RAPID, NON-DESTRUCTIVE METHOD FOR SEPARATING TURFGRASS CLIPPINGS FROM TOPDRESSING SAND USING AN INCLINED VIBRATING DECK

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ABSTRACT

Grass clippings, removed from putting green surfaces, contain sand when sand topdressing is done regularly. Analyses of such clippings may require that the sand be separated from the clippings. In the past, this process has generally been accomplished through time-consuming, destructive techniques that limit the range of analyses. The objective of this study was to develop a rapid, non-destructive technique to separate bentgrass (*Agrostis stolonifera* L.) clippings from topdressing sand. This procedure utilized an inclined, vibrating deck apparatus that effectively separated sand and clippings over a range of 0 to 100% sand. During replicated testing, this technique separated clippings from sand to within 3% of the known clipping weight in sand:clipping mixtures. Unlike the standard muffle furnace method, this technique more accurately measured the clipping biomass without the 9 to 10% remnant ash, which must be removed in an additional step. The technique is simple, rapid, and the undamaged clippings can be used for further analyses without sand weight skewing results.

Keywords

Gravity deck, Gravity table, Muffle furnace, Specific gravity table

INTRODUCTION

In the golf course industry, the practice of topdressing is commonly used on putting greens to smooth the surface, improve ball roll, increase drainage, control thatch, and enhance the biological balance (Christians, 1998; Turgeon, 2002). Typically, sand or amended sand that has particle size characteristics similar to the parent sand of the green is used as topdressing material. Topdressing frequency depends on availability of materials, cost, time of year, and condition of the green. Grass clippings removed from a putting green contain a considerable amount of sand immediately following topdressing. Research conducted on putting greens that requires analysis of clippings for biomass and/or nutrient content necessitates the separation of sand from clippings. In the past, this process has generally been accomplished through techniques that are time-consuming, labor intensive, and/or destructive, which limit the types of analyses that can be conducted following separation (Callahan et al., 1997).

A common method to determine nutrient content and biomass requires that the organic matter (clippings, thatch, roots, etc.) in a sample that also contains an inorganic component (sand or soil) be combusted in a muffle furnace (Shearman, 1986). Combusted clippings are reduced to ash, which must be removed in an additional step to determine clipping biomass and the proportion of sand in the original sample. Analysis of tissue contaminated with inorganic material can significantly affect results.

Gravity separators (gravity decks or tables) are commonly used in grain and seed processing plants to remove foreign materials (Das, 1986; Tkachuk et al., 1990, 1991). These machines utilize a combined cyclic or vibratory motion and air supported fluidization to partition a mixture of solid particles (Wu et al., 1999). The purpose of this research was to develop a rapid, non-destructive technique to separate creeping bentgrass clippings from topdressing sand. Once separated, the clipping biomass can be determined and the clippings can be subjected to further chemical analyses, e.g., through dry combustion (Oxenham et al., 1983; Matejovic, 1995) without sand contamination skewing the results.

MATERIAL AND METHODS

As part of a 3-yr nitrogen (N) leaching study at the Coeur d'Alene Resort Golf Course (Coeur d'Alene, ID) (Johnston et al., 2001), bentgrass clippings taken daily from a walking green mower basket were used to determine clipping biomass and N content. The green was sand topdressed by the golf course superintendent every 2 to 4 wk during the growing season. The green was brushed after topdressing to remove sand from the surface of the leaves and incorporate it into the turf. Following eight topdressing events (four chosen at random from May to August for both 1999 and 2000) when

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Figure. 1. Vibrating deck with sample feed, sandpaper covered deck, and collection cups.

the interval was 4 wk and growth was fairly uniform (Johnston et al., 2001), sand was separated from clippings with the vibrating deck to determine percentage sand in the clipping biomass.

During the N leaching study, determination of clipping biomass by the muffle furnace method was not feasible due to the large number of samples and time required to process each sample. As an alternative, a vibrating deck apparatus previously used for seed separation was adapted to remove sand from clippings (Fig. 1). The custom built vibrating deck was similar to a commercially available single deck-vibrating separator (Model VS1, Hoffman Manufacturing, Albany, OR).

The device was constructed around two variable amplitude Syntron (Anaheim, CA) light-capacity electromagnetic vibrating feeders producing 4000 vibrations min^{-1}, one on a feeder chute and another under the tilted deck (Fig. 1). Amplitude of the feeder chute stroke was set to 0.03 cm and the tilted deck to 0.08 cm. The adjustable deck was set to 14° horizontal tilt and 2.5° forward tilt. The deck surface measured 24.1 cm long x 21.6 cm wide and was covered with 800-grit sandpaper. Clippings and sand were separated because of differences in mass, shape, and density by the stroke amplitude, tilt, and sandpaper of the deck. The sand migrated to the lower portion of the vibrating deck and the clippings migrated to the upper portion. Since the sand and clippings were very different, generally, they separated well, i.e., little material was collected in the center cup (Fig. 1). Any material collected in the center cup was run over the vibrating deck a second time. The clippings and sand fractions were collected in metal cups at the upper and lower end, respectively, of the deck.

To test the effectiveness of this system over a wide range of sand:clipping dry wt. ratios, test samples were prepared with 0, 20, 40, 60, 80, and 100% sand. The sand used in the experiment was composed of feldspar and quartz plus basic volcanic rock that was angular and sub-angular with medium sphericity. Particle size distribution of the sand, based on USGA specifications, was 31.1% coarse, 67.5% medium, and 1.4% fine (Hummel, 1993). Bentgrass clippings were obtained from a triplex green mower basket off a creeping bentgrass research plot that was mowed at 3.4 mm. The plot had not been sand topdressed for approximately four months prior to sampling. Samples were dried at 40°C for 72 h prior to storage in paper envelopes. Prior to each study clippings were again dried.

Two sets of 10 g (dry wt.) sand:clipping mixtures were constructed at each ratio listed above, with one set run through the vibrating deck and the other set combusted in a muffle furnace at 600°C for 4 h (Ledeboer and Skogley, 1967) to compare techniques. After vibratory separation, the collected sand and clipping fractions were combusted and the ash was removed using a 0.1-mm-mesh screen to determine pure sand weight in each fraction. Samples that were only combusted in the muffle furnace were also screened and weighed to determine the amounts of sand and ash recovered from the clippings. The percentages of sand and clippings were determined for each process. Percentage errors were calculated for each sand:clipping mixture based on the known quantity of sand and clippings in each mixture.

The sand:clipping mixture separation experiment was a 2 x 5 factorial with two levels of separation technique and five levels (100% sand omitted from statistical analysis) of sand:clipping ratios. The study was replicated three times (runs over time). Analysis of variance (ANOVA) was conducted using STATISTIX 8 (Analytical Software, 2003). When significant differences occurred ($P = 0.05$) treatment means were separated using Scheffe test at $P = 0.05$.

RESULTS AND DISCUSSION

With the adoption of the practice of light, frequent sand topdressing of golf greens, the constant presence of sand in the clipping biomass has complicated obtaining clipping dry weight. Sand can initially comprise > 80% of the sample dry weight when biomass samples are collected following mowing (Fig. 2). The sand content decreased with time; however, on a 2-wk-topdressing cycle, as normally occurred at the Coeur d'Alene Resort Golf Course during the previous N leaching study (Johnston et al., 2001), the sand content was still 20%, which declined to 10% 4 wk after topdressing. On a 2-wk and 4-wk-topdressing cycle, the percent sand was 20%, or more, in 100% and 61%, respectively, of the samples (Fig. 2). Thus, clippings taking from greens where frequent topdressing is practiced will always contain a sand fraction that must be removed to obtain biomass dry weight prior to chemical analyses of turfgrass clippings.

ANOVA indicated a highly significant separation technique x clipping:sand ratio interaction for both

Table 1. Clipping recovery and associated error for clipping/sand separation by vibrating deck and muffle furnace.

	Clipping recovery†		Error†	
Clippingsin mixture	Vibrating deck	Muffle furnace	Vibrating deck	Muffle furnace
(%)	(%)	(%)	(%)	(%)
100	99.41 c	90.34 d	0.59 bc	9.66 a
80	100.49 bc	90.65 d	0.49 c	9.35 a
60	101.61 abc	90.67 d	1.61 bc	9.33 a
40	103.02 a	90.40 d	3.02 b	9.60 a
20	102.84 ab	90.87 d	2.84 bc	9.13 a
0‡	99.41	99.96	0.59	0.04

†Means within clipping recovery or error followed by the same letter are not significantly different by Scheffe test (P = 0.05).

‡0% clipping recovery means based on percentage of sand recovered when sand = 100%; 0% clipping recovery omitted from ANOVA.

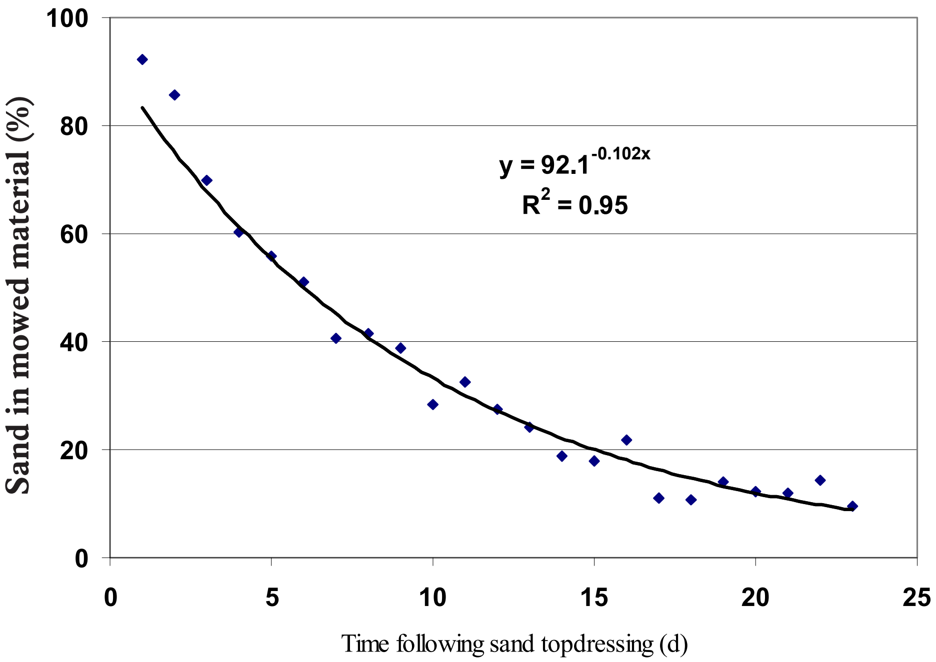

Figure 2. Percentage sand (dry wt. basis) separated by the vibrating deck technique in mowed material (sand + clippings) as affected by time following topdressing.

percentage clipping recovery and percentage error. With 20 to 100% clippings in the sample, the muffle furnace method consistently under estimated the percentage clippings (Table 1). The 9 to 10% error that occurred with the muffle furnace method was primarily due to the ash content in the residue following combustion. The muffle furnace process resulted in approximately 9.4% (range 8.8 to 9.9%) of the original clipping mass, across all sand:clipping ratios, remaining as ash. As the clipping content of the mixture increased, the ash made up a greater amount of the sample recovered following combustion; however, the percentage of ash in the residue was constant.

The vibrating deck method consistently gave a better estimation of the percentage clippings in the sample (Table 1). As the clipping content in the sample decreased from 100 to 20%, the percent error increased slightly. This was due to the large amount of sand in the sample (sand > 60%) carrying clippings along with the sand fraction as sand and clippings separated on the vibrating deck.

CONCLUSIONS

The vibrating deck non-destructively separated bentgrass clippings from topdressing sand. Samples can be processed with this method several times faster than that of the muffle furnace method. Also, little training or technical skill is required to perform the separation. Separated clippings can later be used for further analyses. This rapid, non-destructive technique may have wide-ranging applications.

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