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TRINEXAPAC-ETHYL AND OVERSEEDING EFFECTS ON SHEAR STRENGTH OF FOUR BERMUDAGRASS CULTIVARS GROWN ON SAND-BASED SYSTEM

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Bermudagrass (*Cynodon dactylon* L.*)* is often used for athletic fields due to its wear tolerance and recuperative ability. Studies were conducted May 2007 through November 2008 in Lexington, Kentucky. The cultivars 'Quickstand', 'Tifway', 'Riviera', and 'Yukon' grown in a sand-based medium were used to investigate differences in shear strength. Trinexapac-ethyl (TE) was applied at label rates and frequencies or untreated. Overseeding treatments were perennial ryegrass (*Lolium perenne* L.) at 0, 612, and 1225 kg PLS ha^{-1}. Shear tests were conducted using the Clegg shear tester once wk^{-1} August through October. Significant differences ($p<0.05$) in shear strength indicated Quickstand= Riviera > Tifway =Yukon (2007) and with Riviera ≥ Quickstand > Tifway = Yukon (2008). Significant differences ($p<0.05$) in shear strength due to overseeding were not observed in 2007 and only for the last three observation dates in 2008. Applications of TE did significantly improve turfgrass quality, but were not significant ($p>0.05$) in either year for shear strength.

Introduction

Roche et al. (2008) discussed the importance of playing surfaces that are safe for the players. Surface stability of the sand-based system is a major component involved in shear strength. Gaussoin et al. (2002) defines shear strength as "a measurement of the natural turf surface's capacity to resist the stress and shearing of vertical and horizontal force applied by a participant during athletic competition, recreational play and other activities routinely conducted on turfgrass." Shear strength can be defined as the relationship of the athlete with the playing surface in a "player-to-shoe-to-surface interaction" where traction affects this interaction directly (McNitt, 2000). Anatomical characteristics of the plant species with respect to stolon and rhizome production also influence the shear strength. Rhizome, stolon, and general root growth are the major constituents that comprise the amount of traction a particular turf will provide (Roche et al., 2008).

Several devices have been developed and are currently being used to quantify traction or turf shear strength. One of these instruments is the Clegg Turf Shear Tester (CST) that measures the amount of force required to displace the turf using an arc motion. Limited published information concerning this particular shear tester is available with regards to it use and results. Sheratt et al. (2005) used the CST in a study examining the effects of biomass accumulation on stabilizer systems used for sports fields. They reported comparable results between the CST and the Ohio State University's traction device.

Safe and aesthetically appealing athletic fields are the greatest demands placed on field managers (Richardson, 2002). Sand-based and/or sand-capped fields are becoming more common due to their desirable characteristics. Faster drainage and reduced compaction problems enable these systems to accommodate more play over the course of a year. This increase in available time for use then creates additional problems with respect to wear stress and loss of turf. Additionally, sand based systems can decline rapidly under heavy use due to the unstable nature of the sand (Sherratt et al., 2005). This unstable nature may lead to easier divoting and loss of traction or footing which in return may increase the chances of athlete injury.

The objective of this study was to evaluate the effects of cultivars, applications of Trinexapac-ethyl (TE), and overseeding with perennial ryegrass on shear strength of bermudagrasses grown on a sand-based system. The significance of this study is that even though all of these parameters (overseeding, bermudagrass cultivars, and TE) have been studied, evaluated, and published; no studies have been completed that investigates these parameters together in sand-based systems along with consistent measures of shear strength throughout the normal autumn playing season. With the movement toward sand-based bermudagrass athletic fields, this study investigates the effects of several management parameters on shear strength in an effort to define the best management practices for athletic field managers in the transitional climatic zone.

Materials and Methods

Studies were conducted in 2007 and 2008 at the UK Turfgrass Research Center located on the Spindletop Research Farm in Fayette County, Kentucky. The study site was constructed in the autumn of 1997 to meet USGA putting green specifications. USGA specifications consist of an approximate 30 cm deep, 9:1 sand-peat mix over an approximate 10 cm layer of pea gravel. Prior to the establishment of the bermudagrass turf in June of 2006, the site was managed as creeping bentgrass (*Agrostis stonolifera* L.) putting green.

The bermudagrasses used in this study consisted of two seeded ('Riviera' and 'Yukon') and two vegetatively propagated ('Quickstand' and 'Tifway') cultivars. The four cultivars were chosen based both on previous studies (Bayrer, 2006; Trappe et al., 2007; Williams et al., 2010), and for the public popularity of Quickstand and Tifway for athletic fields in the transitional climatic zone. Bermudagrasses were established 28 June 2006.

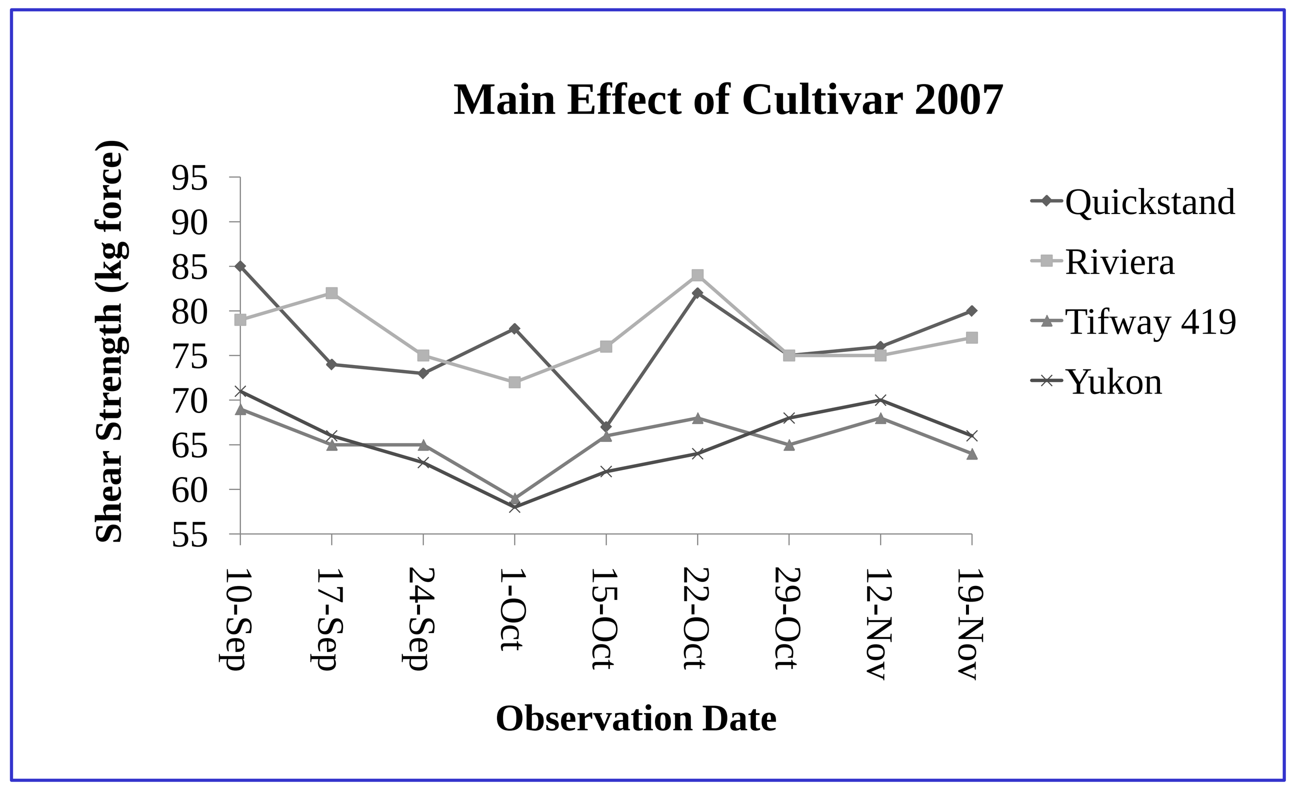
Prior to and throughout the study the site received normal bermudagrass athletic field maintenance in respect to mowing, fertilization and weed control. Normal maintenance consisted of mowing daily at a height of 1.6 cm during peak growth and every other day in slower growth periods excluding dormant periods. Monthly fertilizer applications were split into 2 bi-weekly applications of 24 kg N/ha^{-1} for a monthly total of 48 kg N/ha^{-1} beginning in May and concluding in August of both years. Urea (46-0-0) was used as the source of N. Irrigation was applied as needed to prevent any drought stress for the duration of the experiment. Applications to control crabgrass were made 18 and 25 July 2007, and 25 July, 6 and 22 August 2008. Monosodium acid methanearsonate (MSMA) was applied at a rate of 3.18 L ha^{-1} of formulated product for each application.

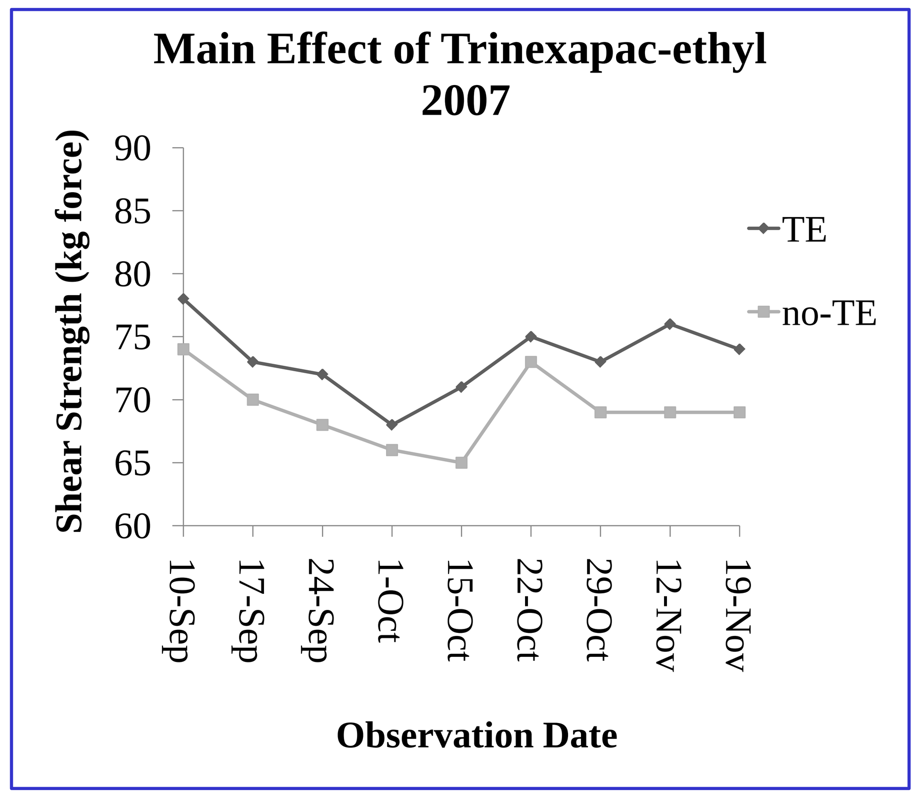
The experimental design was a randomized block-split plot with a whole plot factor and a 3 x 2 subplot factorial structure. The experimental blocks (whole plots) were 2.7 m X 11.6 m and each block contained 6 experimental units. The split plots or sampling units were 1.8 m X 2.7 m. The treatment factors for the experiment were cultivars (whole plot treatments), TE applied at 0.8 L ha^{-1} or untreated, and no overseeding (OS) or overseeding at 612 or 1225 kg ha^{-1} rates (TE [2] x OS [3] subplot factorial treatments). The response variable for this study was shear strength measured in kg-f (kilograms of force) and was obtained using the Clegg Shear Tester (CST),(Wembley DC, WA, Australia) model CCB1C with a 50 mm knife width and set to a 30 mm cutting depth.

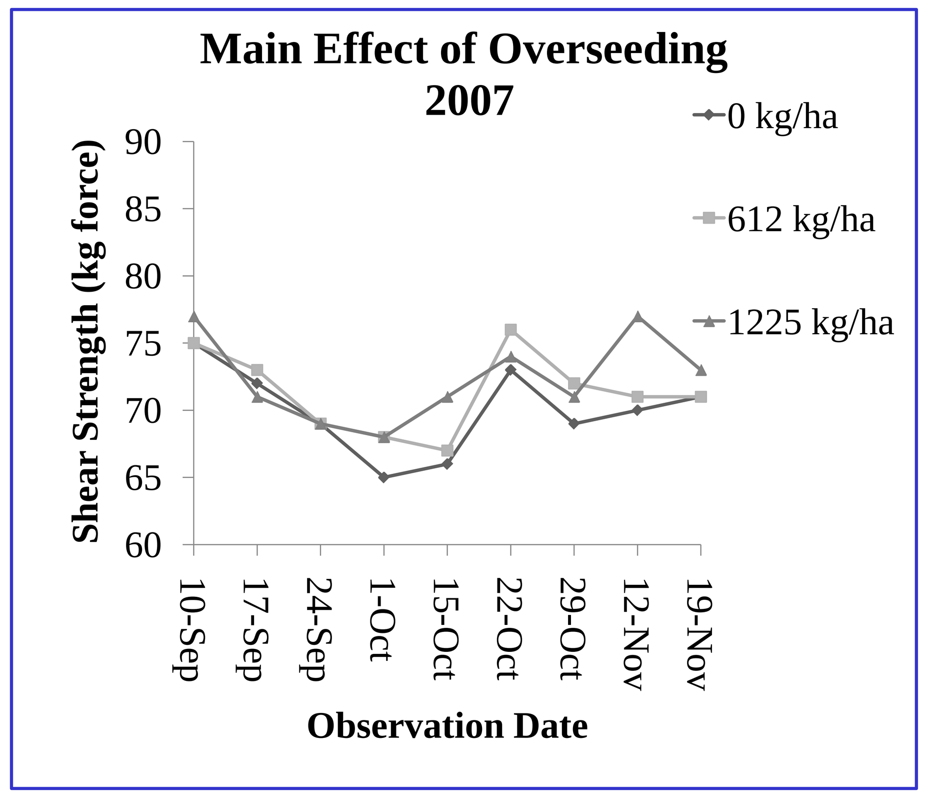
TE was applied at three-week intervals throughout the bermudagrass growing season beginning 30 May and ending 5 October in 2007 and beginning 13 June and ending 15 October in 2008. Applications were made with a CO_2 sprayer using four Tee-Jet #8004 spray tips at a pressure of 30 psi and a carrier rate of 52 gallons per acre. Primo MAXX (Syngenta Professional Products) was applied at a rate of 0.25 ounces per 1000 sq. ft. of formulated product.

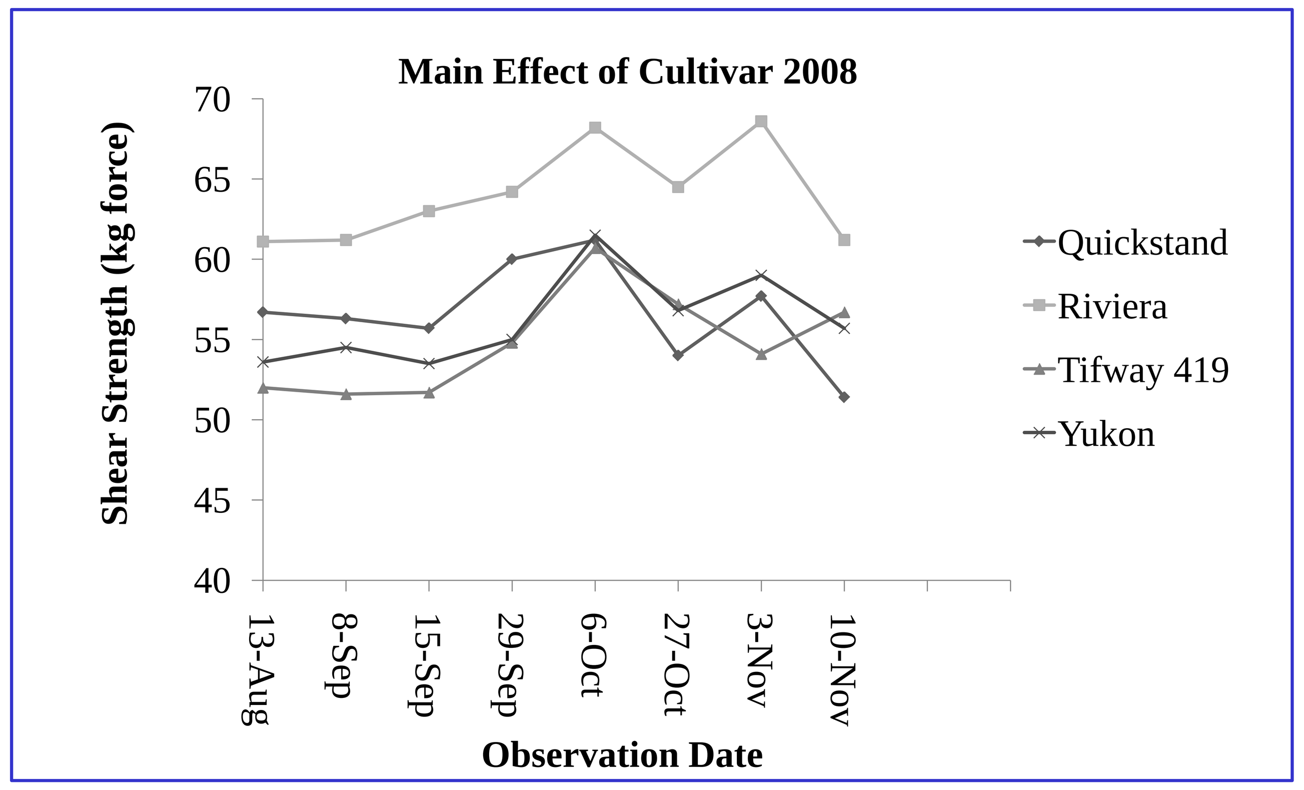
High-rate overseeding treatments were applied in split treatments in both years. All plots receiving medium and high rates were overseeded at the medium rate of 612 kg ha^{-1} on 14 September 2007 and 28 September 2008. The high rate plots received the remaining 612 kg on 21 September 2007 and 7 October 2008 resulting in a total of 1225 kg ha^{-1}. Double Eagle Blend perennial ryegrass (Lesco-John Deer Landscapes, Troy Michigan) was used for all overseeding treatments in both years. The blend consisted of 33.35% 'Prototype' perennial ryegrass, 32.07% 'Pacesetter' perennial ryegrass, and 31.75% 'Notable' perennial ryegrass.

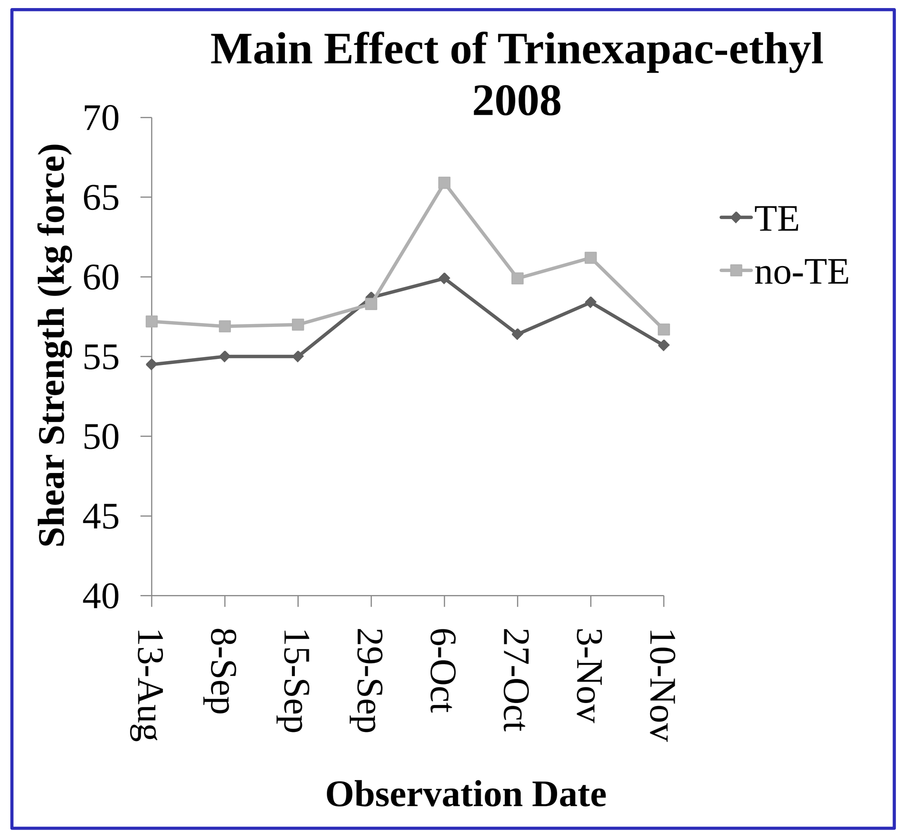
Shear strength data was collected approximately weekly from 31 August through 19 November in 2007 and from 13 August through 10 November in 2008. Three sub-samples (measurements) were taken from sub plots each week and the mean of the three sub-samples was entered for analysis. Statistical analysis was performed using SAS© (SAS Inc., Cary NC.) F-Protected Least Significant Difference (LSD) ($p\leq0.05$ at $\alpha=0.05$), and PROC GLM.

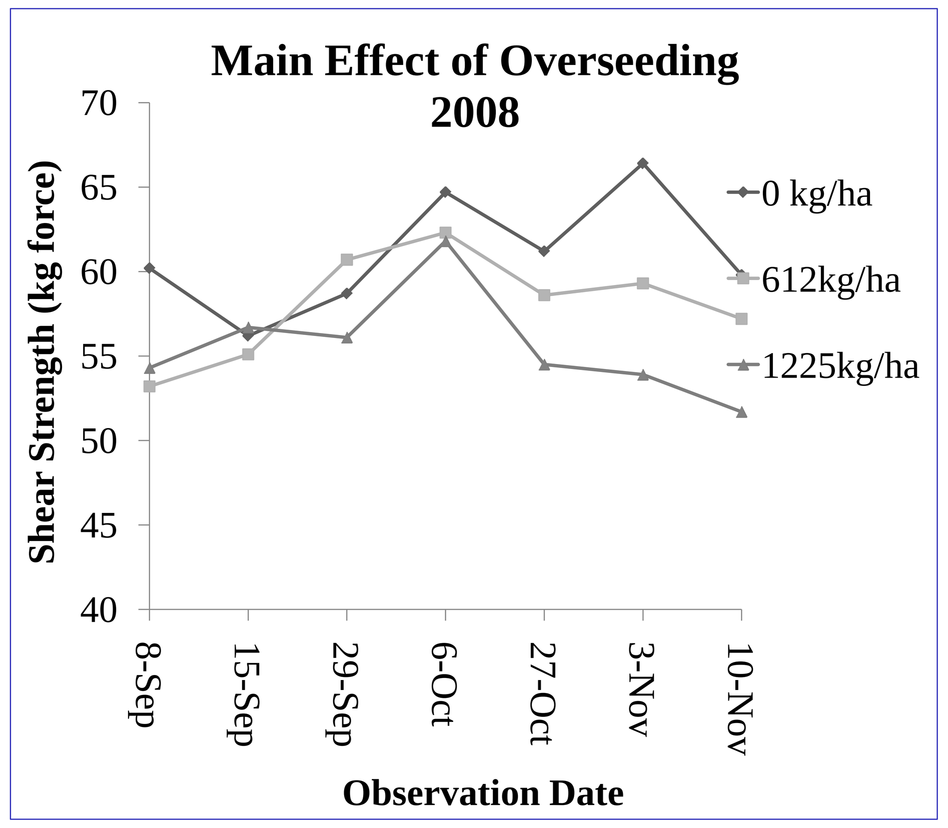












Results & Discussion

Shear strength data indicate the main effect of cultivar was statistically significant ($p\leq0.05$) for all observation dates in 2007. The main effect of cultivar in 2008 was also significant ($p\leq0.05$) with the exception of 6 October. Similar results were recorded in both years in that Riviera exhibited significantly ($p<0.05$) higher shear strength than most or all cultivars.

The main effect of TE applications on shear strength was not significant ($p>0.05$). Three dates over the two year study, 12, 19 November 2007 and 6 October 2008, were observed to have slightly significant differences. Shear strength data indicates no consistent trends in significant differences among TE treated and untreated plots.

The main effect of overseeding was not statistically significant ($p>0.05$) in 2007. Data for 2008 indicates significant differences for the last three observation dates. The significant differences in 2008 may be attributable to an increase in irrigation frequency on the test site. The site received extra irrigation due to a NTEP trial that was being established that bordered this study. The data suggest that ample irrigation in 2008 may have provided enhanced perennial ryegrass establishment relative to 2007. Large and statistically significant differences were observed in shear strength especially for the last three observations. Higher overseeding rates significantly reduced shear strength.

CONCLUSIONS

Previous work has shown that rhizomes, stolons and general root growth above or just below the surface will influence shear strength and will greatly influence the amount of traction the turf can provide (Roche et al., 2008). The observations from this study conclude that the main effects of cultivars were statistically significant ($p\leq0.05$) when evaluating shear strength. Riviera consistently provided higher shear strength measurements for both years of the study. Observations recorded for 2007 showed no significant differences ($p\leq0.05$) in shear strength between Quickstand and Riviera, which were both significantly higher than Tifway and Yukon ($p\leq0.05$). Observations for 2008 indicated significant differences between Riviera and the remaining three cultivars consistently throughout all of the observation dates. These data indicate superior shear strength for Riviera above the remaining cultivars tested.

The main effect of trinexapac-ethyl was not significant in relation to shear strength for either year of the study. Shear strength measurements were very similar both years of the study for TE treated and untreated plots.

The main effect of overseeding on shear strength for 2007 was not statistically significant, while for 2008 significant differences were observed over the last three observation dates. This contrast in terms of shear strength numbers may be associated with extra irrigation the test sites received in 2008. The seeding dates and subsequent germination correlates very well with the almost exponential decrease in shear strength values measured. In this study, the increased irrigation could have aided the germination and establishment of the overseeded ryegrass, and thus contributed to decreased shear strength with increasing seeding rates.

In summary, this study indicates that cultivar is probably the most important consideration when choosing to propagate bermudagrass turf for athletic fields grown on sand-based systems. This study concluded that Riviera provided the most strength and stability of the cultivars tested on a sand-based root zone. Overseeding applications were shown by this study to greatly decrease shear strength in situations under increased irrigation periods during the germination and establishment of the ryegrass as opposed to normal irrigation patterns. Future research should continue to evaluate cultivars of bermudagrass grown on sand-based root zones for shear strength under different management regimes. Specifically, work with other measured parameters, such as irrigation and nitrogen management, may help elucidate the best management practices to work towards improving athletic field turf performance on sand-based root zones.

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