EFFECTS OF AMINOETHYOXYVINYLGLYCINE ON ROOT GRAVITROPISM IN MAIZE

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INTRODUCTION: According to the Cholodny-Went hypothesis (2,8), gravitropism in roots is controlled by the lateral movement of auxin across the root when oriented horizontally in a gravitational field. Several researchers (1, 3, 4) have noted an initial "wrong-way" curvature in stem and coleoptile tissues. This "wrong-way" curvature is characterized by an initial positive curvature prior to negative gravicurvature. Hild and Hertel (4) proposed that the early positive curvature may be an overreaction to the initiation of a strong stimulus. Their model suggests that during the early phases of gravitropism, "wrong-way" curvature results from an overstimulation of the tissue (resulting in inhibition of shoot elongation) and a subsequent adaptation to the stimulus resulting in negative curvature.

Primary roots of maize have been shown to exhibit "wrong-way" curvature, i.e., an initial negative curvature prior to positive gravicurvature. This report characterizes "normal" and "wrong-way" curvature and examines the role of ethylene and auxin in the phenomenon.

MATERIALS AND METHODS: Plant Material. Caryopses of corn (Zea mays L., B73xMO17), were soaked overnight in running tap water and germinated between wet paper towels on opaque plastic trays placed in a vertical position (6).
Kinetics of Gravitropism. The kinetics of gravitropic curvature was measured using a computer-based, video-image analysis system which utilizes a video camera focused on an intact root growing in a humidified chamber (>98% RH). Iodine-stained agarose beads (0.2-0.3 mm diameter) were placed along roots pretreated in water or AVG solutions. The video image was analysed using an IBM-PC computer equipped with a Tecmar Video VanGogh system (Cleveland, OH) and custom software.
Application of (5-^{3}H)-IAA. To measure transport of indoleacetic acid across the elongation zone (5-^{3}H)-IAA (specific activity of 74 MBq/ml IAA) was incorporated into agar donor blocks (1.0% agar, 1.0 mm^3). Roots were pretreated in water or AVG solutions for various time periods prior to being transfered into a humidified chamber in a vertical position. IAA donor blocks were placed 4 mm basipetal to the tip. A receiver block of the same size was placed on the opposite side of the root directly across from the donor block prior to reorientation of the roots. After a transport period, the donor and receiver blocks were placed in separate scintillation vials for determination of radioactivity.

DISCUSSION: Fig. 1 shows the kinetics of gravicurvature in Type I, Type II, and AVG-induced Type II curvature. Type I gravicurvature or transient "wrong-way" curvature (solid line) occurs in approximately 30% of the roots from seedlings. The rapidity in development of the "wrong-way" curvature has been observed in shoot tissues (5, 7). Type II gravicurvature (Fig 1, dashed line) occurs in approximately 70% of the roots from seedlings. The kinetics of "induced" Type I gravicurvature which results from pretreatment of vertically-oriented roots for 1 hour in 1 uM AVG is illustrated in Fig. 1 (dotted line). Note that "wrong-way" curvature comparable to that observed in Type I roots occurs in the AVG-treated roots; but AVG treatment extends the period of negative gravicurvature.

Fig. 2 illustrates the time course of development of auxin asymmetry in the elongation zone of control and AVG-treated roots. Asymmetric distribution of IAA (increased IAA in receiver blocks placed on lower surface of roots) is observed in both control and AVG-treated roots. However, the asymmetry found in control roots decreases after 45 min while the asymmetry continues to increase in AVG-treated roots. The decrease in asymmetry observed in the control roots corresponds with the vertical reorientation of the graviresponding root tip.

From this data the following conclusion can be made: 1) AVG treatment of primary roots of maize converts the "normal" gravicurvature response of Type II roots into the "wrong-way" curvature response of Type I roots. We suggest that AVG alters the sensitivity of the roots to auxin by suppression of auxin-induced ethylene biosynthesis. Suppression of ethylene biosynthesis would result in an initial promotion of growth and upward curvature as auxin accumulates in the lower hemisphere of the root. 2) AVG treatment does not alter the development of asymmetry in IAA across the elongation zone of graviresponding roots.

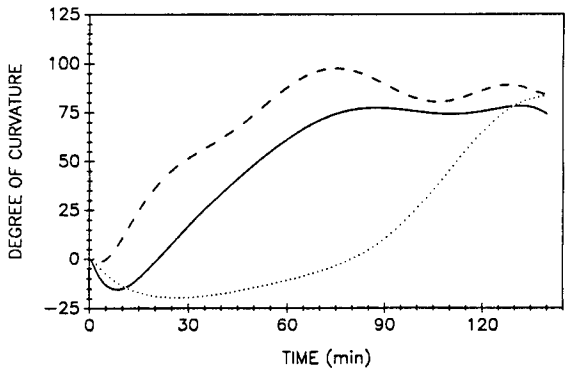

Figure 1. Kinetics of Gravicurvature. Roots were pretreated in water or AVG (1 uM) for 1 hr. The solid line is the kinetics of Type I roots. The dashed line is the kinetics of Type II roots. The dotted line is the kinetics of AVG-induced Type I roots.

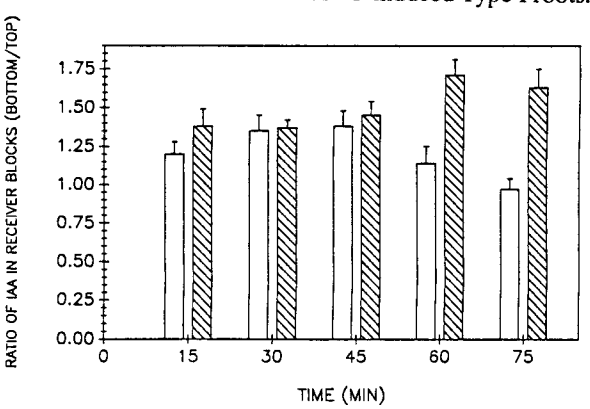

Figure 2. Time-Course of IAA Asymmetry Across Graviresponding Roots. Open bars show H^3-IAA ratios (bottom/top receiver blocks) for control roots pretreated in water for 1 hr. Hatched bars are IAA ratios (bottom/top receiver blocks) for root pretreated in 1 uM AVG for 1 hr.

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