PENETRATION OF TREATED AND UNTREATED BURPLAP BY ROOTS OF BALLED-AND-BURLAPPED NORWAY MAPLES

by Michael R. Kuhns

Abstract. Successful transplanting requires that woody plant roots quickly grow from the root ball, through any packing materials, and into the surrounding soil. Burlap is a common packing material on medium to large root balls; it may be untreated or treated to resist decay, or synthetic "burlap" may be used. Many people believe that roots can easily and quickly penetrate burlap and therefore such materials can be left on the root ball at planting, saving time and decreasing root disturbance, but possibly interfering with root growth after planting. This study was done to determine whether Norway maple (*Acer platanoides* L.) roots could readily penetrate treated and untreated burlap left on root balls during transplanting. I found that the presence of untreated or treated burlap had little or no effect on root growth from the original root ball. Untreated burlap decayed quickly, though the double layer decayed more slowly. Treated burlap did not appear to decay markedly over the course of the study and evidence was found that it can cause root girdling later on. Management implications and recommendations are discussed.

Transplanting of woody plants is successful only if roots grow out from the transplanted root ball into the surrounding soil quickly. However, unless a plant is transplanted bare-root or directly with a tree spade, its root ball will have some type of packing material that may restrict root growth outside the root ball. These packing materials include pots (solid or perforated plastic, various organic and inorganic fibers, clay, etc.), bags (generally some type of perforated plastic or fabric), baskets, and burlap or other fabric wrapped directly around the root ball. Several other new packing materials and systems also are available or are being developed (1).

Burlap is one of the most commonly used packing materials on medium to large root balls. Natural burlap is made from coarse hemp or jute fibers and may be treated to resist decay. Copper napthalate is often used, giving the light-brown burlap a greenish or blue-green color. Synthetic "burlaps" made from non-natural fibers also are used. Burlapped root balls generally are reinforced with rope or cord, nails, wire baskets, or other materials. I also have heard reports of plastic sheeting wrapped around a root ball under a layer of burlap.

Many tree professionals believe roots can easily and quickly penetrate burlap or fiber pots and therefore such materials can be left on the root ball at planting. This saves time during planting and may decrease root disturbance, but it also may interfere with root growth after planting. Typical recommendations include peeling burlap back below the soil surface or cutting away just the top layer before backfilling and removing part or all of any wire basket used (3,4,6). Some also recommend slitting the burlap in several places to help roots grow out (3,4). Others recommend removing of all root ball packing materials at planting or a combination of the above recommendations (5,8). In a random telephone survey of 10 Utah nurseries in November 1995, all said they recommended leaving burlap on root balls at planting, though most said to remove cords and peel the burlap away from the stem and fold it back below ground.

My purpose in this study was to determine wheter tree roots could readily penetrate treated and untreated burlap that was left on Norway maple (*Acer platanoides* L.) root balls during transplanting.

Materials and Methods

Plant material. Two-year-old, 1.2-1.5 m (4-5 ft) tall, bare-root Norway maple seedlings (unbranched whips) were obtained from Sherman Nursery Company (Charles City, IA) in April 1993. From the 150 seedlings received, 120 were selected for planting after rejecting those that appeared unhealthy or unusually large or small. Seedling caliper averaged 11.5 mm when planted. Seedlings were kept in cold-storage until planted on April 29-May 6, 1995.

Six seedlings were randomly assigned to each of four root ball packing-treatment and five harvest date-treatment combinations. The four root ball packing treatments were: a single layer of untreated, natural burlap; a double-layer of untreated burlap; a single layer of copper-napthalate treated burlap (treated to resist decay); and a control with no burlap or other packing material. Burlap weight was 256 g/m^2 (7.5 oz/yd^2; A.M. Leonard, Piqua, OH). Treatment date refers to harvest date or the number of days seedlings were allowed to grow after planting. Harvest dates were August 2-3, 1993 (approximately 92 days after planting; enough time for some root growth); September 13-14, 1993 (165 days after planting; near the end of one growing season); July 21-22, 1994 (445 days after planting; middle of second growing season); and October 11-12, 1994 (527 days after planting; end of second growing season). A fifth harvest date was planned but was unnecessary based on results from other dates. Therefore, only 96 of the seedlings were used in the study.

A planting bed for 120 seedlings was prepared in North Logan, UT, by augering 49 cm diameter holes into the soil 41 cm deep on a 1.5 m by 1.5 m spacing. Holes were lined with Poly-Cel Horticultural Growing Containers (Hummert Intl., Earth City, MO) to contain root systems and to aid in lifting trees at harvest. These containers are heavy-weight (12 mil) black polyethylene bags with drainage holes in a flat bottom and were 49 cm wide by 51 cm deep with a volume of 93 L (24.6 gal). These bags were back-filled with native soil to within 23 cm of the surrounding soil surface.

Bare-root seedlings were balled-and burlapped by placing their roots systems in soil and wrapping the root ball with the appropriate burlap treatment (controls were placed in soil with no burlap). A 24-cm diameter round pot that was 23-cm deep was used as a form. A large piece of burlap (untreated or treated as needed, with a doubled piece for the D treatments) was placed over the pot and pushed inside so that it lined the pot as smoothly as possible. A seedling was then held over the pot with its root system centered inside as soil was placed around it. Soil was gently and evenly packed around the roots. Trees were planted so the original nursery soil level, the pot soil level, and the top of the pot were aligned. These seedlings were then carefully removed from the pot-form and placed on top of the backfilled soil in their assigned hole in the planting bed. Controls were still bare-root at this point. Backfilling around the root ball was then completed, aligning the backfill soil level, surrounding native soil level, and the seedling root collar. No amendments or fertilizers were used. Excess burlap that extended above ground was trimmed back to just below the soil surface.

Trees were watered every week to 10 days in the absence of precipitation, weeds were pulled and sprayed with glyphosate herbicide (Roundup; Monsanto, St. Louis, MO), and insect and disease problems were monitored (no serious problems were observed).

Sampling and measurements. Seedling ground-line diameter was measured every several weeks throughout the two growing seasons. On their designated harvest date (each harvest took two days) seedlings were lifted with their root systems intact and were separated into four parts: stem, leaves, roots inside the original root ball (R1), and roots outside the original root ball (R2). The stem was severed at the ground line and the aboveground portion of the plant was separated into leaves and stem material. These parts were then bagged, oven-dried, and weighed. The soil within each grow-bag was separated into parts R1 and R2 (see above) by gently pulling soil volumes apart at the intact or decayed burlap layer. Roots extending through the burlap or original root ball face were cut with pruners or a sharp knife. In controls where there had been no burlap, or if the burlap had decayed too much, the soil masses were separated by marking off the dimensions of the original 24 cm by 23 cm inner root ball and cutting with a knife. Roots were separated from the soil by hand and using water and screens. Any roots that grew through the grow-bag drain holes were included with the R2 roots. Roots were washed, bagged, oven-dried, and weighed.

Data analysis. Analysis of variance was used to determine if the presence of burlap, the type of burlap, or the number of days after planting

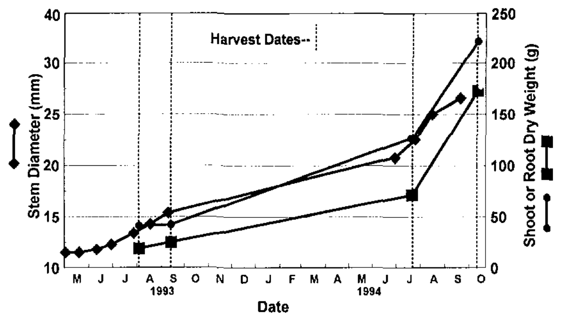

Figure 1. Mean stem diameter (mm), shoot dry weight, and root dry weight (g) for Norway maple seedlings over the course of the study. Harvest dates are indicated by vertical dashed lines.

significantly affected the growth of roots out of the original root ball into the surrounding soil. The percentage of roots outside the original root ball, or RTRATIO, was calculated as RTRATIO = 100 x [R2 / (R2 + R1)] where R2 is the dry weight of roots outside the original root ball and R1 is the dry weight of roots inside the original root ball.

Results and Discussion

Seedlings grew fairly slowly in the first season after planting and more rapidly the next season (Figure 1). Stem diameter increased from about 12 mm at planting to 27 mm near the final harvest. Shoot dry weight increased by a factor of six between the first and last harvests; weight gain was much more rapid in the second year. Root system dry weight was always less than shoot weight, meaning a root:shoot ratio of less than one, but root weight increased nearly 10-fold over the course of the study and was approaching shoot weight by the end of the second season. Shoot diameter growth was fairly active near harvest dates 1, 2, and 3 and had slowed before harvest date 4. No direct measurement of root growth rate near each harvest date was possible, though active, white, growing root tips were observed at each harvest date. Slow growth of shoots and roots within the first season after transplanting as seen here is well documented; see Watson (9) for further discussion of post-transplanting vigor reduction.

Analysis of variance was done to examine the effects of date and burlap on leaf dry weight, stem dry weight, total shoot dry weight, stem diameter, and root dry weight. As expected, date had a highly significant effect (F=86 to 130, α=0.0001) on all of these growth-related variables. Burlap's effect was not significant, as indicated by F values from 0.67 to 1.39 and α =0.57 to 0.25.

At the first harvest date, about 90 days after planting, I noted that the single layer of untreated burlap had decayed to the point where it had many holes and much of it was completely gone, other than for a perceptible separation zone where it had been. Soil masses at this separation zone could be readily pried apart. The double untreated burlap layer was less broken up and decayed, forming a distinct separation layer between the root ball and surrounding soil. The treated burlap was intact and showed no signs of breakage or decay. In all three treatments and in the control, roots were just starting to emerge from the original root ball at 90 days. Burlap and root observations were similar for the second harvest date, with decay being somewhat more advanced for the untreated burlap.

By date 3, after the trees had been in the ground for 14-1/2 months, the single untreated burlap layer had completely decayed, with no fibers recognizable and a less distinct separation zone. The double untreated burlap layer was also nearly completely decayed, but a distinct separation zone was still present. The treated burlap was still intact and seemed as strong as the day it went in the ground. Roots grew through all of these layers and zones, including between the fibers of the treated burlap. Root and burlap observations for harvest date 4 were similar to those for date 3, with the treated burlap as strong and intact as before, even to the point of having retained its green color.

RTRATIO, or the percentage of total root system dry weight found outside the original root ball, was used as an indicator of root system growth beyond the original root ball. A higher RTRATIO for a given date or treatment means more roots penetrated the burlap or grew outside of the original root ball. Analysis of variance of the effects of date and burlap on RTRATIO showed that there were significant differences in RTRATIO (F=9.38, α=0.0001) and that these differences

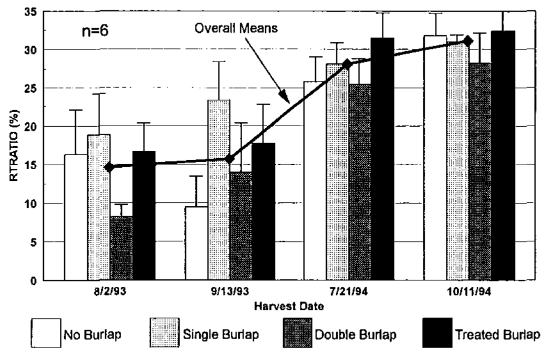

Figure 2. Mean percent of roots outside the original root ball (RTRATIO) for Norway maple seedlings by harvest date and burlap treatment. Solid line indicates RTRATIO mean for each date over all burlap treatments. Vertical lines indicate standard errors of treatment means.

were mainly due to harvest date (F=16.41, α=0.0001) and not burlap treatment (F=2.36, α=0.0771). A date*burlap interaction term was originally included in the model but it was not significant and was dropped (F=0.64, α=0.7638). A significant effect of date on root egress from the original root ball is not surprising. No roots existed outside the original root ball when the seedlings were first harvested, but with time more roots grew out and some increased in diameter. Watson (9) states that it can take at least 20 weeks after transplanting for root growth to be adequate to allow similar rates of soil water uptake from backfill and root ball soil.

Figure 2 shows mean RTRATIO's and standard errors by date and burlap treatment and overall RTRATIO means by date. RTRATIO increased slowly in year one to a high of 16% of total root system weight at harvest 2 on September 13, 1993 (see line in Figure 2). By harvest 3 on July 21, 1994, RTRATIO had increased greatly to 28%; it then leveled somewhat and reached 31% by the final harvest on October 11, 1994 (a RTRATIO of 50% would have meant equal amounts of root inside and outside the original root ball). RTRATIO data were quite variable for the first two harvest dates, perhaps due to difficulty in dealing with the small quantities of roots present during the first growing season (see bars in Figure 2). RTRATIO data in the second year were less variable (lower standard errors), but still indicated no significant effect of burlap. Though the burlap treatment did not significantly affect RTRATIO, the double layer of untreated burlap may have had some effect since it showed a consistently lower RTRATIO, even during the second growing season.

RTRATIO increased quickly with increasing stem diameter or shoot weight (combined leaf and stem weights), then leveled at higher diameters or weights (Figures 3 and 4). The abrupt increase in RTRATIO at lower stem diameters and shoot weights indicates fairly quick growth of roots out from the original root ball early in the study. The leveling of RTRATIO as plants got larger, occurring mostly with plants harvested on dates 3 and 4 in the second growing season, is more difficult to explain. Root systems were still growing rapidly in the second year, so a leveling of root ratio means that relatively more root mass was being added inside the root ball than outside. Perhaps this was due to rapid increase in size of the largest woody portion of the root system where the plant's stem enters the soil. This area where the stem entered the soil was growing rapidly in diameter as the stem grew during the second year and dominated the R1 root mass.

The results presented above indicate that single layers of untreated burlap left in place at planting time have no effect on root egress into the surrounding soil. There could have been some

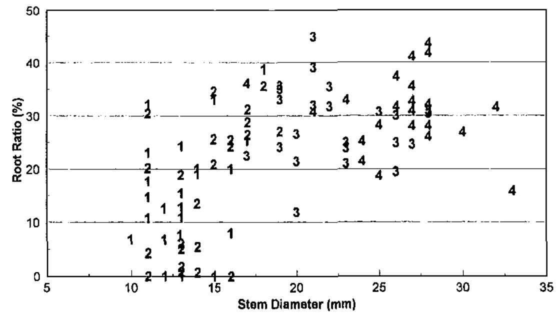

Figure 3. Plot of individual RTRATIO (%) data by stem diameter (mm) for all burlap treatments combined. Numbers indicate harvest date; 1=8/2/93, 2=9/13/93, 3=7/21/94, and 4=10/11/94.

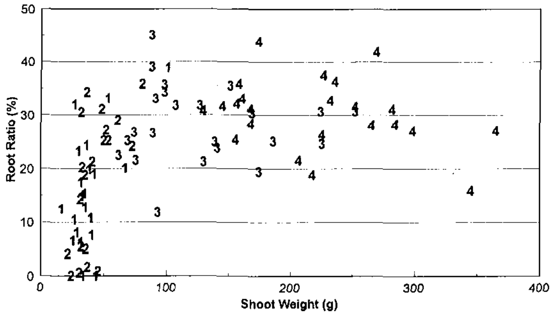

Figure 4. Plot of individual RTRATIO (%) data by shoot weight (g) for all bulap treatments combined. Numbers indicate harvest dates; Date 1=8/2/93, 2=9/13/93, 3=7/21/94, and 4=10/11/94.

effect immediately after planting, though little root growth took place during the first growing season relative to the second season. The single burlap layer decayed very quickly and was thin enough that it did not appear to create much of a separation layer or cause any interface problems between soil layers.

The double layer of untreated burlap did not decay quite as quickly, but had little detectable effect on root egress. Though I did not find a significant difference between double burlap and the control, the lower RTRATIO values observed could have been due to the presence of the previously mentioned separation layer between the original root ball and the outer soil. This layer was distinct enough that inner and outer soil masses would easily separate along it when pried apart. Initially fabric and individual fibers were found in this layer, but these mostly disappeared after the first year. Some authors have expressed a concern that any interface in the soil may slow root penetration (9), though Watson *et al.* (10) found that interfaces caused by textural differences or backfill amendments did not effect root egress from the root balls of newly transplanted trees. Perhaps the decay of a double layer of burlap creates a gap in the soil that would be difficult for roots to cross, similar to the gap that can be formed when trees are transplanted with a hydraulic tree spade. Thicker layers, like those formed when burlap is pushed down into the planting hole, could form even larger gaps as the burlap decays.

A single layer of treated burlap also had no significant effect on root egress. Roots appeared to have grown through the spaces between the burlap fibers quite easily, though little diameter growth occurred over the course of the study. Little documentation of rates of burlap decay could be found in the literature, though an assumption is usually made that it is "biodegradable" and will decay quickly once in contact with the soil (3). From results reported here it appears that this is not necessarily true. If burlap is not treated and is a natural fiber I found that it decays quickly. However, treated burlap like that used in this study does not readily decay, and may last many years in the soil.

During the course of this study I excavated the root systems of a six inch caliper ponderosa pine (*Pinus ponderosa* Laws.) and two medium-sized Mugo pines (*Pinus mugo* Turra.) growing in a clay loam soil in a well-tended residential area. I found essentially intact with little sign of decay treated, natural burlap wrapped around these root systems. Confirmation that this burlap was natural, as opposed to a synthetic fabric, was accomplished by noting that it burned like natural burlap when exposed to a flame and did not melt as many synthetics will. Based on xylem ring counts and the house's age, these plants were transplanted approximately 14 years earlier. Some holes had formed in the burlap and several roots had grown through the fabric, but many of the roots that had undergone secondary diameter growth had stretched the burlap fibers tightly and were constricted down to ˚ of their original diameter where they passed through the burlap. This girdling or constriction may be similar to root constriction associated with wire baskets (2), though the surrounding burlap fibers keep the root from being able to grow over and cover the constricting fibers as it often will with a wire. This girdling was not observed in the present study since the roots were not in place long enough to have undergone much secondary thickening.

Summary and Conclusions

The decision to remove or not remove root ball packing materials should be based on what is best for the tree, tempered with the need to be practical. The results of this study and observations involving the older plants mentioned indicate the following:

1) Planting woody plants with single layers of untreated burlap around their root systems is unlikely to have much negative effect on root growth from the original root ball.

2) Folding back of upper burlap layers below ground will form a burlap "wad" two or more layers thick (similar to our double, untreated treatment) that will take additional time to decay. This may form a separation layer or gap, possibly hindering root egress especially in the first few months after transplanting. A separation layer was observed in this study, though I did not measure any significant effect on root egress. Though more research is needed, in the meantime it may be best to cut away upper burlap layers, rather than fold them back below ground.

3) Treated burlap (which seems to be more commonly used than untreated burlap) will not decay quickly and, though roots may grow through it, those roots may be damaged or constricted as they grow in diameter, as I observed when excavating older plants. Therefore, I recommend removal of treated burlap or synthetic burlap (also likely to decay slowly) from root balls at planting time.

4) Burlap appears to be a good material for wrapping root balls because it is inexpensive, is durable when treated, and it has a coarse weave that allows good root penetration. Its durability when treated, however, means that it may not decay quickly enough after planting to avoid interference with root diameter growth (indicated by older plant excavations).

Future research should examine other root ball packing materials (including other types of treated burlap) that hold up in the nursery but decay quickly (within weeks) in the ground and allow good early root penetration. Research also is needed on effects of different soils and soil properties on root egress and on the effects of wire baskets on roots. Additional excavations are needed of plants that have been in the ground a long time with treated burlap around their root systems to study the effects of burlap on root diameter growth.

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Résumé. Le jute est un matériel couramment utilisé pour l'emballage des arbres en motte. Le jute peut être traité ou non avec un préservatif contre la pourriture. Cette étude a été réalisée pour déterminer si les racines de l'érable de Norvège (Acer platanoides) peuvent effectivement pénétrer le jute traité – une ou deux couches – et le jute non traité entourant la motte durant la période de transplantation. La présence de jute, traité ou non, n'avait peu ou pas d'effet sur la croissance des racines de la motte originale. Le jute non traité se décomposait rapidement, quoique une double épaisseur de jute pourrissait plus lentement. Le jute traité n'a pas semblé se décomposer beaucoup plus au-delà de la période d'étude et il a été découvert qu'il peut même causer une strangulation des racines plus tard.

Zussammenfassung. Ballenleinen ist ein herkömmliches Material, um Bäume mit Ballen zu verpacken. Das Ballenleinen kann unbehandelt oder mit einem Konservierungsmittel behandelt sein, um Fäulnis zu verhindern. Diese Studie wurde unternommen, um zu bestimmen, ob die Wurzeln von Spitzahorn durch ein oder zwei Lagen von imprägniertem bzw. Unbehandeltem Ballenleinen, welches beim Verpflanzen nicht entfernt wurde, leicht durchringen können. Es war kein Unterschied bezüglich des Wurzelwachstums festzustellen. Unbehandeltes Ballenleinen verrottete schneller, wenn auch die Doppellage etwas langsamer war. Behandeltes Ballenleinen schien während der Dauer der Studie nicht besonders gut zu verrotten. Außerdem wurden Hinweise gefunden, daß es die Entwicklung von Würgewurzeln verursacht.