LONG DISTANCE NITROGEN SIGNALING VIA CYTOKININ IN POPLAR

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ABSTRACT

Hybrid poplar is a model tree in many respects: rapid growth, ease of vegetative propagation, small genome and high economic value for fiber and bioenergy. Some poplars have sylleptic branching in that branches grow out from lateral buds in the same season in which they are formed. The result is increased branch number, leaf area and biomass. Three F_1 clones of hybrid poplar (11-11, 47-174 and 49-177; *Populus trichocarpa,* black cottonwood x *P. deltoides,* eastern cottonwood) exhibiting contrasting degrees of sylleptic branching were analyzed with nitrogen and cytokinin treatments in the present study. Nitrogen fertilization of the roots with 5mM NH_4NO_3, NH_4Cl, or KNO_3 strongly enhanced sylleptic branching of the 11-11 clone within a week. Although direct treatment of undeveloped sylleptic buds with NH_4NO_3 had no promotive effect on bud outgrowth, the daily direct treatment of these buds with cytokinin (1 mM benzyladenine) resulted in the initiation of vigorous outgrowth within a week

There is substantial evidence in the literature suggesting a long distance signaling role for cytokinin in nitrogen root fertilization promotion of shoot growth. Of all the nutrients required for plant growth and development, nitrogen is the most limiting. B. Forde (2002) has hypothesized that nitrate applied to the roots of herbaceous plants can be tranduced via the *ipt* enzyme to cytokinin which can then be transported up the xylem to the shoot with subsequent binding to a CRE1-type receptor and promotion of leaf outgrowth. . Sakakibara et al.(1998, 1999) have demonstrated in maize and *Arabidopsis* that type A response regulator genes in the shoot's receiver domain (triggering shoot growth) are inducible only by cytokinins and not by nitrate whereas nitrate can only be transduced to cytokinin in the roots and not in the shoots. As Sakakibara (2003) has pointed out, there are a wide variety of genes which are regulated by the availability of nitrate. This regulation is not governed by a single signaling pathway but rather by a complex signaling network. In long distance signaling of nitrogen availability, there is evidence that both the nitrate ion and cytokinin, moving up the xylem from root to shoot, play key roles. For example, the nitrate ion activates the gene for nitrate reductase expression in leaves among others and in general controls nitrate assimilation and amino acid/nucleotide synthesis whereas cytokinin controls various developmental processes.

The physiological data concerning nitrogen and cytokinin effects on sylleptic branching in hybrid poplar in the present study are consistent with the herbaceous model of nitrogen signaling of Forde and Sakakibara.

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