Municipal composts improve landscape plant establishment in compacted soil

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Abstract
Urban landscape soils are often compacted by construction activities, thereby restricting plant establishment. Common approaches to improve plant establishment on compacted soils are to till soil before plant installation, to apply compost, or to choose plants that can tolerate drought. This research was undertaken to evaluate the relative importance of remedial practices (tillage, compost application, and plant selection) on survival and growth of landscape plants in compacted, non-irrigated soil in a mediterranean climate (western Oregon, USA). In 2008, moist silt loam soil was compacted with a vibrating roller, followed by application of compost, tillage, and plant installation. Planting holes (25 cm deep x 15 cm diameter) for installation of transplants from 3.8-L pots were drilled into compacted soil using a power auger. We report soil and plant data for 2009. Pre-plant compost application increased plant growth and quality of both standard and drought-tolerant landscape plants. The first-year plant growth response to compost was the same for compost left on the soil surface or compost incorporated via roto-tilling. Apparently, enough compost fell into the planting holes on the "no till" plots to stimulate plant establishment. Biosolids compost provided more plant-available nitrogen than yard debris compost, but compost effects on plant growth and quality were similar for most plant varieties. Groundcover plants grew more with the biosolids compost than with the yard debris compost. We conclude that compost application is beneficial for plant establishment for all landscape species tested, and that it is not essential to incorporate the compost into soil before planting.

Key Words
Compost, compacted soil, urban, landscape.

Introduction
Research objectives are to:

1. Evaluate the relative importance of remedial practices (tillage, compost application, and plant selection) on survival and growth of landscape plants in compacted non-irrigated soil
2. Determine whether it is essential to incorporate compost by tillage before installing plants

Methods
Experimental design
Randomized complete block (3 x 2 x 2 factorial) with 4 replications:

- 3 pre-plant compost treatments (biosolids compost, yard debris compost, no compost)
- 2 pre-plant tillage treatments (tilled, not tilled),
- 2 groups of landscape plants (4 species of typical landscape plants, 4 species of landscape plants that are considered drought tolerant)

Site preparation
Location: Oregon State University North Willamette Experiment Station, Aurora, Oregon USA (http://oregonstate.edu/dept/NWREC). Prior to planting, Willamette silt loam soil (Fine-silty, mixed, superactive, mesic Pachic Ultic Argixerolls) was prepared by compacting moist (20 g H_2O/kg) soil with a tandem vibrating roller (Figure 1a). Surface bulk density (0-10 cm) of the compacted soil as determined by coring was 1.5 g/cm^3. Compost (220 dry Mg/ha; approx. 7-8 cm depth; Table 1) was applied after soil compaction, and was either incorporated by rototilling to 10-15 cm depth, or was left on the soil surface (Figure 1b). Planting holes (25 cm deep x 15 cm diameter) for installation of transplants from 3.8-L pots were drilled into compacted soil using a power auger (Figure 1c). After plant installation all plots were mulched with 7-cm of fine Douglar fir (*Pseudotsuga menziesii*) bark (Figure 1d).

Transplanting
Landscape plants were transplanted from 3.8 L (1-gal) pots in Sept, 2008. Two groups of plants were included in the trial. We installed 4 cultivars considered standard landscape plants for our area (*Nandina domestica* 'Compacta', *Vinca major* 'Bowles', *Viburnum davidii*, *Berberis thunbergii* 'Crimson Pygmy'), and 4 cultivars considered more drought-tolerant (*Rosmarinus officinalis* 'Blue Spires', *Cistus* 'Bicolor Pink', *Ceanothus gloriosus*, *Caryopteris x clandonensis* 'First Choice').

Measurements
Soil compaction was determined using a recording penetrometer in fully moist soil (rainy season; Jan 2010). Soil was sampled for nitrate-N analysis in October 2009, approximately 13 months after plant installation. Five soil cores were collected from each plot with a push probe after scraping away mulch and compost from the soil surface. We measured aboveground plant dry weight for 4 plant varieties in October 2009. Plants were removed at ground level then dried at 60°C for 96 h. We also collected data on visual appearance (plant quality) of all plant varieties on a 1 to 5 scale.

Table 1. Nutrient analysis of composts.

Compost Analysis	Unit	Biosolids compost	Yard debris compost
NH_4-N	mg/kg	2100	57
Total N	g/kg	18	14
Organic C	g/kg	420	260
Ash	g/kg	168	499
C:N		23	19
P	mg/kg	9700	2600
K	mg/kg	1500	7100
pH		7.7	7.0
EC (1:5)	mS/cm	1.6	0.9
Stability	mg CO_2-C/g OM/day	1.0 (very stable)	2.9 (stable)

Compost analysis by Soil Control Lab, Watsonville, CA, USA using standard methods (U.S. Composting Council 2004).

Figure 1. Field trial installation, Sept 2008. Soil compaction with vibrating roller (a), tillage treatment (b), plant installation with power auger in no-till treatment (c), all plots planted and mulched with Douglas-fir bark (d).

Results
Soil
Tillage and compost application did not result in large differences in soil compaction as measured by the penetrometer (Figure 2). Penetrometer resistance readings reached approximately 2000 kPa at a depth of 25 cm for no-compost and compost treatments. The compaction applied with the vibrating roller during site preparation increased penetrometer resistance at 25 to 45 cm depth. Although compost did not have a large effect on penetrometer resistance (0-25 cm depth), compost application did increase water infiltration rate (data not shown).

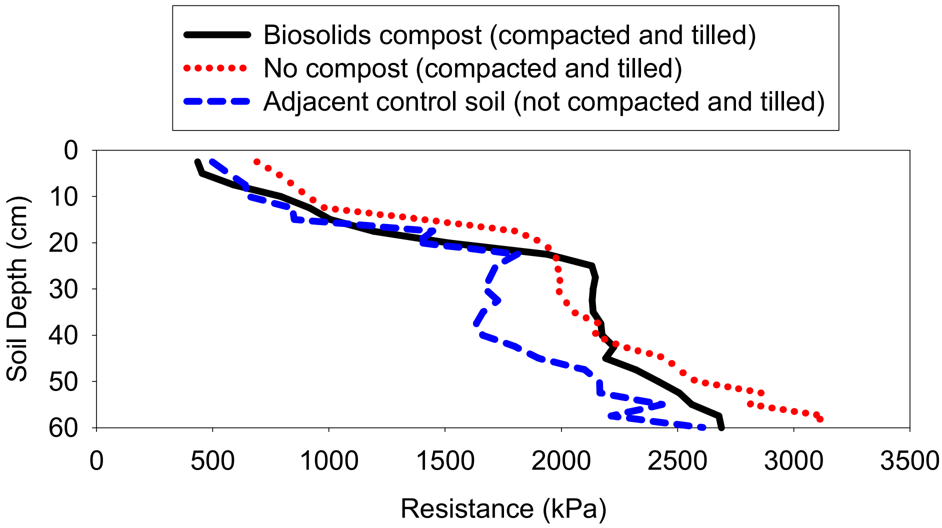

Figure 2. Soil resistance (kPa) as measured by recording penetrometer at 16 months after plant installation.

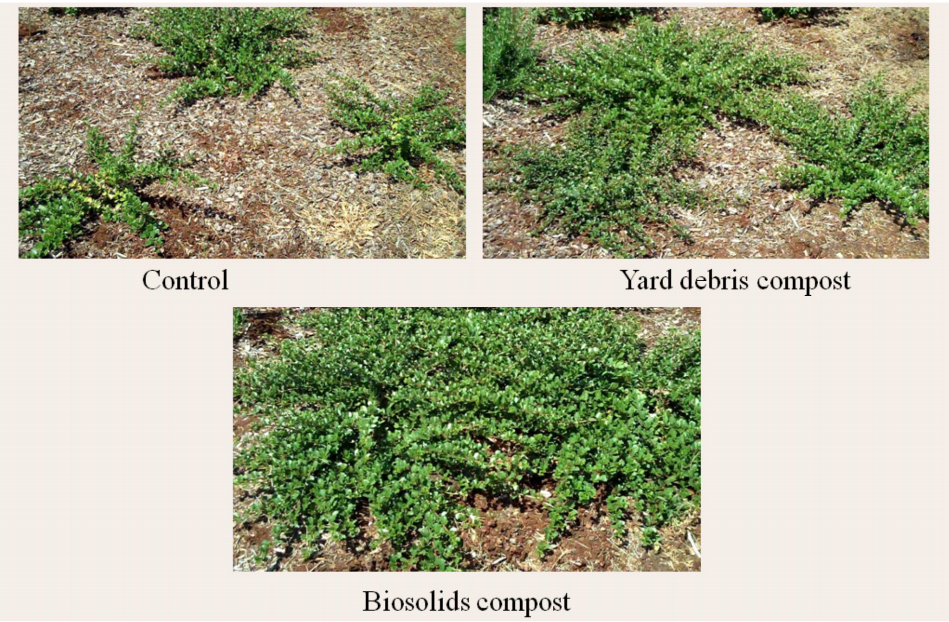

Figure 3. *Ceanothus gloriosus* ground cover plants in July, 2009. Soil amendment treatments (preplant, Sept 2008): control (no compost), yard debris compost or biosolids compost.

Plant Response

In 2009, the pre-plant compost application increased plant growth (Table 2) and quality (data not shown). Across all plant varieties, the first-year plant growth response to compost (plant growth, plant quality, or plant dry weight) was similar for compost left on the soil surface or compost incorporated via retotalling. Plant dry weight was greater with biosolids compost than for yard debris compost for two groundcover plant species (*Vinca major* and *Ceanothus gloriosus*; Table 2).

Table 2. Effect of soil amendment on plant dry weight (October, 2009; 13 months after plant installation).

Soil amendment	*Caryopteris x clandonensis*	*Ceanothus gloriosus*	*Nandina domestica*	*Vinca major*
		g dry wt/plant		
Biosolids compost	315	782	111	120
Yard Debris compost	230	661	106	97
No compost	183	342	63	75
Contrasts		P value		
Compost vs. no compost	0.06	<0.0001	<0.0001	<0.0001
Biosolids compost vs. yard debris compost	0.12	0.06	0.67	0.01

Biosolids compost provided more plant-available nitrogen than the yard debris compost (Tables 1 and 3). *Ceanothus* groundcover color and spread was greater was greater with the biosolids compost (Figure 3). Groundcovers likely benefit from greater nutrient availability at the soil surface, because of a shallow rooting pattern.

Table 3. Soil nitrate-N (0-20 cm) under surface mulch layer.

Soil Amendment	Tillage	Soil NO_3-N
		mg/kg
Biosolids compost	No till	43
	Till	44
Yard debris compost	No till	12
	Till	12
No compost	No till	8
	Till	8

Soil samples collected Oct, 2009, 13 months after plant installation.

Conclusion

Pre-plant compost application increased plant growth and quality of both standard and drought-tolerant landscape plants. The first-year plant growth response to compost was the same for compost left on the soil surface or compost incorporated via roto-tilling. Apparently, enough compost fell into the planting holes on the "no till" plots to stimulate plant establishment. Biosolids compost provided more plant-available nitrogen than yard debris compost, but effects on plant growth and quality were similar for most plant varieties. Groundcover plants grew more with the biosolids compost than with the yard debris compost. We conclude that compost application is beneficial for plant establishment for all landscape species tested, and that it is not essential to incorporate the compost into soil before planting.

Acknowlegement

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Reference

U.S. Composting Council (2004) Test Methods for the Examination of Composting and Compost. http://www.tmecc.org/tmecc/