Carbohydrate sources used in new root growth following transplant of *Quercus rubra* L. seedlings

Joshua L. Sloan and Douglass F. Jacobs

Hardwood Tree Improvement and Regeneration Center
Department of Forestry and Natural Resources
Purdue University, West Lafayette, Indiana
E-mail: jsloan@purdue.edu; djacobs@purdue.edu

Abstract

To determine the extent to which northern red oak (*Quercus rubra* L.) relies on current photosynthate when developing new roots following transplanting, 1+0 seedlings were transplanted and a batch of seedlings was exposed to $^{14}CO_2$ at one of three successive growth stages as identified by the *Quercus* morphological index (QMI) (Hanson et al. 1986). Following a translocation period, seedlings were analyzed for ^{14}C content so as to characterize sink activity of organs across growth stages. New root growth following transplant is initiated relying primarily on stored carbohydrates during the shoot linear stage of growth, while current photosynthate contributes to new root growth at the lag stage. Better understanding of northern red oak seedling physiology will allow for the production of higher quality target seedlings and help to improve outplanting success.

Introduction

Few studies have examined carbon allocation in hardwood tree species that exhibit episodic growth patterns, characterized by the recurrent development of flushes throughout the growing season (Dickson et al. 2000*a*, Dickson et al. 2000*b*). Published literature, often using northern red oak as the species of interest, indicates that patterns of allocation vary greatly depending upon the growth stage of the seedling, as measured against the *Quercus* Morphological Index (QMI) (Dickson et al. 2000*a*, Dickson et al. 2000*b*, Hanson et al. 1986). Until now, most studies have focused upon allocation and partitioning patterns only during the first growing season.

Materials and methods

1+0 container-grown northern red oak seedlings of half-sib seed origin were transplanted into a mixture of sand and peat (1:1 by volume) in 7.6L pots and placed in environmental growth chambers (27°C/16h days, 21°C/8h nights). Seedlings were irrigated to maintain pots at container capacity. Unlabeled seedlings were harvested at time of transplant (FIH) and prior to bud break (BUD). At the shoot linear (SL), leaf linear (LL), and lag (LAG) stages, groups of seedlings were removed from the growth chambers and current photosynthate was labeled with ^{14}C in a gas-tight closed-loop chamber containing $^{14}CO_2$. The seedlings were then replaced in growth chambers for a translocation period of 48 hours. Following the translocation period, seedlings were separated by organ and flush, oven-dried, ground, and analyzed for ^{14}C via accelerator mass spectrometry (AMS) at the Purdue Rare Isotope Measurement Laboratory (PRIME Lab).

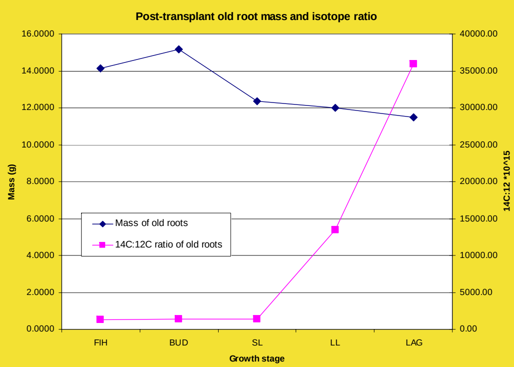

Figure 2. Old root mass and ^{14}C:^{12}C across growth stages

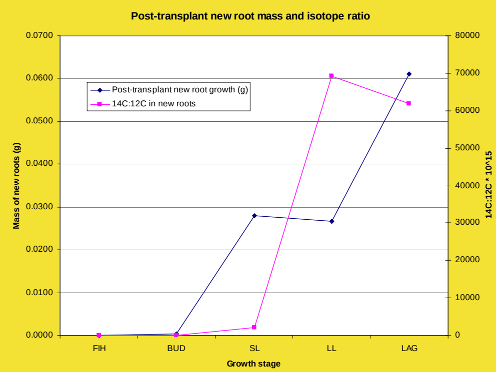

Figure 3. New root mass and ^{14}C:^{12}C across growth stages

Growth Stage	Old root mass (g)	14C:12C *10^15 of old roots	New root mass (g)	14C:12C *10^15 of new roots
FIH	14.12 A	1264.50 A	0.00 A	N/A
BUD	15.17 A	1383.67 AB	0.00 A	N/A
SL	12.35 A	1377.67 B	0.03 B	1993.50 A
LL	12.02 A	13464.75 ABC	0.03 B	69127.50 AB
LAG	11.47 A	35948.00 C	0.06 B	61842.00 B

Table 1. Root growth and ^{14}C:^{12}C across growth stages

Results and Discussion

Significant new root growth occurred beginning at the shoot linear stage of growth (SL), while significant levels of labeled current photosynthate did not appear in new roots until the lag stage of the flush (LAG) (Fig. 3, Table 1). This suggests that initial new root growth following transplant relies on stored carbohydrates, while current photosynthate only begins to contribute to root growth as the flush matures. Additionally, current photosynthate begins to accumulate in old roots during lag phase, perhaps to replenish depleted carbohydrate reserves (Fig. 2, Table 1).

The apparent reliance upon stored carbohydrates for post-transplant root initiation highlight the potential importance of managing for ample carbohydrate reserves during nursery production.

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References

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