leaves, tie up the remaining crown until the palm is relocated in the new site, and then untie the crown immediately. Care should be taken to protect the root ball from physical damage and desiccation during the transplanting process, and the backfill around the new transplant should be kept uniformly moist until the plant is established.

Literature cited

Broschat, T.K. 1990. IBA, plant maturity, and regeneration of palm root systems. HortScience 25:232.

Broschat, T.K. 1991. Effects of leaf removal on survival of transplanted *Sabal* palms. J. Arboricult. 17:32–33.

Broschat, T.K. 1994. Effects of leaf removal, leaf tying, and overhead irrigation on transplanted pygmy date palms. J. Arboricult. 20:210–213.

Broschat, T.K. 1995. Planting depth affects survival, root growth, and nutrient content of transplanted pygmy date palms. HortScience 30:1031–1032.

Broschat, T.K. 1998. Root and shoot growth patterns in four palm species and their relationships with air and soil temperatures. HortScience 33:995–998.

Broschat, T.K. and H.M. Donselman. 1984. Regrowth of severed palm roots. J. Arboricult. 10:238–240.

Broschat, T.K. and H.M. Donselman. 1987. Factors affecting palm transplanting success. Proc. Fla. State Hort. Soc. 100:396–397.

Broschat, T.K. and H. Donselman. 1990. Regeneration of severed roots in *Washingtonia robusta* and *Phoenix reclinata*. Principes 34(2):96–97.

Broschat, T.K. and A.W. Meerow. 2000. Ornamental palm horticulture. University Press of Florida, Gainesville.

Costonis, A.C. 1995. Factors affecting survival of transplanted *Sabal* palms. J. Arboricult. 21:98–102.

Donselman, H. M. 1991. Planting a palm tree.Coop. Ext. Serv. Fact Sheet ENH-46. Univ. of Florida Inst. of Food and Agr. Sci., Gainesville.

Harris, R.W., J.R. Clark, and N.P. Metheny. 1999. Arboriculture—Integrated management of landscape tress, shrubs, and vines. Prentice Hall, Upper Saddle River, N.J.

Hodel, D.R. 1995. An ounce of prevention. Amer. Nurserymen 182(4):68–75.

Hodel, D.R. 1996. Planting palms correctly for vigorous, attractive growth and fewer problems. Turf Tales 3(1):10–11.

Hodel, D.R. 1997. Planting palms. Grounds Maintenance 32:C10–12.

Hodel, D.R., A.J. Downer, and D.R. Pittenger. 1998. Palm root regeneration, p. 46–50. In: D. Neeley and G.W. Watson (eds.). Proc. Intl. Wkshp. Tree Root Development in Urban Soils. The Landscape Below Ground, II. Intl. Soc. Arboricult., Champaign, Ill.

Hodel, D.R. and D.R. Pittenger. 2003. Studies on the establishment of date palm (*Phoenix dactylifera* 'Deglet Noor') offshoots. Part I: Observations on root development and leaf growth. Palms 47(4):191–200.

Hodel, D.R., D.R. Pittenger, and A.J. Downer. 2003. Effects of leaf removal and tie up on juvenile, transplanted Canary Island datepalms (*Phoenix canariensis*) and queen palms (*Syagrus romanzoffiana*). Palms 47(4):177–184.

Howard, F.W., D. Moore, R.M. Giblin-Davis, and R.G. Abad. 2001. Insects on palms. CABI Publ., New York.

Meerow, A.W. 1997. Betrock's guide to landscape palms. Betrock Info. Serv., Hollywood, Fla.

Meerow, A.W. and T.K. Broschat. 1992. Transplanting palms. Coop. Ext. Serv. Circ. 1047. Univ. of Florida Inst. of Food and Agr. Sci., Gainesville.

Nixon, R.W. and J.B. Carpenter. 1978. Growing dates in the United States. U.S. Dept. Agr. Info. Bul. 207, Washington, D.C.

Pittenger, D.R, A.J. Downer, and D.R. Hodel. 2000. Palm root regeneration and its significance in transplanting. In: T.G. Ranney (ed.). Metropolitan Tree Improvement Alliance (METRIA). Proc. 11th METRIA Conf. 20 Apr. 2004. <http://www.ces.ncsu.edu/fletcher/programs/nursery/metria/metria11>.

Reuveni, O., Y. Adato, and H. Lilien-Kipnis. 1972. A study of new and rapid methods for the vegetative propagation of date palms. Proc. 49th Annu. Date Grower's Inst.:17–23. Indio, Calif.

Tomlinson, P.B. 1961. Palmae. Vol. II., p. 47–52 in: C.R. Metcalfe (ed.). Anatomy of the monocotyledons. Clarendon Press, Oxford, U.K.

Tomlinson, P.B. 1990. The structural biology of palms. Clarendon Press, Oxford, U.K.

Zaid, A. (ed.). 1999. Date palm cultivation. United Nations, FAO, Plant Production and Protection Paper 156. Rome.

A Review of the Effects of Transplant Timing on Landscape Establishment of Field-grown Deciduous Trees in Temperate Climates

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ADDITIONAL INDEX WORDS. fall, root growth, root regeneration, season, spring, summer

SUMMARY. Prudent landscape professionals can enhance chances for successful establishment by timing tree transplant operations to coincide with ideal seasonal conditions. However, transplant timing is usually determined by economic factors, resulting in trees being transplanted at times that are unfavorable for their survival and growth. Knowledge of the effects of season of transplanting on the establishment of landscape trees can help assure the highest probability of success, especially since special post-transplant management may be required if trees are transplanted at unfavorable times. This manuscript reviews past and current research on the effects of transplant timing on landscape establishment of deciduous shade trees. Specific results are summarized from several key studies.

Season of transplant affects post-transplant establishment in two general ways. First, season, or time of year, dictates specific plant growth stages (e.g., dormancy, shoot expansion, leaf drop) and consequently affects a variety of plant resources that influence the potential for quick post-transplant root system regeneration, the key to successful transplant establishment. For example, buds of

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temperate zone plants are released from dormancy upon satisfaction of chilling requirements and, along with lengthening days, shoots begin elongation when spring temperatures rise. Transplanting during active shoot elongation is generally ill-advised (Dumbroff and Webb, 1978; Harris and Fanelli, 1999; Watson and Himelick, 1982, 1983) due to the risk of desiccation (Farmer, 1975) and competition between roots and shoots for available carbohydrates (Lathrop and Mecklenburg, 1971; Richardson, 1958; Watson and Himelick, 1982, 1983) during this growth stage, which can result in suppression of new root growth (Dumbroff and Webb, 1978). Transplanting when trees are in-leaf also results in greater desiccation risk. Consequently, growth stage of shoots can have a major impact on root system regeneration.

The second way that season of transplant affects post-transplant establishment is that seasons have characteristic weather (e.g., soil temperature, soil moisture, humidity, wind, etc.) that affects plant growth and potential for root system regeneration. In contrast to the shoots of temperate zone hardwoods, which have a dormant period that can be overcome by chilling, the roots may not exhibit an easily identified period of innate dormancy (Richardson, 1958; Taylor and Dumbroff, 1975). However, Arnold and Young (1990) found evidence with several apple (*Malus*) species to support that some inherent dormancy may exist in the root system that is satisfied by low temperature exposure. Although root growth is linked to shoot growth by endogenous signals (Farmer, 1975; Larson, 1970; Richardson, 1958), root growth is strongly influenced by environmental factors such as soil temperature and moisture (Lyr and Hoffmann, 1967). Thus, for transplanting, we focus on weather conditions that affect root growth.

Each species has different amplitudes or an "ideal" range of rhizosphere temperatures that are most suitable for root growth. This range is usually related to the normal climatic amplitude of temperatures in the region to which the species or ecotypes of the species are native. The typical range that permits root growth for temperate species is between 35 and 77 °F (1.7 and 25.0 °C) (Lyr and Hoffmann, 1967). Local soil temperatures therefore strongly affect root growth opportunity for transplanted trees. Struve and Moser (1985) determined that as temperature increased from 50 to 79 °F (10.0 to 26.1 °C) in the root zone of root-pruned scarlet oak (*Quercus coccinea*) seedlings, time until new root initiation decreased, numbers of initiated new roots increased, and root elongation rate increased. Larson (1970) reported that little new root growth occurred in northern red oak (*Quercus rubra*) seedlings at temperatures less than 55 °F (12.8 °C). Maximum root elongation occurred in Struve and Moser's research at 79 °F, while no new root growth was evident below 50 °F. These findings were similar to data for other temperate zone species (Harris et al., 1995, 1996; Headley and Bassuk, 1991; Lyr and Hoffmann, 1967). At 79 and 70 °F (21.1 °C), roots initiated growth 6 d following pruning, whereas at 61 F ° (16.1 °C), root growth was initiated after 12 d. No elongation or initiation occurred at 50 °F. As a point of reference, soil temperatures typically drop to 50 °F in early November and remain below 50 °F until early April in Blacksburg, Va., located in the Appalachian mountains of southwestern Virginia and in USDA plant hardiness zone 6a (Harris et al., 2001). Periods with favorable root growth temperatures will vary in length according to local climate.

Due to favorable conditions, such as increased soil moisture, cooler temperatures, and the associated reduced potential for desiccation, fall and spring are usually considered ideal times for transplanting temperate species (Harris et al., 1999; Watson and Himelick, 1997; Watson et al., 1986), particularly if post-transplant care is minimal. Favorable environmental conditions and appropriate growth stage coincide in fall and spring, making these seasons the preferred choices for transplanting. Additionally, many woody plants have distinct periods of active root elongation in fall and spring (Cripps, 1970; Deans, 1979; Deans and Ford, 1986; Dell and Wallace, 1983; Harris and Fanelli, 1999; Harris et al., 1995; Roberts, 1976; Stone and Schubert, 1959; Stone et al., 1962; Wargo, 1983). Which season is preferable for transplanting depends on many factors that can influence either growth stage or rhizosphere environment, such as local weather, tree species, type of planting stock, and time of harvest.

Fall planting is reported to be superior to spring planting (Buckstrup and Bassuk, 2000; Harris and Bassuk, 1994; Harris et al., 1996; Kelly and Moser, 1983; Watson and Himelick, 1983; Whitcomb, 1984; Witherspoon and Lumis, 1986), inferior to spring planting (Buckstrup and Bassuk, 2000; Harris and Bassuk, 1994; Larson, 1970; Watson et al., 1986), or have no advantage to spring planting (Harris et al., 2001; Watson and Himelick, 1982; Watson et al., 1986). This lack of agreement is a result of climate, age, size, type of planting stock, species, and experimental differences. Although genotype × environment interactions are apparent from the mixed research results, lists of species that generally transplant best in fall or spring have been compiled (Gilman, 1997; Schein, 1993; Watson and Himelick, 1997). Additionally, Dirr (1998) provides recommendations for some species.

Fall transplanting offers a number of advantages, including a greater opportunity for trees to grow new roots and develop contact between the roots and soil (Buckstrup and Bassuk, 2000) and more time for the tree to acclimate to the physiological stresses of transplanting before deciduous species resume growth in spring (Harris and Fanelli, 1999). In a study comparing the effects of fall and spring harvest and transplant dates on first-season root, shoot, and trunk diameter growth of turkish hazelnut (*Corylus colurna*), Harris et al. (2001) reported that root growth of early fall–transplanted trees began before that of spring-transplanted trees. Another study addressing early root system regeneration of sugar maple (*Acer saccharum*) and northern red oak determined that October-transplanted trees began root system regeneration earlier and produced more roots in the first season post-transplant than the November- and March-transplanted trees (Harris et al., 2002). In Blacksburg, Va., no new roots were evident for November-transplanted northern red oak or willow oak (*Quercus phellos*) when subsamples were excavated in January, but November transplants apparently began root growth earlier than March transplants. Total amount of early new root growth was relatively small, however, and no apparent advantage to the earlier root growth was evident in terms of canopy development (Richardson-Calfee et al., 2004).

Recently, Buckstrup and Bassuk

(2000) compared transplant success of fall- and spring-planted hackberry (*Celtis occidentalis*), american hophornbeam (*Ostrya virginiana)*, and swamp white oak (*Quercus bicolor*). After the first year, spring-planted hackberry had slightly greater shoot growth than the corresponding fall-planted trees. However, fall-planted american hophornbeams and swamp white oaks had better growth than spring-planted trees. Thus, although results for the first post-transplant season were species-specific, fall transplanting was only marginally less effective for one species and more favorable for two other species in New York. Little difference existed between spring- and fall-transplant treatments after the second growing season. Watson et al. (1986) followed twig growth of eight tree species that were transplanted at various times throughout the year for 5 years after transplanting and also found the effects of time of transplanting to be transitory. However, Shoemake and Arnold (1997) reported that differences in growth between half-sib families of sycamore (*Platanus occidentalis*) persisted for at least 2 years after transplanting.

Harris et al. (1996) established that in southwest Virginia, fringetree (*Chionanthus virginicus*) transplanted more successfully in fall than spring. Trees transplanted in early November had wider canopies and greater leaf area the following summer than trees transplanted in early December and mid-March. Additionally, November-transplanted trees had more root growth after one growing season than December- or March-transplanted trees. March transplants had the least total leaf area, leaf dry mass, and root extension into the backfill soil. Root growth outside the original root ball did not occur in any treatment until early July (1 month after budset).

Although fall transplanting may accelerate first-season root growth of some species in certain locations, root growth will probably not initiate until after spring budbreak in cold-soil regions (Harris and Bassuk, 1995; Harris et al., 2001; Richardson-Calfee et al., 2004; Struve and Joly, 1992). Nonetheless, fall planting is still advantageous for most species of deciduous shade trees in northern climates. For example, Witherspoon and Lumis (1986) determined that in Ontario, root system regeneration of littleleaf linden (*Tilia cordata*) was greatest when trees were transplanted in early November vs. late April. However, late-fall (late November through December) transplanting is not advised in climates with severe winters because of an increased risk of desiccation and cold injury (Harris and Bassuk, 1994; Harris et al., 1999).

Desiccation may be exacerbated in cold soils because of increased hydraulic resistance across roots at temperatures below 45 °F (7.2 °C) (Running and Reid, 1980). Desiccation may account for differences in survival rates of fall- and spring-transplanted trees (Bates and Niemiera, 1997; Buckstrup and Bassuk, 2000; Richardson-Calfee et al., 2004). A lack of early post-transplant root system regeneration in fall-transplanted trees will result in fall transplants having to rely solely on the transplanted root systems over winter in cold climates. As mentioned previously, limiting soil temperatures may relate to the normal climatic range of temperatures in the region to which the species is indigenous, with root growth of southern species being limited at higher temperatures than northern species. Conversely, northern ecotypes may be less well adapted to hot summer temperatures in southern climates (Shoemake and Arnold, 1997). Thus, trees that are marginally hardy in any area are probably best transplanted in spring instead of fall. However, if root balls are protected from cold during handling, most hardy trees probably can be successfully transplanted whenever they are dormant if winters are not severe. Spring transplanting (prior to budbreak) avoids most risks of damaging cold weather, but transplanting at budbreak is often detrimental to bare-root stock (Dumbroff and Webb, 1978; Farmer, 1975) and can result in poor root production and growth due to water stress and competition between roots and shoots for carbohydrates (Watson and Himelick, 1982).

Summer transplanting of field-grown trees is generally not recommended because of the associated high temperatures and increased transpiration demands (Acquaah, 1999), particularly if the trees are harvested in summer. Container-grown trees may be a better summer option (Harris and Bassuk, 1991), although typical container root balls are prone to rapid drying (Hanson et al., 2004). While irrigation is desirable for all transplanted trees, regular irrigation is essential for summer transplants. Despite the negative aspects, advantages of summer transplanting include warm soil and air temperatures, long daylength, and fully developed tree crowns, which produce the carbohydrates necessary for new root production and growth (Watson et al., 1986). Watson et al. (1986) indicated that field-grown species can grow more when transplanted in Illinois in late spring or summer compared to early spring or fall. For example, May-transplanted redbuds (*Cercis canadensis*) and July-transplanted norway maples (*Acer platanoides*) had greater twig growth than trees transplanted in other months. Therefore, summer transplanting may be successful, especially if the post-transplant environment can be manipulated to reduce desiccation. Antitranspirants and stripping of leaves are occasionally employed to reduce the transpirational demand for summer transplants, but these practices are often harmful or of no benefit (Davies and Kozolwski, 1974; Harris et al., 1999) and cannot be offered as general recommendations.

In summary, judicious timing can pay dividends when transplanting landscape trees. Spring and fall are generally the most favorable seasons for transplanting deciduous trees in temperate regions due to non-desiccating environmental conditions and the natural capacity for root growth at these times. Transplanting success is seriously compromised when shoots are actively growing. Summer transplanting can be injurious, but it can be successful if post-transplant environmental conditions can be manipulated to reduce desiccation. Although trees may be transplanted successfully during any season, the interaction of species and local climate should be considered. Fall appears to be the best time overall for planting many species of deciduous trees in cool temperate climates. Soils are generally wetter in the fall and there is consequently a lower threat for drought soon after transplanting for fall vs. spring transplants. For well-irrigated landscapes, transplant timing may have a more limited effect.

Literature cited

Acquaah, G. 1999. Horticulture: Principles and practices. Prentice-Hall, Upper Saddle River, N.J.

Arnold, M.A. and E. Young. 1990. Growth and protein content of apple in response to root and shoot temperature following chilling. HortScience 25:1583–1588.

Bates, R.M. and A.X. Niemiera. 1997. Effect of cold storage and pre-transplant desiccation on root growth potential and bud break of bare-root qashington hawthorn and norway maple. J. Environ. Hort. 15:69–72.

Buckstrup, M.J. and N.L. Bassuk. 2000. Transplanting success of balled-and-burlapped versus bare-root trees in the urban landscape. J. Arboricult. 26:298–308.

Cripps, J.E.L. 1970. A seasonal pattern of apple root growth in western Australia. J. Hort. Sci. 45:153–161.

Davies, W. and T. Kozolwski. 1974. Short- and long-term effects of antitranspirants on water relations and photosynthesis of woody plants. J. Amer. Soc. Hort. Sci. 99:297–304.

Deans, J.D. 1979. Fluctuations of the soil environment and fine root gowth in a young sitka spruce plantation. Plant Soil 52:195–208.

Deans, J.D. and E.D. Ford. 1986. Seasonal patterns of radial root growth and starch dynamics in plantation-grown sitka spruce trees of different ages. Tree Physiol. 1:241–251.

Dell, B. and M. Wallace. 1983. Periodicity of fine root growth in Jarrah (*Eucalyptus marginata* Donn ex Sm.). Austral. J. Bot. 31:247–254.

Dirr, M.A. 1998. Manual of woody landscape plants: Their identification, ornamental characteristics, culture, propagation and uses. 5th ed. Stipes, Champaign, Ill.

Dumbroff, E.B. and D.P. Webb. 1978. Physiological characteristics of sugar maple and implications for successful planting. For. Chronicle 54:92–95.

Farmer, R.E.J. 1975. Dormancy and root regeneration of northern red oak. Can. J. For. Res. 5:176–185.

Gilman, E.F. 1997. Trees for urban and surburban landscapes. Delmar, New York.

Hanson, A.M., J.R. Harris, R.W. Wright, and A.X. Niemiera. 2004. Water content of a pinebark growing substrate in a drying mineral soil. HortScience 39:591–594.

Harris, J.R. and N.L. Bassuk. 1991. Tree planting fundamentals. J. Aboricult. 19:64–70.

Harris, J.R. and N.L. Bassuk. 1994. Seasonal effects on transplantability of scarlet oak, green ash, Turkish hazelnut and tree lilac. J. Arboricult. 20:310–317.

Harris, J.R. and N.L. Bassuk. 1995. Effects of defoliation and antitranspirant treatment on transplant response of scarlet oak, green ash and turkish hazelnut. J. Arboricult. 21:33–36.

Harris, J.R., N.L. Bassuk, R.W. Zobel, and T.H. Whitlow. 1995. Root and shoot growth periodicity of green ash, scarlet oak, turkish hazelnut, and tree lilac. J. Amer. Soc. Hort. Sci. 120:211–216.

Harris, J.R., P. Knight, and J. Fanelli. 1996. Fall transplanting improves establishment of balled and burlapped fringe tree (*Chionanthus virginicus* L.). HortScience 31:1143–1145.

Harris, J.R. and J. Fanelli. 1999. Root and shoot growth periodicity of pot-in-pot red and sugar maple. J. Environ. Hort. 17:80–83.

Harris, J.R., R. Smith, and J. Fanelli. 2001. Transplant timing affects first-season root growth of turkish hazelnut (*Corylus colurna* L.). HortScience 36:805–807.

Harris, J.R., J. Fanelli, and P. Thrift. 2002. Transplant timing affects early root system regeneration of sugar maple and northern red oak. HortScience 36:805–807.

Harris, R.W., J.R. Clark and N.P. Matheny. 1999. Arboriculture: Integrated management of landscape trees, shrubs, and vines. 3rd ed. Prentice Hall, Uper Saddle River, N.J.

Headley, D. and N. Bassuk. 1991. Effect of time of application of sodium chloride in the dormant season on selected tree seedlings. J. Environ. Hort. 9:130–136.

Kelly, R.J. and B.C. Moser. 1983. Root regeneration of *Liriodendron tulipifera* in response to auxin, stem pruning, and environmental conditions. J. Amer. Soc. Hort. Sci. 108:1085–1090.

Larson, M.M. 1970. Root regeneration and early root growth of red oak seedlings: Influence of soil temperature. For. Sci. 16:442–446.

Lathrop, J.K. and R.A. Mecklenburg. 1971. Root regeneration and root dormancy in *Taxus* spp. J. Amer. Soc. Hort. Sci. 96:111–114.

Lyr, H. and G. Hoffmann. 1967. Growth rates and growth periodicity of tree roots. Intl. Rev. For. Res. 181–236.

Richardson, S.D. 1958. Bud dormancy and root development in *Acer saccharinum*. In: K.V. Thimann (ed.). Physiology of forest trees. Ronald Press. New York.

Richardson-Calfee, L.E., J.R. Harris, and J.K. Fanelli. 2004. Seasonal effects of transplanting on growth and pre-budbreak root system regeneration of northern red oak and willow oak. J. Environ. Hort. 22:75–79.

Roberts, J. 1976. A study of root distribution and growth in a *Pinus sylvestris* L. (scots pine) plantation in Thetford Chase, Anglia. Plant Soil 44:607–621.

Running, S. and C. Reid. 1980. Soil temperature influences on root resistance of *Pinus contorta* seedlings. Plant Physiol. 65:635–640.

Schein, R.D. 1993. Street trees, a manual for municipalities. Tree Works, State College, Pa.

Shoemake, L.J. and M.A. Arnold. 1997. Half sib family selection improves container nursery and landscape performance of sycamore. J. Environ. Hort. 15:126–130.

Stone, E.C. and G.H. Schubert. 1959. Root regeneration potential of ponderosa pine lifted at different times of the year. For. Sci. 5:322–332.

Stone, E.C., J.L. Jenkinson, and S.L. Krugman. 1962. Root-regenerating potential of douglas-fir seedlings lifted at different times of year. For. Sci. 8:288–297.

Struve, D.K. and B.C. Moser. 1985. Soil temperature effects on root regeneration of scarlet oak seedlings. Ohio Agr. Res. Dev. Ctr. Res. Cir. 2841:12–14.

Struve, D.K. and R.J. Joly. 1992. Transplanted red oak seedlings mediate transplant shock by reducing leaf surface area and altering carbon allocation. Can. J. For. Res. 22:1441–1448.

Taylor, J.S. and E.B. Dumbroff. 1975. Bud, root, and growth regulator activity in *Acer saccharum*. Planta 104:110–114.

Wargo, P.M. 1983. Efects and consequences of stress on root physiology. J. Arboricult. 9:173–176.

Watson, G., E. Himelick, and E. Smiley. 1986. Twig growth of eight species of shade trees following transplanting. J. Arboricult. 12:241–245.

Watson, G.W. and E.B. Himelick. 1982. Seasonal variation in root regeneration of transplanted trees. J. Arboricult. 8:305–310.

Watson, G.W. and E.B. Himelick. 1983. Root regeneration of shade trees following transplanting. J. Environ. Hort. 1:50–52.

Watson, G.W., E.B. Himelick, and T.E. Smiley. 1986. Twig growth of eight species of shade trees following transplanting. J. Arboricult. 12:241–245.

Watson, G.W. and E.B. Himelick. 1997. Pinciples and practices of planting trees and shrubs. Intl. Soc. Arboricult., Savoy, Ill.

Whitcomb, C.E. 1984. Another look at fall planting. Oklahoma Agr. Exp. Sta. Res. Rpt. P-855.

Witherspoon, W. and G. Lumis. 1986. Root regeneration of *Tilia cordata* cultivars after transplanting in response to root exposure and soil moisture levels. J. Arboricult. 12:165–168.