Improvement of Compacted Soil with Tillage and Leaf Compost

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The objectives of this field study was to determine whether tillage to reduce compaction and amending to increase the organic matter content of the soil would improve the establishment and survival of a low maintenance turfgrass cover.

Materials and Methods

Soil testing assessments identified a sandy loam at Jakes Branch County Park in Beachwood NJ that was severely compacted, acidic and low in P, K, Ca and Mg. The soil organic matter content was 1.53%, by weight, which is considered a medium level for sandy loam.

Four soil treatments consisting of two levels of tillage and three levels of organic matter amending were applied to the sandy loam in a randomized complete block design. Due to space limitations it was not feasible to evaluate all combinations of these factors. The treatment structure evaluated no soil improvement with the soil improvement treatments of tillage only and tillage combined with two rates of leaf compost outline in the table below.

Summary of the levels of tillage and organic matter amendment of four treatments evaluated on sandy loam at Jake Branch County Park in Beachwood NJ.

Treatment #	Tillage	Organic Matter Amendment
1	None	None
2	Subsoiler & Rotadairon®	None
3	Subsoiler & Rotadairon®	99 cubic yards of leaf compost per acre
4	Subsoiler & Rotadairon®	390 cubic yards of leaf compost per acre

The trial site area was prepared by removing and stockpiling the topsoil-like layer (about 1 inch depth). The subsoil was graded to produce a smooth slope and rolled to firm after which the topsoil was replaced over the trial area and loosened with a Harley rake. These actions represent typical soil preparation methods for landscaping and represent the physical preparation of soil for the control treatment (#1).

Sixteen 8- x 20-feet plots were marked to serve as guides for tillage equipment. All treatments that received tillage were ripped three times with a subsoiler (1.5 to 2 feet apart) to the 12 inch depth, which broke up the soil surface into large clods. A Rotadairon® (5 feet swath) was used to till the large soil clods at the surface 6 inch depth into finer clods. The tiller approximately treated the center 6 feet of each 8-feet wide plot.

After this initial tillage, dolomitic lime, phosphate (0-46-0), and potash (0-0-50) were applied, based on soil test results, at 42, 4.7 and 6.1 pounds per 1000 square feet, respectively, over the trial site.

After fertilization, the two treatment levels of leaf compost were incorporated into the sandy loam. Leaf compost was spread at 99 and 195 cubic yards per acre over the center 6-feet swath of respective plots after which all tillage plots were tilled with 2 passes of a Rotadairon® tiller. Leaf compost was spread at 195 cubic yards per acre over the center 6-feet swath of the plots receiving the greatest organic matter amendment rate after which all tillage plots received another 2 passes of the tiller. Appendix 1 presents a map of the treatment layout over the experimental site.

The trial site was fertilized and seeded with three varieties of turfgrass on 25 September 2012. OceanGro (5-5-0) fertilizer was applied to the entire trial area at 1 pound of N and available phosphate per 1,000 square feet. Bullseye' tall fescue, 'Spyder LS' tall fescue, and 'Heron' hard fescue were seeded at 3.1, 3.3, and 2.5 pounds per 1,000 square feet, respectively.

Results

Tillage and amendment of soil with leaf compost influenced the establishment of the turf. Initially, tillage and amending with leaf compost had a limited or negative effect on establishment (Table 1). This was likely due to the greater concentration of nutrients at the soil surface nearest seedling plants in the non-tilled, non-amended plots compared to other treatments. Additionally, the C:N ratio of the leaf compost was greater than recommended, which caused symptoms of nitrogen deficiency in the turf plants (see color data in Table 2).

Improved turf cover with tillage and amending were apparent by May 2013. Turf cover of the plots receiving tillage only and amending with 99 cu. yd. per acre leaf compost averaged about 90% by June 2013, which represented an increase in turf cover of 16% on average compared to the non-tilled treatment. The negative effect of the C:N ratio was still evident in June 2013 on the plots amended with 390 cu. yd. per acre of leaf compost; turf cover was about 10% lower in this treatment compared to the plots treated with tillage only and leaf compost at 99 cu. yd. per acre.

Turf quality was generally better on plots receiving soil improvement treatments; however, the quality of plots amended with leaf compost at 390 cu. yd. per acre lagged behind the tillage only and 99 cu. yd. per acre leaf compost treatments (Table 3). This was attributed to the leaf compost having a C:N ratio that was greater than recommended.

Drought stress was evident during the June evaluation of the trial and visual observations of wilt clearly indicated that the non-tilled treatment was experiencing greater drought stress than the soil improvement treatments (Table 3). Measurements of soil volumetric water content in 2013 indicated that soil improvement treatments increased water holding capacity of the soil (Table 4). Amending the sandy loam with leaf compost at 390 cu. yd. per acre increased volumetric water content by 6.7 and 5.5 pounds per cubic foot of soil in May and June, respectively, compared to the non-tilled treatment.

Tillage and amending soil with leaf compost reduced the bulk density of the sandy loam (Table 4). The greatest reduction in soil bulk density was observed in the sandy loam amended with leaf compost at 390 cu. yd. per acre.

Additional data has been collected in 2012 and 2013 is currently being analyzed. Plots will continue to be monitored for turf performance and soil volumetric water content and bulk density

during 2013 and 2014. We are currently working out the details of a mini-disc infiltrometer technique and will use this method to characterize the soil infiltration and porosity of treatments during late 2012 or 2013.

Table 1. Tillage and leaf compost effects on the establishment of a turfgrass mixture (tall fescue and hard fescue) seeded on 25 September 2012 on a sandy loam at Jakes Branch County Park in Beachwood NJ.

	Treatment Factors		2012				2013	
#	Tillage[a]	Leaf Compost[b]	18 Oct.	19 Nov.	19 Dec.	4 Mar.	9 May	23 Jun.
		cubic yards per acre	---------- Visual Rating of Turf Cover (%) ----------					
1	None	0	28	48	73	69	56	73
2	Yes	0	38	44	61	58	74	91
3	Yes	99	28	34	50	50	66	88
4	Yes	390	26	31	46	40	61	79
	Orthogonal Contrasts							
	Treatment 1 vs. 2, 3, 4		NS	**	***	***	*	**
	Treatment 2 vs. 3, 4		**	**	***	***	*	*
	Treatment 3 vs. 4		NS	NS	NS	**	NS	*
	CV (%)		13.2	13.9	5.0	6.6	9.9	6.1

[a] Tillage included three passes (1.5 to 2 feet apart) of a subsoiler to the 12 inch depth after which a Rotadairon rototiller (5 feet swath) was operated twice over each plot treating approximately the center 6 feet of each plot.

[b] Leaf compost applied as one application at 99 cubic yards per acre or as two split applications of 390 cubic yards per acre. All tillage plots received 2 passes of a Rotadairon® tiller after each application of leaf compost.

Table 2. Tillage and leaf compost effects on the turf color of a turfgrass mixture (tall fescue and hard fescue) seeded on 25 September 2012 on a sandy loam at Jakes Branch County Park in Beachwood NJ.

	Treatment Factors		2012			2013		
#	Tillage[a]	Leaf Compost[b]	18 Oct.	19 Nov.	19 Dec.	4 Mar.	9 May	23 Jun.
		cubic yards per acre	---------- Turf Color (9 = dark green color, 5 = acceptable green color) ----------					
1	None	0	6.8	5.3	6.8	4.8	3.5	6.5
2	Yes	0	7.8	5.8	6.3	5.5	5.5	7.5
3	Yes	99	6.3	5.3	5.8	5.0	5.3	6.5
4	Yes	390	6.0	4.5	4.5	4.0	3.8	5.0
	Orthogonal Contrasts							
	Treatment 1 vs. 2, 3, 4		NS	NS	**	NS	**	NS
	Treatment 2 vs. 3, 4		***	**	**	*	*	***
	Treatment 3 vs. 4		NS	*	**	*	**	***
	CV (%)		5.1	8.1	9.2	12.1	12.8	6.9

[a] Tillage included three passes (1.5 to 2 feet apart) of a subsoiler to the 12 inch depth after which a Rotadairon rototiller (5 feet swath) was operated twice over each plot treating approximately the center 6 feet of each plot.

[b] Leaf compost applied as one application at 99 cubic yards per acre or as two split applications of 390 cubic yards per acre. All tillage plots received 2 passes of a Rotadairon® tiller after each application of leaf compost.

Table 3. Tillage and leaf compost effects on the turf quality and wilt of a turfgrass mixture (tall fescue and hard fescue) seeded on 25 September 2012 on a sandy loam at Jakes Branch County Park in Beachwood NJ during 2013.

	Treatment Factors		Turf Quality		Wilt Stress
#	Tillage[a]	Leaf Compost[b]	9 May	23 Jun.	23 Jun.
		cubic yards per acre	-------- 9 = best, 5 = acceptable --------		---- 9 = none, 1 = all turf wilted ---
1	None	0	2.8	5.0	5.9
2	Yes	0	4.3	6.8	8.5
3	Yes	99	4.0	6.5	8.9
4	Yes	390	3.0	4.8	9.0
	Orthogonal Contrasts				
	Treatment 1 vs. 2, 3, 4		*	*	***
	Treatment 2 vs. 3, 4		NS	*	NS
	Treatment 3 vs. 4		*	**	NS
	CV (%)		16.5	12.3	7.0

[a] Tillage included three passes (1.5 to 2 feet apart) of a subsoiler to the 12 inch depth after which a Rotadairon rototiller (5 feet swath) was operated twice over each plot treating approximately the center 6 feet of each plot.

[b] Leaf compost applied as one application at 99 cubic yards per acre or as two split applications of 390 cubic yards per acre. All tillage plots received 2 passes of a Rotadairon® tiller after each application of leaf compost.

Table 4. Tillage and leaf compost effects on the soil volumetric water content and bulk density of a turfgrass mixture (tall fescue and hard fescue) grown on a sandy loam at Jakes Branch County Park in Beachwood NJ during 2013.

	Treatment Factors		Volumetric Water Content[c]		Bulk Density	
#	Tillage[a]	Leaf Compost[b]	9 May	23 Jun.	9 May	23 Jun.
		cubic yards per acre	---------- pounds per cubic foot ----------		---------- pounds per cubic foot ----------	
1	None	0	13.2	7.8	86	80
2	Yes	0	12.6	8.0	84	74
3	Yes	99	14.4	9.4	76	70
4	Yes	390	19.9	13.3	60	57
	Orthogonal Contrasts					
	Treatment 1 vs. 2, 3, 4		*	*	***	***
	Treatment 2 vs. 3, 4		***	**	***	***
	Treatment 3 vs. 4		***	**	***	***
	CV (%)		9.4	15.6	3.3	3.8

[a] Tillage included three passes (1.5 to 2 feet apart) of a subsoiler to the 12 inch depth after which a Rotadairon rototiller (5 feet swath) was operated twice over each plot treating approximately the center 6 feet of each plot.

[b] Leaf compost applied as one application at 99 cubic yards per acre or as two split applications of 390 cubic yards per acre. All tillage plots received 2 passes of a Rotadairon® tiller after each application of leaf compost.

[c] Volumetric water content and bulk density measured with a Troxler (Model 3411-B) surface moisture-density gage in the backscatter mode.

Appendix 1. Map of experimental area showing the arrangement of treatments in the compaction trial.