

ORIGINAL ARTICLE

Applied Turfgrass Science

Timing of fraise mowing for overseeding establishment of perennial ryegrass

Matthew C. Carpenter¹  | James D. McCurdy¹  | Gerald L. Miller² | Barry R. Stewart¹ 

¹Plant and Soil Sciences, College of Agriculture and Life Sciences, Mississippi State University, Mississippi State, Mississippi, USA

²Botany and Plant Pathology, College of Agriculture, Purdue University, West Lafayette, Indiana, USA

Correspondence

Matthew C. Carpenter, now at Botany and Plant Pathology, College of Agriculture, Purdue University, West Lafayette, Indiana, USA. Email: carpenmc@purdue.edu

Assigned to Associate Editor Adam Thoms.

Abstract

Overseeding of bermudagrass (*Cynodon dactylon* L.) with perennial ryegrass (*Lolium perenne* L.) is often performed to provide green cover of dormant warm-season turfgrass in the winter. Fraise mowing is a cultural practice that can be used to disrupt the soil surface and hasten establishment of overseeded perennial ryegrass. Research was conducted to determine the most effective timing of overseeding for perennial ryegrass establishment in Northeast Mississippi, and to compare fraise mowing with other common cultural practices performed to enhance overseeding establishment. Treatments included fraise mowing at two depths (0.3 or 0.6 inches), scalping to a height of 1 inch, or vertical mowing to a depth of 1 inch at three timings (mid-September, mid-October, and end-October) prior to seeding perennial ryegrass at 435 lb pure live seed acre⁻¹. Plots were evaluated weekly for turfgrass quality, visual perennial ryegrass cover, and total green cover with digital image analysis. Fraise mowing to a depth of 0.6 inches and scalping resulted in quicker perennial ryegrass establishment. Fraise mowing to a depth of 0.3 inches resulted in quicker perennial ryegrass establishment than both the untreated control and vertically mowed treatments. End-October fraise mowing resulted in the slowest establishment, as growing conditions were not favorable for perennial ryegrass growth. Although the mid-September and mid-October treatments provided the most rapid perennial ryegrass establishment, almost all seeding timings were visually similar by March 15th of the following year. Though fraise mowing temporarily causes an undesirable playing surface, more rapid perennial ryegrass establishment is afforded by restricting bermudagrass competition.

1 | INTRODUCTION

Overseeding bermudagrass (*Cynodon dactylon* L.) with perennial ryegrass (*Lolium perenne* L.) is often performed

to provide green cover of dormant warm-season grasses in the winter (McCauley et al., 2019). Typical timings in the Southeast coincide with the onset of winter dormancy in bermudagrass spurred by cooler temperatures and shorter day length in the fall (Green et al., 2004; Munshaw et al., 2017a). When fall overseeding is performed too early, juvenile perennial ryegrass must compete with actively growing bermudagrass for sunlight, water, nutrients, and soil space

Abbreviations: AUGCC, area under green cover curve; AURCC, area under ryegrass cover curve; AUTQC, area under turfgrass quality curve; GC, green cover; RC, ryegrass cover; TQ, turfgrass quality; WAS, weeks after seeding.

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(Maloy, 2000; Ward et al., 1974). Cultivation prior to seeding may aid in reducing bermudagrass competition. Scalping, or lowering the mowing height, can stunt bermudagrass growth prior to overseeding, improve seed-soil contact, and may be the most practical and cost-effective approach for turfgrass managers on a lower budget (Aldahir et al., 2015; Green et al., 2004; Maloy, 2000). Scalping turns the bermudagrass unsightly and brown until perennial ryegrass germinates and establishes (Longer, 1998). Surface disruption through vertical mowing (verticutting) can also reduce competition from bermudagrass and remove thatch (*Hyparrhenia* Andersson ex Fourn.), which aids in perennial ryegrass establishment (Duble, 1996; Munshaw et al., 2017a).

Fraise mowing is a cultivation method aimed at removal of unwanted grass, weeds, thatch, or surface aberrations for a more consistent turfgrass playing surface (Munshaw et al., 2017b; Redexim Turf-Stripper Model 1200 User Manual and Parts Book, 1702-manual-turf-stripper-1200-english). Cultivation via fraise mowing is performed with a set of tines or blades perpendicularly attached to a rotating spindle parallel to the soil surface. Thatch, soil, and vegetative material are excavated by the spinning apparatus and are propelled onto a conveyor for disposal. Depending upon depth of excavation, the action of fraise mowing may result in as little as scalped turfgrass (shallow) or barren soil (deep) (Brosnan et al., 2018; Munshaw et al., 2017b). Fraise mowing before ryegrass overseeding may remove actively growing bermudagrass and accompanying thatch, thus reducing competition for establishing seed (Munshaw et al., 2017b; Ward et al., 1974).

Bermudagrass thrives in warmer temperatures with an optimum air temperature for shoot growth of 81–95°F, and optimum soil temperature for root growth from 75–84°F (Beard, 1973; Youngner, 1961). Conversely, the optimum air temperature for ryegrass shoot growth is 59–75°F, and the optimum soil temperature for root growth is 50–64°F (Beard, 1973; Youngner, 1961). These temperatures are consistent with fall and spring temperatures in the southeastern United States. Amid the average fall air temperature being between 52 and 75°F and ryegrass competition, bermudagrass struggles to grow (NWS, 2023; Wharton, 1999). The average first frost in Starkville, MS, occurs between November 1st and 10th (NWS, 2023). Perennial ryegrass needs approximately 2–3 weeks to establish, making October the best time to overseed warm-season grasses in the southern United States (Kopec & Umeda, 2015). Timing greatly affects the performance of the perennial ryegrass establishment with any overseeding method (Kopec & Umeda, 2015).

Although aggressive fraise mowing may improve perennial ryegrass establishment, an athletic field or golf course may not be attractive or playable for a period of time due to the potentially destructive process. This recovery period sets deeper fraise mowing apart from other methods, because most other methods leave some amount of green cover after treatment

Core Ideas

- Fraise mowing and scalping can reduce competition and stimulate perennial ryegrass germination and establishment.
- Mid-October is the best timing to perform overseeding treatments with perennial ryegrass in northern Mississippi.
- Fraise mowing provides a good seedbed and an improved playing surface once perennial ryegrass is established.
- Aggressive fraise mowing can result in an undesirable playing surface while perennial ryegrass is establishing.

and require minimal or no cessation of field use. Munshaw et al. (2017b) performed a study suggesting untreated control and verticut treatments, both of which leave green color, exhibited a better and more consistent green perennial ryegrass cover (RC) than fraise mown treatments. Nevertheless, fraise mowing is being used by many turfgrass managers as site preparation for overseeding (Minnick, 2018).

Fraise mowing may be an effective method for perennial ryegrass overseeding, and timing of the practice may directly impact the effectiveness of perennial ryegrass establishment. Therefore, research was conducted to compare cultivation methods prior to overseeding and to assess how fall timing affects perennial ryegrass establishment.

2 | EVALUATING CULTIVATION AND TIMING OF FALL PERENNIAL RYEGRASS OVERSEEDING

Research was conducted at the Mississippi State University R.R. Foil Plant Science Research Center in Starkville, MS, from September 2017 to May 2018 and September 2018 to May 2019. Plots consisted of ‘Tifway’ hybrid bermudagrass established on a Marietta fine sandy loam (fine-loamy, siliceous, active, Fluvaquentic Eutrudept) with a pH of 6.2 (1:1 soil/H₂O). The experimental design was a split-plot within a randomized complete block design, with timing as the main plot, and mechanical surface cultivation as subplots. Treatments were replicated four times with subplots (4 ft × 10 ft) randomized within the main plot (20 ft × 10 ft).

The five subplot cultivations included an untreated control, fraise mowing at 0.3 inches or 0.6 inches below the soil surface, vertically mowing in one direction at 1 inch below the soil surface, or scalping 1 inch above soil surface. A Redexim Charter House Turf Stripper (1200) (3.9 ft width) was used for

fraise mowing; a Toro Aerothatch 83 (44830) (3.9 ft width) was used for vertical mowing; and an Exmark 52 Lazer Z X-Series Zero-Turn Mower (LZX27KC526) (4.3 ft width) was used for scalping. Treatments were performed on September 21, October 12, and October 31 in 2017. In 2018, treatments were performed on September 18, October 9, and October 30.

Immediately after treatment, experiments were overseeded at a pure live seed rate of 435 lb acre⁻¹ with Ph.D.[®] perennial ryegrass blend (The Hogan Co. with an Andersons Scotts Accupro Drop Spreader (SSD) (3 ft width). Experiments were irrigated enough to prevent drought stress. Experiments were fertilized every two weeks with urea (46-0-0) at a rate of 22 lb N acre⁻¹ beginning 7 days after seeding (Woods Farm Supply Inc.). Grass was mown once a week with a Craftsman 4.5 hp rotary lawn mower at a height of 2 inches (917.385321) (2 ft width).

Assessments were conducted weekly for three weeks after the treatment, then bi-weekly throughout the course of the experiment. Visual percent perennial RC was assessed on a scale of 0 to 100%, with 0 = no ryegrass cover and 100 = complete ryegrass cover. Visual turfgrass quality (TQ) was assessed on a 1–9 scale, with 1 being dead or dormant grass with a straw brown color and 9 being uniform, dense, dark green turfgrass (Morris & Shearman, 2014). Percent green cover (GC) was evaluated using digital image analysis similar to Karcher and Richardson (2003) and Richardson et al. (2001). Images were taken in a 3.3 ft² light box containing four 100 W equivalent natural daylight compact fluorescent light bulbs (Sylvania). Images were captured with a 10 MP Canon digital camera (Canon PowerShot G12) that was white-balanced with the following settings: f/2.8 aperture, 1/25 sec. shutter speed, and 100 ISO. Percent green cover in images was determined using the Turf Analyzer software program (<http://turfalyzer.com>; Karcher et al., 2017).

All data were subject to analysis of variance (version 9.4, SAS Institute) with means separated using Fisher's Protected least significant difference ($\alpha = 0.05$). Data were analyzed to diagnose and make inferences from linear models. Response variables differed due to cultivation methods and timings. Significant year-by-treatment interactions were observed for all response variables; therefore, data were analyzed separately by year. This is potentially due to differences in environmental conditions including growing degree days (base 32°F), which were greater than 17 weeks after seeding (WAS) in 2018 (3,859) compared to 2017 (2,936). The overall effect of all measurements were evaluated through the calculation of area under the curve. The area under the curve was calculated from 0–17 WAS with the formula:

$$AUC = \sum [(y_i + y_{i+1}) / 2] (t_{i+1} - t_i)$$

where $i + 1, 2, 3, \dots, n - 1$, y_i is the measurement, and t_i is the time at the i th rating (Shaner & Finney, 1977).

3 | EFFECT OF CULTIVATION AND TIMING ON PERENNIAL RYEGRASS ESTABLISHMENT

Cultivation method and timing influenced RC in both years (Figure 1 and Table 1). In 2017, at 5 WAS, 0.6-inch fraise mowing and scalping in both mid-September and mid-October (RC > 71%), and 0.3-inch fraise mowing (RC = 68%) in mid-October led to higher percent RC than all other treatments. Fraise mowing at 0.6 inches and scalping in mid-September and mid-October led to consistently high RC from 5–17 WAS in 2017. Verticut and noncultivated plots both had a RC of less than 42%, at 5 WAS for all timings. In 2018, at 3 WAS, 0.6-inch fraise mowing in mid-October led to the highest RC among all other treatments (RC = 78%). Fraise mowing at 0.6 inches and seeded in mid-October led to higher RC than both fraise mowing depths seeded in mid-September at 9 and 15 WAS in 2018 ($P = 0.0276$; $P = 0.0433$).

In 2017, plots fraise mown at 0.6 inches and scalped had higher area under ryegrass cover curve (AURCC) values than other cultivation methods and noncultivated plots (AURCC > 14,625) (Figure 2A and Table 1). Verticut plots did not have a different AURCC value than noncultivated plots. The effect of treatment timing in 2017 did not differ between mid-September and mid-October fraise mown plots, with both having higher AURCC values than the end-October timing ($P < 0.0001$) (Figure 2B). In 2018, scalped plots and 0.6-inch fraise mown plots seeded in mid-October had higher AURCC values than all plots seeded at end-October and all verticut and noncultivated plots (AURCC > 15,706) (Figure 2C). Scalping was the only cultivation method resulting in a higher AURCC value than verticut and noncultivated plots for the end-October timing.

4 | TURFGRASS QUALITY AND GREEN COVER

The area under turfgrass quality curve (AUTQC) was calculated for both 2017 and 2018 (Figure 3A, 3B, 3C, and Table 1). In 2017, no significant interaction occurred between cultivation method and timing ($P = 0.1366$) (Figure 3A and 3B). Plots seeded in mid-September and mid-October led to higher AUTQC values than those seeded in late October. Plots fraise mowed at 0.6 inches and scalped had higher AUTQC values than other cultivation methods (AUTQC > 1,236). AUTQC differed due to cultivation method timing interaction in 2018 ($P = 0.0350$) (Figure 3C). No differences in AUTQC values were observed in plots scalped and fraise mown at either depth in 2018 when seeded at the same timing. When seeded in mid-October 2018, scalping and fraise mowing at 0.6

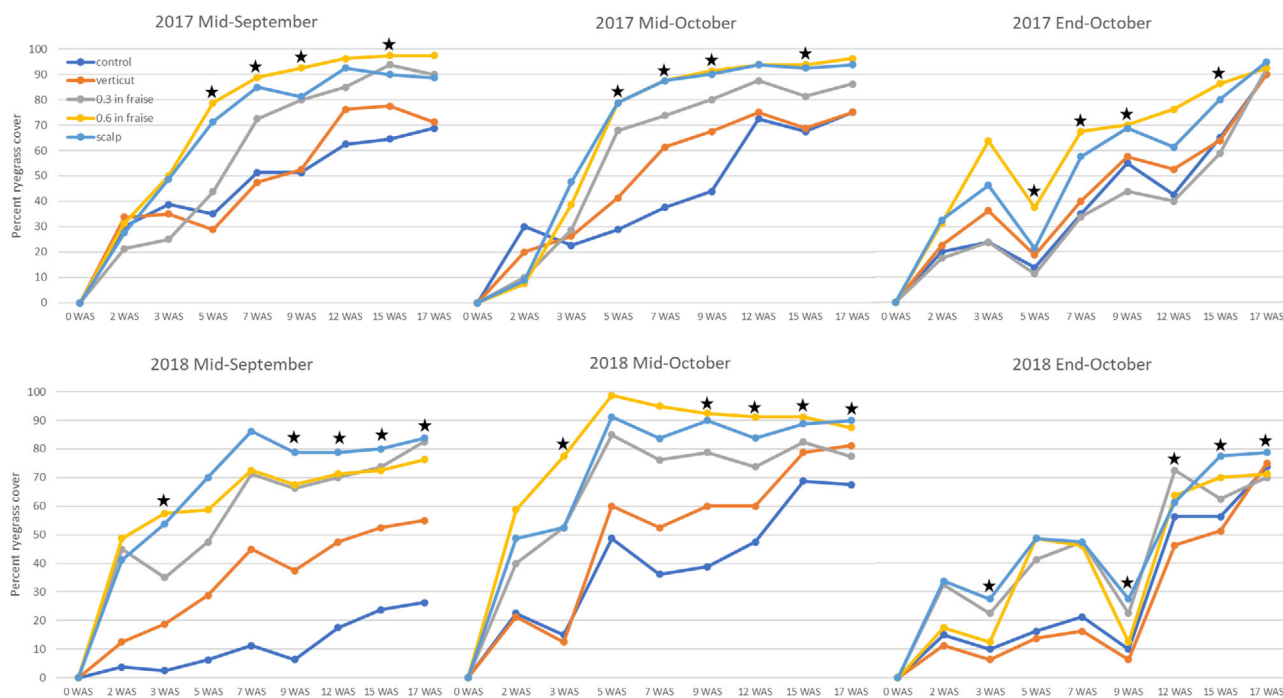


FIGURE 1 Effect of cultivation method and timing on establishment of perennial ryegrass on overseeded bermudagrass according to visual percent ryegrass coverage in 2017 and 2018. Significant differences were observed for all weeks in both 2017 and 2018. The star emblem, represent significant interactions between cultivation method and timing according to Fisher's protected least significant difference (LSD) ($P < 0.05$). 0 = 0% ryegrass cover to 100 = 100% ryegrass cover.

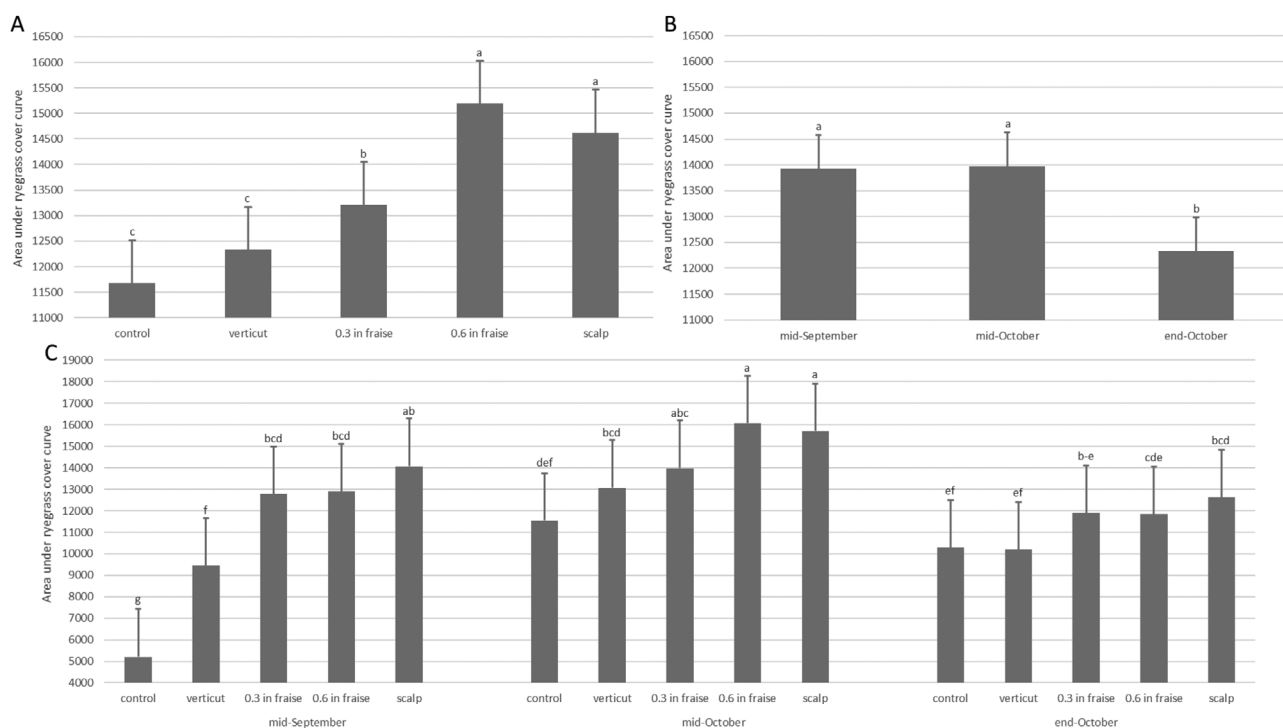


FIGURE 2 Effect of cultivation method and timing on establishment of perennial ryegrass on overseeded bermudagrass according to the area under ryegrass cover curve (AURCC) in 2017 and 2018. AURCC was calculated as in Shaner and Finney (1977). Columns with the same letter are not significantly different according to Fisher's protected LSD ($P < 0.05$). (A) AURCC of cultivation methods in 2017 ($P < 0.0001$), (B) AURCC of timings in 2017 ($P < 0.0001$), (C) AURCC of cultivation methods and timings in 2018 ($P = 0.0033$).

T A B L E 1 Analysis of variance results for both main effects and interactions between the two summarized for each response variable in 2017 and 2018.

Response variable ^a	Effects	0 WAS ^b	2 WAS	3 WAS	5 WAS	7 WAS	9 WAS	12 WAS	15 WAS	17 WAS
2017										
Ryegrass cover and AURCC										
	Method	***	NS	***	***	***	***	***	***	***
	Timing	***	***	NS	***	***	***	***	***	***
	Method × timing	**	NS	NS	**	*	***	NS	*	NS
AUTQC										
	Method	***	***	***	***	***	***	***	***	***
	Timing	***	***	***	***	***	***	***	***	*
	Method × timing	**	***	NS	**	**	**	NS	**	NS
AUGCC										
	Method	***	*	NS	***	***	***	***	***	**
	Timing	***	***	***	***	***	***	***	***	***
	Method × timing	***	**	NS	NS	NS	NS	***	**	*
2018										
Ryegrass cover and AURCC										
	Method	***	***	***	***	***	***	***	***	***
	Timing	***	**	***	***	***	***	***	***	***
	Method × timing	***	NS	***	NS	NS	*	*	*	***
AUTQC										
	Method	***	**	***	***	***	***	***	***	***
	Timing	***	***	***	***	***	***	***	***	***
	Method × timing	***	NS	NS	NS	NS	NS	**	NS	***
AUGCC										
	Method	***	*	***	***	***	***	***	***	***
	Timing	***	***	***	***	***	***	***	***	***
	Method × timing	***	NS	NS	NS	NS	NS	**	NS	***
AUGCC										
	Method	***	*	***	***	***	***	***	***	***
	Timing	***	***	***	***	***	***	***	***	***
	Method × timing	***	NS	NS	NS	**	*	***	***	***

^aRyegrass cover and AURCC (Area Under Ryegrass Cover Curve) were assessed visually on a 0–100% scale (0% = no ryegrass and 100% = complete ryegrass coverage). AUTQC (Area Under Turfgrass Quality Curve) was assessed visually on a 1–9 rating scale respectively (0 = dead turf, 6 = acceptable, and 9 = perfect). AUGCC (Area Under Green Cover Curve) was determined through digital image analysis.

^bWAS, weeks after seeding.

*Significant at the 0.05 probability level.

**Significant at the 0.01 probability level.

***Significant at the 0.001 probability level.

[†]NS, nonsignificant at the 0.05 probability level.

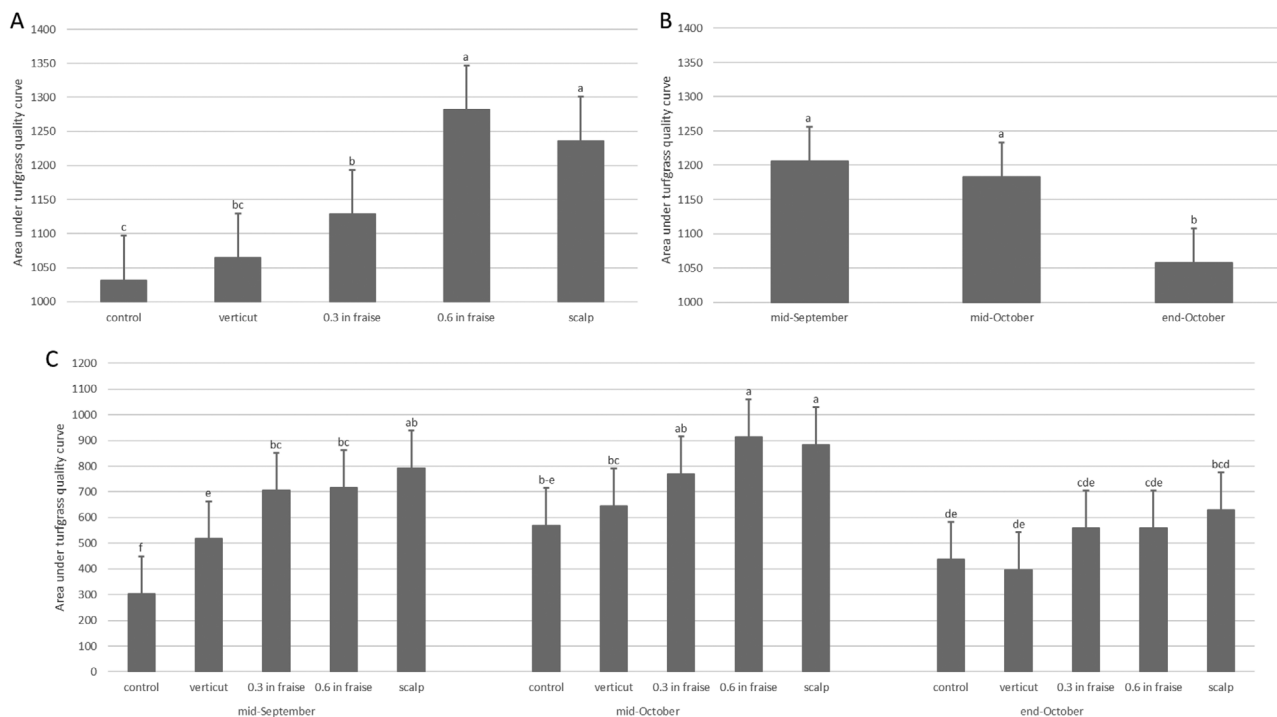


FIGURE 3 Effect of cultivation method and timing on the area under turfgrass quality curve (AUTQC) in 2017 and 2018. AUTQC was calculated as in Shaner and Finney (1977). Columns with the same letter are not significantly different according to Fisher's protected LSD ($P < 0.05$). (A) AUTQC of cultivation methods in 2017 ($P < 0.0001$), (B) AUTQC of timings in 2017 ($P < 0.0001$), (C) AUTQC of cultivation methods and timings in 2018 ($P = 0.0350$).

inches led to higher AUTQC values than when seeded in mid-September or end-October and fraise mowed at either depth (AUTQC > 884).

In 2017 and 2018, at 12 WAS, all cultivation methods seeded in mid-October led to higher percent GC assessed with digital image analysis ($P = 0.0047$; $P = 0.0103$). In 2017, verticutting in mid-September and mid-October led to lower area under green cover curve (AUGCC) values than all other treatments (AUGCC = 11,643; AUGCC = 13,745) (Figure 4A and Table 1). The AUGCC values for mid-September and end-October untreated control plots were not significantly different in 2017. Fraise mowing at 0.6 inches and scalping in mid-October led to higher AUGCC values than all other cultivation methods in 2018, except 0.3-inch fraise mowing in mid-October and scalping in mid-September and end-October ($P = 0.0007$) (Figure 4B). In 2017 and 2018, all plots treated in mid-October were among the top statistical group in the AUGCC, except verticutting in 2017.

5 | SUMMARY AND CONCLUSION

Fraise mowing may have many desirable outcomes, but like scalping, it creates a visually undesirable and unplayable area until overseeded ryegrass establishes. Overseeding into the bermudagrass canopy without prior cultivation prevents seed

to soil contact and increases competition for sunlight and other resources. In contrast to a study done by Munshaw et al. (2017), in which treatments were fraise mowed at 0.26-, 0.50-, and 1.0-inch depths, fraise mowing resulted in better perennial ryegrass establishment than both verticutting and the untreated control. In both Kentucky and Tennessee, they found no significant differences in their study past 3 WAS. Ward et al. (1974) found verticutting prior to overseeding was beneficial but only when three or more passes were made, which was not the case in this study. Scalping is often recommended before overseeding to stunt bermudagrass growth (Landry, 1993; Longer, 1998; Trappe et al., 2012); however, the amount of reduction in mowing height is unclear between various studies. Kopec and Umeda (2015) suggest mowing no more than 25% the standard height when preparing for overseeding. In this study, scalping 50% from the 2-inch standard height to 1 inch resulted in rapid ryegrass coverage comparable to aggressive fraise mowing.

Both verticutting and scalping require extensive clean-up of the removed thatch and verdure. A fraise mower provides a conveyor to get this waste into a truck or trailer for disposal, whereas scalping and verticutting require bagging or manual removal from the turfgrass surface. Perennial ryegrass establishment at the deeper fraise mowing of 0.6 inches may have resulted from more uniform removal of unwanted grass, weeds, thatch, and light competition, while increasing

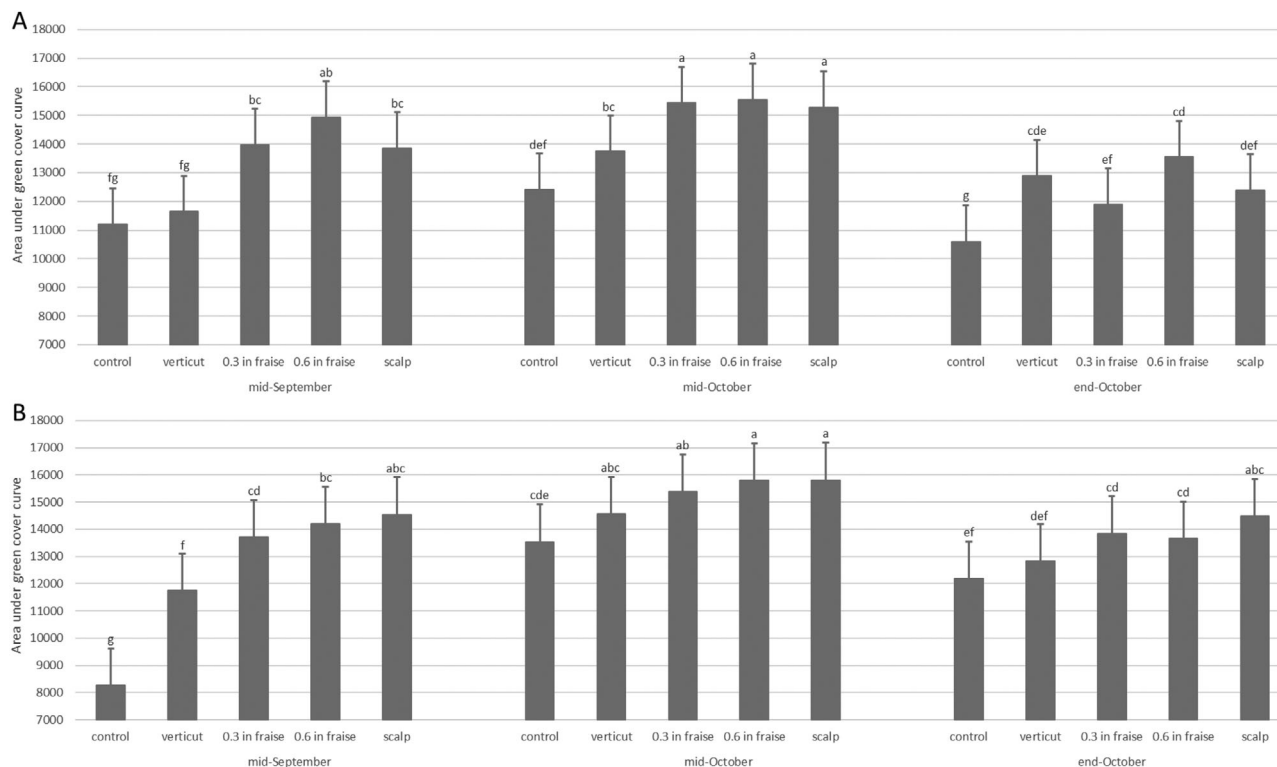


FIGURE 4 Effect of cultivation method and timing on area under green coverage curve (AUGCC) in 2017 and 2018. Area under green cover curve calculated as in Shaner and Finney (1977). Digital images were taken from each plot every seven days (Karcher & Richardson, 2003) and analyzed using the Turf Analyzer software program to determine percent green coverage (Karcher et al., 2017). Columns with the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P < 0.05$). (A) AUGCC of cultivation methods and timings in 2017 ($P = 0.0198$), (B) AUGCC of cultivation methods and timings in 2018 ($P = 0.0007$).

the amount of direct seed to soil contact. Longer (1998) found that, in the more northern location of Fayetteville, AR, mid-September overseeding performed better than mid-October. In central Mississippi with a longer fall and warmer temperatures, mid-October provided better ryegrass establishment than seeding in either mid-September or end-October. Overseeding can benefit the dormant bermudagrass by acting as a buffer for winter traffic which has been found to delay spring green-up by up to a month (Stewart et al., 2008). Provided proper removal of ryegrass is conducted in the spring, fall fraise mowing may benefit bermudagrass overall by stimulating new growth with less thatch when coming out of dormancy.

Seedbed preparation is essential to provide the quickest ryegrass overseeding establishment. In this study, verticutting in one direction at 1 inch below the soil surface did not result in perennial ryegrass establishment comparable to other cultivation methods, and in some seeding timings did not produce better establishment than noncultivated plots. Fraise mowing was effective at removing thatch and senescing bermudagrass. Removal of the senesced bermudagrass and thatch increased seed to soil contact, allowed space for ryegrass germination, and provided a thatch free surface for the returning bermudagrass in the spring. Fraise mowing at the shallower 0.3-inch

depth was not as effective in establishing ryegrass cover as fraise mowing at 0.6 inches or scalping. Both fraise mowing at 0.6 inches and scalping removed bermudagrass foliage more uniformly than fraise mowing at 0.3 inches.

This study indicates the end of October is too late to seed ryegrass into an existing bermudagrass stand in central Mississippi. Fraise mowing at 0.6 inches and scalping prior to seeding in mid-October routinely provided the quickest ryegrass establishment in this trial and are suggested in similar climactic regions.

AUTHOR CONTRIBUTIONS

Matthew C. Carpenter: Conceptualization; data curation; formal analysis; investigation; methodology; writing—original draft. **James D. McCurdy:** Resources; software; validation; visualization; writing—review and editing. **Gerald L. Miller:** Data curation; formal analysis; resources; validation; writing—review and editing. **Barry R. Stewart:** Funding acquisition; project administration; resources; software; supervision; writing—review and editing.

ACKNOWLEDGMENTS

The authors would like to acknowledge Redexim for allowing us to use their Turf Stripper, The Hogan Company

for the donation of seed, and all other assistance from the Mississippi Agricultural and Forestry Experiment Station necessary to make this study possible.

CONFLICT OF INTEREST STATEMENT

There are no conflict of interest statements to be made.

ORCID

Matthew C. Carpenter  <https://orcid.org/0009-0009-7317-1269>

James D. McCurdy  <https://orcid.org/0000-0002-9275-4939>

Barry R. Stewart  <https://orcid.org/0000-0002-4448-7186>

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How to cite this article: Carpenter, M. C., McCurdy, J. D., Miller, G. L., & Stewart, B. R. (2023). Timing of fraise mowing for overseeding establishment of perennial ryegrass. *Crop, Forage & Turfgrass Management*, 9, e20254. <https://doi.org/10.1002/cft2.20254>