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From Forest Nursery Notes, Winter 2010

155. © Seasonal fluctuation of root carbohydrates in hybrid aspen clones and its relationship to the sprouting efficiency of root cuttings. Stenvall, N., Piisila, M., and Pulkkinen, P. Canadian Journal of Forest Research 39:1531-1537. 2009.

Seasonal fluctuation of root carbohydrates in hybrid aspen clones and its relationship to the sprouting efficiency of root cuttings

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Abstract: We examined the relationship between root carbohydrates and sprouting efficiency in four hybrid aspen (*Populus tremula* × *Populus tremuloides*) clones. Our hypothesis was that the interclonal variation in sprouting efficiency is due to the concentration of carbohydrates. In addition to that relationship, we wanted to study seasonal fluctuation of carbohydrates and how the -18°C storage conditions of stock plants affects the stability of carbohydrate content and thus sprouting ability of roots cuttings. Clones varied in root carbohydrate content, and sucrose showed the greatest variation throughout the year. Sucrose levels were highest in the clone with the highest sprouting efficiency and lowest in the clone with the lowest sprouting efficiency. Carbohydrate concentrations were highest in winter and lowest in early autumn. In general, root cuttings sprouted most efficiently when root carbohydrate levels peaked. Although root cuttings taken from frozen (-18°C) stock plants sprouted poorly in summer and autumn, they had high and almost constant carbohydrate concentrations throughout the year.

Résumé : Nous avons étudié la relation entre les hydrates de carbone dans les racines et l'efficacité du drageonnement chez quatre clones de peuplier hybride (*Populus tremula* × *Populus tremuloides*). Nous avons émis l'hypothèse selon laquelle la variation interclonale de l'efficacité du drageonnement serait due à la concentration des hydrates de carbone. En plus de cette relation, nous voulions étudier la fluctuation saisonnière des hydrates de carbone et la façon dont les conditions d'entreposage à -18°C des plantes-mères influencent la stabilité de la teneur en hydrates de carbone et, par conséquent, la capacité des boutures de racine à drageonner. La teneur en hydrates de carbone des racines variait selon le clone et le sucrose a connu la plus forte variation tout au long de l'année. Le niveau de sucrose était le plus élevé chez le clone qui drageonnait le plus efficacement et le plus faible chez le clone qui produisait le moins de drageons. La concentration des hydrates de carbone était la plus élevée en hiver et la plus faible au début de l'automne. En général, les boutures de racine drageonnaient le plus efficacement lorsque le niveau d'hydrates de carbone culminait. Bien que les boutures de racine prélevées sur des plantes-mères gelées (-18°C) n'aient pas bien drageonné en été et à l'automne, elles avaient des concentrations élevées et presque constantes d'hydrates de carbone pendant toute l'année.

[Traduit par la Rédaction]

Introduction

Carbohydrate reserves in the roots of perennial plants are essential to future growth, development, and re-establishment (Loescher et al. 1990). In poplars, for example, sexual reproduction occurs before leaf expansion and photosynthetic competence in early spring (Loescher et al. 1990; Eckenwalder 1996). Asexual reproduction, either naturally from root suckers or artificially from root cuttings, is also dependent on stored carbohydrate (Frey et al. 2003). Thorpe and Murashige (1970) have shown that stimulation of primordial buds (starting points) occurs only when a sufficient amount of starch has accumulated. Such reserves must supply the development of the emerging sprout through to its photosynthetic competence (Schier and Zasada 1973; Schier 1976).

European aspen (*Populus tremula*) and the closely related North American quaking aspen (*Populus tremuloides*) are

artificially crossed to produce a fast-growing hybrid that is cultivated for bioenergy, paper making, and timber (Yu et al. 2001; Hynynen and Sanaslahti 2002) in northern Europe. In Finland, hybrid aspen is propagated mainly by root cuttings. In our earlier studies, we found considerable variation in the sprouting efficiency (percentage of sprouted cuttings) of hybrid aspen clones (Stenvall et al. 2004, 2005), which may, in part, be due to carbohydrate concentration (Johansson 1993).

Root carbohydrate reserves include both soluble and insoluble sugars. Although the main soluble carbohydrate is sucrose, fructose and glucose can also be present in high concentrations (Bonicelet al. 1987; Loescher et al. 1990). Most of the insoluble carbohydrate is starch (Loescher et al. 1990). Carbohydrate reserves vary during the annual cycle of plants, with root carbohydrate concentrations being highest during the dormant period and reducing in the spring

Received 27 October 2008. Accepted 20 April 2009. Published on the NRC Research Press Web site at cjfr.nrc.ca on 18 August 2009.

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