HARVEST METHOD HAS NO INFLUENCE ON GROWTH OF TRANSPLANTED GREEN ASH[1]

by David L. Hensley

Abstract. Green ash were grown with or without in-ground fabric bags and transplanted as bag-grown, balled-and-burlapped, or as bareroot plants. Heights and stem diameters were measured for four growing seasons after transplanting. Roots were harvested and weighed upon termination of the study. There were no differences in average or total tree heights or stem diameters or in dry root weights regardless of harvest method.

Nursery production of landscape trees in in-ground fabric bags (grow bags) has increased since their introduction in 1984. Several advantages have been described by grow bag originators (15,23,24). Fabric bag design and technology have evolved, but some of the initial expectations for commercial grow bags have not been met (9).

Advertised advantages for grow bags include retention of more of the plant's root system, no circling or distortion of roots, concentration of carbohydrates in the roots allowing rapid root generation following transplanting, and fewer seasonal constraints on transplant operations (9,17,23). Nursery production costs using fabric bags are greater (9,18,19), but harvest costs may be reduced (9,16,18). Other limitations of grow bags have been noted and include species variability in tolerance to root restriction, lack of suitability for holding in the field or using trees over time, and difficulty in planting (9,18). Root ball sizes are sometimes smaller than recommended by the American Association of Nurseryman for balled-and-burlapped (B&B) trees (1).

Early publications on fabric bags indicated more rapid establishment of bag-grown nursery plants in the landscape because of increased carbohydrate and nutrient levels in the roots and a more fibrous root system (17,23).

Girdling, or constricting the tree's stem, blocks translocation of carbohydrates, hormones, and other possible root-promoting factors resulting in increased root formation (11). Chong, Lumis and Cline (3) reported that fabric bags girdled roots penetrating through the bag. Girdling restricted the carbohydrate flow from leaves and roots of poplar (*Populus deltiodes* x *nigra*) to those roots outside the bags and nutrient flow from roots outside the bag into the contained plant. Total root sugar content of primary roots of live oak (*Quercus virginiana*) was significantly greater for bag-grown than for field-grown trees. Total sugar content of sweetgum (*Liquidambar styraciflua*) roots, however, was less in bag-grown than in field-grown trees (10).

Tree response to fabric containers appears to be species dependent (6,7,10). Some species have increased root weight inside the harvested fabric bags, whereas other species were unaffected. Field containerization did not influence growth parameters of southern magnolia (M*agnolia grandiflora*), Drake elm (*Ulmus parvifolia* cv. Drake), crape myrtle (*Lagerstroemia indica*), or slash pine (*Pinus eliottii*) (12). Sweetgum and live oak root dry weights in fabric containers were greater than field grown plants. There is little evidence linking increased root dry weight (6) or root density (7) within the root ball of fabric containers to reduced stress following transplanting or enhanced posttransplant shoot or trunk growth.

Production and harvest methods can affect regrowth of transplanted trees, but results have varied with study and species. Machine harvesting green ash (*Fraxinus pennsylvania*) and other species with soil resulted in 4 to 10 times greater growth than for comparable-sized dormant plants moved bareroot (21). Growth of pecan (*Carya illinoensis*) transplanted as container- or field-

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grown trees was similar after 5 years (13). *Juniperus* species grew equally well whether transplanted as bareroot or balled-and-burlapped (14). However, Norway spruce (*Picea abies*) and American arborvitae (*Thuja occidentalis* 'Pyramidalis') in the same study transplanted more successfully balled-and-burlapped than bareroot. Blessing and Dana (2) reported that field-grown *Juniperus chinensis* cv. Sea Green had greater root spread and regenerated root dry weight than did container-grown plants 16 weeks after transplanting.

Fuller and Meadows (5) reported that trees produced in fabric containers regenerated roots after transplanting at a similar rate as trees produced in the field. Gilman and Harris (8) reported greater root regeneration by fabric container-grown slash pine and leyland cypress (x *Cupressosyparis leylandii*) than for field-grown plants 10 weeks after transplanting. Laurel oak trees from fabric containers regenerated the same number of roots, but grew less in trunk diameter in the year after transplanting than trees transplanted from the field with a tree spade (8). No differences occurred between field- and fabric-bag-grown trees in the number and cross-sectional areas of roots, although the bag-grown roots balls were smaller (7).

Neither caliper nor top growth of crape myrtle and live oak (*Quercus virginiana*) differed as a result of transplanting field- or fabric bag-grown plants, although height of both species was greater for transplanted field-grown plants. Root regeneration by live oak, but not by crape myrtle, was enhanced in plants produced in bags. July-transplanted live oak produced in bags survived, whereas traditional field-grown trees did not (20).

When this study was undertaken in 1985, little research had been published. There was more conjecture than facts concerning grow bags and their potential use. Most of the studies cited above have been published since initiation of the present study. The purpose of this study was to determine if, as marketing had indicated, grow bags increased survival and post-transplant growth of trees transplanted into the landscape. A secondary purpose was to compare the growth of trees harvested in grow bags, as B&B, or as bareroot over several seasons after transplanting.

Materials and Methods

Uniform one-year-old, 50-cm(20 in) seedlings of green ash were planted in the spring, 1985 at the Horticulture Research Center, Wichita, KS, in square 36 cm (14 in) polypropylene fabric bags with plastic bottoms (Dewitt Co., Sikeston, MO) or without bags in nursery rows. The bags were backfilled with unamended field soil. Plants were planted and grown using routine management procedures. Height and stem diameter of each tree were measured shortly after planting.

Trees were measured and harvested in the spring of 1988. There were no significant differences in tree height or stem diameter between those grown with or without the fabric bag (J. Pair and D. Hensley, unpublished data). Some root girdling occurred at the fabric and soil interface, and rooting depth was restricted by the plastic liner in the bottom of the bag. Trees grown without bags were harvested by hand as balled-and-burlapped or bareroot with root systems approximately the same size as the bagged root systems. Bagged trees were harvested by digging around the root balls before extracting the bags. Harvest of bag-grown plants was less arduous than standard balling or barerooting practices.

The balled-and-burlapped, barerooted, and fabric-bag-grown trees were transported to Manhattan, KS and planted on April 13, 1988, in a Haynie fine sandy loam at the Ashland Horticulture Research Farm. Trees were uniform and averaged 1.8 m (6 ft) in height and stem diameters averaged 2.5 cm (1 in). Thirty cm-wide (12 in) holes were augured and expanded by hand to be approximately 15 cm (6 in) larger than the root systems. Each harvest method was replicated five times in a randomized complete block design.

Fabric bags were removed before planting, while the burlap was not removed from balled-and-burlapped trees. All plants were watered well within 24 hr after planting. Plants were irrigated as necessary and fertilized each spring with approximately 225 g (8 oz) of 12-12-12 (N-P_2O_5-K_20) per tree.

Heights and stem diameters at 15 cm (6 in) were measured at planting and again on September 8, 1988, September 25, 1989, October 12, 1990, and September 19, 1991. Plants were harvested in October 1991, with a 112 cm (44 in) mechanical tree digger (Vermeer Co, Pella, IA). All soil was removed with high pressure water, and the harvested root systems were allowed to air dry under cover until weighing on May 26, 1992.

Results and Discussion

Transplanting bag-grown trees into the final growing site was laborious and time consuming, compared to planting balled-and-burlapped or bareroot trees. Pruners and a large knife were required to sever roots growing through the bags and cut the fabric so that the bag could be removed. Removing the bag from the soil balls required time and care to avoid damaging or destroying the root ball. Root balls, especially in sandy soil, can be damaged if the bags are not removed carefully (9).

All transplanted trees survived. There were no differences (F test) in average tree height or caliper at any measurement during the duration of the study, regardless of harvest method. The average annual height (Fig 1) and stem diameter (Fig 2) growth by the transplanted trees was smallest during the planting season. There were no differences among harvest methods for any of the average annual growth measurements.

There were also no differences (F test) in average harvested weights among plants transplanted in root bags (28.7 kg (63.3 lb)), balled-and-burlapped (27.1 kg (59.7 lb)), or as bareroot trees (27.5 kg (60.5 lb)).

These results indicate that for green ash, root containment in fabric bags did not promote growth after transplanting. One originator of fabric bag culture reported 5,000 new roots on a bag-grown green ash, opposed to 120 on control trees 42 days after transplanting (18). Any positive effect of bag culture on post-transplant growth during the four growing seasons of this study were not detectable. Additionally, the root systems within the machine-harvested plug appeared identical when the soil was removed.

Root development following transplanting varies with species, environmental conditions, physiological status, time of year, cultural practices, type of root system (6), soil texture and depth, and oxygen diffusion rates (22). Green ash transplants relatively easily (4), and the study site was relatively good for plant growth. After-planting care was not exceptional but adequate to assure survival and growth. In this situation, the added production or transplanting expense of using the plants in fabric bags is not justified for green ash and possibly other more easily transplanted species

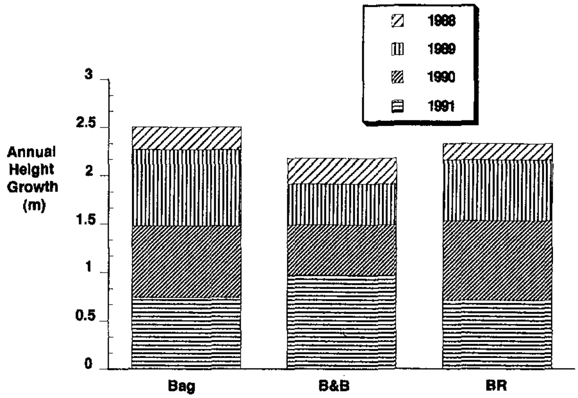

Figure 1. Average annual height growth (m) of green ash transplanted as bag-grown (Bag), balled-and-burlapped (B&B), or as bareroot (BR) harvested trees.

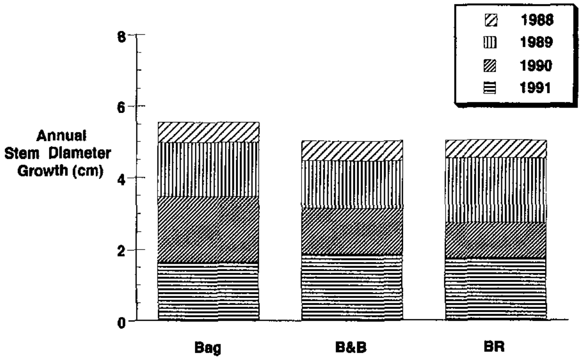

Figure 2. Average annual stem diameter growth (cm) of green ash transplanted as bag-grown (Bag), balled-and-burlapped (B&B), or as bareroot (BR) harvested trees.

There was also no disadvantage to moving this species bareroot. The trees were transplanted within a few days of lifting and not held in storage. Survival and subsequent regrowth might have been different with additional handling and long-term storage.

From the results of this study and others in the literature, fabric bags are not a panacea. Producers, contractors, and landscape designers should not consider fabric-bag production as a method to dramatically increase the transplantability or growth of every landscape ornamental. Results have proven to vary greatly with species. Fabric bags provide no advantage and increase production and transplanting costs for easily established landscape species. Root confinement systems, however, may offer certain advantages for production and re-establishment of difficult-to-transplant species, although few studies have involved these difficult species. Advantages and disadvantages must be considered within species differences, environmental conditions, and economics.

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Résumé. Des frênes de pennsylvanie (Fraxinus pennsylvanica) furent laissés en croisance en pleine terre, avec ou sans contenant artificiel, et transplantés à racines nues, motté et emballé ou en contenant. Le diamètre de la tige et la hauteur furent mesurés et la plante pesée au terme de la recherche. Il y eut aucune différence dans la moyenne ou le total pour ce qui est de la hauteur des arbres, du diamètre des tiges ou de la masse en racines sèches quelque soit la méthode de production employée.

Zusammenfassung. Grüne Esche (*Fraxinus pennsylvanica*) wurde angezogen im Boden mit oder ohne Jutesack und verpflanzt als im Jutesack gewachsen, mit eingeschlagenen Wurzelballen oder mit nackten Wurzeln. Die Höhe und die Stammdurchmesser wurden am Ende der Studie gemessen und bewertet. Unabhängig von der Erntemethode traten keine Unterschiede bei der durchschnitts- bzw. absoluten Baumhöhe, dem Stammdurchmesser oder dem Trockenwurzelgewicht auf.