisia argentifolii* Bellows and Perring, is among the most noxious pests of numerous field and vegetable crops, causing billions of dollars worth of damage through direct feeding and massive deposition of honeydew (Byrne et al., 1990; Perring et al., 1993; Brown et al., 1995). Nevertheless, very little has been reported on the physiological mechanisms via which SLW infestation impairs plant productivity. A reduction in net photosynthetic rate (Pn) and stomatal conductance caused by SLW has been reported in tomato (Buntin et al., 1993) and cotton (Shtaynmetz, 1990; Yee et al., 1996). However, it is unclear whether the reduced stomatal conductance is a cause or consequence of the reduced Pn. Our previous work has shown that relative Pn (infested/non-infested) is correlated with SLW infestation and provided an indication that the reduced Pn is more likely due to non-stomatal limitations than stomatal factors (Lin et al., 1999). This study was aimed at characterizing the mechanisms by which SLW impairs the photosynthetic activity in cotton plants.

Materials and Methods

Cotton plants (*Gossypium hirsutum* L., cv. Siv'on) were examined under SLW-infested and non-infested treatments. Large-scale experiments were conducted in an insect-proof screenhouse divided into two compartments; SLW was introduced into one compartment at the onset of flowering, and plants were grown for an entire season. Small-scale experiments were carried out in insect-proof cages located in a temperature-controlled greenhouse; SLW was introduced into predetermined cages at the four-true-leaf stage, and plants were grown until flowering onset. In both experiments, treatments were replicated four times, with 20 pots per plot for the screenhouse experiments and 6 pots per plot (cage) for the greenhouse experiments. Chlorophyll content and chlorophyll fluorescence (PAM-2000, WALZ, Effeltrich, Germany) were assessed. Gas exchange measurements were conducted both in-situ (LI-6200, LI-COR, Lincoln, NE) and in the lab (LI-6262, LI-COR, Lincoln, NE) to establish daily curves, CO_2 response curves and light response curves.

Results and Discussion

Generally, similar results were obtained in both the screenhouse and greenhouse experiments. Silverleaf whitefly infestation significantly reduced cotton Pn throughout the day, with the biggest differences occurring at noontime and the smallest in the late afternoon. Stomatal conductance generally exhibited significantly lower values in SLW-infested plants than in the non-infested ones. Intercellular CO_2 concentration (Ci) was, however, not affected by SLW injury, indicating that stomatal limitation is probably not the major factor limiting Pn. Estimates of stomatal limitation, based on CO_2 response curves, were unaffected by SLW infestation, confirming the above conclusion.

Leaf chlorophyll content, a measure of the light-harvesting capacity of the photosynthetic system, was not affected by SLW infestation. In contrast, reduced chlorophyll content has been reported in SLW-infested tomato plants (Buntin et al., 1993). The fluorescence ratio (Fv/Fm) is proportional to the quantum yield of photosystem II (PS II) photochemistry (Adams et al., 1990) and the fluorescence yield (Fv'/Fm') indicates the efficiency of excitation energy transfer to open PS II reaction centers (Andrews et al., 1995). Silverleaf whitefly infestation significantly reduced both Fv/Fm and Fv'/Fm', suggesting that impaired photochemical reactions are probably among the mechanisms via which SLW reduces Pn. An analysis of light response curves further supported this conclusion. The initial slopes of the light response curves manifested significantly lower values for the SLW-infested plants than the non-infested counterparts, indicating a reduction in the maximum efficiency with which cotton leaves can utilize an absorbed photon for CO_2 fixation. The Pn/Ci curves, obtained under the saturating light intensity, revealed significantly lower CO_2 saturated Pn and initial slopes. The reduced CO_2 saturated Pn implies a suppressed capacity for RuBP regeneration (Farquhar et al., 1987), which may stem from insufficient ATP and NADPH formation caused by the SLW-impaired photochemical reaction. The initial slopes of light response curves are correlated positively to the in vitro measurements of Rubisco activity (von Caemmerer and Farquhar, 1981); our results therefore provide indirect evidence that Rubisco limitation may be among the major causes for the SLW-induced reduction in Pn.

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