Effect of Physical Manipulation and Plant Growth Regulator Application on Branching of Oak, Linden, and Kentucky Coffeetree©

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INTRODUCTION

Red oak (*Quercus rubra*), littleleaf linden Shamrock® (*Tilia cordata*), and Kentucky coffeetree (*Gymnocladus dioica*) are trees currently produced by the nursery industry. However, training these tree species to have a high quality canopy can be challenging. Nursery producers have identified species-specific challenges to developing ideal canopy characteristics and branch structure. For example, growers often experience difficulty developing well spaced branches on red oaks. Oaks have multiple lateral buds immediately subtending the terminal bud, which develop into clusters of branches. These branch clusters alternate with unbranched sections of the central leader. On lindens, the primary branches are often a mix of very short, somewhat stunted branches and very long, vigorous branches which create an unbalanced, asymmetrical appearance. Coffeetree is a particularly challenging species because few branches develop on young trees in production, making it difficult to develop a full canopy.

A naturally occurring hormone in plants, auxin, is known to inhibit branching. Auxin moves downward from the stem apex through the plant, repressing lateral bud break (Childers et al., 1995). This process is termed apical dominance. In order to decrease the amount of auxin and thus stimulate branching, nursery growers head back (prune out) the central leader of trees, removing the source of the auxin. Another hormone involved in branching is cytokinin. Cytokinin stimulates cell division and branching. The auxin to cytokinin ratio is important in regulating shoot and root growth and, as such, plays an important role in branch development.

Plant growth regulators (synthetic plant hormones or inhibitors of naturally occurring plant hormones) have been used on woody plants. They are used on fruit trees to increase budbreak (Young, 1987). Some plant growth regulators are also used to increase compactness and increase shoot growth (Lewis, 1989). Plant growth regulators have also been used to stimulate flushes of growth (Poston et al., 2007). However, using plant growth regulators has not been widely adopted by the nursery industry.

Nursery producers often use labor intensive pruning techniques to manipulate branch architecture. Heading back cuts are commonly made to increase branch number (Gilman, 2002). Pruning is frequently used during shrub production to control size and create more dense plants. However, labor is increasingly expensive and the effectiveness of heading back cuts in ornamental tree production has not been researched thoroughly. In addition, less common training techniques, such as whipping (removing all branches), have been tried on a very limited basis (Fulcher et al., 2005).

The objective of this study was to determine the effectiveness of heading back cuts, other physical manipulations and a plant growth regulator on branch architecture of three trees in pot-in-pot production.

MATERIALS AND METHODS

All plants were received as bareroot liners. The oaks and lindens were potted into 7 and 15 gal-containers, respectively in the Spring 2007 and the coffeetrees were potted into 15-gal containers in Spring 2008. All plants were potted with Barky Beaver Professional Grow mix. The trees were placed into pot-in-pot production the year of potting.

Plants were fertilized with Harrells® 19N–4P–8K, 5–6 month release fertilizer. The plants in 7-gal containers received 100 g per plant and those in 15-gal containers received 200 g per plant. Trees were irrigated as needed with microirrigation emitters.

The initial caliper and branch number were taken on 3 April 2008. On 18 April 2008 all treatments were imposed except for the application of MaxCel®, a synthetic cytokinin, (Valent Corp., Richardson, Texas), which was applied on 23 May 2008 at a concentration of 2500 ppm. All species were subjected to MaxCel, heading back (pruning out the top 4 inches of the central leader to a healthy, lateral bud), and untreated control. Additional treatments were assigned to each species based on addressing the particular challenges for that species: the oaks were subjected to rubbing out the subtending buds, the lindens to whipping, and the Kentucky coffeetrees to sanding and notching.

The oaks tend to have well developed branches. However, the branches tend to be unevenly spaced and grow in clusters. Other research has shown that rubbing out the lateral buds subtending the terminal bud can enhance branch development on oak trees (Dan Struve, pers. commun.). On lindens, there is disparity in branch length and vigor. By removing all branches (whipping), the canopy will be composed entirely of new branches which will develop with the support of a relatively large root system. Kentucky coffeetrees often develop few branches during production. Notching interrupts auxin flow, relieving the lateral buds from apical dominance. In the notching technique, a small cut is made above the lateral buds. It is important not to cut so deeply that the xylem is severed. Sanding was recommended by a nurseryman as a technique to stimulate budbreak on coffeetrees (Gary Phelps, pers. commun.). The sanding treatment involved rubbing sand paper (100A grit) over the buds while the trees were dormant. Swollen buds were not sanded due to the risk of damaging them.

On 30 May, the MaxCel-treated plants were rated on a scale of 1–5 for phytotoxicity (data not shown). On 10 June, the trees received a treatment of Snapshot® to reduce the germination of weed seeds. The final branch count was conducted on 29 July, 2008. The quality of the canopy was rated on a scale of 1 to 3. A rating of 1 was given when a tree had an asymmetric, light canopy. A tree was rated as a 3 when the canopy was very dense and had branches that were evenly spaced. The final caliper was taken on 15 Aug. 2008.

RESULTS AND DISCUSSION

No treatment significantly increased the final number of primary branches or the final caliper (Tables 1, 2, 3). The time to apply each treatment and general lack of a

Table 1. Effect of branch inducing treatments on red oak.

Treatment	Initial caliper (mm)	Increase in caliper (mm)	Initial branch number	Increase in branch number
Untreated control	16.8	6.4	7.9	1.5
Heading back cut	16.9	5.8	8.0	-0.3
MaxCel®	16.5	4.9	7.1	2.8
Rub out	16.6	3.9	7.0	4.9
ANOVA P value	0.1281	0.8043	0.8250	0.4013

Table 2. Effect of branch-inducing treatments on Shamrock® linden.

Treatment	Initial caliper (mm)	Increase in caliper (mm)	Initial branch number	Increase in branch number
Untreated	19.6	6.8	10.0	4.4
Head back	18.2	5.9	11.1	4.4
MaxCel®	19.3	6.4	10.6	3.3
Whip	18.8	6.0	11.1	2.2
ANOVA P value	0.3821	0.7265	0.9290	0.6021

Table 3. Effect of branch-inducing treatments on Kentucky coffeetree.

Treatment	Initial caliper (mm)	Increase in caliper (mm)	Initial branch number	Increase in branch number
Untreated	8.8	2.6	0.0	1.6
Head back	18.6	2.8	0.0	1.2
MaxCel®	18.6	2.8	0.0	1.2
Notch	18.8	2.5	0.0	1.7
Sand	18.7	2.3	0.0	1.5
ANOVA P value	0.9918	0.9173	-	0.3749

Table 4. Canopy quality ratings for three tree species subjected to branch-inducing treatments.

Treatment	Oak	Linden	Coffeetree
Untreated	2.1	1.8 ab[z]	2.4
Head back	2.0	2.2 b	1.6
MaxCel®	2.0	2.3 b	2.2
Notch	-	-	2.5
Rub out	2.1	-	-
Sand	-	-	1.9
Whip	-	1.3 a	-
ANOVA P Value	0.9479	0.0123	0.00507

[z]Means followed by the same letter were not significantly different (Tukey's HSD $\propto = 0.05$)

significant effect on branch number and/or quality suggests that these techniques are not a useful tool for nursery producers on these species. However, in the case of notching and sanding, the technique may not have been performed correctly and further refinement of the technique could be effective in stimulating branching. The application of MaxCel plant growth regulator caused significant phytotoxicity on the lindens. The oaks were much less affected, and the coffeetrees were not affected (data not shown). On lindens, the leaves appeared to be scorched and had dark spots on the underside of the leaves. Eventually many of the leaves abscised. At the end of the season, plants that were headed back and MaxCel-treated plants had a significantly better quality than the whipped plants (Table 4). Additionally, the growth that occurred on the whipped plants consisted of nontypical foliar shape and size for the cultivar, possibly due to juvenility. For this reason, the lindens could not be sold as true to type. Interestingly, plants that were whipped had the same number of primary branches by the end of the summer as plants subjected to the other treatments.

There was no increase in branch number due to any treatment. With the exception of the lindens, treatments did not significantly influence tree quality. These data suggest that the common practice of heading back trees to stimulate branching and/or increase quality is not effective on red oak and coffeetree and warrants a more thorough examination on other species.

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