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Evaluation of Turfgrass Clippings from Mulching Versus Side Discharge Mower Operation

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Abstract

Mower design and operation have been based on reducing clipping size to enhance filtering into the turfgrass canopy away from the surface. Reduced clippings on the surface can increase surface uniformity, a primary goal for lawn mower use. This study was conducted to determine the effectiveness of mulching mower units to reduce clipping particle size compared with traditional side-discharge mower units. Three commercially available mowers of different horsepower/size were tested in mulching and side-discharge modes of operation to evaluate clipping parameters from tall fescue and zoysiagrass maintained under typical home-lawn conditions. Turfgrass species and mower size had a greater impact on clipping length and specific projected area than mode of operation. Tall fescue clippings were 28% longer than zoysiagrass and had a 34% greater specific projected area. A medium or large mower produced clippings 28 to 31% shorter than the small mower and decreased the specific projected area by 19 to 32%. Mulching operation did not decrease clipping size as hypothesized. Instead, mulching resulted in average increases of 9 and 0.2% in clipping length and specific projected area, respectively. A side discharge mode of operation may result in fewer clippings on the surface, increasing surface uniformity compared to a mulching mode of operation.

It has been reported that recycling lawn clippings promotes retention of plant nutrients and enhances turfgrass quality (Heckman et al., 2000; Kopp and Guillard, 2002; Bigelow et al., 2005). Little information has been found in the literature as it relates to turfgrass particle size from mowing and decomposition rates. Studies by Angers and Recous (1997) reported the decomposition of rye (*Secale cereal* L.) green residues and wheat (*Triticum aestivum* L.) straw was influenced by particle size. It seems reasonable to postulate from previous work that smaller turfgrass clippings are more likely to filter down through the turfgrass canopy to the soil surface, enhancing the onset of decomposition and providing an environmental benefit. From a consumer's perspective, fewer clippings visible on the turfgrass surface can result in a more uniform, attractive turfgrass canopy.

Rotary lawn mowers are equipped with decks that house one to three horizontal rotating blades that cut turfgrasses. The decks of these mowers are designed to lift, cut, and discharge leaf tissue through side or rear orifices. Many mowers offer a mulching

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Core Ideas

- Mulching lawn mowers may not reduce turfgrass clipping size and subsequent rate of clipping decomposition for nutrient recycling.
- Mower horsepower/horsepower and turfgrass species can influence turfgrass clipping size.
- Lawn mower deck design and mode of operation can influence clipping size and distribution on the turfgrass surface.

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Conversions: For unit conversions relevant to this article, see Table A.

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Table A. Useful conversions.

To convert Column 1 to Column 2, multiply by	Column 1 Suggested Unit	Column 2 SI Unit
28.3	cubic foot, cu ft	liter, L (10^{-3} m^3)
645	square inch, sq inch	square millimeter, sq mm (10^{-6} m)^2
25.4	inch	millimeter, mm (10^{-3} m)
2.54	inch	centimeter, cm (10^{-2} m)

option which closes discharge orifices resulting in completely enclosed decks. For some mowers, decks are changed to mulching-specific decks designed for mulching operation only. In principal, mulching-specific decks cut clippings multiple times before discharging the 'mulched' debris beneath the unit into the turfgrass canopy. This suggests mulching units should produce more visually appealing turfgrass stands as a result of fewer observed clippings on the turf surface immediately following a mowing event. Miller et al. (2016) observed inconsistent post-mowing turfgrass quality between various mower setups. Observations concluded that clipping turfgrasses with a mulching unit resulted in lower turfgrass quality compared with using a side-discharge unit due to excessive clippings remaining on the turfgrass surface. However, subsequent clipping sizes generated from side discharge and mulching mowers were not investigated. The objective of this study was to evaluate the effectiveness of mulching mower operation to reduce clipping particle size compared with traditional side-discharge mower operation.

Mowing Units

A field study at the Lake Wheeler Turfgrass Research Laboratory in Raleigh, NC was designed to assess the influence of mower setup on post-mowing clipping size. The study was replicated in space by using two turfgrass species and analyzed as a combined experiment (McIntosh, 1983). Each mowing unit was used on actively growing 'El Toro' zoysiagrass (*Zoysia japonica* Steud.) maintained at 2.5 inches and tall fescue (*Festuca arundinacea* Schreb.) maintained at 3.5 inches. The field collections were completed between 27 and 29 Aug. 2018. Turf species were chosen due to popularity among North Carolina homeowners.

Three commercially available mowers from the Toro Company (Bloomington, MN) were chosen for all testing procedures. Mowers were selected to range all market designations from small homeowner to large commercial mower units. The mowers used during evaluations were the following: Recycler Lawn Mower (22-inch cut diameter) (Small), Commercial Walk-Behind Mower (36-inch cut diameter) TURBO FORCE (Medium), and Z Master Professional 5000 Series Riding Mower (52-inch cut diameter) TURBO FORCE (Large). Pre-test mowing was used to establish equivalent clipping removal (actual heights-of-cut) within grasses among mowers. The dynamics of turfgrass rigidity, mower weight, and mower tire width required bench height settings to be different for some turfgrass and mower combinations (Table 1). Engine speed and measured bench mowing heights for all mower treatments can be found in Table 1. Each mower was operated at 3 mph during testing.

Post-mowing clipping size was measured for each mower set to both side-discharge and mulching modes. The large and small mowers had built-on features that closed the discharge chute, preventing the need to add-on attachments when switching to mulching mode. However, the medium mower required an additional kit to convert to mulching mode.

Turf Clipping Collection

Prior to mowing test plots, two 1 sq ft areas were pre-marked within each plot. Pre-marked areas were allowed to dry and vacuumed by a FEIN Wet/Dry Vacuum (Schwäbisch Gmünd, Germany) to remove debris where clippings were to be collected post mowing. The vacuum had a 5.8-gal capacity and an air flow rate of 151 cu ft min^{-1} and 98.4 inches of static water lift.

The first tissue collection area was within the mower deck path, and the second was on the edge of the mower deck path following mulching operation. For side discharge, a sample was again collected within the mower deck path. The second collection area was within the side discharge area of clipping dispersion. Zoysiagrass plots only required a single square foot collection for both locations. For tall fescue, a total of four 1 sq ft samples were collected to make a composite sample

Table 1. Mower engine horsepower, engine speed, blade configuration, and measured bench mowing heights for all mower treatments on zoysiagrass and tall fescue.

Mower	Horsepower	Engine speed	Blade configuration‡	Zoysiagrass	Tall fescue
		rpm†		———Height of cut, inches———	
Small	3.7	2900 ± 100	1 (22)	2.25	3.00
Medium	15.0	3600 ± 100	2 (18)	2.00	2.50
Large	25.0	3800 ± 50	3 (18)	2.00	2.50

†rpm = revolutions/min.

‡Blade configuration = number of blades (blade length in inches).

Table 2. Test statistic (probability > *F*) for turfgrass clipping length and area for the primary sources of variation and their interactions.

Source of variation	Clipping length	Clipping-specific projected area
Grass	< 0.0001	< 0.0054
Mower	< 0.0001	< 0.0001
Grass × mower	< 0.0001	0.1998
Mode of mowing	0.0034	0.2677
Mode of mowing × grass	0.0003	0.8271
Mode of mowing × mower	0.7810	0.0029
Mode of mowing × grass × mower	0.7622	0.3457
Collection location	< 0.0001	< 0.0001
Collection location × grass	< 0.0001	< 0.0001
Collection location × mower	0.0206	0.8119
Collection location × mode	0.0061	0.7622
Collection location × grass × mower	0.0021	0.5024
Collection location × grass × mode	0.6982	0.0498
Collection location × mower × mode	0.0481	0.0002

within the mower deck for both mower operation setups. A single square foot collection within the area of clipping dispersion was sufficient for side-discharge mode with tall fescue. Clippings were immediately placed in sealed plastic bags and placed in a cooler with ice to maintain hydration. Samples were transported to a lab, and analysis was initiated so that all samples were analyzed within 3 h of collection.

Clipping Size Analysis

To quantify clipping particle length and area, the W.S. Tyler Group Computer Particle Analyzer II (Mentor, OH) was used. Previous research found the particle analyzer to be > 97% accurate in both particle counts and dimensional measurements with adequate sampling (Bartley et al., 2019). The target number of clippings for analysis was at least 30,000 particle counts. In this study, turfgrass clipping counts averaged 44,180 for all the samples analyzed with a mean of 56,814 zoysiagrass clipping particles and 31,546 tall fescue particles used in the analysis. Clipping counts as a function of mowing mode were similar with 47,355 for side discharge and 41,006 for mulching. Similarities were also noted for collection points with 45,785 collected from inside the deck and 42,576 collected from the edge of the decks (includes area of dispersion for side discharge).

In addition to counting the clipping particles, the average particle length and specific projected area of clipped turfgrass particles were determined for each sample. To calculate a sample's specific projected area, the sum projected area of all particles within a sample was divided by the number of particles within the sample. This value provides information on the average size of the clippings regardless of its shape. Given these two size metrics, the mean clipping variable can be labeled as longer/shorter and larger/smaller. Data were subject to analysis of variance to evaluate the primary factors and their interactions. Means were separated with a Fisher's protected LSD test.

Table 3. Average length of collected turfgrass leaf tissue (inches) as a function of grass, mowing mode, and mower. Values represent a mean of six samples (three replications from two collection points).

	Tall fescue		Zoysiagrass	
Mower	Mulch	Side discharge	Mulch	Side discharge
Small	0.366 a†	0.319 a	0.216 a	0.228 a
Medium	0.240 b	0.181 b	0.169 b	0.185 b
Large	0.224 b	0.193 b	0.204 a	0.196 b
Mean	0.278 A	0.232 B	0.196 A	0.202 A

†Means with the same lowercase letter within the column or uppercase letter in a row (same grass) are not significantly different ($P = 0.05$) according to Fisher's protected least significant difference test.

Treatment Effects on Clipping Length and Specific Projected Area

This study concentrated on clipping size from mowers of three distinct sizes. The analysis of variance indicated that all primary treatment components of this study influenced clipping length in addition to many treatment interactions (Table 2). It was interesting to note that clipping length was influenced by mower and mode of mowing but there was not a mower × mode interaction.

The specific projected area of clippings was less influenced by treatments compared with clipping length. While both mower and grass species influenced clipping-specific projected area, the mode of mowing was not a significant factor, nor was there a mower × grass interaction. The location of collected clippings in relation to the mower deck was not originally considered to be important, but an evaluation of whether clippings were collected at the edge of the deck or underneath the deck indicated a large influence on both clipping length and area.

Previous work that evaluated cut quality of different mowers on multiple cool-season grass species and various mowing modes (mulching, side discharge, and bagging) found that clipping turfgrasses with a mulching unit resulted in lower turfgrass quality due to excessive clippings remaining on the turf surface (Miller et al., 2016). Those results were based on total clipping weight rather than clipping particle size.

Measured Post-Mowing Clipping Length

The premise behind a mulching mower is that clippings stay under the deck longer so that the spinning blades can make multiple contacts with the plant tissue, further reducing the tissue particle length/size. This was not the case when evaluating tall fescue post-mowing clipping length. Tall fescue clipping length was 20% longer when mulched compared with side discharge (Table 3). No differences were noted for zoysiagrass clippings when comparing mowing modes. On average, tall fescue clippings were 28% longer than zoysiagrass clippings. This is at least partially due to the mowing heights at which these grasses were maintained before initiating the study. However, it does not explain why mulching did

Table 4. Average length of collected turfgrass leaf tissue (inches) as a function of grass, mowing mode, and collection location with respect to the mower deck. Samples taken from inside the deck were collected from under the middle of the deck; whereas, samples taken from the edge included from the right side of deck's edge and under the deck. Values represent a mean of nine samples (three replications of three mower sizes).

	Tall fescue		Zoysiagrass	
Location	Mulch	Side discharge	Mulch	Side discharge
Inside	0.204 b†	0.177 b	0.188 a	0.216 a
Edge	0.377 a	0.287 a	0.204 a	0.188 b

†Means with the same letter within the column are not significantly different ($P = 0.05$) according to Fisher's protected least significant difference test.

Table 5. Specific projected area (sq inch) of total turfgrass leaf tissue pieces collected as a function of grass, mowing mode, and mower. Values represent a mean of six samples (three replications from two collection points).

	Tall fescue		Zoysiagrass	
Mower	Mulch	Side discharge	Mulch	Side discharge
Small	0.0015 a†	0.0017 a	0.0011 a	0.0011 a
Medium	0.0013 ab	0.0012 b	0.0009 a	0.0009 b
Large	0.0009 b	0.0009 c	0.0009 a	0.0007 c
Mean	*0.0013 A*	*0.0013 A*	*0.0010 A*	*0.0009 A*

†Means with the same lowercase letter within the column or uppercase letter in a row (same grass) are not significantly different ($P = 0.05$) according to Fisher's protected least significant difference test.

not reduce measured tissue length of both grasses compared with side discharge. There was a grass × mode interaction but not a mode interaction with mower or mower and grass.

Considering the three-way interaction, using the small mower on tall fescue resulted in longer clippings compared with the medium and large mowers regardless of mode. The medium mower reduced zoysiagrass tissue length compared with both the small and large mowers in mulching mode but similarly to the large mower in side-discharge mode. The slower blade speed of the low-power, small mower is most likely the reason it did not reduce clipping length as effectively as the larger mowers. Furthermore, the dense zoysiagrass canopy may have moderated the effect of mower performance as the data were more similar across all treatment combinations.

The sample collection location in relation to the mower deck further illustrates the importance of deck design in regards to clipping size (Table 4). On average, the tall fescue clippings collected along the deck edge were 74% longer than those collected under the deck regardless of mowing mode. Furthermore, tall fescue clippings collected at the deck edge were nearly 85% longer following mulching. This suggests clippings from the deck edge were not coming in contact with the mower blades at the frequency of clippings collected from underneath the deck. Longer clippings deposited along the deck's edge can result in a clumping appearance across the turfgrass surface, reducing surface uniformity of the mown turfgrass. The data taken in zoysiagrass showed there were minimal differences in clipping length for the two collection points.

Specific Projected Area of Clippings

Post-mowing turfgrass tissue length is a parameter of particular interest since tissue of greater length may be more likely to remain on the surface, thus reducing the visual quality of the clipped turfgrass following mowing. However, the specific projected area of the tissue is likely the most critical data in relation to the rate of decomposition. The specific projected area decreased with increasing mower size for side discharge (Table 5). This is likely the result of increased mower blade speed. The specific projected area decreased from 19 to 32% as mower sized increased. There was a trend in decreasing specific projected area in the mulch mode of operation for tall fescue at percentages similar to those measured in tall fescue side discharge, but there was no change in specific projected area for zoysiagrass due to mower size operating in the mulching mode.

The response of clipping specific projected area related to the location of clipping collection was similar to that seen with clipping length (Table 6) in tall fescue. Tall fescue clippings collected at the deck edge were larger than those clippings collected under the deck. Specifically, the specific projected area was two to three times larger. No differences were noted for the zoysiagrass collection areas.

Implications of Mower Setup

In summary, the two measurements of clipping size—length and area, were evaluated for three mowers of varying size using mulching and side-discharge modes on two turfgrass species. The test hypothesis was that mulching would reduce clipping size. The results indicated that mulching did

Table 6. Specific projected area (sq inch) of collected turfgrass leaf tissue as a function of grass, mowing mode, and location with respect to the mower deck. Samples taken from inside the deck were collected from under the middle of the deck; whereas, samples taken from the edge included from the right side of deck's edge and under the deck. Values represent a mean of nine samples (three replications of three mower sizes).

	Tall fescue		Zoysiagrass	
Location	Mulch	Side discharge	Mulch	Side discharge
Inside	0.0008 b†	0.0006 b	0.0009 a	0.0009 a
Edge	0.0018 a	0.0020 a	0.0011 a	0.0009 a

†Means with the same letter within the column are not significantly different ($P = 0.05$) according to Fisher's protected least significant difference test.

not decrease clipping size, and in one instance, resulted in longer clippings. The turfgrass species and mower size had a greater impact on clipping length and specific projected area than mode of mowing. Our results, combined with previous data indicating that mulching mowers resulted in greater clipping deposits on the surface, suggest that a mower used in a mulching mode of operation may leave longer clippings on the turfgrass surface that could reduce decomposition rates and visual turfgrass quality.

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