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Effects of salicylic acid on growth and proline of cucumber seedlings

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1. Introduction

Salicylic acid (SA), a natural plant phenolic, has beem reported to act as a signal molecule in providing defence againt pathogen attack (Durner et al., 1997), and now recognized as an endogenous regulator in plants. Exogeneus application of SA to plant exerts diverse physiological and biochemical effects (Raskin, 1992) such as promotion of stomatal closure, inhibition of dry mass accumulation, sugar and amino acid uptake and ethylene synthesis. Leaf and root growth, and chlorophyll and protein contents were reduced by SA treatment (Pancheva et al., 1996). As a result of SA treatment, breakdown in the synthesis of RuBPCO, an inhibition of the Hill reaction activity as well as changes in net photosynthethic rate were reported (Chandra and Bhatt, 1998 ; Pancheva and Popova, 1998). The established effects of SA on stomatal function, chlorophyll content, transpiration rate and respiratory pathways raise the assumption that SA might posses another physiological function, most probably involved in regulation of some photosynthetic reactions. The proline content is known to reflect stress situations in higher plants and higher proline has been associated with plants grown with heavy metals and water deficit (Zaifnejad et al., 1997).

The objective of our study was to determine the effects of SA and water deficit, administered separately and in combination, on growth traits and proline accumulation in shoots and roots of cucumber.

2. Materials and methods

Seeds of cucumber(*Cucurmis sativus* L.) were germinated for 2 days in 2 layers of moist filter paper in moist vermiculite at 25℃ in the dark. Then they were transferred into petri dishes containing 40 ml distilled water or equal amount of water solutions of the required SA solutions (100, 500 and 1000 μM). To monitor growth, lengths and widths of seedlings were measured and intial and final fresh and dry weights of the seedlings were determined. For anatomical observations, leaf samples were taken at mid-lamina from the second leaf of 10-d-old seedlings and fixed with 2.5% glutaraldehyde in phosphate buffer (pH 7.4). The thickness of the lamina

between bundles was examined. Water deficit was induced with polyethylene glycol(PEG)-8000 at 4.4, 7.0 and 9.6%(w/w) in solution (eguivalent to approximately -0.09, -0.13 and -0.17 MPa). Total titratable acidity was measured according to Pancheva et al. (1996). The proline contents were determined according to Bates et al. (1973).

3. Results and Discussion

The concentrations lower than 100 μM SA had no effect on the seedling growth, while concentrations of SA higher than 1000 μM completely inhibited the seedling growth. Relative to control, SA-treated seedlings also exhibited a higher accumulation of proline levels and leaf titratable acidity. The extent of changes in titratable acidity was not strong as that of changes in proline levels. The increased values of proline content and titratable acidity claim that SA could provide alterations very often associated with plant responses to stress-related reactions. Distinct differences were observed in leaf components of the control and SA-treated seedlings. Treatment of seedlings with SA caused a reduction in lamina thickness and in the dimensions of adaxial and abaxial epidermis. The reduction of epidermal width was more pronounced on the adaxial epidermis. The distance between bundles was also reduced. The results show that SA treatment to cucumber seedlings causes alterations in leaf anatomy, suggesting that exogenous SA application decreases photosynthetic activity as a result of effects on thylakoid membranes and light-induced reactions connected them. The lower leaf photosynthetic area and probably changes in its water balance could be another possible explanation. Roots of plants grown in PEG had little change in root length. Increased levels of SA and PEG progressively decreased root length ; PEG treatments had a greater effect than SA. The SA + PEG treatments had relatively little effect on root length. SA reduced root dry matter most likely by reducing root elongation. The root length values decreased smaller to dry matter when the level of SA and PEG increased. Water deficit had greater effects on shoot and root proline accumulation than SA, and shoots had higher proline than roots. Proling was generally higher in shoots than in the roots as water deficit increased. Plants grown with SA + PEG had much higher proline than plants grown with SA alone. Proline accumulation is a reservoir of energy and amino groups for post-stress growth. Proline accumulation could be a symptom of water deficit, and may not be directly involved in water deficit resistance.

4. Abstract

The effects of salicylic acid (SA) on growth and proline were investigated in

cucumber seedlings. Exogenous application of SA(100 μM - 1mM) led to a noticeable decrease in root and shoot growth, and dry weights of seedlings. Anatomical observation on leaf anatomy of cucumber revealed that the thickness of all leaf tissue components decreased in SA-treated plants. The effect was most pronounced on the width of the adaxial epidermis. In the separate and simultaneous effects of SA and water deficit induced by PEG on growth and proline accumulation, the water deficit treatments had greater effects on growth traits and proline content than SA. Combinations of SA and PEG decreased dry matter and root length, and resulted in higher proline in both shoots and roots than SA stress alone. Shoots had higher proline than roots.

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