

Best Management Practices for Sea Isle 2000 Surface Conditions as a Putting Green Turf Under Desert Conditions

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Executive Abstract

*Sea Isle 2000, the recently developed Seashore paspalum cultivar intended for use on golf greens, was subjected to various surface cultivation practices of grooming, vertical mowing, and topdressing frequency, in order to investigate the (1) effects of these cultural practices on turfgrass quality (2) effects on ball roll distance (BRD), so as to devise best management practices (BMP) for cultural management recommendations for this grass in a hot/dry climate. The trial was conducted for the two summer seasons of 2002 (year1), and 2003 (year 2). Turfgrass **quality** in year 1 was significantly affected by imposed management treatments on all four evaluation dates, in which the groom vs. non-groom contrast was highly significant. Non-groomed treatments produced better quality than turf groomed 5-6x weekly. In year two, the cultural management treatment effect was not significant, and treatment means ranged from 5.5 to 7.8. The non-groomed/topdressed and verticut at 14-day treatment had mean quality scores of 7.0 or greater on three of four evaluations in year two. This treatment had the least number of cultural management contact events. The most aggressive treatment in terms of the number of contact events (groom/topdressed and vertically mowed at 7 days) never reached a mean quality score of 7.0, but had acceptable turf otherwise (6.8, 6.5, 5.8 and 6.5 in year two). The treatments that did not receive any vertical mowing (groom/topdressed and verticut at 7 days and groomed/topdressed and verticut at 14 days) always produced mean turf quality scores of 6.0 or above. Over the two year test, the non-groomed treatments which were both verticut and topdressed at 7 or 14 day intervals had 12 of 16 possible quality mean scores of 7.0 or more. The turfs which were groomed and topdressed only at 7 or 14 day intervals (never verticut) had mean quality scores of 7.0 or more on 6 of 16 possible rating scores. Turfs that were groomed/topdressed and verticut at either 7 or 14 day intervals had mean quality scores of 7.0 or greater on 4 of 16 possible evaluation scores.*

***For Ball roll distance (BRD)** in year one, the treatment F ratio was significant on five of the ten BRD measurement events, with significance occurring on double mowed turfs on three events, and twice when plots received supplemental rolling. Rolling with an 875 lb Brouer roller numerically increased BRD values on all treatments*

(over double mowing alone) on 5 July, 16 August, and 26 August, decreased BRD values on 19 July, and had no effect for BRD on 26 July. The greatest BRD values which occurred during year one, was a test mean of 103 inches (double mow only) and 98" for rolled turfs. In year two, the treatment F ratio for treatment effects was not statistically significant on any evaluation date. This was true when BRD was taken after turfs were double mowed, and also followed by rolling. Rolling had minimal benefit, and was inconsistent in BRD effect. BRD was almost 20% greater in year two than a in year one. When BRD was recorded only **after double mowing**, turfs that were not groomed ranked numerically higher than groomed turfs for BRD response on all data sampling dates in year one. In general, turfs which received the most frequent number of cultural management practices (regular grooming, topdressing and vertical mowing) tended to have the lowest ranking BRD values, except towards the seasons end (16 and 26 August). Although the main "treatment" effect in the ANOVA was significant on 3 of 5 collection dates (for double mowed BRD values), these trends show that in general, regular grooming decreased BRD values more so than for non-groomed surfaces. In year two, BRD values were essentially identical in mean performance, ranging only a few inches in BRD when measured after the standard double mowing. The greatest difference in BRD among treatments occurred on 27 June, as a BRD of 99.8" occurred for turfs that were non-groomed/topdressed and vertically mowed every 7 days versus non-groomed/topdressed and vertically mowed every 14 days (105"). Again note that there were no significant treatment effects for BRD in year two.

When BRD was measured after mowing , **followed by additional rolling** , the rolling effect tended to increase BRD values across all treatments in year one, except in July, which normally had the most humid weather. Rolling did increase BRD values by 10% in early July (July 5), but also decreased, or had no effect on BRD in the middle or late July (16 and 26 July), and then increased BRD values slightly in August (16, 26 August) of year one. Although the largest increase in BRD values from rolling occurred in early July (almost 9 inches) of year one, the effect was not significant between surface treatments. Rolling was significant when imparted across surface management treatments in August of year 1, as at least one of the two non-groomed turfs tended to have the largest BRD values after rolling. In year two, supplemental rolling imparted very little gain in BRD, except in late September. Substantial increases or decreases in BRD did not occur from rolling relative to treatments in year two, as sometimes occurred in year one. BRD averages across all treatments (with the addition of rolling) were from 96.4" – 109.8" in year two. For both years, rolling) was inconsistent with respect to BRD. Rolling on the day of BRD assessment only sometimes increased, decreased, or had no effect on BRD. Rolling as a regular cultural management treatment should be evaluated.

BMPS for Quality and BRD Performance together:

In year one, the "groom" treatment which was verticut and topdressed every 7 days always ranked the slowest for BRD responses. While this specific treatment always ranked lowest in BRD, it did not have the lowest overall turf quality scores. Groomed turfs which were verticut

*and topdressed every 14 days ranked the lowest for quality scores on three of four evaluation dates. Therefore in year one, treatments which produced (in general terms) the greatest BRD values and ranked the highest in overall quality were turfs which received **no-grooming, and topdressed either every 14 or 7 days**. The treatment which produced the lowest ranking BRD values and lowest ranking quality scores in year one, was the treatment of grooming, verticutting and topdressing every 14 days. In year two, BRD was not related to any surface cultivation treatment. Although not statistically significant, **non-groomed plots topdressed either at 7 or 14 day intervals**, ranked first for BRD in late season (3 September, 30 September). BRD values were in general, 10-20% greater across all treatments in 2003 than in 2002.*

*Although BRD and quality were not significant in year two, certain trends resulted **over the two year test period** in that plots that were **not groomed** had mean treatment quality scores of 7.0 or more on 12 of 16 possible (joint treatment) evaluations. These treatments also had high BRD values. Also, treatments devoid of vertical mowing (groomed/topdressed only at either 7 or 14 day intervals) produced mean quality scores of 7.0 or more on 6 of 16 possible (joint treatment) events over the two year period. BRD values for these treatments were always within 1-2 inches of the test mean BRD values as well. Treatments which received the most frequent contact events (regular grooming/topdress/verticut at either 7 or 14 day intervals over two years, had mean quality scores of 7.0 or greater on only 16 possible events. **Over the course of the study, in general, turfs which were non-groomed / verticut and topdressed @ either 7 or 14 day intervals produced the higher ranking quality turfs, along with higher ranking BRD performance.***

Long term BRD values would most likely include a mixture of topdressing and verticutting either at 7 or 14 days intervals, with grooming practiced on an as needed basis, especially during the first two thirds of the summer season.

Introduction

In previous tests (2000-2001) the seashore paspalum cultivar *Sea Isle 2000* demonstrated that it could withstand mowing at 1/8" (0.125"), with fair turf quality when fertilized at the rate of 0.38 to 0.50 lb/N/M, using an ammonium nitrate source. Ball roll distances (BRD) during these trials showed an inverse relationship to mowing height (as expected), but rarely a response to applied nitrogen. At a 1/8" height, stimpmeter (BRD) values over a two year period averaged 84" (mowed only) and 92" (mowed, and rolled) noting that seasonal responses did occur. Based on those results, another test was devised (which now kept mowing height constant, generally applied lesser fertility, and incorporated more surface cultural management treatments. This would help to determine best management practices (BMP) in terms of surface grooming techniques for overall greens performance of paspalum which are completely lacking in the arid south west. Frequencies of vertical mowing, grooming, and topdressing timings became the new set of treatment structures of this two year study in order to investigate (1) their effects on turfgrass quality (2) their effects on BRD and (3) to determine which treatment (s) would provide the most suitable BMP for golf course greens management of *Sea Isle 2000* paspalum in a semi arid environment.

Materials and Methods

A 3600 ft² USGA green of *Sea Isle 2000* located at the University of Arizona Karsten turf Research Center in Tucson was used for this test. The previous mowing height X applied fertilizer test was terminated in the fall of 2001. Treatments and block configurations were implemented perpendicular to the previous years (tests) treatments, to negate any potential residual (confounding) effects. Treatments were divided into grooming versus not grooming, vertical mowing frequency, and topdressing frequency. Topdressings were made using a Jacobsen belt drive-walking unit at the rate of 0.02-inch sand per seven-day event (0.04 inch when applied every 14 days). Grooming took place 4-5 times weekly, with grooming depth set at 1/8" below the mowing at height, unless adjusted as necessary (see results and discussion). Vertical mowing was performed with a Ryan vertical mower set to a depth of 3/16" to 1/4" below the mowing height. Blade spacing on the grooming unit was 6 mm. The turf was mowed with either a 22" Jacobsen or 22" John Deere walk behind greens mower 6-7 times weekly at 0.125 inch. Grooming blades were spaced at 1/4" on the grooming bar. Grooming was not practiced the day after topdressing to enhance sand penetration and to extend reel sharpness.

Treatments

The six surface treatments were as follows.

1. Groom 5x week, vertical mow at 7 days, topdress at 7 days.
2. Groom 5x week, vertical mow at 14 days, topdress at 14 days.
3. Groom 5x week, no vertical mow, topdress at 7 days.
4. Groom 5x week, no vertical mow, topdress at 14 days.
5. No groom, vertical mow at 7 days topdress at 7 days,.
6. No groom, vertical mow at 14 days, topdress at 14 days.

Treatments began on June 15, 2002. The field layout was a RCBD with four replications. Plot size was 40" wide x 13' in length. The entire green was irrigated to avoid stress, and applied 80-85% reference ET using an on site Rainbird linked weather station. Plots received visual scores of turfgrass color, quality, density, and texture using the NTEP visual rating system (1-9, 1 = dead, 5 = marginal, 6 = acceptable, 9 = best possible). BRD was measured on five dates during both the summer seasons of 2002 and 2003. In each case, BRD was taken after a double mowing, and then immediately again after an additional rolling event (875 lb. Brouer roller, 1 x pass). Therefore, rolling occurred once, only on the day that BRD was taken. One exception occurred on 24 June 2004, when a one time failure of the roller resulted in BRD for mowed turf only.

Data were subjected to the analysis of variance technique, using SAS software. Orthogonal linear contrasts were used in the treatment analysis to measure the significance of grooming, vertical mowing, and topdressing frequencies. These are discussed as appropriate in the results and discussion section. Bonferroni's protected LSD values were calculated as the treatment mean separation statistic only when the F ratio for the cultural management treatment main effect was significant at P = 0.05, or less.

Results and Discussion

Ball roll distance (BRD - Year 1, 2002)

BRD values were measured (by rolling three Karsten Ping 3 golf balls with a USGA Stimpmeter) in each of two directions after double mowing, *and, again* after the additional rolling) on 5 July, 19 July, 26 July, 16 August, and 26 August. No data were possible to collect in June since the greens developed three colossal circular patches areas that cross-infected three of the four replications at greenup. The patches were entire, sunken, with some loss of turf, with a faint yellow to bronze edge of the patch (ring itself). These symptoms were indicative of *Rhizoctonia* yellow patch which would have infected the green the previous fall. Unfortunately, samples were not taken before Heritage and Fore were applied. The turf required 3-4 weeks to recover fully from multiple fungicide applications and two applications of 15-15-15 at [0.5 lbs. N/M] in late May and in mid-June again.

For summer 2002, the treatment F ratio was significant on five of the ten BRD measurement events, with significance occurring on double mowed turfs on three events, and twice when plots received supplemental rolling (Table 1). Rolling with the Brouer unit numerically increased BRD values on all treatments (over double mowing alone) on 5 July, 16 August, and 26 August, decreased BRD values on 19 July, and had no effect on 26 July (Table 1).

On 5 July 2002, the treatment main effect was significant, as BRD values ranged from 76-81 inches (Table 1). Turf that was groomed, verticut and topdressed every 14 days produced the lowest mean BRD value (76") while those not groomed, verticut and topdressed every 7 days produced the largest mean BRD value (81"). The range of five inches between treatments, although statistically significant, is probably not great enough that a golfer would be capable of realizing the benefit of rolling. On this date, the greatest overall improvement in rolling occurred (over all surface treatments) as the mean of all plots when rolled averaged 87.1", compared to 79.0" when the test was double mowed only. When rolled, there was no difference between surface treatments for BRD. The range for BRD among treatment means when rolling was added was 85"-90", noting that the treatment rank response was *not* similar for the rolling and mowed only response.

When not rolled, the turfs that were groomed, topdressed every 7 days, and verticut every 7 days, had significantly slower BRD values than turfs topdressed 7 days, verticut at 7 days, and *not* groomed on the 5 July evaluation date. No other contrasts were significant. The treatment which showed the greatest increase due to rolling included those that were groomed and both topdressed and verticut every 14 days (13.0" gain), as well as those that were not groomed, and both topdressed and verticut every 14 days (11.0" gain). All other surface treatments showed increased BRD gains from 6-8 inches due to the additional rolling. In essence, rolling increased BRD performance by 12" for the slower double mowed plots and increased all others to 6 inches, otherwise (Table 1).

On 19 July, the greatest BRD values occurred during the test, with a test mean of 103" (double mow only) and 98" for rolled turfs. Note the reduction in BRD for the turfs, when rolled (see discussion below). The main effect of surface treatments was not significant for BRD for double mowed turf, double mowed and rolled turfs, or for the calculated difference after rolling took place (Table 1). The range in BRD for double mow-only turfs was 100.3" to 106.3" (6.0" range), and from 91.3" to 100.6" (9.3" range) when rolling was added.

When turfs were double mowed only on 19 July 2002, the contrast between "groomed" vs. "non-groomed" treatments (averaged over all topdressing/verticut treatments) was highly significant for BRD. Groomed turfs averaged a BRD value of 101.4", while non-groomed turfs averaged 105.6" for BRD on 19 July. When rolling was added, all treatments ranked similar for BRD performance, noting again that rolling collectively actually reduced BRD. Among treatments when rolled, turfs that were "groomed" collectively averaged a mean BRD value of 95.8", while those which were "non-groomed" averaged a BRD mean value of 100.5". This contrast was statistically significant.

On 26 July, the treatment main effect and all linear contrasts were non-significant for BRD, regardless of supplemental rolling, or not. Likewise, there was no difference in BRD values between rolled and unrolled turfs (89.6" vs. 89.4"), respectively, when averaged over all treatments. The range for mean BRD values between surface treatments for double mowed only turfs was 87.3" to 91.0", while when rolling was added, the range changed to 88.2", to 91.3" (Table 1).

On 16 August 2002, the F ratio was significant for the treatment main effect for BRD when turfs were double mowed, and when followed by rolling. However, the absolute increase in BRD realized from rolling (delta value BRD) was not significant. (Table 1). After double mowing, the range of BRD values was from 85.2 to 91.3 inches (6.1"). Basically, the two non-groomed treatments had the largest BRD values (90.2"-91.3"), while turfs that were groomed, topdressed and verticut every 7 days had the lowest BRD value (85.2"). No contrasts were significant for the BRD response among double mowed turfs.

When rolling was added, the treatment effect for BRD response was significant, with treatments ranging from 91.0 to 98.4 inches. Again, the turfs which were not groomed produced the greatest BRD value (no groom, verticut 7 days, topdressed at 7 days) of 98.4". The same no groom / verticut, topdressing treatment that ranked least when mowed only (85.2") ,also ranked lowest for BRD following rolling (91.0") on 16

August. Again, there was no difference among surface cultivation treatments, for the absolute mathematical difference for BRD between mowed and rolled turfs (Table 1).

On 16 August 2002, several contrasts were significant for treatments for BRD response when the test received the supplementary rolling. Treatments that were groomed (regardless of topdressing and verticut frequencies) were lower in BRD averages, versus the two treatments which were not groomed (92.8", 95.8", respectively). Actually, the 7 day intervals of topdressing and vertical mowing made this difference statistically significant (no groom, 7 day verticut, 7 day topdress = 98.4). The contrast was significant (for BRD) among non-groomed turfs which received verticutting and topdressing every 7 days, versus verticutting and topdressing every 14 days (98.4" and 93.3", mean BRD values, respectively). This demonstrated a somewhat improved BRD performance among non-groomed turf surfaces, when topdressing was applied more frequently (@ 7 day intervals). However, this occurred only when the test received supplemental rolling.

On 26 August 2002, the F ratio for the treatment main effect was significant for BRD among surface cultivated treatments when the test was double mowed, and again when subsequent rolling was employed. The range of treatment means for BRD values when turfs were double mowed only was 74.1 to 78.6 inches. The absolute difference between treatments due to the supplemental rolling was not significant for the main "treatment" effect.

The treatment range for BRD (after double mowing) was 74.1", to 78.6". Although this was statistically significant, it had no applied or biological difference between surface treatment effects.

For BRD conducted after double mowing and supplemental rolling, the treatment main effect was significant, and the range among treatment means was 76.9" to 83.1" (6.2 inches). Again, the non-groomed turfs produced the larger BRD values of 82.3" – 81.3" (Table 1). The two treatments that were groomed and topdressed every 7 days were lowest in BRD. In this case, both treatments that were groomed, and topdressed every seven days (either with or without verticutting), produced low BRD of 76.9" and 78.4", respectively.

Also, after the test received supplemental rolling, the contrast for groomed versus non-groomed turf was again significant. The non-groomed turf had a slightly greater collective mean BRD, than groomed turfs (82.7", 79.3, respectively). Turfs which received any form of verticutting (regardless of grooming and topdressing treatments) showed a statistically significant difference in BRD values than those that were never verticut. Note that the BRD means of these grouped turfs were less than 2.0 inches, and therefore, of no meaningful consequence. The absolute increase in BRD values due to supplemental rolling added 2.8" to 7.5" across all treatments, which was not significant.

Ball Roll Distance (BRD) – Year 2: 2003

BRD values were taken on 27 June, 24 July, 28 July, 3 September and 30 September, 2003. In all cases, the F ratio for the main effect of cultivation treatments was non-significant for BRD (Table 2). This was true even when turfs were subsequently rolled as well. In general, BRD were greater in 2003 than in 2002 across all treatments. This may be due to accumulative and repetitive treatment affects. BRD values averaged over 100 inches in June and September and averaged 92.4 to 96.4 inches in July. Only on 19 July in Year I, 2002, did BRD values reach 100 inches (Table 2).

In Year II, rolling (on the day of BRD assessment) did not have as great an impact as it did in year I on BRD. The greatest gain in BRD from rolling occurred on 30 September 2003, when all "groomed" treatments benefited from a 5.0"-6.8" increase in BRD. Interestingly, the non-groomed treatments showed only a 2.8"-3.8" increase in BRD from rolling on this date. Again, there were no significant treatment effects in Year II for BRD performance (Table 2).

Summary – BRD when turfs were double mowed only. Year 1, 2002

As a general trend, turfs that were *not groomed* ranked largest for BRD values on all data sampling dates. This was true when BRD values were taken after the turf was double mowed (no rolling imposed).

Secondly, groomed turfs which were not verticut at all, tended to be intermediate in BRD values from 5 July to 16 August, but not so towards seasons end on 26 August. This is noted as a seasonal trend.

Lastly, in general, turfs which received the most frequent number of cultural management practices (*groomed, topdressed and verticut*) tended to have the *lowest ranking BRD* values, except towards the seasons end (16 and 26 August). Although the main “treatment” effect in the ANOVA was significant on 3 of 5 collection dates (for double mowed BRD values), these trends show that in general, *regular grooming decreased BRD* values vs. actual BRD values for the non-groomed surfaces. Also, when regular grooming was practiced, the addition of vertical mowing and topdressing every 7 days decreased BRD performance more so than groomed plots that were topdressed and vertical mowed every 14 days. This was true in terms of treatment ranks midseason (5 July), and late in the season (16 and 26 Aug) (Table 1).

Year 2 : 2003

In Year two, BRD values were essentially identical in mean performance, ranging only a few inches in BRD when measured after the standard double mowing. Thus again, there were no significant treatment effects for BRD in year two (Table 2). The greatest difference in BRD among treatments occurred on 27 June, as a BRD of 99.8” occurred for turfs that were non-groomed/topdressed and vertically mowed every 7 days versus non-groomed/topdressed and vertically mowed every 14 days (105”) (Table 2).

Summary – BRD when turfs were double mowed / followed by supplemental rolling. – Year 1 2002

When rolling was added after double mowing, the rolling effect tended to increase BRD values across all treatments, except in July which normally has the most humid weather. Rolling did increase BRD values by 10%, in early July (July 5), and also decreased, or had no effect on BRD values in middle or late July (16 and 26 July), and then increased BRD values slightly in August (16 and 26 August). Although the largest increase in BRD values from rolling occurred in early July (almost 9 inches), the effect was not significant between surface treatments. Rolling was significant when imparted across surface management treatments in August, as either one of the two *non-groomed turfs* tended to have the largest BRD values after rolling (Table 1).

Of interest is the result that rolling decreased BRD values on 19 July (from 2.3” to 9.8”). This may be due to (undetermined) soil moisture effects on turgidity, shoot angles, or overall leaf stiffness. It has been observed that *Sea Isle 2000* possess a unique canopy comprised of nearly all vertical stolons which yield individual plants which have two narrow, and two broader leaves (at greens height). The curved upward angle of the (broader) leaves produces an “air-porous” canopy of upright stiff leaves just below the mowing line. Perhaps if this “structure” is altered by the weight of rolling, the shoots would then be more horizontal, which would then form a rougher plane than otherwise realized. This may be a unique situation for Seashore paspalum which may be responsible for producing lower BRD values after rolling.

Year II : 2003

Supplemental rolling imparted very little gain in BRD, except in late September at the seasons end. Substantial increases or decreases in BRD did not occur from rolling relative to treatments in year two, as sometimes occurred in year one. BRD averages across all treatments (with the addition of rolling) was from 96.4” – 109.8” in 2003 (Table 2).

General Agronomics:

As mentioned previously, no data collection was possible in June of 2002, due to the presence of large circular patches which affected three of the four replicate field blocks after green up. These sunken patches occurred in a random reticulated pattern and could be viewed in the early morning hours prior to mowing. On June 15, the numbers of patches per plot were counted on each plot. Each patch was about 0.2 ft² in area and counted as the number of overdrops imposed by a 6.0” round plastic disk which occupied the infected plot surface. The infestation level was not affected by any surface treatment effects (Table 3). Soon after treatment initiation in mid June, the plots which received the most contact from cultural management practices (regular grooming, topdressed and verticut every 7 days) showed slight scalping. This was short lived, not related to surface treatments, and most likely an adjustment to the initial activity on the plots.

In 2003, numerous small sunken patches appeared the fourth week of May, sporting a light orange ring at the outer edges. This was accompanied by a loss of some turf inside the patches. Applications of FORE and HERITAGE fungicides, followed by 0.50 lbs/N/M of a water soluble N source were necessary to obtain satisfactory turf conditions for further testing. The presence and or severity of disease were not related to any "treatments" (data not shown).

Turfgrass Color- Year I : 2002

The treatment main effect was significant in late August and early September, but not in mid-July or early August. Mean color scores ranged from 6.0-6.8 on 23 July, and from 5.5-6.5 on 1 August, when the treatments produced similar rank color responses (Table 4). On 28 August, mean color scores ranged from 5.8 to 7.5, where by the most aggressive treatment combinations of regular grooming, along with topdressing and verticutting every 7 days ranked lowest for color (5.0), while the non-groomed treatment which was topdressed and verticut every 7 days was noticeably darker in color (mean color = 7.5). The non-groomed turfs had better color (7.2) versus the groomed turfs (6.4) averaged across topdressing and verticut timings, and this contrast was significant.

Ten days later on 7 September, the greatest difference between treatments for color occurred between groomed turfs topdressed every 7 days, vs. those topdressed every 14 days. Both of these treatments were not verticut at all. These plots could be easily discerned by their color (6.5 vs. 5.3, respectively) as frequent topdressing practices produced better color towards the end of the season (Table 4).

Year II : 2003

The F ratio for the surface cultivation main effect was statistically significant only on one of four dates in 2003 (3 August). Mean color scores ranged from 5.0-7.5 throughout the test in Year II (Table 5).

In Year II, turfs which were groomed/topdressed and verticut either every seven or every fourteen days had the lowest mean color scores on August 3 (5.0 and 4.8, respectively) (Table 5). These same treatments had low color mean score on 1 August in Year I (Table 4). Additionally, in year two only, the non-groomed/topdress and verticut turfs, at either the 7 or 14 day intervals had marginal color scores on 3 August.. This demonstrated that the 'vertical mowing' component caused a one time stained injury to the turf, depicted in terms of loss of color retention after vertical mowing..

Throughout the two year test, the groom/topdress at 7 days, and the groom/topdress at 14 days always had mean color scores of 6.5 or more of seven of eight evaluation dates (Tables 4,5). These treatments received no vertical mowing whatsoever. All other treatments had some slight decreases in color at various times, although not always statistically significant.

Turf quality - Year 1: 2002

Turfgrass quality was significantly affected by imposed management practices on all four-evaluation dates from July to September (Table 6). In each case, the groom vs. non-groom contrast was significant, as non-groomed treatments produced better quality than turf groomed 5-6x weekly.

On 23 July, mean quality scores were the best for the 2002 summer season (test mean = 7.3). Treatment means ranged from 6.0 to 8.0 at this time as the treatment with the least amount of cultural management contact practices (no grooming, verticut 14 days, topdressed 14 days) produced the best mean quality scores of 8.0. This was followed by the treatment which was also not groomed, but received both vertical mowing and topdressing every 7 days (quality mean = 7.8) (Table 6). The contrast comparing non-groomed to groomed turfs (regardless of topdressing and verticutting events) was highly significant, as non-groomed plots averaged mean quality scores of 7.9, while groomed plots provided mean quality score of 6.9 (Table 6).

For August 1, all four groomed turfs averaged 6.0, while the two non-groomed treatment combinations scored higher at 6.8 for overall turf quality. For the 28 August ratings, groomed treatment combinations averaged 6.5, while non-groomed treatments averaged 7.5 for turf quality. For 7 September, groomed plots averaged 6.3, while non-groomed plots averaged a higher combined mean quality score of 7.2. Thus, grooming decreased quality somewhat, noting that the overall quality among groomed treatments was generally satisfactory (5.5 to 7.5 across four treatments on four dates).

Also on 23 July, the contrasts for both frequency of verticutting (7 vs. 14 days, regardless of grooming or topdressing) were significant. Treatments topdressed weekly had mean quality score of 7.7, while those that were topdressed every 14 days had a mean quality score of 7.0 (Table 6).

On 28 August, turfs verticut and topdressed every 7 days had lower but acceptable quality scores when they were groomed (6.3) as opposed when not-groomed (7.5). Once again, turf quality scores were slightly improved when grooming was not practiced, and no consistent trend existed (for quality) if these non-groomed plots were verticut and topdressed every 7 or 14 days (Table 6).

Through the summer test period of 2002, there were only two treatments which received a mean quality score of less than 6.0. This occurred for turfs that were groomed, topdressed and verticut every 14 days (Table 6). These mean quality scores of 5.5 (1 August) and 5.8 (7 Sept) were only marginally below average, and short lived.

Year 2 : 2003

Unlike observed turfgrass quality in Year I, the cultural management treatment effect was not significant in year two, 2003 (Tables 6,7). The best overall test mean quality score was 7.3 on 2 July 2003, identical in value to that of 23 July 2002.

In year two, the treatment means ranged from 5.5 to 7.8 again with no treatments having statistically different quality responses (Table 7). On 3 August, treatments that were not verticut had mean quality scores of 6.8 and 7.3 (groom/topdressed a 7 days, groom/topdressed at 14 days). All other remaining treatments which received vertical mowing (regardless of grooming or not) had slightly lower one time quality scores of 5.5-5.8. This was therefore a response to overall vertical mowing. Again this affect was short-lived and statistically non-significant. The non-groomed/topdressed and verticut at 14-day treatment had mean quality scores of 7.0 or greater on three of four evaluations in 2003 (Table 7). This treatment had the least number of contact events. The most aggressive treatment in terms of the number of contact events (groom/topdressed and vertically mowed at 7 days) never reached a mean quality score of 7.0, but had acceptable turf otherwise (6.8, 6.5, 5.8 and 6.5) (Table 7).

With this in mind, the treatments that did not receive any vertical mowing (groom/topdressed and verticut at 7 days : groom/topdressed and verticut at 14 days) always produced mean turf quality scores of 6.0 or above. These treatments ranged from 6.0-7.8 for mean turfgrass quality over the two-year study (Tables 6,7). The treatments which were not groomed had similar performance in year two to those above. Note again that in year 1, both of the non-groomed treatments ranked statistically better than the groomed treatments for turfgrass quality (Table 6). The one time slight decrease in quality from vertical mowing observed on 3 August 2003, caused the one time exception of a resultant quality value of less than 6.0 (5.8) for both non-groomed treatments in 2003 only (Table 7). Note again that the F ratio for the management effect was not statistically significant in 2003.

Texture - Year I : 2002.

Visual leaf texture scores were assigned to all plots on four evaluation dates, and the treatment F ratio was significant on three dates (all except 7 Sept, 2002). The treatment means for turfgrass visual texture throughout the entire summer ranged from 5.3 to 7.8, with the best overall textures produced in midsummer (23 July, test mean = 6.5) (Table 8).

On July 23, treatments that were both topdressed and verticut every 14 days had a coarser overall texture when groomed (5.5), than when not groomed (7.8). This contrast was significant. Likewise, plots which included any vertical mowing at all had better visual texture scores (6.7) than treatments which were never verticut (6.2). This contrast was also significant.

On August 1, again, the turfs topdressed and verticut every 14 days had better texture scores (6.8) when not groomed, as opposed to being regularly groomed (5.3) (Table 8). This again confirms the overall major effect of grooming as decreasing quality, and increasing visible leaf texture. Grooming had some effect on visual density in the first half of the summer, but not in September (see below).

On 28 August, again both the contrasts for [groom vs. non-groom], and [groom vs. no groom for plots verticut and topdressed every 14 days] were significant. Plots which collectively received regular grooming had moderate texture (6.1), while those not groomed had a finer leaf appearance (7.3) (Table 8). Plots which received verticutting and topdressing every 14 days, had texture scores of 6.0 and 7.0, if grooming was included, or excluded, respectively. At this time, groomed plots verticut and topdressed every 7 days had a more coarse appearing turf, with mean texture scores of (5.8). At this date, this same treatment also ranked lowest in visible density (6.3). This corroborates that there is some relationship to visual density and texture in Sea Isle 2000 as a green. By 7 September, there was no difference between treatments for turf texture (Table 8).

Year 2 :2003

In Year II, the surface cultivation treatment main affect was also significant on three of four evaluation dates, with 9 June being the exception (Table 9). The range of texture mean scores ranged from 4.8 to 7.5. In 2003 the finer turf appeared on 2 July (at end of dry period, with a test mean = 7.5). The turf appeared coarser (as the lowest date mean scores occurred during the monsoon) at 3 August (test mean of 5.5). (Table 9). Statistical significance was imparted throughout July and August from the fact that the two treatments which had no vertical mowing had greater texture mean scores (8.5, 7.8 on 2 July and 7.3, 5.8 on 3 August). These same two treatments had greater texture mean scores on 9 June as well, although the F ratio for 'treatments' was not significant (Table 9). In year one, it was the treatments which were not groomed which had finer texture appearing turfs (Table 8). Again, the vertical mowing prior to the 3 August 2003 ratings, caused decreases in quality, color, and texture. On 7 September 2003, all texture mean scores ranged from 6.0 to 6.8.

Over a two-year period, no individual treatment consistently produced the finest texture appearance, as spikes in extremes occurred as one-time events for either coarse or fine apparent leaf texture response to treatments.

Density - Year 1 : 2002

The treatment effect for visual turfgrass density was significant in mid July and early August, but not in late August or September. The contrast for groomed vs. non-groomed turfs (regardless of other cultural practices) showed that turfs which were groomed had lower density scores than plots that were not groomed (Table 10). This was also the case on 23 July and on 1 August, but not for the remainder of the season. Across all dates, one of the two treatments which were not groomed, always ranked the highest numerically for mean density appearance, noting that there was a difference between treatments which were topdressed at 7 or 14 day intervals (not groomed). The non-groomed treatments always had scores of 6.8-7.8 through out the season, and ranked above the groomed treatments for apparent density.

On 1 August, all the turfs which were groomed had a collective mean density score of 7.0, while all turfs not groomed averaged a collective mean density core of 7.6. This contrast was significant. Note that all surface treatments produced acceptable apparent visual density scores at this time. Also on 1 August, the treatments which were verticut and topdressed every 14 days, produced lower mean texture scores (6.3) when groomed, as opposed to when grooming was not practiced (7.8) (Table 10).

Although the F ratio for treatments was not significant on both 28 August and 7 September, the turfs that were not groomed tended to have higher visual density scores than those treatments which received grooming.

Year 2: 2003

In year two, visual canopy density scores were significant from treatments on only one of four dates (3 August). Mean treatment scores throughout the summer ranged from 5.8 to 8.0, with the highest test mean occurring on 2 July 2003 (Table 11).

In year two, the groomed plots which did not receive any vertical mowing (groom/topdressed at 7 days : groom/topdressed at 14 days) tended to have the best seasonal trend performance for visual density (Table 11). In the previous year, the two non-groomed plots significantly had greater visual density ratings then other plots, but not as described in year two (Table 11). The slow recovery response from vertical mowing

prior to the 3 August 2003 ratings also showed a slight decrease in density. This verticutting affected the grass negatively also for turfgrass colors, quality, and texture (on 3 August, 2003). Otherwise, trends would have been similar in both years for non-groomed plots having good density scores (Tables 10, 11). Note again that the F ratio for the treatment main effect was significant on only one date in 2003, again due to a most likely over aggressive vertical mowing in late July 2003 (Table 11).

A regular grooming treatment coupled with weekly topdressing and weekly verticutting still produced acceptable turf in terms of turf density, over the two-year test period (Tables 10, 11).

Other : 2003

Because of the fact (1) that BRD was neither unaffected, increased or decreased by rolling, (2) that apparent differences in visual texture and density could not be demonstrated as statistically significant, and (3) that consistent empirical observations of the wide leaf/short internodes combination of whorled leaves were observed (which produced large aerial voids between leaves), physical measurements were taken to measure stolon depth, rhizome plane depth, and an orientation of surface stolons as they originated from the lower rooting nodes. These were measured to perhaps show any association with surface cultivation treatments, or trends about the unique canopy structure of paspalum. Two sub-samples using a 4.0 inch diameter cup cutter were randomly removed from each plot and the mean was used for analysis. The horizontal stolon plane ranged from 19.6 to 22.0 mm in depth, while the rhizome plane (estimated 90% depth of the deepest rhizomes) ranged from 66.0 to 74.4 mm (Table 12). The F ratio for the cultural management treatment effect was not significant for these parameters. Stolon orientation was scored for 10 stolons/plug as either being 1 = horizontal, 2 = lateral, or 3 = vertical as the main axis in projection from the rooted node(s), to the final upright four leaf shoot. Mean treatment scores ranged from 1.8 to 2.3 and were not related to treatments (Table 12). The most 'vertical' shoots occurred for the non-groomed/topdressed verticut at 14 day treatment (mean of 2.3) Those treatments which tended to have the most horizontal stolons (from the rooted node base to upright green shoot) were non-groomed/topdressed and verticut at 7 days, and groom/topdressed and verticut at 14 days.. There mean values were 1.8 (Table 12).

Again, vertical mower damage that persisted after a late July execution in 2003 was noted as exemplary, and was recorded as a separate injury value on 3 August 2003. Plots were rated on a visual scale of 1-6, where 1 = no damage, 4 = moderate, and 6 = severe. Naturally, plots that received a vertical mowing showed damage scores from 2.3 (slight) to 3.8 (near moderate) damage (data not shown). 'Groomed and topdressed' only turfs naturally exhibited essentially no damage. As noted previously, this particular vertical mowing event did negatively influence color, quality, texture, density and BRD values in early August.

BRD and Quality Together

Year 1 : 2002

When grooming was omitted as a primary cultural practice, BRD values tended to be larger than for treatments in which grooming was omitted . The contrast of "all groom" vs. "all non-groom" treatments was significant for BRD values when turfs were double mowed and then rolled on both 16 and 26 August, 2002. When turfs had BRD measurements taken after standard double mowing (no-rolling), the "groom" vs. "no-groom" contrast was significant on 19 July. At that time, all treatments which received grooming averaged a BRD value of 101.5", while those which did not receive grooming averaged 105.9" (Table 1). Note that the average golfer may not perceive a performance value increase in BRD of less than 6.0 inches. A close look at individual treatments showed that the "groom" treatment which was verticut and topdressed every 7 days always ranked lowest for BRD values. This was true on all dates that BRD was measured. This particular treatment tended to "weigh" the contrast in favor of lower BRD performance within "groom" receiving treatments. While this specific treatment always ranked lowest in BRD, it did not have the lowest overall turf quality scores. Groomed turfs which were verticut and topdressed every 14 days ranked lowest for quality scores on three of four evaluation dates.

Therefore, treatments which produced (in general terms) the *greatest BRD values and ranked the highest in overall quality* would be turfs which received *no-grooming, and topdressed either every 14 or 7 days*. The treatment which produced the lowest ranking BRD values and the lowest ranking quality scores was the

treatment of grooming, verticutting and topdressing every 7 days. Overall turf quality was not related to color, but was influenced more by similar ranking treatment responses to visual density and textures, both of which responded less favorably to the cultural practice of regular grooming.

Year II: 2002

For year two (2003), the no-groom / topdress and verticut @ 7 day, and the no-groom / topdress and verticut @ 14 day treatments had mean quality score of 7.0 or greater, on 5 of eight possible outcomes. The BRD for these treatments was similar to the BRD values for the groom/ no verticut / topdress @ 7 day, and the groom/ no verticut / topdress @ 14 day treatments. These latter treatments had mean quality scores of 7.0 or greater on 4 of eight possible outcomes in 2003, and were similar in BRD to both of the non-verticut treatments as well. No individual treatment ranked first consistently for quality and BRD in 2003, but numerically lower (but fully acceptable) mean quality scores resulted from the treatments which received the greatest number of contact events (groomed/ vertical mowed /topdressed @ 7 or @14 day intervals).

Both Years:

Though BRD and quality were not significant in 2003 (year two), certain trends resulted over the two year test period in which both treatments that were not groomed had mean treatment quality scores of 7.0 or more on 12 of 16 possible (joint treatment) evaluations. These treatments *also* had high BRD values.

Conclusions

Sea Isle 2000 Paspalum Responses To Greens Surface Cultural Management Treatments

Color

Year 1 : 2002. The treatment main effect was significant in late August and early September and not in mid-July or early August. The most aggressive treatment combinations of grooming, topdressing and vertical mowing tended to produce lower color scores in late August, while treatments which were not groomed (regardless of other treatments) had lower color scores in early September.

Year 2: 2003. The F ratio for the surface cultivation main effect was statistically significant only on one of four dates in 2003 (3 August). Mean color scores ranged from 5.0-7.5 throughout the test in year two. In year two, turfs which were groomed/topdressed and verticut either every seven or every fourteen days had the lowest mean color scores on August 3 (5.0 and 4.8, respectively). These same treatment had low color mean scores on 1 August in year one.

Both years: Throughout the two year test, the groom/topdress at 7 days, and the groom/topdress at 14 days always had mean color scores of 6.5 on more of seven of eight evaluation dates. These treatments received no vertical mowing. All other treatments had some slight decreases in color at various times, although not always statistically significant.

Quality

Year 1: 2002. Turfgrass quality was significantly affected by imposed management treatments on all four evaluation dates from July to September. For all four evaluation dates, the groom vs. non-groom contrast was significant, as non-groomed treatments produced better quality than turf groomed 5-6x weekly.

Year 2: 2003. The cultural management treatment effect was not significant in Year II, 2003. The best overall test mean quality score was 7.3 on 2 July 2003, as the treatment means ranged from 5.5 to 7.8. The non-groomed/topdressed and verticut at 14-day treatment had mean quality scores of 7.0 or greater on three of four evaluations in 2003. This treatment had the least number of contact events. The most aggressive treatment in terms of the number of contact events (groom/topdressed and vertically mowed at 7 days) never reached a mean quality score of 7.0, but had acceptable turf otherwise (6.8, 6.5, 5.8 and 6.5).

The treatments that did not receive any vertical mowing (groom/topdressed and verticut at 7 days : groom/topdressed and verticut at 14 days) always produced mean turf quality scores of 6.0 or above.

Both years: The non-groomed treatments which were both verticut and topdressed on 7 or 14 day intervals had 12 of 16 possible quality mean cores of 7.0 or more. The turfs which were groomed and topdressed only at 7 or 14 day intervals (never verticut) had mean quality scores of 7.0 or more on 6 of 16 possible rating scores. Turfs that were groomed/topdressed and verticut at either 7 or 14 day intervals had mean quality scores of 7.0 on 4 of 16 possible evaluation scores.

Texture

Year 1 : Visual leaf texture scores were assigned to all plots on four evaluation dates, and the treatment F ratio was significant on three dates (all except 7 Sept, 2002). Plots that were groomed had lower visible leaf texture scores than non-groomed plots on three of four evaluation dates.

Year 2: In year two, the surface cultivation treatment main effect was also significant on three of four evaluation dates. The range of texture mean scores ranged from 4.8 to 7.5.

Both years: Over a two-year period, no individual treatment consistently produced the finest texture appearance, as spikes in extremes occurred as one-time events for either coarse or fine apparent leaf texture in response to treatments.

Density

Year 1: Plots that were groomed had lower apparent visible density scores than non-groomed plots on three of four dates.

Year 2: In year two, visual canopy density scores were significant from treatments on only one of four dates (3 August). Mean treatment scores throughout the summer ranged from 5.8 to 8.0. In Year II, the groomed plots which did not receive any vertical mowing (groom/topdressed at 7 days : groom/topdressed at 14 days) tended to have the best seasonal trend performance for visual density. In the previous year, the two non-groomed plots significantly had greater visual density ratings than other plots, but not as described in year two.

Both years: A regular grooming treatment coupled with weekly topdressing and weekly verticutting still produced acceptable turf in terms of density, over the two-year test period .

Ball Roll Distance (BRD)

Year 1: General, or summer 2002, the treatment F ratio was significant on five of the ten BRD measurement events, with significance occurring on double mowed turfs on three events, and twice when plots received supplemental rolling.

Rolling with an 875 lb Brouer roller numerically increased BRD values on all treatments (over double mowing alone) on 5 July, 16 August, and 26 August, decreased BRD values on 19 July, and had no effect for BRD on 26 July.

On 19 July, the greatest BRD values occurred during the test, with a test mean of 103 inches (double mow only) and 98" for rolled turfs.

Year 2. : General - The treatment F ratio for treatment effects was not statistically significant on any evaluation date for BRD in 2003. This was true when BRD was taken after turfs were double mowed, and followed by subsequent rolling. Rolling had minimal benefit, and was inconsistent in effect.

Summary – BRD when turfs were double mowed only.

Year 1: As a general trend, turfs that were *not groomed* ranked numerically higher than groomed turfs for BRD response on all data sampling dates. This was true when the test was double mowed prior to the BRD measurements. Groomed turfs which were not verticut at all, tended to be intermediate in BRD from 5 July to 16 August, but not so towards seasons end on 26 August. This is noted as a seasonal trend.

In general, turfs which received the most frequent number of cultural management practices (*regular grooming, topdressed and verticut*) tended to have the *lowest ranking BRD* values, except towards the seasons end (16 and 26 August). Although the main “treatment” effect in the ANOVA was significant on 3

of 5 collection dates (for double mowed BRD values), these trends show that in general, *regular grooming decreased BRD* values more so than for non-groomed surfaces.

Year 2: In year two, BRD values were essentially identical in mean performance, ranging only a few inches in BRD when measured after the standard double mowing. Thus again, there were no significant treatment effects for BRD in year two. The greatest difference in BRD among treatments occurred on 27 June, as a BRD of 99.8” occurred for turfs that were non-groomed/topdressed and vertically mowed every 7 days versus non-groomed/topdressed and vertically mowed every 14 days (105”).

Both years: When double mowed only, no treatment or related series (groom vs no groom :verticut vs no-verticut) produced consistent ranks for BRD. In year one, non-groomed turfs generally ranked highest for unrolled BRD values, while in year two, no particular treatment (or treatment series) did .

Summary – BRD when turfs were double mowed followed by supplemental rolling.

Year 1: When rolling was added after double mowing, the rolling effect tended to increase BRD values across all treatments, except in July, which normally had the most humid weather. Rolling did increase BRD values by 10% in early July (July 5), and also decreased, or had no effect on BRD in the middle or late July (16 and 26 July), and then increased BRD values slightly in August (16, 26 August).

Although the largest increase in BRD values from rolling occurred in early July (almost 9 inches), the effect was not significant between surface treatments.

Rolling was significant when imparted across surface management treatments in August, as at least one of the two *non-groomed turfs* tended to have the largest BRD values after rolling.

Year 2: Supplemental rolling imparted very little gain in BRD, except in late September at the seasons end. Substantial increases or decreases in BRD did not occur from rolling relative to treatments in year two, as sometimes occurred in year one. BRD averages across all treatments (with the addition of rolling) was from 96.4” – 109.8” in 2003.

Both years: Rolling (on the day of BRD measurements only, synonymous with tournament preparation) was inconsistent with respect to BRD. Rolling sometimes increased, decreased, or had no effect on BRD. Rolling as a *regular cultural management treatment* should be evaluated.

BMP’S for Quality and BRD Performance together:

Year 1 : 2002

- The “groom” treatment which was verticut and topdressed every 7 days always ranked the slowest for BRD responses. This was true on all dates that BRD was measured. While this specific treatment always ranked lowest in BRD, it did not have the lowest overall turf quality scores.
- Groomed turfs which were verticut and topdressed every 14 days ranked the lowest for quality scores on three of four evaluation dates.
- Therefore, treatments which produced **BOTH** (in general terms) the greatest BRD values and ranked the highest in overall quality would be turfs which received no-grooming, and topdressed either every 14 or 7 days.
- The treatment which produced the lowest ranking BRD values and lowest ranking quality scores was the treatment of grooming, verticutting and topdressing every 14 days.
- Overall turf quality was not related to color, but was influenced more by similar ranking treatment responses to visual density and textures, both of which responded less favorably to the cultural practice of regular grooming.

Year II : 2003

- BRD was not related to any surface cultivation treatment in year two.
- Although not statistically significant, non-groomed plots topdressed either at 7 or 14 day intervals, ranked first for BRD in late season (3 September, 30 September)
- BRD values were in general, 10-20% greater across all treatments in 2003 than in 2002.

Both Years

- Though BRD and quality were not significant in 2003 (year two), certain trends resulted over the two year test period in which **both treatments** that were **not groomed** had mean treatment quality scores of 7.0 or more on 12 of 16 possible (joint treatment) evaluations. These treatments *also* had high BRD values.
- Treatments devoid of vertical mowing (groomed/topdressed only at either 7 or 14 day intervals) produced mean quality scores of 7.0 or more on 6 of 16 possible (joint treatment) events. BRD values for these treatments were also within 1-2 inches of the test date mean BRD value, on almost assessment date.
- Treatments which received the most frequent contact events (regular grooming/topdress/verticut at either 7 or 14 day intervals, had mean quality scores of 7.0 or greater on 4 of 16 possible events. These treatments also mean BRD values similar to the date mean averages in year 1 and year 2.

To consistently obtain high ranking BRD values, long term practices would most likely include a mixture of topdressing and verticutting either at 7 or 14 days intervals, with grooming practiced on an as needed basis, especially during the first two thirds of the summer season.

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Appendix Table (A)
Applied fertility program for Sea Isle 2000, 0.125" mow height
Summer 2002

Karsten Turf Research Center
University of Arizona

4/2/02	¼ # N/1000	34-0-0
4/15/02	¼ # N/1000	15-5-8
4/19/02	5 oz/1000	Ferromec
4/19/03	4 oz/1000	Pana-sea
4/30/02	½ # N/1000	15-5-8
5/7/02	5 oz/1000	Ferromec
5/10/02	¼ # N/1000	15-5-8
5/20/02	½ # N/1000	16-4-16
6/4/02	6 oz/1000	Ferromec
6/10/02	5 oz/1000	Ferromec
6/11/02	½ # N/1000	16-4-16
6/25/02	6 oz/1000	Fe Chelate
6/25/02	2 oz/1000	Mn Chelate
7/18/02	6 oz/1000	Fe Chelate
7/18/02	2 oz/1000	Mn Chelate
7/23/02	6 oz/1000	Fe Chelate
7/23/02	2 oz/1000	Mn Chelate
7/25/02	½ # N/1000	16-4-16
8/5/02	6 oz/1000	Fe Chelate
8/5/02	3 oz/1000	Mn Chelate
8/5/02	6 oz/1000	Mg Chelate
8/19/02	6 oz/1000	Fe Chelate
8/19/02	3 oz/1000	Mn Chelate
8/19/02	6 oz/1000	Mg Chelate
9/4/02	6 oz/1000	Fe Chelate
9/4/02	3 oz/1000	Mn Chelate
10/30/02	¼ # N/1000	34-0-0
11/7/02	5 oz/1000	Ferromec
11/18/02	½ # N/1000	34-0-0
11/26/02	5 oz/1000	Ferromec
11/26/02	4 oz/1000	Pana-sea
12/4/02	½ # N/1000	12-6-12
12/17/02	¼ # N/1000	15-5-8

APPENDIX TABLE B
Fertilizer applications to Sea Isle 2000 Seashore Paspalum,
Mow height 0.125 inch
2003
Karsten Turf Research Center
University of Arizona

5/4/2003	Fertilizer	Ferromec 15-0-0	5oz/1000
5/16/2003	Fertilizer	0-0-24	.75lb/1000
5/16/2003	Fertilizer	12.6.12	.125lbN/1000
5/20/2003	Fertilizer	Magnesium	3oz/1000
5/20/2003	Fertilizer	Manganese	3oz/1000
5/20/2003	Fertilizer	Ferromec 15-0-0	5oz/1000
5/23/2003	Fertilizer	12.6.12	.125lbN/1000
5/29/2003	Fertilizer	12.6.12	.125lbN/1000
6/3/2003	Fertilizer	12.6.12	.125lbN/1000
6/3/2003	Fertilizer	Magnesium	3oz/1000
6/3/2003	Fertilizer	Manganese	3oz/1000
6/3/2003	Fertilizer	Ferromec 15-0-0	5oz/1000
6/10/2003	Fertilizer	0-0-24	.75lb/1000
6/16/2003	Fertilizer	0-0-24	.75lb/1000
6/18/2003	Fertilizer	Magnesium	3oz/1000
6/18/2003	Fertilizer	Manganese	3oz/1000
6/18/2003	Fertilizer	Ferromec 15-0-0	5oz/1000
6/30/2003	Fertilizer	Magnesium	3oz/1000
6/30/2003	Fertilizer	Manganese	3oz/1000
6/30/2003	Fertilizer	Ferromec 15-0-0	5oz/1000
7/1/2003	Fertilizer	0-0-24	.75lb/1000
7/15/2003	Fertilizer	0-0-24	.75lb/1000
7/15/2003	Fertilizer	Magnesium	3oz/1000
7/15/2003	Fertilizer	Manganese	3oz/1000
7/15/2003	Fertilizer	Ferromec 15-0-0	5oz/1000
7/29/2003	Fertilizer	0-0-24	.75lb/1000
7/29/2003	Fertilizer	Magnesium	3oz/1000
7/29/2003	Fertilizer	Manganese	3oz/1000
7/29/2003	Fertilizer	Ferromec 15-0-0	5oz/1000
8/11/2003	Fertilizer	0-0-24	.75lb/1000
8/17/2003	Fertilizer	Magnesium	3oz/1000
8/17/2003	Fertilizer	Manganese	3oz/1000
8/17/2003	Fertilizer	Ferromec 15-0-0	5oz/1000
9/8/2003	Fertilizer	Ferromec 15-0-0	5oz/1000

Table 1. Grand Average Ball Roll (3 N-S & 3 S-N), Inches From a 'Sea Isle 2000' Paspalum Putting Green Under Select Cultural Management Regimes. Summer 2002, Karsten Turfgrass Research Facility, University of Arizona.

Treatment Regime	5-Jul			19-Jul			26-Jul			16-Aug			26-Aug		
	*	△		*	△		*	△		*	△		*	△	
(1) G+TD7+V7	77.9	84.8	6.8	101.1	91.3	9.8	88.6	88.2	0.4	85.2	91.0	5.9	74.1	76.9	2.8
(2) G+TD14+V14	75.7	88.2	12.5	100.3	95.6	4.7	87.3	89.1	1.8	89.5	93.0	3.5	78.0	81.5	3.6
(3) G+TD7	78.7	86.3	7.6	102.9	97.3	5.5	90.2	91.3	1.1	90.0	94.4	4.4	77.0	78.4	1.4
(4) G+TD14	79.8	85.5	5.8	101.5	99.1	2.3	88.9	89.8	0.9	89.1	92.8	3.7	73.8	80.2	6.4
(5) D7+V7	80.5	88.2	7.7	105.6	100.6	5.0	90.5	90.0	0.5	91.3	98.4	7.2	78.6	83.1	4.5
(6) TD14+V14	78.5	89.7	11.2	106.3	100.4	5.9	91.0	89.4	1.6	90.2	93.3	3.2	74.8	82.3	7.5
Test Mean	78.5	87.1	8.6	102.9	97.4	5.5	89.4	89.6	0.2	89.2	93.8	4.6	76.0	80.4	4.3
LSD	2.8	ns	ns	ns	ns	ns	ns	ns	ns	4.6	4.4	ns	3.9	4.4	ns

**Note: * indicates ball roll after a single pass with water-filled weighted roller.
Rolling factor = 0.07 Kg-cm**

Table 2. Degree Scalp, %-Plot Scalp and Visible Disease Patches[†] From a 'Sea Isle 2000' Paspalum Putting Green Under Select Cultural Management Regimes. Summer 2002, Karsten Turfgrass Research Facility, University of Arizona.

Treatment Regime	degree scalp	%-plot scalp	# disease patches
	28-Jun	28-Jun	1-Aug
(1) G+TD7+V7	1.5	2.5	6.3
(2) G+TD14+V14	1.0	0.0	11.8
(3) G+TD7	1.0	0.0	8.8
(4) G+TD14	1.0	0.0	9.3
(5) D7+V7	1.0	0.0	7.3
(6) TD14+V14	1.0	0.0	5.8
Test Mean	1.1	0.4	8.2
LSD	ns	ns	ns

patches =number of 15 cm diameter patches (~ 0.2 ft²) per plot

Degree scalp = 1-6. 1=none, 4=moderate, 6=severe.

Values are the mean of four repliactions

**Table 3. Visual Canopy Texture From a 'Sea Isle 2000'
Paspalum Putting Green Under Select Cultural Management Regimes.
Summer 2002, Karsten Turfgrass Research Facility, University of
Arizona.**

Treatment Regime	23- Jul	1- Aug	28- Aug	7- Sep
(1) G+TD7+V7	6.5	6.0	6.0	6.5
(2) G+TD14+V14	5.5	5.3	6.0	6.0
(3) G+TD7	6.5	6.5	5.8	6.8
(4) G+TD14	5.8	6.0	6.3	6.0
(5) D7+V7	6.8	7.3	7.5	6.3
(6) TD14+V14	7.8	6.8	7.0	6.8
Test Mean	6.5	6.3	6.4	6.4
LSD	1.0	0.9	1.1	ns
Texture = 1-9, 1=coarse, 6=medium 9=finest possible				

**Table 4. Visual Turfgrass Color From a 'Sea Isle 2000'
Paspalum Putting Green Under Select Cultural Management Regimes.
Summer 2002, Karsten Turfgrass Research Facility, University of Arizona.**

Treatment Regime	23- Jul	1- Aug	28- Aug	7- Sep
(1) G+TD7+V7	6.5	5.8	5.8	6.0
(2) G+TD14+V14	6.5	5.5	6.5	6.3
(3) G+TD7	6.8	6.5	6.5	6.5
(4) G+TD14	6.5	6.5	6.8	5.3
(5) D7+V7	6.5	6.0	7.5	5.8
(6) TD14+V14	6.0	6.0	6.8	5.8
Test Mean	6.5	6.0	6.6	5.9
LSD	ns	ns	0.9	1.0
Color 1-9, 1= dead, 6=acceptable, 9=best possible. Values are the mean of four replications				

**Table 5. Visual Turfgrass Quality From a 'Sea Isle 2000'
Paspalum Putting Green Under Select Cultural Management Regimes.
Summer 2002, Karsten Turfgrass Research Facility, University of Arizona.**

Treatment Regime	23- Jul	1- Aug	28- Aug	7- Sep
(1) G+TD7+V7	7.5	6.0	6.3	6.3
(2) G+TD14+V14	6.0	5.5	7.0	5.8
(3) G+TD7	7.3	6.0	6.5	6.5
(4) G+TD14	7.0	6.5	6.0	6.5
(5) D7+V7	7.8	7.3	7.5	7.0
(6) TD14+V14	8.0	6.3	7.5	7.3
Test Mean	7.3	6.3	6.8	6.5
LSD	0.8	1.3	1.2	1.3

Quality=1-9, 1=dead, 5=marginal, 6= acceptable, 9=best possible
Values are the mean of four replicactions
Variable: qual0723

**Table 6. Visual Turfgrass Density From a 'Sea Isle 2000'
Paspalum Putting Green Under Select Cultural Management Regimes.
Summer 2002, Karsten Turfgrass Research Facility, University of
Arizona.**

Treatment Regime	23- Jul	1- Aug	28- Aug	7- Sep
(1) G+TD7+V7	7.0	7.0	6.8	6.8
(2) G+TD14+V14	6.3	6.3	7.3	6.8
(3) G+TD7	6.0	7.3	6.3	7.0
(4) G+TD14	6.5	7.3	6.8	6.5
(5) D7+V7	6.8	7.3	7.5	7.3
(6) TD14+V14	7.3	7.8	7.3	7.3
Test Mean	6.6	7.1	7.0	6.9
LSD	1.1	1.0	ns	ns

Density = 1-9, 1=dead, 5=marginal, 6= acceptable, 9=best possible
Values are the mean of four replicactions
Variable: den0723

Table 7. Visual QUALITY of a 'Sea Isle 2000' Paspalum Putting Green Under Select Cultural Management Regimes. Summer 2003 (yr #2). Karsten Turfgrass Research Facility, University of Arizona.

Treatment Regime	20-Jun	2-Jul	3-Aug	1-Oct
G+TD7+V7	6.8	6.5	5.8	6.5
G+TD14+V14	6.5	7.8	5.5	7.0
G+TD7	7.5	7.5	6.8	6.5
G+TD14	6.8	7.8	7.3	6.8
TD7+V7	7.3	6.8	5.8	7.8
TD14+V14	7.0	7.5	5.8	7.3
Test Mean	7.0	7.3	6.1	7.0
LSD	ns	ns	ns	ns

Table 8. Vertical mower damage of a 'Sea Isle 2000' Paspalum Putting Green Under Select Cultural Management Regimes. Summer 2003 (yr #2). Karsten Turfgrass Research Facility, University of Arizona.

Treatment Regime	3-Aug
G+TD7+V7	3.0
G+TD14+V14	3.8
G+TD7	1.0
G+TD14	1.5
TD7+V7	2.8
TD14+V14	2.3
Test Mean	2.4
LSD	1.3

Table 9. Visual TEXTURE of a 'Sea Isle 2000' Paspalum Putting Green Under Select Cultural Management Regimes. Summer 2003 (yr #2). Karsten Turfgrass Research Facility, University of Arizona.

Treatment Regime	9-Jun	2-Jul	3-Aug	1-Oct
G+TD7+V7	6.3	6.3	5.3	6.0
G+TD14+V14	6.8	7.5	4.8	6.8
G+TD7	6.5	8.5	5.8	5.8
G+TD14	7.5	7.8	7.3	6.0
TD7+V7	6.3	6.0	4.8	6.8
TD14+V14	6.8	7.5	5.3	7.3
Test Mean	6.7	7.3	5.5	6.4
LSD	ns	1.2	1.1	0.9

Table 10. Visual Turfgrass Density From a 'Sea Isle 2000' Paspalum Putting Green Under Select Cultural Management Regimes. Summer 2002, Karsten Turfgrass Research Facility, University of Arizona.

Treatment Regime	23-Jul	1-Aug	28-Aug	7-Sep
(1) G+TD7+V7	7.0	7.0	6.8	6.8
(2) G+TD14+V14	6.3	6.3	7.3	6.8
(3) G+TD7	6.0	7.3	6.3	7.0
(4) G+TD14	6.5	7.3	6.8	6.5
(5) D7+V7	6.8	7.3	7.5	7.3
(6) TD14+V14	7.3	7.8	7.3	7.3
Test Mean	6.6	7.1	7.0	6.9
LSD	1.1	1.0	ns	ns

Density = 1-9, 1=dead, 5=marginal, 6= acceptable, 9=best possible

Values are the mean of four replications

Variable: den0723

Table 11. Visual Canopy DENSITY of a 'Sea Isle 2000' Paspalum Putting Green Under Select Cultural Management Regimes. Summer 2003 (yr #2). Karsten Turfgrass Research Facility, University of Arizona.

Treatment Regime	20-Jun	2-Jul	3-Aug	1-Oct
G+TD7+V7	6.3	6.3	5.8	7.3
G+TD14+V14	7.0	8.0	5.0	7.3
G+TD7	7.5	7.5	7.8	7.3
G+TD14	7.0	8.0	7.8	6.8
TD7+V7	7.0	7.0	5.8	8.0
TD14+V14	6.0	7.5	6.0	7.5
Test Mean	6.8	7.4	6.3	7.3
LSD	ns	ns	1.1	ns

Table 12. Average Stolon 'plane' depth and orientation (2 sub-samples) & Rhizome 'plane' depth (2 sub-samples) of a 'Sea Isle 2000' Paspalum Putting Green Under Select Cultural Management Regimes. October 3rd, 2003 (yr #2), Karsten Turfgrass Research Facility, University of Arizona.

Treatment Regime	Stolon plane		Rhizome plane
	Depth (mm)	Orientation*	Depth (mm)
G+TD7+V7	19.6	2.1	66.0
G+TD14+V14	22.5	1.8	67.1
G+TD7	23.1	2.1	71.9
G+TD14	25.4	2.1	64.3
TD7+V7	20.9	1.8	69.5
TD14+V14	22.0	2.3	74.4
Test Mean	22.3	2.0	68.9
LSD	ns	ns	ns

* 1= horizontal 2= 45 degrees 3= vertical