Soil Aerification For Enhancing Turf Quality Under Traffic Stress

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Background

High utility lawns are very common in urban conditions, and in such lawns traffic stress is a major problem affecting turf quality. It is a well-known fact that traffic stress causes soil compaction and turf injury. Soil compaction is the foremost adverse effect that interferes with turf growth (especially root growth.) Soil compaction forms an impervious layer at the surface which prevents water infiltration, nutrient uptake, and gaseous exchange between the soil and the atmosphere. Compaction usually occurs on the upper 2-3 inches of soil surface. Compacted soil conditions alter normal root growth and development in turf. Surface layer soil compaction can be rectified by following a suitable soil aeration technique. Most people are not aware of the benefits of soil aerification, yet it is one of the most important cultivation techniques for a healthy and quality turf.

Soil Aerification

Soil aerification, as defined by Beard and Harriet (2005), is altering the soil without harming the turf. It is one of the many types of soil cultivation that reduces soil compaction, thatch accumulation, ultimately improving drainage, gas exchange, deeper root growth, and water infiltration (McCarty, 2005). By removing cores of soil, aeration provides space for roots and soil to expand, reducing further compaction. Aeration is also a method of thatch control, because the microorganisms brought to the surface of the lawn helps to break down thatch. All of these factors help turf to establish deeper roots. Aerification is performed using a wide range of equipment that drill, slice, or inject water into the soil. Different methods of soil aerification include hollow tine aerification, solid tine aerification, and water injection.

Hollow- tine aerification (HTA)

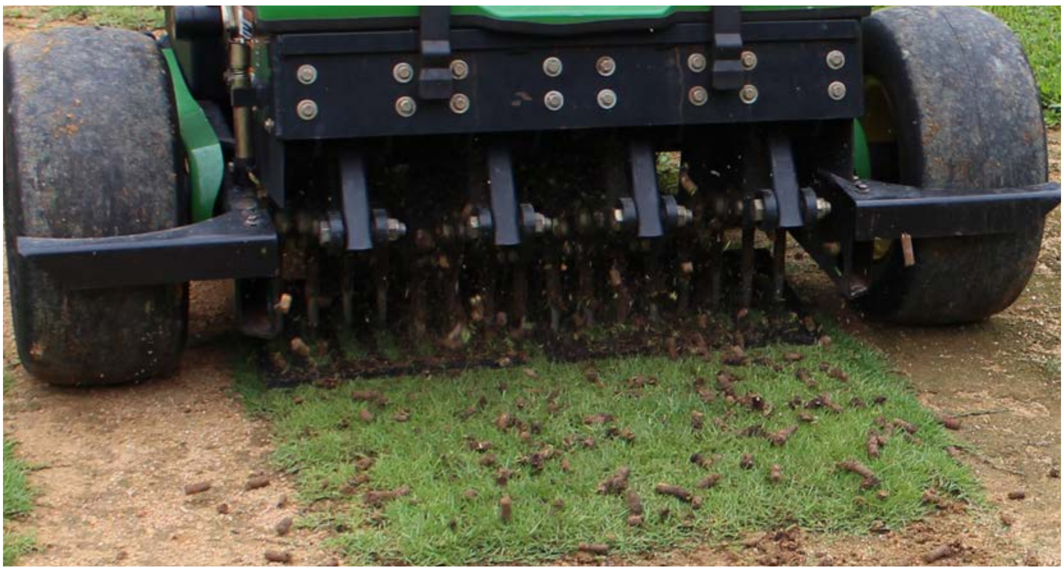


Fig. 1 Hollow-tine aerification

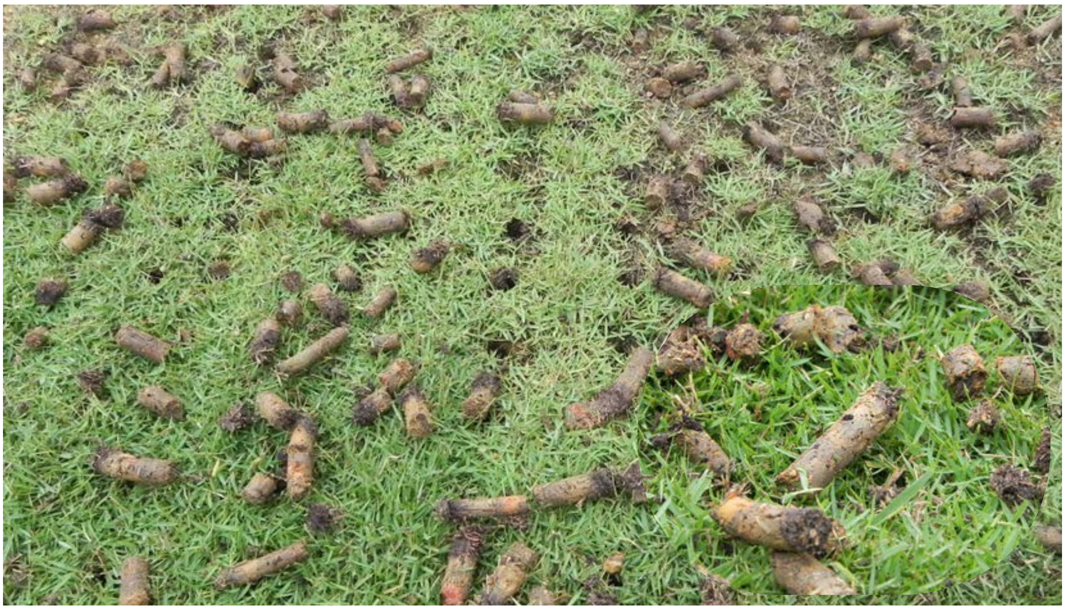


Fig. 2 Hollow-tine aerification cores

Hollow-tine aerification or coring involves driving specially designed metal "tubes" into the surface of turf, automatically extracting a core of turf with soil (**Fig. 1 and 2**). It improves root growth by reducing soil strength, bulk density and increasing soil porosity. An added benefit of the HTA is thatch reduction Primarily, HTA reduces thatch through physical removal. Secondly, HTA opens up the thatch layer providing a better environment for microorganisms to decompose organic matter. The disadvantage of HTA is its exclusion on highly compacted hard clay based soils as there are more possibilities for the tines to be damaged.

Solid- tine aerification (STA)

Solid tine aerification creates a hole and does not remove a core (**Fig. 3**) which makes it less disruptive and it is often used for this reason. Solid tines can go deeper than hollow tines and are mainly preferred for highly compacted hard surfaces (usually clay based soils). The drawbacks of solid tine aerification are the lesser tine diameter compared to hollow tine, creation of a compacted zone at the bottom and side of the tine and the inability for physical thatch removal.

Fig. 3 Solid-tine aerification

Water injection (WI)

Water injection is an innovative method of turf aerification. High pressure jets of water are utilized to produce deep, irregular channels into the soil. The primary benefits are the variable depth of penetration and lesser surface disruption (**Fig. 4**). In addition, it can be used to inject turf protection chemicals into the soil. Water injection system can be used throughout the season during heat or dry stress period when traditional aerators would cause severe turf damage. As with other techniques, water injection has its disadvantages including: the inability to be practiced on a larger scale (very laborious), the requirement of large amounts of water, and the lack of accessibility beyond golf courses because of its high resource consumption.

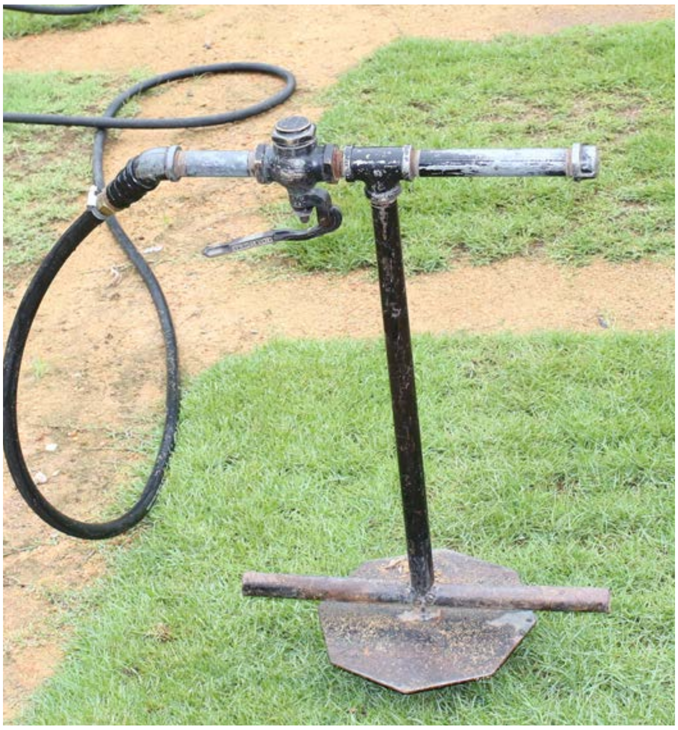
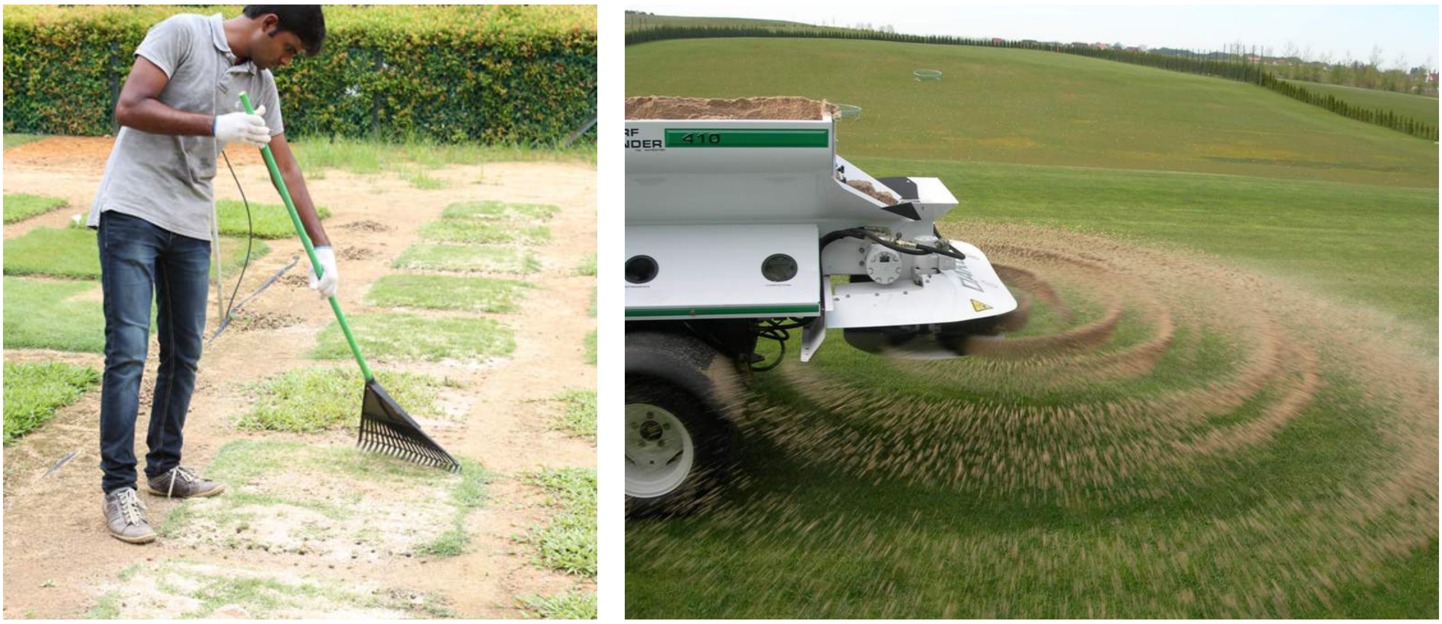


Fig. 4 Water Injection

Top Dressing

Top dressing is an important practice which has to be followed after hollow tine and solid tine aerification in order to close the holes in the soil formed by the tines. Top dressing is the process of applying a thin layer of root zone material (usually sand) over the turfgrass. Top dressing (**Fig. 5 & 6**) will improve water infiltration and speeds up decomposition and breakdown of thatch layer.

Fig. 5 & 6 To ensure best results from aerification, top dressing with sand must be thoroughly incorporated into the aeration holes.



Research

The Centre for Urban Greenery and Ecology (CUGE) has completed a study on performance of warm season turfgrasses under simulated traffic and assessed their recuperative potential by different aerification techniques. This study aims at identifying recuperative potentiality of warm season turfgrasses and suitable technologies to recover traffic-stressed turf. Experimental treatments were arranged in a factorial randomized complete block design (fRCBD) with four replications. The study involved two phases,

Phase I

Three turfgrass species - Cowgrass (*Axonopus compressus*), Seashore paspalum (*Paspalum vaginatum*) and Manilagrass (*Zoysia matrella*) were grown in an experimental site at Hort Park (**Fig. 7**). NParks approved soil mixture (ASM- comprising of loamy soil, mature compost and sand in the ratio of 3:2:1) was used as the growing media. Turfgrasses were subjected to traffic stress at zero and high intensity. Traffic was artificially imposed using a motorized Kesmac KTR 30 walk-behind turf traffic simulator weighing 240 kg with 165 cm of length and 85 cm width (figure 8). The high traffic intensity was generated by running twelve traffic passes per treatment which is equivalent to a high level football game in terms of human traffic as per international turf standards. Three such treatments were followed per week on alternate days. The traffic was applied for a period of four months.

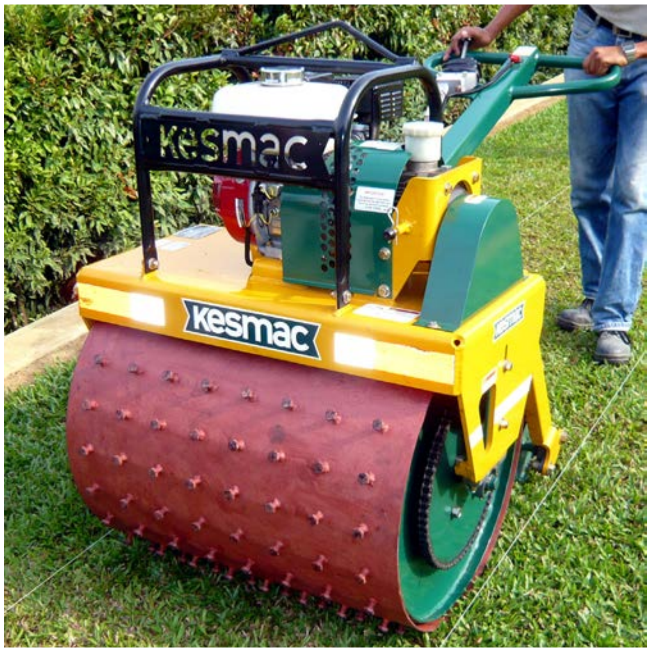


Fig. 7 (left) Experimental plots at Hort Park
Fig. 8 (right) Turf traffic simulator

Phase II

The experimental site used for Phase I was continued to assess the recuperative potential of turfgrass by three aerification techniques involving hollow tinning, solid tinning and water injection. The recuperative potential and suitable aerification technique for trafficated sites were investigated by observing the growth parameters such as visual turf quality, turf density, thatch content, root length and root volume. Physiological parameters including total non-structural carbohydrates (TNC), total cell wall content, total chlorophyll content and lastly soil parameters that include bulk density and infiltration rate were recorded.

Table 1 Aerification specifications used in research

Type of Aerification	Depth (cm)	Tine Spacing (cm)	Relative Soil Loosening	Surface Disruption
Hollow tine aerification	5	3.5	High	Moderate to heavy
Solid tine aerification	15	2	Low-moderate	Low
Water injection	40	N/A	Low-moderate	Nil

Results

All statistical computations were conducted using analysis of variance (ANOVA) with the IBM SPSS v21 statistical package. Means were separated by Fisher's least significant difference test with an alpha of 0.05.

The experimental results of this study show that

- Seashore paspalum exhibited highest recuperative potential
- Hollow tine aerification proved to be good for all the turfgrasses under study to reduce thatch with increased infiltration rate and reduced bulk density

Fig. 9 Comparative results of Pre and Post- Aerification

Pre-Aerification Turf Quality

Post-Aerification Turf Quality

Table 2 Mean values of thatch, bulk density and infiltration rate of soil influence by different aerification techniques

Aerification techniques	Thatch (g)	Bulk density (gcm^{-3})	Infiltration rate (mms^{-1})
Hollow - tine aerification (HTA)	6.91*	1.43*	2.69*
Solid - tine aerification (STA)	11.30*	1.55*	2.37*
Water injection (WI)	9.82*	1.63*	1.84*
SE.m	0.096	0.036	0.089
CD	0.276	0.103	0.256

'*' - significant difference; 'SE.m' - standard error of means

Recuperative potential of turfgrass

High

Paspalum vaginatum

Zoysia matrella

Axonopus compressus

Low

Aerification efficiency

High

Paspalum vaginatum

Zoysia matrella

Axonopus compressus

Low

Table 3 Benefits of aerification techniques

Aerification techniques	Reduces Thatch	Bulk density	Infiltration
Hollow - tine aerification (HTA)	Good	Good	Good
Solid - tine aerification (STA)	Poor	Moderate	Good
Water injection (WI)	Poor	Good	Moderate

Application

It is a major challenge to maintain good quality turf under severe traffic stress. Hence, it is important to consider traffic tolerant turfgrass species during establishment and for best results, aerification technique should be included in the turf maintenance program.

The recuperative potential of turfgrasses is associated with the ability of a grass to recover from injury. Based on the results, Seashore Paspalum has good recuperative potential followed by Manilagrass (**Fig. 8**).

HTA was found to be the best for all turfgrasses under study followed by water injection aerification. For practical purposes, HTA would be highly recommended as water injection is laborious and it also consumes much water. HTA reduces thatch accumulation and minimizes its build up by incorporating soil. Further to this, soil microorganisms help to breakdown the thatch and reduce its accumulation. As a general recommendation, soil aerification has to be done once in three months for moderate to high utility lawns.

References

Beard, J.B., and J. B. Harriet. 2005. Beard's Turfgrass Encyclopaedia for Golf Courses, Grounds, Lawns, Sports Fields. *Michigan State University Press*.

McCarty, L.B. 2005. Best Golf Course Management Practices. 2nd Edition. *Prentice Hall, Inc.*, Upper Saddle River, NJ.

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