MANAGEMENT INFLUENCES ON GROWTH OF TRANSPLANTED *MAGNOLIA GRANDIFLORA*

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Abstract. Container-grown *Magnolia grandiflora* were planted in spring and fall with or without hardwood mulch and a complete fertilizer. Fertilizer was placed either in the bottom of the planting hole, mixed with the backfill, or surface applied after planting. Growth measurements were made during 3 seasons. Height growth was not influenced by planting date but was reduced the first season as a result of mulching. After 22 months, however, mulched plants were significantly larger than controls. Fertilization at planting resulted in significant height increases at every evaluation, but fertilizer location was not a factor. Spring planting, mulching, and fertilization resulted in significant increases in stem diameter. Spring planting, mulching and soil incorporation of fertilizer resulted in significantly more branches per plant during the third season.

Résumé. Des plants de *Magnolia grandiflora* cultivés dans des contenants furent plantés au printemps et à l'automne, avec ou sans un paillis de feuillus et un fertilisant complet. Les mesures de croissance furent prises au cours de trois saisons. La croissance en hauteur ne fut pas influencée par la date de plantation, mais fut réduite pendant la première saison de croissance lors de la présence d'un paillis. Cependant, après 22 mois, les plants avec un paillis étaient significativement plus gros que les arbres témoins. La fertilisation lors de la plantation a entraîné une augmentation significative de la croissance en hauteur dans tous les cas, mais la localisation du fertilisant n'était pas un facteur. La plantation au printemps, l'application d'un paillis et d'un fertilisant ont résulté en une augmentation significative de la croissance en diamètre. La plantation au printemps, l'application d'un paillis et d'un fertilisant dans le sol a résulté en une augmentation significative du nombre de branches par plant au cours de la troisième saison.

Establishment of woody plants after transplanting is dependent on the interaction of numerous environmental, physiological, and cultural factors. Success of the operation affects future plant growth and development, design expectations, site maintenance requirements, consumer satisfaction, and profit for the nurseryman/landscape contractor.

A large percentage of the root system is removed during harvest so rapid regeneration is essential for successful reestablishment (3, 9, 14). Root regeneration varies with species, physiological conditions, developmental stage, and the environment (9). Any stress or limiting factor which can be reduced will increase transplant survival and subsequent growth, and reduce costs for the industry and consumers.

Water is frequently the most limiting factor encountered during transplanting since absorbing sites are greatly reduced during harvest. General strategies used by plantsmen to alleviate this problem have included: 1) soil modification to increase the soil water-holding capacity, 2)) pruning the top to reduce transpiration and establish a more normal root to shoot ratio (root:shoot), and 3) mulching.

Mulching has long been a recommended procedure for establishing woody ornamentals (6, 15). Mulches may benefit transplanted plants by reducing turf competition for water and nutrients (7), and potential allelopathic effects from grasses (2). Height and diameter of established silver maple *(Acer saccharinum)* in a sandy loam increased one year after mulching with 10 cm of wood chips but there were no effects on growth of established red *(Acer rubrum)* or sugar *(Acer saccharum)* maple in a sandy clay (4).

Recommendations for fertilization at planting have varied for woody plants. van de Werken (13) and Shoup et al. (11) reported no response to nitrogen fertilization of bare-root shade trees at planting. Other recommendations vary from 0.009 to 0.05 kg N per hole or in backfill, and 0.009 to .07 kg per application on the surface around newly planted trees (7). Significant growth response was obtained from two applications of 0.11 kg N as NH_4NO_3 following planting of *Magnolia grandiflora* and *Zelkova serrata* in a silt loam (6, 7). There was no apparent experimental evidence of differences in effectiveness between surface application and backfill incorpation at planting (7).

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Ideal planting times depend upon local environmental conditions as well as plant species. Some plants, such as *Cornus florida, Magnolia* sp., *Rhododendron* sp., and others are preferentially planted in the spring (10). Dickinson and Whitcomb (1) have recommended fall planting of container species in numerous publications. These are based on a single study during a mild winter in Oklahoma. Increased root and shoot growth was generally found for *Pinus thumbergii, Quercus macrocarpa,* and *Quercus acutissima* after 1 growing season (11 months for fall-planted and 7 months for spring-planted species). Greater root growth was found for spring-planted *Juniperus chinesis* 'Pfitzeriana' and there was significantly greater top growth by *Pistacia chinesis* as a result of spring planting. Fifty percent of the *Ilex cornuta* planted in the fall died before spring.

Good and Corell (5) found fall planting successful for a number of species in Long Island, New York, if they were planted approximately 4 weeks before the soil temperatures dropped below 4°C. Hensley et. al. (8) found fall planting of containerized *Cotoneaster acutifolia* superior to overwintering and spring planting in a severe Kansas winter. Swanson (12) concluded spring transplanting was preferable to fall transplanting in areas of cold, open winters with dry winds and low relative humidity.

The purpose of this study was to examine the effect of mulching, fertilization at planting, and planting date on short and longer-term growth of *Magnolia grandiflora.*

Materials and Methods

Container-grown (0.2 m^3 plastic containers), 2-year-old Southern magnolia were planted on September 27, 1979, and March 27, 1980, using the following treatments: control (no addition or mulch); 7.6 cm of hardwood bark mulch applied in a 90 cm circle after planting; and 75.0 g of 12-5-10 (N-P-K) fertilizer placed either on the bottom of the planting hole, mixed thoroughly into the backfill, or surface applied after planting. All possible treatment combinations were included in the randomized complete design and all treatments were replicated 6 times. Nitrogen sources for the fertilizer were ammonium phosphate and urea.

The site was a level area of Pope silt loam in established tall fescue *(Festuca arundinacea).* The area was not deficient in any of the major soil supplied nutrients (Table 1), and turf growth and color did not indicate nitrogen deficiency. The turf had received an annual spring nitrogen addition prior to but not after initiation of this study. The turf was mown periodically during the study, and the area was not irrigated.

Height and stem diameter measurements were taken at planting and all branches were removed. Height and stem diameter measurements and number of branches were determined July 17, 1980, December 16, 1980, and May 6, 1982. All stem diameters were measured 7.5 cm above the soil. Factorial analysis for variance and LSD were conducted on the data. Growth data are reported as percent increases based on initial parameters.

Results and Discussion

Height Growth. Height growth of *M. grandiflora* was significantly affected by the presence of mulch and fertilizer by July of the first season but planting date had no influence (Table 2). Mulched plants were shorter at the end of the first full season but the difference was not statistically significant ($Pr > F = 0.12$). This trend was reversed when plants were evaluated 22 months later. Mulched plants had grown significantly more than nonmulched plants.

Reduced growth from mulch application during the first season was likely due to competition for nitrogen from decomposition of the organic material. The hardwood bark from a local sawmill source undoubtedly contained some wood, and the composting before application was insufficient to remove it. Application of supplemental nitrogen, regardless of placement in the planting area, was adequate to overcome the nitrogen deficiency resulting from mulch decomposition.

Table 1. Soil test results of the planting sites.

	Nutrient levels (kg/ha)				
Planting site	*pH*	*P*	*K*	*Ca*	*Mg*
fall	7.4	66	202	5488	140
spring	7.0	49	212	4211	149

Mulched plants eventually surpassed non-mulched plants within the 22 month period between evaluations (Table 2). The beneficial aspects of mulching outweighed the initial growth suppression resulting from nitrogen deficiency. There were no significant interactions between mulching, time of planting, or fertilizer location.

Fertilizer application at planting resulted in significant increases in height growth compared to controls at every evaluation (Table 2). This sustained response was most evident during the third season after planting. There were no growth differences resulting from the varied placement of the material. These results support the hypothesis that there is no difference between backfill or surface application of fertilizer materials at planting (7).

Harris (6) also found significant increases in growth of *M. grandiflora* due to fertilization at planting. Other reports, however, have not found a response for some species (11, 13). Differences would be anticipated between species, methods, sites, and experimental technique, with the greatest response likely on nutrient deficient sites.

Stem Diameter. Stem diameter of *M. grandiflora*

Table 2. Percent increase in height of *Magnolia grandiflora* as influenced by planting date, mulching, and fertilizer placement.

Sampling date	*Planting time* fall	spring	*Mulch* with	without	*Fertilizer placement* none	top	backfill	bottom
7/80	22.9	24.0	20.4	26.6*[z]	18.9a[x]	25.7b	27.0b	22.4ab
12/80	25.9	28.3	25.2	28.9	20.3a	29.7b	31.1b	27.2b
5/82	84.0	90.8	94.0	80.8*	73.6a	92.6b	92.3b	91.2b

[z]Indicates significant difference (.05) between mean pairs.
[x]Mean separation (.05). Means within main effect followed by the same letter are not statistically different.

Table 3. Percent increase in stem diameter of *magnolia grandiflora* as influenced by planting date, mulching, and fertilizer placement.

Sampling date	*Planting time* fall	spring	*Mulch* with	without	*Fertilizer placement* none	top	backfill	bottom
12/80	25.1	34.6**[z]	33.1	26.68*[x]	24.1a[y]	26.4ab	33.6ab	35.3b
5/82	99.6	119.6**	121.7	97.5**	93.6a	109.3ab	119.2b	116.2b

[z]Indicates highly significant difference (.01) between mean pairs.
[y]Indicates significant difference (.05) between mean pairs.
[x]Mean separation (.05). Means within main effect followed by the letter are not significantly different.

Table 4. Average number of branches per plant by *Magnolia grandiflora* as influenced by planting date, mulching, and fertilizer placement.

Sampling date	*Planting time* fall	spring	*Mulch* with	without	*Fertilizer placement* none	top	backfill	bottom
12/80	6.4	6.3	7.4	5.2**[z]	6.0	5.5	7.2	6.8
5/82	8.2	9.9*[y]	10.4	7.7**	7.2a[x]	8.1a	10.8b	10.2b

[z]Indicates highly significant difference (.01) between mean pairs.
[y]Indicates significant (.05) difference between mean pairs.
[x]Mean separation (.05). Means within main effect followed by the same letter are not significantly different.

also increased in response to treatments at planting (Table 3) but there were no significant interactions among treatments. Spring planting resulted in a highly significant increase in stem growth at the end of the first and during the third growing season. There were no statistical differences between stem diameters of the fall- and spring-planted trees at the beginning of the study.

Mulching resulted in a significant increase in caliper growth after the first and at the beginning of the third season (Table 3). However, stem diameter was not as responsive as height growth to apparent N competition.

Fertilizer application resulted in stem growth increases during the first season (Table 3) but these were less distinctive than increase in height. Although there were no signficant diameter differences between the fertilizer placements, application at the bottom of the planting pit resulted in a significant increase over the control during the first season. All fertilized plants, except the surface application, had significantly greater stem diameters than controls by May of the third growing season.

Number of Branches. Spring-planted *M. grandiflora* averaged significantly more branches per plant than fall-planted individuals when evaluated in May, 1982 (Table 4). There were no differences in branch initiation during the first season, however. Mulched plants had significantly more branches during both evaluations (Table 4).

Fertilization had no effect on branching during the first season but incorporation of nutrients in the backfill or placement in the bottom of the planting hole resulted in significantly more branches by the third season (Table 4). There were no significant interactions between main effects.

Conclusions

These results indicate that fertilization at or shortly after planting of containerized *M. grandiflora* resulted in larger, higher quality landscape plants. Nitrogen fertilization would be especially important if an organic mulch is utilized. Such procedures have been frequently recommended by horticulturists but have been questioned in light of conflicting studies. These disagreements are likely due to species, site, and procedural differences. Placement of the fertilizer, whether mixed into the backfill or applied to the surface after planting, had no influence except on stem diameter.

This study found no influence of time of planting except on stem diameter and number of branches. Spring planting proved superior to fall in both instances. This is in contrast to recommendations by others, who found fall planting preferable (1). Ideal planting times will depend on environmental conditions of the particular locality and will vary with species.

Literature Cited

1. Dickinson, S. and C. Whitcomb. 1977. *The effects of spring vs. fall planting on establishment of landscape plants.* SNA Nursery Rsh. J. 4(9):9-19.
2. Fales, S.L. and R.C. Wakefield. 1981. *Effects of turfgrass on establishment of woody plants.* Agron. J. 73:605-610.
3. Flemer, W. III. 1982. *Successful transplanting is easy.* J. Arboric. 8:234-240.
4. Fraedrich, S.W. and D.L. Ham. 1982. *Wood chip mulching around maples: effect on tree growth and soil characteristics.* J. Arboric. 8(4):85-89.
5. Good, G.L. and T.E. Corell. 1982. *Field trials indicate the benefits and limits of fall planting.* Amer. Nurseryman 156(8):31-34.
6. Harris, R.W. 1983. Arboriculture Care of Trees, Shrubs, and Vines in the Landscape. Prentice-Hall, Inc., Englewood Cliffs, NJ 688 p.
7. Harris, R.W., J.L. Paul and A.T. Leiser. 1977. Fertilizing woody plants. Univ. of Calif. Ag. Sci. Leaflet 2958.
8. Hensley, D.L., H. Khatamian and F. Gibbons. 1984. *Effect of fall planting and overwintering techniques on growth of transplanted Peking cotoneaster.* 1984. J. Arboric. 10(9):255-258.
9. 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.
10. Pirone, P.P. 1978. Tree Maintenance. Oxford Univ. Press, New York.
11. Shoup, S., R. Reavis and C. Whitcomb. 1981. *Effects of pruning and fertilizers on establishment of bareroot deciduous trees.* J. Arboric. 7(6):155-157.
12. Swanson, B.T. 1977. *Transplanting woody plants effectively.* Amer. Nurseryman 146(8): 7-8.
13. van der Werken, H. 1981. *Fertilization and other factors enhancing the growth rate of young shade trees.* J. Arboric. 7:191-194.
14. Watson, G.W. and E.B. Himelick. 1982. *Root distribution of nursery trees and its relationship to transplanting.* J. Arboric. 8(9):255-229.
15. Whitcomb, C. 1980. *Effects of black plastic and mulches on growth and survival of landscape plants.* J. Arboric. 6(1):10-12.

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