Influence of Backfill Soil Amendments on Establishment of Container-grown Shrubs

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Summary. *Cotoneaster apiculata* and *Juniperus chinensis* 'Pfitzeriana Compacta' were planted on a site with compacted clay soil. Plants were placed in holes the same size as the root ball (no backfill), or in holes three times the diameter of the root ball with sloping sides. The three backfill soils used were composed of site-soil (50%) amended with sand (40%) and leaf compost (10%), site-soil (75%) amended with mushroom compost (25%), and unamended site-soil. After 14 months, root density was not different in any of the treatments, and root densities were not different in the compacted clay soil outside of the planting hole, indicating that root growth was not inhibited at the interface between the backfill soil and the compacted site clay soil. Shoot growth of *C. apiculata* grown in backfill amended with sand and leaf compost was larger than shoot growth of plants grown in other backfills.

Planting hole preparation is an extremely important factor in transplanting success (Kozlowski and Davies, 1975). Root incursion decreases in compacted and hard-to-penetrate soils (Perry, 1982; Zisa et al., 1980). Well-aerated soils around

the root ball assure more rapid growth after transplanting (Bridel et al., 1983). When the backfill soil differed from the site soil, development of roots only in the backfill soil was attributed to difficulty in growing across the backfill and site-soil interface (Schulte and Whitcomb, 1975). Quantitative measurements were not reported in this single-season experiment, and the root systems may have grown large enough within the planting hole backfill soil to supply plants with necessary water and nutrients. The purpose of this study was to quantify the effect of backfill amendments on root development of container plants for sites with compacted clay soils, typical of those encountered in many urban areas.

Twenty *Cotoneaster apiculata* and 20 *Juniperus chinensis* 'Pfitzeriana Compacta' from 2-gal (7.5-liter) containers were planted on a disturbed site with compacted clay soil and ≈2 inches (5 cm) of topsoil. The soil was typical of disturbed soils frequently encountered in midwestern suburban landscapes. Poor drainage caused the open planting holes to fill quickly with water during rain, and remain full of water for several days. Planting occurred on 14 June 1989. Three treatments were wide holes with different types of backfill amendments. The fourth treatment was a hole the same size as the root ball without backfill between the root ball and the undisturbed site soil. The wide holes were 24 inches (61 cm) wide (three times the diameter of the root ball) at the surface with sides sloped at about a 45° angle down to the bottom of the root ball. The sloped sides were intended to minimize labor for digging—a consideration important in practical applications—and to prevent roots from being trapped in the planting hole by a vertical interface if they were unable to penetrate the site-soil (Watson, 1992). The three backfill soil types were: 1) unamended clayey site soil that had been removed from the holes, 2) site-soil (50%) amended with 2 mm of sand (40%) and leaf compost (10%) by volume, and 3) site-soil (75%) amended with 25% mushroom compost. Plants were spaced 6 ft (2 m) apart in a completely randomized design with five replications of each treatment. The soil around each tree was mulched with a 3 ft² (1 m²), 2-inch (5-cm) -deep layer of wood chips to minimize evaporational losses from the soil.

Each plant was watered with 5 gal

(18 liters) of water every 3rd day for the first 2 weeks. Root ball soil moisture was monitored with tensiometers for the remainder of the summer, and the plants were watered as needed to ensure survival. The mulch squares were kept weed-free with both glyphosate herbicide and hand-weeding.

Core samples 2.5 inches (6.5 cm) in diameter and 6 inches (15 cm) deep were used to evaluate root development. In Sept. 1990, one core was removed from each planting hole for assessing root development. The center of the core was on the north side of the plant, 7 inches (17.5 cm) from the center of each planting hole so that cores were taken outside of the original root ball. Cores from the 24-inch (60-cm) -wide planting holes contained both backfill soil (upper two-thirds) and clay soil (lower one-third) and they were subdivided along the diagonal interface. Roots were separated from the soil, and root surface area density (root density) for each core was measured (von der Heide-Spravka and Watson, 1990) and expressed as square millimeters of surface area per cubic centimeter of soil. Terminal shoot growth for the first complete growing season after planting was determined on 6 Sept. 1990 by averaging measurements of eight shoots from each plant.

Response to backfill amendments for each species was analyzed using one-way analysis of variance. Newman-Keuls test ($P = 0.05$) was used for mean separation. Differences in root surface area density between the backfill soil and the clay soils were determined using a t test ($P = 0.05$).

There was no significant difference in root density in any of the backfill soil treatments (Table 1). Widely separated mean values without significant differences are common in root data because of inherent high variability in root samples. It is interesting to note that even the unamended clay soil backfill served as adequate root growth medium after it was broken up and mixed with the topsoil during the planting process.

Roots were not restricted to the planting hole by the abrupt interface between backfill and site soil; thus, root densities were not less in the clay soil outside of the planting hole compared to the backfill (Table 1). Root densities are usually lower in compacted soils (Perry, 1982; Zisa et al.,

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Table 1. Root surface area densities for container-grown *Cotoneaster apiculata* and *Juniperus chinensis* 'Pfitzeriana Compacta' 14 months after transplanting. Backfill and clay soil root densities were derived from the same core sample by separating the two soils along the diagonal interface. There were no significant differences between columns or rows ($P = 0.05$) for either species.

Species	Backfill treatment	Backfill root density (mm ² ·cm ⁻³) ^z	Clay soil root density (mm ² ·cm ⁻³) ^z
<i>C. apiculata</i>	None ^y	---	6.15 ± 4.05
	Unamended site soil	5.09 ± 2.04	2.04 ± 0.75
	25% mushroom compost	5.93 ± 3.26	2.36 ± 2.07
	40% sand, 10% leaf compost	10.14 ± 5.55	5.31 ± 5.65
<i>J. chinensis</i>	None ^y	---	6.25 ± 7.38
	Unamended site soil	10.24 ± 2.20	7.47 ± 3.04
	25% mushroom compost	5.50 ± 5.65	2.17 ± 2.67
	40% sand, 10% leaf compost	7.76 ± 3.14	5.12 ± 5.12

^zMean ± SD.

^yHole was the same size as the container and no backfill was used.

1980) and, in our study, mean root densities tended to be lower in the clay soil, but high sample variation precluded statistical confirmation of this trend.

Schulte and Whitcomb (1975) described inhibition of root growth outside the planting hole when the backfill soil was amended. Roots were described as "more fibrous" in the highly amended backfill soil, and were apparently adequate to supply water and nutrients for the plants during the single growing season over which their study was conducted. If their study had been conducted longer, the roots may have grown out of the planting hole.

Shoot growth in our study was not different due to backfill amendment, except for *C. apiculata* with the 40% sand and 10% compost-amended

backfill (Fig. 1). This shoot growth response was not directly associated with a significant increase in root density, although root density for the unamended backfill was about one half that of the sand and compost-amended backfill.

In conclusion, amending backfill soils for *Cotoneaster apiculata* and *Juniperus chinensis* 'Pfitzeriana Compacta' did not result in significant differences in root density in the backfill, nor did the amended backfill soil result in decreased root density outside of the planting hole, as had been reported previously (Shulte et al., 1975).

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Fig. 1. Shoot growth of container-grown *Cotoneaster apiculata* and *Juniperus chinensis* 'Pfitzeriana Compacta' after transplanting. Backfill amendments were (bars of figure, from left to right): no backfill, unamended soil from site, amended with 25% mushroom compost, and amended with 40% sand and 10% leaf compost. For each species, treatments with the same letters are not significantly different.