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The response of photosynthesis to water deficit in atrazine-susceptible and resistant biotypes of *Solanum nigrum*

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ABSTRACT CO_2 assimilation under photorespiratory and non-photorespiratory conditions and stomatal conductance responses to water deficit were examined in intact attached leaves of atrazine-susceptible (AS) and resistant (AR) biotypes of *Solanum nigrum*. We found that the AR biotype of *S. nigrum* plant acclimated better to water deficit than the AS one, as revealed by the measurements of stomatal conductance, CO_2 assimilation and photorespiration rate.
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KEY WORDS

Solanum nigrum
drought
D1 protein mutant
CO_2 assimilation
stomatal conductance

Triazine-resistance in weeds is due to a mutation of the psbA chloroplast gene, resulting in Ser→Gly substitution in the 264 position of the photosystem II reaction centre D1 protein, causing a decreased binding of both atrazine and Q_B (Pfister and Arntzen 1979). Numerous studies on the growth, physiology and competition of AS and AR plants have confirmed that atrazine-resistance has negative physiological consequences Resistant biotypes are generally less productive as compared to AS biotypes (Gressel 1985).

In the present work, we examined the effect of progressive water deficit on gas exchange in attached leaves of AS and AR biotypes of *S. nigrum.* Drought is one of the major important environmental factors limiting plant growth and productivity. Photosynthesis is particularly sensitive to water deficit because the stomata close to conserve water as available soil water declines. Photorespiration is greatly enhanced as a result of water deficit since the stomata close and CO_2 assimilation is inhibites.

Materials and Methods

Plant material

Potted AR and AS *S. nigrum* plants were grown in soil in the growth chamber under moderate (350 μmol photons m^{-2} s^{-1}) light conditions, 16 h light period and 25-28°C. The plants were irrigated every 2 d throughout the experiments. The youngest, fully expanded intact leaves of about 40-45-day-old plants were used as control. This time irrigation was stopped in several plant containers, and the measurements were repeated every 3-4 d to capture the different degrees of drought.

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Measurements of CO_2 assimilation and photorespiration

The light response of CO_2 fixation was measured with an LCA-3 infrared gas analyser (Analytical Development Co. Ltd, England) in an open gas-exchange system. The attached leaves were exposed for 6 min to white light of different light intensities (from 30 to 1250 μmol photons m^{-2} s^{-1}). Air with controlled CO_2 (345 vpm) and O_2 (21% or 1% v/v) contents in N_2 was passed through the chamber at 300 ml min^{-1}. The difference in CO_2 uptake in 21% and 1% O_2 is due to photorespiration. The assimilation rates were calculated according to the equations of von Caemmerer and Farquar (1981).

Measurements of stomatal conductance

The conductance of stomata was determined with a porometer (AP4, Delta-T, UK). After calibration measurements were performed on the abaxial surface of leaves under growth conditions.

Results and Discussion

The light intensity dependence of the rates of CO_2 assimilation in well watered plant leaves of both biotypes is very similar (Váradi et al. 2003). The initial stomatal conductance values were somewhat higher in the AS biotype (Fig. 1). Drought-induced changes for both biotypes first were observed as a decrease in stomatal conductance, however, unexpectedly this decline was higher in the AS biotype. Stomatal conductance remained higher in the AR biotype under water deficit (Fig. 1). It seems, that the AR biotype exhibits more open stomata under progression of drought as compared with AS plants. CO_2 assimilation decreased progressively in both biotypes, but the drought-induced inhibition of CO_2 assimilation was more pronounced in the AS biotype (results not shown).

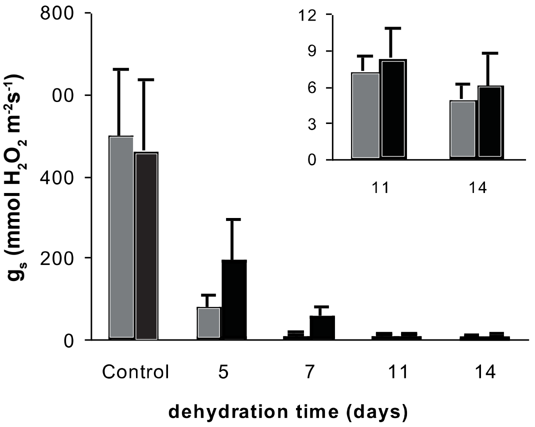

Figure 1. Dehydration response of stomatal conductance of leaves of atrazine-susceptible (grey column) and atrazine-resistant (black column) biotypes of medial-light-grown *Solanum nigrum*. The results are means ± SE from three independent experiments.

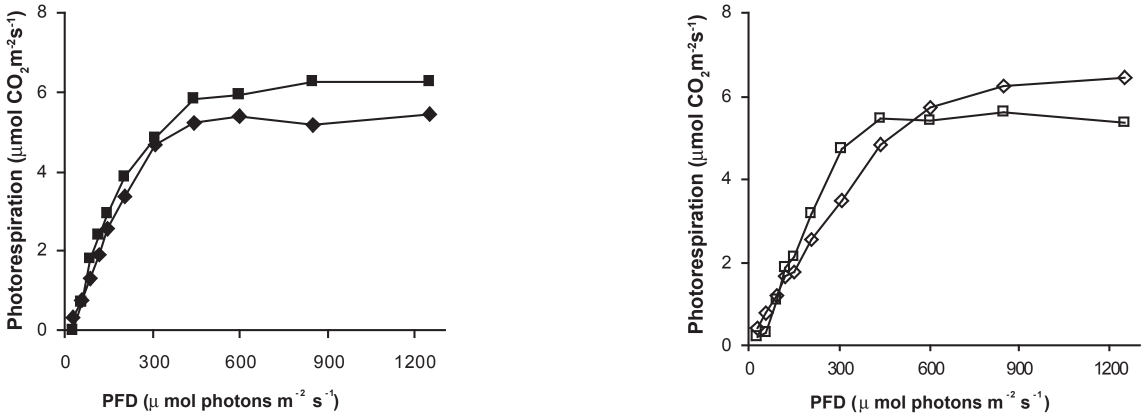

Figure 2. Light response curves of photorespiration of AS (left, close symbols) and AR (right, open symbols) biotypes of medial-light-grown *Solanum nigrum* (control (diamond) and 8 days dehydrated (rectangle)). The results are means from at three independent experiments.

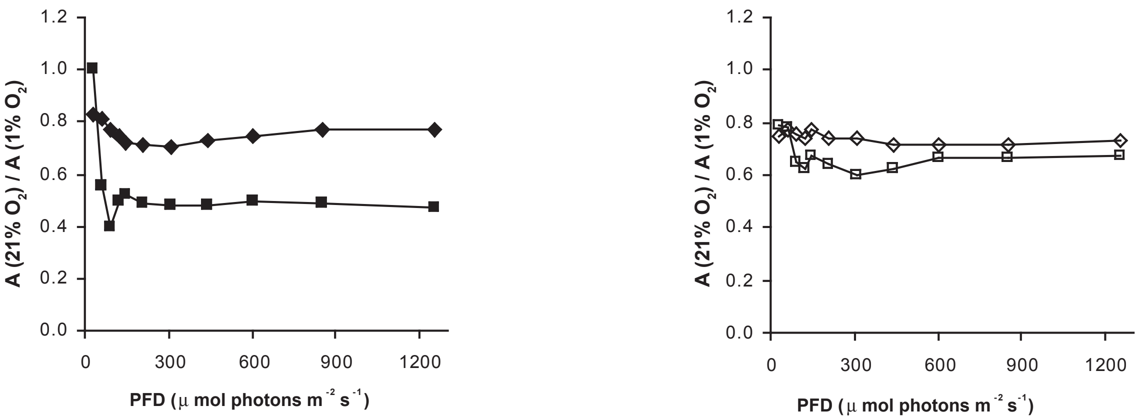

Figure 3. Light response of CO_2 utilization rate of the atrazine-susceptible (left, close symbols) and atrazine-resistant (right, open symbols) biotypes of medial-light-grown *Solanum nigrum* (control (diamond) and 8 days dehydrated (rectangle)). The results are means from three independent experiments.

Photorespiration was greatly enhanced as a consequence of water deficit because the stomata closed and CO_2 assimilation became limited (Fig. 2). The role of photorespiration was assessed by varying the air composition to inhibit the oxygenation reaction of Rubisco (Sharkey 1988). Alterations in the light response of the CO_2 utilization rates (*i.e.* the light response of the ratio of CO_2 assimilation rates at O_2 concentrations of 21% and 1%) under water deficit are shown in Figure 3. There was a considerable dissimilarity in CO_2 utilization rates between the AS and AR weeds. The higher sensitivity of AS biotype to advanced dehydration manifests in the 25-30% decline of the CO_2 consumption rate. The larger photorespiratory rate of AS weed biotype may also be considered as an enhanced defence mechanism in order to dissipate the higher excess of excitation energy due to the limitation in CO_2 availability.

We concluded that photosynthesis is progressively inhibited during water deficit, and stomatal limitations in S. *nigrum* biotypes are determinant. Higher conductivity of stomata in the D1 protein mutant plants allowed satisfactory CO_2 assimilation rate under dry circumstances. Our results strongly suggest that the AR biotype of *S. nigrum* is more tolerant to water deficit than the AS biotype when other natural stress factors, such as high temperature or photoinhibitory light conditions are absent.

References

Gressel J (1985) Herbicide tolerance and resistance; alteration of site of activity. In Duke SO, ed., Weed physiology, Vol. II, CRC Press, Boca Raton, Florida, USA, pp. 159-189.

Pfister K, Arntzen CJ (1979) The mode of action of photosystem II-specific inhibitors in herbicide resistant weed biotypes. Z Naturforsch 34c:996-1009.

Sharkey TD (1988) Estimating the rate of photorespiration in leaves. Physiol Plant 73:147-152.

Váradi Gy, Polyánka H, Darkó É, Lehoczki E (2003) Atrazine resistance entails a limited xantophyll cycle activity, a lower PSII efficiency and an altered pattern of excess excitation dissipation. Physiol Plant 118:47-56.

Von Caemmerer S, Farquar GD (1981) Some relationships between the biochemistry of photosynthesis and the gas exchange of leaves. Planta 153:376-387.