AERIFICATION TINE EFFECTS ON HYBRID BERMUDAGRASS ATHLETIC FIELDS

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ABSTRACT

There is little research examining the effect of aerification tine type (hollow or solid) and length on athletic fields. The objective of this research was to evaluate different aerification tines of varying depth, diameter and density (hollow versus solid), examining their effect on soil hardness, compaction, duration of effects, and turf quality on 'Tifway' bermudagrass (*Cynodon dactylon* (L.) Pers. x *C. transvaalensis* Burtt-Davy). Treatments were: 1) 'standard' depth hollow tine (10 cm long, 1.9 cm diam.) (SHT), 2) standard depth solid tine (10 cm long, 1.9 cm diam.) (SST), 3) 'deep' depth hollow tine (20 cm long, 2.2 cm diam.) (DHT), 4) deep depth solid tine (20 cm long, 2.2 cm diam.) (DST), 5) pull-behind drum type aerifier with hollow tines (9.5 cm long, 0.7 cm diam.) (PB), and, 6) a non-aerified control (Control). Four replications of each treatment were applied at the Auburn University football practice field in May, June, July and August of 2001 and 2002, and five replications of each treatment were applied at the Auburn University Turfgrass Research Unit (TGRU) in May, June, July and August of 2002 and 2004. The experimental design was an incomplete factorial arrangement of aerification equipment/tine type, arranged as a randomized complete block design with 4 replications at the Practice Field and 5 replications at the TGRU. Traffic/compaction at the Practice Field was real foot traffic via football practice, while compaction at the TGRU was applied by daily use of a weighted roller. Treatments were applied to a Marvyn loamy sand at each location. Collected data included soil resistance as measured by a penetrometer, surface hardness as measured with an impact hammer, shoot density, thatch depth, and dry root weight. Penetrometer readings revealed that use of deep depth tines (DHT and DST) reduced soil penetration resistance over a 0-240 mm depth. There was no difference in soil resistance in plots that were non-aerified or had been aerified with the PB equipment. In some cases (about 50% of the time) aerification with the SHT significantly reduced impact at the turf surface (to ~ 75 mm in depth), as compared to the non-aerified control. After two years (8 aerifications in total) the beginning of an aerification hard pan was detected in treatments aerified with standard depth solid tines (SST). Although root density and shoot density were sometimes affected by treatment, the differences were not consistent across sites and years. Best long-term and deepest relief of soil compaction was afforded by use of deep aerification tines that were hollow.

METHODS

- Experiments performed at two locations (AU Football Practice Field and the TGRU), both with existing stands of Tifway hybrid bermudagrass maintained at 2.5 cm.
- Practice Field study was conducted in 2001 and 2002, TGRU conducted in 2002 and 2004.
- Traffic/compaction at the Practice Field was real foot traffic via football practice, while compaction at the TGRU was applied via daily use of a weighted roller.
- Four and five replications of treatments at the Practice Field and TGRU, respectively. Plot size was 6.1 x 6.1 m at the Practice Field and 2.4 x 3.1 m at the TGRU, with 6.1 m alleys between all plots for turning equipment.
- In May, June, July and August of each year the following treatments were applied: 1) 'standard' depth hollow tine (10 cm long, 1.9 cm diam.) (SHT), 2) standard depth solid tine (10 cm long, 1.9 cm diam.) (SST), 3) 'deep' depth hollow tine (20 cm long, 2.2 cm diam.) (DHT), 4) deep depth solid tine (20 cm long, 2.2 cm diam.) (DST), 5) pull-behind drum type aerifier with hollow tines (9.5 cm long, 0.7 cm diam.) (PB), and, 6) a non-aerified control (Control). Any debris was removed following aerification (as occurred with hollow tine treatments) with sand topdressing following on all treatments.
- Collected data included soil resistance at 2 and weeks after each aerification (and weekly for 6 weeks after each August aerification) as measured by cone penetrometer (Rimik®), surface hardness (same measurement timing as with aerification) as measured with an impact hammer (Clegg®), shoot density (Spring and Fall), thatch depth (Spring and Fall), and dry root weight (Spring and Fall).

Figure 1. Aerification equipment used to apply the treatments. Left, Soil Reliever® used for the deep-depth tine treatments (DST shown), and, right, Ryan® aerifier used for the standard tine treatments (SST shown).

RESULTS & DISCUSSION

Figure 2. Soil resistance measured via a Remik penetrometer as affected by aerification, four weeks after August, 2001 treatments. AU Practice Field.

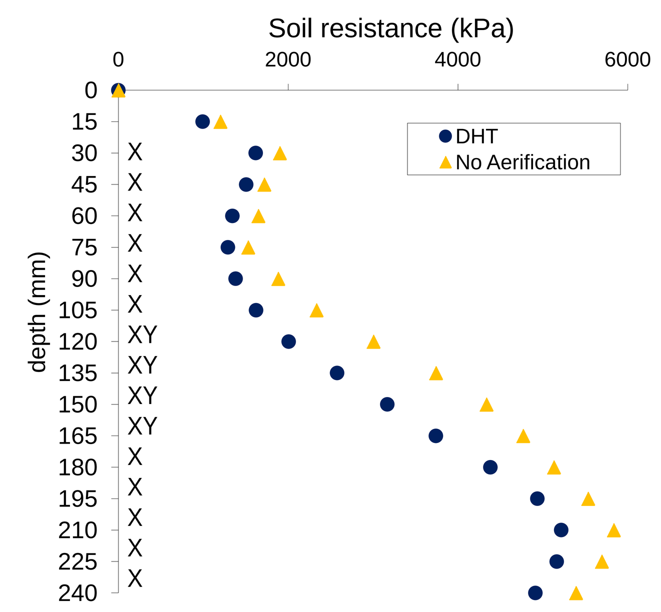


Figure 3. Soil resistance measured via a Remik penetrometer as affected by aerification, one week after August, 2002 treatments. TGRU.

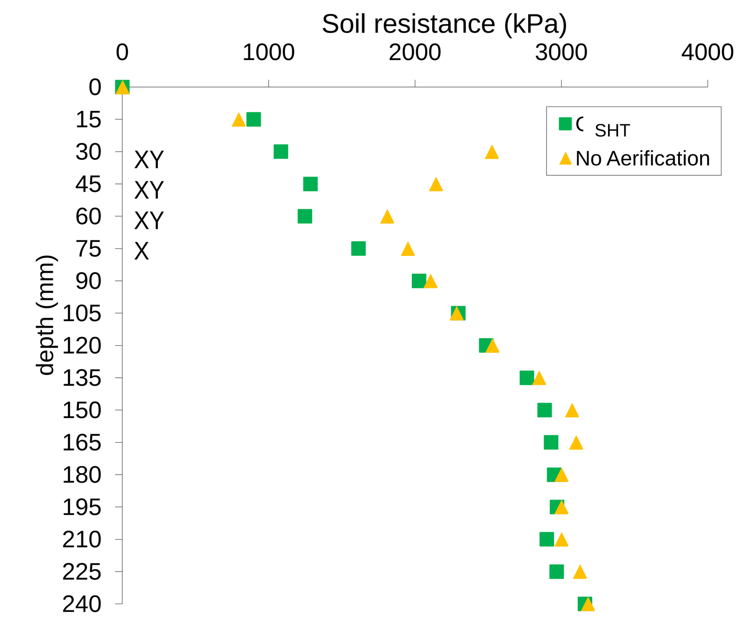


Figure 4. Soil resistance measured via a Remik penetrometer as affected by aerification, six weeks after August, 2002, treatments. AU Practice Field.

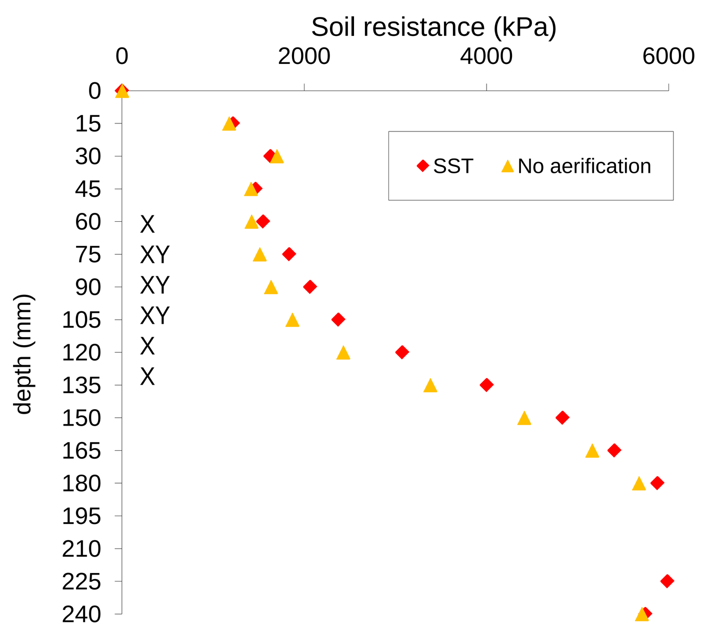
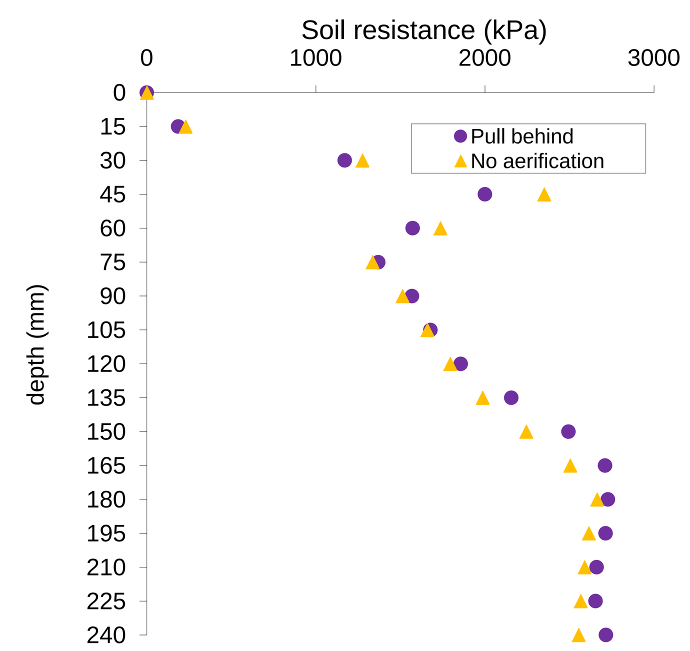


Figure 5. Soil resistance measured via a Remik penetrometer as affected by aerification, one week after August, 2004 treatments. TGRU.



At each sampling depth, if that depth is marked with an 'X' then it had a significantly different soil resistance (at alpha = 0.10) than the corresponding measurement from the non-aerified treatment. If the depth is marked with an 'XY', than that soil resistance measurement was significantly different than measured in any other treatment (including all other aerification treatments). Absence of any 'X' or 'XY' marks indicates no significant differences due to treatment at that depth. 'DHT' = deep depth, hollow tine; 'SHT' = standard depth, hollow tine; 'SST' = standard depth, solid tine.

The use of deep depth aerification tines (DHT or DST) often significantly reduced soil resistance beyond that measured in other aerification treatments and the non-aerified control (Fig. 2). Such differences lasted for 6 weeks after the final August aerification.

Treatments that utilized the 'standard' depth tine (SST or SHT) typically reduced soil resistance in the upper 60 cm of soil (Fig. 3).

Continued use of the SST treatment produced a measurable aerification pan at the bottom of the aerification depth (Fig. 4). In those cases, soil resistance was greater in plots aerified with the SST (as compared to the non-aerified control plots). This effect was often significant in the 75-105 mm soil depths. This effect was observed at both locations in the second year of the study, and only with the SST treatment.

The PB treatment never affected soil resistance beyond that measured in the non-aerified control.

Table 1. Clegg impact hammer readings as affected by aerification treatments at 1, 2, 3, 4, 5 and 6 weeks after the August aerification, 2002, AU Practice Field.

	Week after the August, 2002 aerification					
Trt	1 9 Aug	2 16 Aug	3 22 Aug	4 30 Aug	5 6 Sept	6 13 Sept
	Clegg† reading ($\boldsymbol{g}_{max}$)					
DHT§	46 b‡	36 b	38 c	51 b	44 c	53 d
DST¶	50 a	38 b	42 ab	54 ab	46 bc	57 bc
SHT$^{\#}$	50 a	41 a	45 a	56 ab	50 a	59 ab
SST††	55 a	43 a	42 ab	58 a	48 ab	63 a
Pull Behind‡‡	52 a	41 a	41 ab	55 ab	48 ab	58 bc
No aerification	51 a	41 a	43 ab	52 b	46 bc	54 cd

Use of the larger diameter deep depth hollow tines (DHT) sometimes produced a turf surface with a lower impact reading (Tables 1 and 2). However, impact readings, regardless of aerification treatment, were variable and often equal to those measured in the non-aerified control.

Table 2. Clegg impact hammer readings as affected by aerification treatments at 1 week after May aerification and 4 weeks after July aerification, 2002, TGRU, Auburn, AL.

	1 week after aerification	4 weeks after aerification
Trt	Clegg† reading ($\boldsymbol{g}_{max}$)	
	21 May	30 July
DHT§	54 b‡	76 c
DST¶	54 b	83 ab
GA60H$^{\#}$	52 b	80 ab
GA60S††	55 b	83 ab
Pull Behind‡‡	57 ab	82 ab
No aerification	64a	86 a

† Five readings randomly taken per plot, readings recorded as the last of 3 drops of the hammer at each spot.
‡ Within each set of data, means followed by the same letter are not significantly different from each other at alpha = 0.10.
DHT§ - Deep-tine aerification, hollow tines
DST¶ - Deep-tine aerification, solid tines
SHT$^{\#}$ - Standard-tine aerification, hollow tines
SST†† - Standard-tine aerification, solid tines
Pull Behind‡‡ - Rolling type aerifier, hollow tines.

Root and shoot responses to aerification were variable (Table 3). In some months any aerification improved the dry weight of roots (in 3 of 6 data sets), while in others there was no significant difference in root or shoot density, when compared to the non-aerified control.

Table 3. Root weight and shoot density of Tifway hybrid bermudagrass as affected by aerification treatment, Practice Field, 2001 and TGRU, 2004.

	Practice Field, Sept 2001	
	Dry weight of roots	Shoot density
Trt	g core$^{-1\dagger}$	number core^{-1}
DHT§	3.9 a‡	101.1 c
DST¶	4.4 a	120.7 a
SHT$^{\#}$	5.3 a	105.7 bc
SST††	6.0 a	99.8 c
Pull Behind‡‡	4.8 a	115.3 ab
No Aerification	1.6 b	105.9 bc

	TGRU, Oct 2004	
	Dry weight of roots	Shoot density
Trt	g core$^{-1\dagger}$	number core^{-1}
DHT§	0.20 b‡	162.9 a
DST¶	0.27 ab	175.3 a
SHT$^{\#}$	0.30 a	139.6 b
SST††	0.22 ab	161.9 a
Pull Behind‡‡	0.21 b	177.8 a
No Aerification	0.20 b	173.9 a

† Three cores were removed per plot, all shoots in each core counted and all roots washed and dried. One core measured 32 cm^{-2} in surface area and was 15 cm in depth.
‡ Within each set of data, means followed by the same letter are not significantly different from each other at alpha = 0.10.
DHT§ - Deep-tine aerification, hollow tines
DST¶ - Deep-tine aerification, solid tines
SHT$^{\#}$ - Standard-tine aerification, hollow tines
SST†† - Standard-tine aerification , solid tines
Pull Behind‡‡ - Rolling type aerifier, hollow tines.