Response of Sea Isle I Paspalum to Fertilization and Mowing for Tee and Fairway Turf

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Introduction

Paspalum vaginatum is a warm season (C4 photosynthetic pathway) grass which has had limited use in turf. The cultivars *Excalibur* and *Adelaide* have been used with some success in southern California, Texas, and gulf areas of the southeastern United States. Attributes of this species include: 1) moderate growth rate, 2) heat tolerance, and 3) salinity tolerance. Limitations to date have included: 1) vegetative establishment requirements, 2) scalping tendency, and 3) yellow-green turf color.

Collections made and evaluated by Dr. Ronnie Duncan at the University of Georgia have resulted in the identification of genotypes (clones) which have been selected for improved turf-type growth habits, resistance to insects and diseases, and enhanced establishment rate (R. Duncan, personal communication). Two of these clones are slated for commercial propagation and release. Sea Isle 2000 is a single clone cultivar intended for greens use, and Sea Isle 1 is a single clone cultivar intended for fairway and tee use. This report addresses research investigations for Sea Isle I, performed from 1999-2000, and the 2000-2001 seasons.

The research objectives were to: 1) investigate the tolerance of and turf responses of Sea Isle I, to both tee (3/8") and fairway (5/8") mowing heights, and to 2) determine the response of this grass to nitrogen fertilization under semi-arid conditions. Previous literature and correspondence with scientists and turf managers alike express the observations that P. vaginatum is a low nitrogen user, compared to most bermudagrass cultivars. If applied at "bermudagrass type rates and frequencies," P. vaginatum has been reported to produce excess scalping and thatch. With the investigation of the turf performance of newer cultivars (which have shorter internodes), it is imperative to investigate the response of new cultivars to various levels of nitrogen. Evaluating these two variables together allows for the identification of fertilizer/mowing combinations which provide an acceptable turf, especially in an arid environment.

Materials and Methods

Establishment

Sea Isle I was planted on a native soil test area of 60' x 120' in August of 1998 at the Karsten Turfgrass Research Center, University of Arizona in Tucson, Arizona. Vegetative propagules were spread on 16" centers as rooted plugs and irrigated and fertilized for establishment, which reached approximately 70-75% cover by early November. The following spring of 1999, plants were fertilized with 0.5 lb. –N- bimonthly from a complete quick release fertilizer form mid-May to early October. The turf was irrigated to avoid stress and was mowed 3x weekly at ¾". The entire test area was rolled and verticut on several occasions as needed to remove elevated crowns from enlarged transplant plugs. A final vertical mowing in mid-September provided a smooth surface of stolons and upright plants.

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In April of 2000, plant heights of 3/8" and 5/8" were achieved by multiple daily mowings of dormant plants over a six day period by using a 24" walk behind reel-type mower. On June 14, tee plots were mowed with either a 22" or 26" walk behind mower, while a 5/8" fairway height was obtained by using a John Deere 2836 triplex reel-type mower. Fertilizer treatments were comprised of either 0, 0.35, 0.66, 0.99 lbs. –N- per thousand square feet, from June to October in Year 1 and from May to October in Year 2. Ammonium nitrate was used as the –N- source, while 0.5 lbs. K-/M/Month (from 0-0-50) and –P- was applied (0-27-0) as 1.0 lb. P/M/ 2 months using a calibrated drop spreader. The irrigation water was tertiary reclaimed municipal waste water, with an average nitrate content of 10 ppm.

Field Design and Treatment Allocations:
The field design was a split plot with mowing height as the main plots (12' x 24') and applied fertilization levels assigned to sub-plots (6 x 12). Linear orthogonal contrasts were utilized to test the main effects of mowing height and applied nitrogen and their interactions. LSD values are provided for main affect mean separation, while interaction means (means of all eight-field treatments) are provided for discussion and references to management performance levels and seasonal trends.

Soil Analyses:
Soil samples were collected on the same dates as tissue clippings. Five sub-samples were collected from each plot in 2000 and ten in 2001. Cores were taken to a depth of six inches in 2000, and to four inches in 2001. Turf was removed from the top of each core. Soils were dried at 65^{o}C for 24 hours and mixed thoroughly before analysis. The first sample each season was analyzed for NH_4-N and NO_3-N via steam distillation and titration following extraction with 1N KCl; pH in a 1:1 soil:water extract; EC in saturated paste; K, Ca, Mg, and Na with ICP following extraction in ammonium acetate buffered at pH 7.0; P by ICP following sodium bicarbonate extraction; Cu, Fe, Mn, and Zn extracted with DTPA via ICP; B and SO_4-S by ICP after extraction with hot water. Soil samples collected all other dates each year were analyzed for NH_4-N and NO_3-N as described above.

Turf Tissue Analyses:
Turfgrass clippings were taken once per month, approximately 2 weeks after each fertilization. Sampling dates in 2000 were June 28, July 26, August 28, September 26, and November 10. In 2001, sampling dates were May 18, June 20, July 18, August 24, September 19, and October 19. Clippings represent 2 days growth as dry weight, from a 20.75" x 14' swatch of turf, for each of the 36 individual plots. Clippings were dried at 65^{o}C until weight loss ceased, and weighed to determine dry matter production. Clippings were ground in a Wiley Mill. Tissue from the first, third, and fifth sampling date each year were ashed, dissolved in 2N HCl, and analyzed for total N and S in a CNS analyzer, and for total P, K, Ca, Mg, B, Cu, Fe Mn, Na, and Zn by ICP. Samples from the second and fourth and sixth (in 2001 only) sampling dates were analyzed for total N only. In 2000, the samples from the second date were destroyed in an accident before they could be analyzed.

Turf Responses
Data collected included agronomic visual response variables according to NTEP rating standards, which most often included, turfgrass color, quality, and visual density scores. Percent plot and degree of chlorosis appears when warranted during both the summers of 2000 and 2001. Clippings were taken from plots by triple mowing alleyways on the outside edge of the plots and then taking one width of the mower blade lengthwise across the plot. Clippings were dried for one week in a hot air convection oven @ 135C, weighed, and then analyzed for mineral content. In July of each year, thatch/rhizome matt depth was measured by taking three sub-samples per plot from 4" cup cutter samples. The matt layer was defined as the distance in mm as the vertical plane from the rhizome base to the base of the green turf. Shoot counts were made from the same sub-samples and averaged for analysis.

Results and Discussion

Turfgrass Color - Year One
The main effect of mowing height had no effect on turfgrass color, while fertilizer had a slight but significant effect in the fall only in year one (Table 1). Between mowing height, mean color scores ranged from 5.5 (3/8" July) to 6.7 (3/8" June). Most scores were 6.0 or greater, except for the 5/8 " cut turf in November, when the leaves turned straw earlier than the low cut turf of 3/8". Neither height of cut ranked consistently higher or lower than the other in year one.

Among fertility rates, mean color scores ranged from 5.8 to 6.8 in the major growing season, and from 5.2 to 7.0 in the fall, when color difference between fertility rates (averaged over mowing heights) was significant (Table 1). In the summer months, either the 0, 0.33, or 0.66 lb. –N- rate provided adequate color in this light colored turf. Chlorosis-type symptoms appeared in July at the high rate of 0.99 lb. –N-, which detracted from the overall turf color. A significant interaction occurred between mowing height and applied fertility rate in November as the 3.8" (tee) turf increased linearly in color with applied nitrogen, while the 0.99 lb. fertilizer –N- rate exhibited chlorosis as outlined above.

Seasonal trends observed in year one for turfgrass color was as follows. For tee height turf mowed at 3/8", the higher rates of 0.99 and 0.66 lbs. –N- produced higher ranking turf color throughout year one, with the exception of July, when all turfs appeared light in color (5.3-5.7) . In three of five months, the 0.33 lb. –N- rate provided acceptable turf scores of 6.0 or more for the 3/8" tee height turf, which was not adequate to hold color into late November of year 1 (Appendix –A).

At the 3/8" height, the high rates of –N- provided slightly darker turf color in June, August, September, October and November. In July this high rate produced a cholorotic turf, which again degraded color scores temporarily. Therefore at 3/8", turf color scores varied only slightly with some applied nitrogen, with the 0.66 lb. –N- applied rate producing adequate color in all months in year 1.

For the 5/8" fairway height turf, acceptable color scores were achieved with nitrogen applications of "0" (no) nitrogen at all in June (6.3), July (7.0), August (6.3) and September (7.0). In October of year 1, the 5/8 height required 0.33 lbs. –N- to achieve suitable color, which was minimal but acceptable in November (5.7). At the same 5/8" height, high rates of nitrogen were beneficial in June, July, and October but not in September, August, and November (Appendix –A).

At the 5/8" height, the 0.33 lb. –N- rate had good color in all but June and October. When increased to 0.66 lbs. –N- monthly, September, August, and November turfs had low color scores due to chlorosis in August and September and leaf tip chlorosis in November (Appendix –A).

Of seasonal interest, was the trend that the 3/8" cut turf was slightly greater in color then the 5/8" cut turf in June, in which at that time the color response was linear with increasing –N- rate for the 3/8" treatments. In July (although not significant) all 5/8" plots were noticeable darker than the 3/8" plots, regardless of –N- rate. No relationship with mowing height and applied N was achieved for color in the months of August, September, October or November in year 1 (Appendix –A).

Turfgrass Color – Year Two

Mowing height again had no effect on turfgrass color for Sea Isle 1, as mean color scores ranged usually less than 0.5 of one rating unit between mowing heights (averaged over fertilizer rates). Again, the 3/8" turf had slightly higher color scores, as the taller leaves became dormant earlier at the 5/8" cut turf.

As in the previous year, fertilization had a very minor roll in turf color in year two, showing a marginal effect at early in the season . The increase in color with –N- rate was realized in May and June of year 2, with a noticeable difference between the "0" and 0.66 or higher rates of –N- applied. The linear contrast for fertilizer was significant in May and June of 2001 (year 2). At both heights, Sea Isle 1 did require additional nitrogen to provide acceptable color in May, June and July, but heavier applied rates did decrease overall color due to chlorosis-type symptoms in August, which returned to normal by October (Appendix –A). The 5/8" turf maintained adequate color throughout year 2 when it received 0.33 lbs. N/M, particularly after May. The 3/8" turf at 0.66 lbs. produced good color and avoided the iron chlorotic-type symptoms in August, which developed at the 0.99 lb. –N- rate.

Two-Year Summary

As was the case in year 1, mowing height had no effect on turfgrass color for Sea Isle 1, as mean color scores ranged usually less than 0.5 of one rating unit between mowing heights (averaged over fertilizer rates). In both falls, the 3/8" turf had slightly higher color scores, as the taller leaves became dormant at the 5/8" cut turf.

As was the case in year 1, fertilization had a very minor roll in turf color, showing a marginal effect at either early in the season (year 2), or late in the fall season (year 1).

When observed over two years, the 0.66 lb. rate produced an acceptable turf in terms of color for the 3/8 mowed turf, with the 0.33 lb. rate producing a fully acceptable color at the 5/8" fairway height turf. Note again that the turf was NOT fall overseeded, and that turf responses were measured well into the fall.

Turfgrass Quality – Year One

Overall turf quality for Sea Isle I was not appreciably affected by mowing height or nitrogen rates alone in year 1. When averaged over fertilizer rates, the quality scores ranged from 5.8 – 7.0 among mowing heights (Table 2). The highest quality turf scores were realized in July and October. The lowest average quality scores occurred in June of year 1 (5.8 for either mowing height). Only in October was the 5/8" turf significantly greater in quality than the 3/8" turf (7.0 vs. 6.6, respectively). Otherwise, there was very little difference between mowing heights for overall mowing quality (Table 2).

Among applied -N rates (when averaged over mowing heights) quality scores ranged from 5.8 – 7.5 among fertilizer rates. The "0" nitrogen application produced the best quality turf in September (7.5 vs. 6.2 for all other applied –N- rates). The general observational trend was that quality increased with applications up to and including the 0.66 lb. rate. The 0.99 lb. applied rate often ranked lowest (or second lowest) for quality (when averaged over mowing heights) (Table 2).

There was no interaction between mowing heights and applied fertilizer in year 1. However, there were some trends that occurred. The 3/8" turf which received no fertilizer had low quality turf scores in June, but was then fully acceptable in July, August, September and October. Among the 3/8" plots, turf quality increased with applied –N- rate in June 2000, whereas turf quality decreased with increased –N rates in August and beyond (Appendix –B).

Overall, the applied fertilizer rate of 0.33-lb. nitrogen produced satisfactory turf at the 3/8" mowing height (Appendix –B). At the 5/8" height, the highest ranking fertility treatments for quality were those that received no fertilizer. This occurred in all months in year 1 for Sea Isle 1. All other responses to nitrogen at 5/8" for quality were variable, noting their quality scores were essentially acceptable with minimal observational differences occurring for overall turf quality (Appendix –B). Note again that it was the chlorosis type symptoms (at the high –N rate) that resulted in low turf color and quality scores.

Turfgrass Quality – Year Two

Again in year 2, overall turf quality was not affected by mowing height to any great extent. Again in year two, applied nitrogen had a small effect on overall quality, and this affect was significant towards the seasons end (September in 2000, October in 2001). The seasonal ranges were from 5.7-7.2 in 2001.

When observed for both full length seasons, the 0.33 or 0.66 lb. –N- rates produced an acceptable quality turf, while the 0.99 lb. –N- rates caused decreased qualities in both years in August, and also for September and October in year 2 (abnormally warm fall). With the exception of the early spring months, the 0-lb. rate provided acceptable turf as well.

Overall, an applied fertilizer rate of 0.33-lb. nitrogen produced satisfactory turf at the 3/8" mowing height.

Turfgrass Quality - TwoYear Summary

In both years, overall turf quality was not affected by mowing height to any great extent, as the range of mean height scores ranged from 5.8 to 7.2, with 11 of 12 possible seasonal scores being values of 6.0 or greater (Table 2).

In both years, applied nitrogen had a small effect or overall quality, and again was significant towards the seasons end (September in 2000, October in 2001) (Table 2). Overall, the applied fertilizer rate of 0.33-lb. nitrogen produced satisfactory turf at the 3/8" mowing height. Overall, the applied fertilizer rate of 0.33-lb. or less of nitrogen produced satisfactory turf at the 5/8" mowing height (Appendix –B).

The general trend in both years was that the 0.99 lb. rate produced quality turf scores no better than the 0.66 lb. –N- rate, and in year 2, lesser quality turf in August, September and October .

Texture – Year One

Visual texture was not affected by mowing height or fertilizer rates in year 1. Differences in rating scale observations were always less than 0.5 units between mowing heights, and at most, 1.0 unit between fertilizer rates. The finest leaf textures occurred in July (humid), with the coarsest looking turf appearing in June (dry). Again, differences between mowing heights or fertilizer rates did not affect texture appearance in year 1.

Texture – Year Two

For year two, the visual texture response was significant on only one date (October) as the taller turf appeared finer in texture. In year two, the finest appearing turf occurred in September (test mean = 6.7) (Table 3). Mean texture scores were usually within 0.5 rating units or less, in both years between mowing heights. While all fertilizer treatments produced acceptable leaf texture, it is of interest that no nitrogen at all produced the highest mean ranks for visual texture on 7 out of 11 evaluation months (Appendix-C). The applied –N rate source of variation was not significant at all in year two.

Texture - TwoYear Summary

Both mowing height and applied fertilizer –N rates had little effect on visual texture of Sea Isle I paspalum. It is of interest that no nitrogen at all produced the highest mean ranks for visual texture on 7 out of 11 evaluation months (Appendix-C). The typical response of finer leaf texture accompanying lower mowing heights was not realized, as the 3/8" and 5/8" cut turfs appeared similar in leaf visual texture. By observation only, there was two leaf widths present in the canopy at both heights.

Density – Year One

Likewise with texture, visual density was not affected by either mowing height or fertilizer rate main effects in year 1. In all months but October, the 3/8" plots tended to produce a thicker appearance turf, but this was not linked to fertilizer application at this height whatsoever (Table 4).

Density – Year Two

Visual density was not affected by mowing height but was affected by fertility on one occasion in year two (June). The linear contrast for mow height affect was significant for mowing in year 2, as the turfgrass became finer in appearance as mowing height increased, which is an atypical expectation (Table 4). This occurred in August and September. In June of year 2, increases in fertility increased visual density, with 0.66 lbs. producing the same effect as 0.99 lbs. –N-, while the "0" treatment appeared least dense at this one time event, but what still acceptable (mean=6.0). (Table 4).

Density - TwoYear Summary

Visual density was not affected by mowing height and/or fertility rate main effects. This was the case in both years (Table 4).The nitrogen applications showed no real biological effect, with the exception of July (year 1) and June (year 2). Overall both years, a fertilizer rate of 0.33 or 0.66 lbs. –N- produced turf with an adequate visual density, with no benefit achieved at 0.99 lbs. At the 3/8" height, mean density values of 6.0 or greater were achieved at 0.33 lbs. –N/M in both years, while at the 5/8" height, this was achieved at "0" applied nitrogen (Appendix –D). The soil residual N most likely proved adequate at this height for Sea Isle I.

Clippings – Year One

Clipping dry weight production was not generally affected by mowing height or fertilization rate in year 1 for Sea Isle 1. Clipping production was statistically greater for the 5/8" over the 3/8" height only in October. The greatest amount of clippings occurred in August, during hot-humid conditions. Fertilization rates also had little effect on dry clippings (averaged over mowing heights). The greatest differences were observed between the 0 and 0.99 lb. –N- rates in June, July and August although differences were small (10%) and non-significant (Table 5).

Clippings – Year Two

Differences between clipping dry matter production were greater between mowing heights in year 2. The linear affect for mowing height was significant on all dates, noting an increase in clippings as mowing height increased. In May 2001, the 3/8" turf produced more clippings than the 5/8" turf, presumably due to solar energy absorption perhaps being greater in the 3/8" turf early in the season. Turfgrass clipping production was greatest in September of year 2 (Table 5).

The main effect and the linear contrast for applied –N was significant for clipping response on five of six dates in year two. There was generally a two fold increase in dry matter clipping production from 0 to 0.99 lb. –N- applied rate in year 2. These trends and results did not occur in year 1 (Table 5). Perhaps the build up of organic matter and CEC increase in time caused these notable differences in clipping biomass between years.

Clippings – Two Year Summary

Differences between clipping dry matter production were greater among mowing heights in year 2, than in year 1 for Sea Isle 1. (Table 5). While turfgrass clipping production was greatest in August of year 1, it occurred greatest in September of year 2. In general, greater biomass occurred in response to fertilization more so at the 5/8" height, versus the 3/8 " height (especially in year two) (Appendix –E).

Shoot Courts – Year One

Shoot density and thatch measurements were taken in late August of 2000. The mean numbers of shoots within a 4.0-inch cup-cutter ranged form 476.8 to 554.6 for the 3/8" and 5/8" height cut turfs and from 495.6 to 531.4shoots/plug across fertilizer levels (Table 6). The fertilizer main effect and the interaction with mow height were not significant. The linear contrast for mowing height was significant, as the 3/8" produced 30% more shoots then the 5/8" turf. Among the twelve field treatments, the mean shoot counts ranged from 448 to 568 shoots/plug. Within each mowing height, fertilizer level had no effect on shoot count density in year 1 for Sea Isle 2000 (Appendix –F).

Shoot Courts – Year Two

In year two the number of shoots produced was significantly greater for the 3/8" turf. The fertilizer main effect and the interaction with mow height were not significant. Shoot density was roughly 20% greater at the lower 3/8" than the 5/8" cut turf both years. Within each mowing height, the two higher –N- levels produced more shoots than the 0.33 or 0 level of nitrogen., in the second year only (Appendix –F).

Shoot Courts – Two Year Summary

The number of shoots produced was greater for the 3/8" turfs than the 5/8" turf. This was significant in year two. Fertilizer effect was not significant, nor was the interaction of mowing and applied nitrogen. Shoot density was roughly 20% greater at the lower 3/8" than the 5/8" cut turf both years.

Thatch/Matt/Rhizome Plane – Year One

Thatch (rhizome layer plane) exhibited a positive linear relationship (significant linear contrast) with mowing height (3/8" = 12.2mm, 5/8" = 15.4 mm) while the quadratic contrast was significant for applied N rates. The 0.33 lb. –N rate made a slightly deeper rhizome/matt layer depth than other rates of N. (Table 6). The interaction was not significant. Among the eight field treatment combinations, the extremes for matt depth means were 9.6 mm (3/8" @ 0.99 lbs. –N-) to 18.3 mm (5/8" at 0.33 lbs. –N-) (Appendix –F).

Thatch/Matt/Rhizome Plane – Year Two

The mow height main effect was significant for matt depth in year two as again the 5/8" turf produced a deeper rhizome plane (16.0 mm versus 10.6 mm for 3/8" turf). Applied N had no effect in year two.

Thatch/Matt/Rhizome Plane – Two Year Summary

Mowing height had the greatest effect on rhizome plane/matt depth in both years, while applied N rates had very little effect.

Clipping Production/Clipping Nutrient Content/Soil Analysis – Shoot Weights – Year One

Mowing height significantly affected clipping dry weights in July and November in 2000. Early in the season, clipping weights tended to be greater in plots cut at 3/8", but for the remainder of the season turf mowed at 5/8" produced more clippings. These trends were biologically significant even when not statistically significant.

Nitrogen application levels did not significantly affect dry matter production in 2000. In every month there was a trend for plots receiving higher rates of nitrogen to produce more clippings, although differences were slight.

There was not a significant interaction between mowing height and nitrogen application rate. (See Table)

Clipping Production/Clipping Nutrient Content/Soil Analysis – Shoot Weights – Year Two

Clipping production was affected both by mowing heights in June and September in year two. In May, plots mowed at 3/8" produced slightly more (but statistically insignificant) clippings than those mowed at 5/8". Thereafter, plots mowed at the higher height produce more dry matter than plots mowed at the shorter height.

Nitrogen application rate was significantly related to clipping dry weight in May and July. As in year one, there was a trend for plots receiving greater amounts of nitrogen fertilizer to produce more dry matter in all months. Maximum production generally occurred with the highest level of nitrogen.

There was not a significant interaction between mowing height and nitrogen application rate. (See Table)

Clipping Production/Clipping Nutrient Content/Soil Analysis – Shoot Weights – Two- Year Summary

There was a trend for early season paspalum to produce more clipping mass when mowed at 3/8" early in each growing season, and then for the paspalum mowed at 5/8" to produce more clippings for the remainder of the season. Increasing the level of nitrogen fertilizer increased clipping production, but effects were often not statistically significant. Maximum clipping production generally occurred at the highest rate of nitrogen application.

Tissue Nutrient Content – Year One

Clipping composition in the first year was not generally affected by mowing height. On the August 28 sampling date, turf mowed at 3/8" had significantly more potassium (3.00%) than turf mowed at 5/8" (2.80%).

Nitrogen application rate significantly affected tissue nitrogen concentration in September and November. For all sampling dates, increasing levels of nitrogen fertilizer tended to increase nitrogen concentrations in turf clippings. Control plots receiving no nitrogen fertilizer always had the lowest nitrogen concentrations, and those receiving the highest fertilizer rate usually had the highest nitrogen concentrations. In November, turfgrass from plots with higher levels of nitrogen fertilizer had significantly more calcium and iron, and significantly less potassium than that from plots with lower nitrogen fertilizer levels.

Tissue Nutrient Content – Year Two

Mowing height generally did not affect tissue nutrient concentrations. In July, plots mowed at 3/8" had higher concentrations of boron and lower concentrations of iron than plots mowed at 5/8". In September, 3/8" plots had lower concentrations of calcium than 5/8" plots.

Increasing nitrogen application rate significantly increased tissue nitrogen in all months except September, when the increase was not significant. In all cases, the unfertilized plots produced tissue with the lowest nitrogen concentration, and the highest nitrogen application rate produced tissue with the highest nitrogen concentrations. In May and July, increasing the level of nitrogen applied also increased the amount of tissue potassium and sulfur (both also increased in September, although the increases were not statistically significant). Tissue collected in May had lower calcium levels with increasing levels of nitrogen fertilizer. In July, increasing nitrogen levels increased concentrations of tissue magnesium and copper, and decreased concentrations of boron. In May, increasing levels also decreased tissue boron concentrations, although not significantly. In both July and September, higher tissue zinc was associated with increasing levels of nitrogen fertilization.

Tissue Nutrient Content – Two Year Summary

Mowing height had a minimal effect on tissue nutrient concentrations. As expected, increased nitrogen fertilization increased tissue nitrogen concentrations. Increasing nitrogen fertilizer levels also increased tissue potassium, sulfur, and zinc, and decreased levels of boron.

% Straw Turf (Year One Only)

The main effect of mowing was significant for % straw turf in the fall of 2000 (Table 6). The percent straw increased linearly (significant contrast) as mowing height increased, while a significant quadratic mow x fertilizer interaction occurred. This occurred since the 0.99 lb. –N- rate caused the greatest amount of early fall leaf necrosis at the 5/8" fairway turf (58%), and the least amount (13%) at the low height 3/8" cut turf. As expected when not overseeded, the higher cut turf turned dormant quicker than the low cut turf most likely due to heat absorption, tip removal, and leaf tip chilling affects.

Scalping (Year Two Only)

In the fall of year 2, turf injury from scalping-type symptoms occurred in October, under short day length, but abnormally warm temperatures. Both the intensity (degree of) and percent plot scalping were scored on all plots. The degree (intensity) of scalping was not significantly affected by mowing height, but fertilizer did affect both the degree and percent of the plot showing the scalp-like symptoms (Table 6). Essentially no scalping occurred at the 0 lb. –N- rate, with some scalping occurring at the highest 0.99 lb. –N- rate. This would be noticeable to the lay observer/golfer/turf user. Clearly, the greatest amount of scalping occurred at the 5.8" height when fertilized with 0.99 lbs. –N- month (Appendix –F).

Chlorosis - Year One

In the native soil, iron –type chlorosis symptoms developed throughout the entire test in year 1 on Sea Isle 1. The degree (intensity) and extent (percent of plot) of chlorosis was recorded in each month of the test in year 1. The greatest amount of chlorosis (degree and extent) occurred in June. Although the fertilizer rate response was quadratic, it bore no biological relevance to the overall response. (Table 7). The amount (percent) of plot surface exhibiting chlorosis was not affected by mowing height, and was significant only once at the end of the season in October. A mean score of 3.0 or more indicates slight-moderate chlorosis, notable to the lay person. Throughout the test, the intensity of chlorosis generally corresponded with the amount of plot chlorosis estimated. Within mowing heights, the "0" –N- rate had the least amount and degree of chlorosis in June, July, and August at either the 3/8" or 5/8" height, indicating that nitrogen increased the chlorite-type response noted here.

Again in year two, the chlorosis-type symptoms appeared within Sea Isle I. Although not always statistically demonstrated, the degree and amount of chlorosis was slightly more noticeable at the higher height of cut (Table 7). It was strongly observed that applied nitrogen caused an increase in both degree and percent plot expression of chlorosis-type symptoms in year two (August through October).

The percent plot chlorosis essentially doubled or tripled as the applied –N- rate increased from 0.66 to 0.99 lb. –N-/M. Topical iron application of Ferromec (15-0-0- plus Fe) did reduce expression, but never completely eliminated these symptoms. More investigative research is needed to elucidate the suspected corrective element deficiency on Sea Isle I when grown on a high pH soil in a semi-arid environment. Perhaps accumulation of soil nitrogen may have occurred by the second year of the test, including an increase in soil organic matter and cation exchange capacity. In almost all cases, the 0.99 lb. –N- rate (at either mowing height) had the greatest amounts of these symptoms, followed closely by the 0.66 lb. –N- rate within each height. Within the same fertilizer rate, the 5/8" turf generally had more chlorosis-type symptoms than when mowed at 3/8" (Appendix-G).

Chlorosis – Two Year Summary

In both years, noticeable chlorosis-type symptoms appeared within Sea Isle I. Although not always statistically demonstrated, the degree and amount of chlorosis was slightly more noticeable at the higher height of cut. It was strongly observed that applied nitrogen caused an increase in both degree and percent plot expression of chlorosis-type symptoms in year two.

SUMMARY

1 Sea Isle I Paspalum tolerated mowing stresses of 3/8" and 5/8" when mowed 3X weekly, in a semi-arid environment.

2. Sea Isle I is a light to medium color grass.

3. In two years of testing, mowing height had no effect on turfgrass color for Sea Isle 1, as mean color scores ranged usually less than 0.5 of one rating unit between mowing heights (averaged over fertilizer rates).

4. In both years , fertilization had a very minor roll in turf color, showing a marginal effect at either early in the season (year 2), or late in the fall season (year 1).

5. When observed over two years, the 0.66 lb. rate produced an acceptable turf in terms of color for the 3/8 mowed turf, with the 0.33 lb. rate producing a fully acceptable color at the 5/8" fairway height turf. Note again that the turf was NOT fall overseeded, and that turf responses were measured well into the fall.

6. In both falls, the 3/8" turf had slightly higher color scores, as the taller leaves became dormant at the 5/8" cut turf.

7. In both years, overall turf quality was not affected by mowing height to any great extent, as the range of mean height scores ranged from 5.8 to 7.2, with 10 of 11 possible seasonal scores being values of 6.0 or greater (Table 2).

8. In both years, applied nitrogen had a small effect or overall quality, and again was significant towards the seasons end (September in 2000, October in 2001) (Table 2).

9. The general trend in both years was that the 0.99 lb. rate produced quality turf scores no better than the 0.66 lb. –N- rate, and in year 2, lesser quality turf in August, September and October .

10. Overall, the applied fertilizer rate of 0.33-lb. nitrogen produced satisfactory turf at the 3/8" mowing height.

11. Overall, the applied fertilizer rate of 0.33-lb. or less of nitrogen produced satisfactory turf at the 5/8" mowing height (Appendix –B). Excess N was related to increased turf chlorosis symptoms, especially at the fairway height turf.

12. Both mowing height and applied fertilizer –N rates had little effect on visual texture of Sea Isle I paspalum. The typical response of a finer leaf texture accompanying lower mowing heights was not realized.

13. Visual density was not affected by mowing height and/or fertility rate main effects in either year. At the 3/8" height, mean density values of 6.0 or greater were achieved at 0.33 lbs. –N/M in both years. At the 5/8" height, this was achieved without supplemental nitrogen applications. "

14. Differences between clipping dry matter production were greater between among mowing heights in year 2, than in year 1 as the 5/8" mowed turf produced more clippings than the 3/8" turfs.

15. In general, greater clipping biomass occurred in response to fertilization more so at the 5/8" height, versus the 3/8 " height (especially in year two) (Appendix –E).

16. The number of shoots produced was greater for the 3/8" turfs than the 5/8" turf. This was significant in year two. Fertilizer effect was not significant for overall shoot density counts Shoot density was roughly 20% greater at the lower 3/8" than the 5/8" cut turf both years.

17. In both years, noticeable chlorosis-type symptoms appeared within Sea Isle I, more so at the higher cut turf, and at higher applied N rates.

18. For all sampling dates, increasing levels of nitrogen fertilizer tended to increase nitrogen concentrations in turf clippings.

19. Mowing height had a minimal effect on tissue nutrient concentrations. As expected, increased nitrogen fertilization increased tissue nitrogen concentrations.

20. Increasing nitrogen fertilizer levels also increased tissue potassium, sulfur, and zinc, and decreased levels of boron.

Shoot Clipping Biomass Responses to Applied N. Sea Isle I Paspalum
University of Arizona
Tucson, Arizona

Year One

2000	Date				
Nitrogen level	June 28 (ns)	July 26 (ns)	Aug 28 (ns)	Sept 26 (ns)	Nov 10 (ns)
0	33.3	34.0	57.6	30.4	6.6
0.33	32.8	31.9	57.6	25.8	9.5
0.66	36.2	34.7	58.7	26.2	10.1
0.99	37.5	38.1	63.9	24.3	9.9

2000	Date				
Mowing Ht	June 28 (ns)	July 26	Aug 28 (ns)	Sept 26 (ns)	Nov 10
3/8	36.8	38.4 a	50.7	19.1	6.7 b
5/8	33.1	30.8 b	68.2	34.3	11.3 a

Year Two

2001	Date					
Nitrogen level	May 18	June 20 (ns)	July 18	Aug 24 (ns)	Sept 19 (ns)	Oct 19 (ns)
0	8.6 c	24.4	23.6 b	20.4	29.9	7.0
0.33	12.6 bc	33.7	28.3 b	28.1	35.3	10.8
0.66	15.8 ab	31.1	36.1 b	33.0	53.7	14.3
0.99	20.1 a	40.8	50.8 a	48.8	52.2	13.1

2001	Date					
Mowing Ht	May 18 (ns)	June 20	July 18	Aug 24 (ns)	Sept 19	Oct 19 (ns)
3/8	16.5	17.1 b	20.2 b	27.5	19.2 b	3.8
5/8	12.1	47.9 a	49.2 a	37.6	66.4 a	18.9

Turfgrass Clipping N Content in Response to Applied Soil N Rates. Sea Isle I Paspalum.
University of Arizona
Tucson, Arizona

2000	DATE					
N Rate		June 28 (ns)	July 26	Aug 28 (ns)	Sept 26	Nov 10
0 lb N		3.28	-	3.70	3.54 c	3.44 c
0.33 lb N		3.96	-	3.83	3.68 b	3.54 bc
0.66 lb N		4.01	-	3.84	3.77 ab	3.78 ab
0.99 lb N		3.96	-	3.88	3.82 a	3.86 a
2001	May 18	June 20	July 18	Aug 24	Sept 19 (ns)	Oct 19
0 lb N	3.06 c	2.56 b	2.77 d	2.73 b	2.71	2.70 b
0.33 lb N	3.23 b	2.62 b	2.95 c	2.92 ab	2.80	2.89 b
0.66 lb N	3.35 a	2.90 a	3.04 b	3.01 a	2.72	3.10 a
0.99 lb N	3.46 a	3.00 a	3.13 a	3.10 a	2.95	3.18 a

Table 1. Visual Color of a 'Sea Isle 1' Paspalum Fairway
Under Select Mowing Height and Fertilization Regimes.
Summer 2000 & 2001, Karsten Turfgrass Research Facility, University of Arizona.

	2000						*2001*						
	27-Jun	*28-Jul*	*28-Aug*	*27-Sep*	*30-Oct*	*20-Nov* ☆	*17-May*	*25-Jun*	*13-Jul*	*21-Aug*	*10-Sep*	*6-Oct*	*Avg.*
Mow Height													
3/8"	6.7	5.5	6.4	6.2	6.3	5.8	6.6	6.4	6.2	6.3	6.4	6.3	6.3
5/8"	6.3	6.7	6.1	6.5	6.2	5.2	6.7	6.2	6.7	6.8	6.3	5.8	6.3
Test Mean	6.5	6.1	6.3	6.3	6.2	5.5	6.6	6.3	6.4	6.6	6.4	6.0	6.3
LSD	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
Fertilizer Rate (nitrogen /1000 ft^2)													
0 lb.	6.3	6.2	6.3	6.5	5.3	5.2	5.7	5.5	6.2	6.8	5.7	5.8	6.0
0.33 lb.	6.2	5.8	6.3	6.8	6.0	5.5	6.2	6.0	6.7	6.8	6.8	6.5	6.3
0.66 lb.	6.7	6.5	6.3	5.8	6.5	5.3	7.2	7.0	6.7	6.8	6.3	6.0	6.4
0.99 lb.	6.7	5.8	6.0	6.3	7.0	6.0	7.5	6.7	6.2	5.8	6.7	5.8	6.4
Test Mean	6.5	6.1	6.3	6.4	6.2	5.5	6.6	6.3	6.4	6.6	6.4	6.0	**6.3**
LSD	ns	ns	ns	ns	0.83	0.66	0.8	1.1	ns	ns	ns	ns	

☆ winter color

Color = 1-9, 1=dead, 6= fully acceptable, 9 = best posible. Values are the meanof 4 replications

Test Mean = mean of all tretaments on that date event.

LSD= Least significant differeance mean separation statistic. Ns=non significant, no value applicable.

Table 2. Visual Quality of a 'Sea Isle 1' Paspalum Fairway
Under Select Mowing Height and Fertilization Regimes.
Summer 2000 & 2001, Karsten Turfgrass Research Facility, University of Arizona.

	2000					*2001*						
	27-Jun	*28-Jul*	*28-Aug*	*27-Sep*	*30-Oct* ☆	*17-May*	*25-Jun*	*13-Jul*	*21-Aug*	*10-Sep*	*6-Oct*	*Avg.*
Mow Height												
3/8"	5.8	6.8	6.5	6.7	6.6	6.4	6.7	6.3	5.8	6.2	6.1	6.3
5/8"	5.8	6.3	6.3	6.3	7.0	6.3	7.0	7.2	6.4	7.2	6.0	6.5
Test Mean	5.8	6.6	6.4	6.5	6.8	6.3	6.8	6.7	6.1	6.7	6.5	6.5
LSD	ns	ns	ns	ns	0.36	ns	ns	ns	ns	ns	ns	
Fertilizer Rate (nitrogen /1000 ft^2)												
0 lb.	5.8	6.8	7.0	7.5	7.0	5.7	6.7	6.5	6.3	7.2	7.2	6.7
0.33 lb.	5.5	6.5	6.3	6.2	6.8	6.2	6.5	6.7	6.3	7.0	6.7	6.4
0.66 lb.	6.0	6.8	6.3	6.2	7.0	6.5	7.2	6.8	6.3	6.7	5.7	6.5
0.99 lb.	5.8	6.2	5.8	6.2	6.3	7.0	7.0	6.8	5.5	5.8	4.7	6.1
Test Mean	5.8	6.6	6.4	6.5	6.8	6.3	6.8	6.7	6.1	6.7	6.0	**6.5**
LSD	ns	ns	ns	1.12	ns	ns	ns	ns	ns	ns	1.3	

Quality= 1-9, 1=dead, 6= fully acceptable, 9 = best posible. Values are the meanof 4 replications
Test Mean = mean of all tretaments on that date event.
LSD= Least significant differeance mean separation statistic. Ns=non significant, no value applicable.

Table 3. Visual Texture of a 'Sea Isle 1' Paspalum Fairway
Under Select Mowing Height and Fertilization Regimes.
Summer 2000 & 2001, Karsten Turfgrass Research Facility, University of Arizona.

	2000					*2001*						
	27-Jun	*28-Jul*	*28-Aug*	*27-Sep*	*30-Oct*	*17-May*	*25-Jun*	*13-Jul*	*21-Aug*	*10-Sep*	*6-Oct*	*Avg*
Mow Height												
3/8"	5.3	6.6	6.6	6.4	6.9	6.9	6.7	6.3	5.9	6.3	5.9	6.3
5/8"	5.3	6.9	6.6	6.3	7.1	6.4	6.5	6.5	6.8	7.2	6.5	6.6
Test Mean	5.3	6.8	6.6	6.4	7.0	6.7	6.6	6.4	6.3	6.7	6.2	6.4
LSD	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.4	
Fertilizer Rate (nitrogen /1000 ft^2)												
0 lb.	5.7	7.0	7.4	6.5	7.5	7.2	7.0	6.5	6.7	7.0	6.3	6.8
0.33 lb.	5.2	6.5	6.4	6.0	6.5	6.8	6.8	6.2	6.2	6.8	6.7	6.4
0.66 lb.	5.3	7.2	6.2	6.7	7.2	6.3	6.2	6.8	6.5	6.7	5.8	6.4
0.99 lb.	5.2	6.3	6.4	6.3	6.8	6.3	6.4	6.0	6.0	6.3	6.0	6.2
Test Mean	5.3	6.8	6.6	6.4	7.0	6.7	6.6	6.4	6.3	6.7	6.2	**6.4**
LSD	ns	ns	ns	ns	0.70	ns	ns	ns	ns	ns	ns	

Texture = 1-9, 1=dead, 6= fully acceptable, 9 = best posible. Values are the meanof 4 replications
Test Mean = mean of all tretaments on that date event.
LSD= Least significant differeance mean separation statistic. Ns=non significant, no value applicable.

Table 4. Visual Density of a 'Sea Isle 1' Paspalum Fairway
Under Select Mowing Height and Fertilization Regimes.
Summer 2000 & 2001, Karsten Turfgrass Research Facility, University of Arizona.

	2000				*2001*					
	28-Jul	*28-Aug*	*27-Sep*	*30-Oct*	*17-May*	*25-Jun*	*21-Aug*	*10-Sep*	*6-Oct*	*Avg.*
Mow Height										
3/8"	7.2	6.6	7.0	6.9	6.6	7.0	6.2	6.8	6.8	6.8
5/8"	7.0	6.4	6.3	7.3	6.6	6.9	6.7	7.3	6.8	6.8
Test Mean	7.1	6.5	6.7	7.1	6.6	7.0	6.4	7.0	6.8	6.8
LSD	ns	ns	ns	ns	ns	ns	ns	ns	ns	
Fertilizer Rate (nitrogen /1000 ft^2)										
0 lb.	7.2	7.0	6.8	7.5	6.2	6.0	6.8	7.2	7.0	6.9
0.33 lb.	6.5	6.3	6.5	6.7	6.3	6.8	6.3	7.0	7.0	6.6
0.66 lb.	7.8	6.3	6.7	7.3	6.8	7.5	6.5	7.2	6.7	7.0
0.99 lb.	6.8	6.3	6.7	7.0	7.0	7.5	6.0	6.7	6.5	6.7
Test Mean	7.1	6.5	6.7	7.1	6.6	7.0	6.4	7.0	6.8	**6.8**
LSD	1.21	ns	ns	ns	ns	1.2	ns	ns	ns	

Density = 1-9, 1=dead, 6= fully acceptable, 9 = best posible. Values are the meanof 4 replications
Test Mean = mean of all tretaments on that date event.
LSD= Least significant differeance mean separation statistic. Ns=non significant, no value applicable.

Table 5. Clipping Dry Mass (grams) Collected From a 'Sea Isle 1' Paspalum Fairway Under Select Mowing Height and Fertilization Regimes. Summer 2000 & 2001, Karsten Turfgrass Research Facility, University of Arizona.

	2000					*2001*						
	28-Jun	*26-Jul*	*28-Aug*	*26-Sep*	*10-Nov*	*17-May*	*22-Jun*	*16-Jul*	*22-Aug*	*19-Sep*	*17-Oct*	*Avg.*
Mow Height												
3/8"	36.8	38.4	50.7	19.1	6.7	16.5	17.1	20.2	27.5	19.2	3.7	23.3
5/8"	33.1	30.8	68.2	34.3	11.3	12.1	47.9	49.2	37.6	66.4	18.9	37.2
Test Mean	34.9	34.6	59.5	26.7	9.0	14.3	32.5	34.7	32.6	42.8	11.3	30.3
LSD	ns	ns	ns	ns	3.47	ns	28.9	ns	ns	29.6	ns	
Fertilizer Rate (nitrogen /1000 ft^2)												
0 lb.	33.3	34.0	57.6	30.4	6.6	8.6	24.4	23.6	20.4	29.9	7.0	25.1
0.33 lb.	32.8	31.9	57.6	25.8	9.5	12.6	33.7	28.3	28.1	35.3	10.8	27.9
0.66 lb.	36.2	34.7	58.7	26.2	10.1	15.8	31.1	36.1	33.0	53.7	14.3	31.8
0.99 lb.	37.5	38.1	63.9	24.3	9.9	20.1	40.8	50.8	48.8	52.2	13.1	36.3
Test Mean	34.9	34.7	59.5	26.7	9.0	14.3	32.5	34.7	32.6	42.8	11.3	**30.3**
LSD	ns	ns	ns	ns	ns	4.4	11.8	18.2	22.8	ns	5.8	

Cliiping dry weight in grams per plot. Values are the mean of 4 replications
Test Mean = mean of all tretaments on that date event.
LSD= Least significant differeance mean separation statistic. Ns=non significant, no value applicable.

Table 6. Thatch (mm), Shoot Count and Percent Straw on a 'Sea Isle 1' Paspalum Fairway Under Select Mowing Height and Fertilization Regimes. Summer 2000, Karsten Turfgrass Research Facility, University of Arizona.

	2000			2001	
	thatch(avg)	**shoots(avg)**	**%-straw**	**thatch(avg)**	**shoots(avg)**
	31-Aug	*31-Aug*	*20-Nov*	*31-Aug*	*31-Aug*
Mow Height					
3/8"	12.2	554.6	17.1	10.6	712.7
5/8"	15.4	476.8	48.8	16.0	598.7
Test Mean	13.8	515.7	32.9	13.3	655.7
LSD	ns	ns	9.98	2.6	ns
Fertilizer Rate (nitrogen /1000 ft^2)					
0 lb.	12.8	531.4	34.2	12.7	590.7
0.33 lb.	15.7	495.6	28.3	12.3	594.7
0.66 lb.	14.2	525.4	33.3	13.0	722.7
0.99 lb.	12.5	508.6	35.8	15.2	714.7
Test Mean	13.8	515.3	32.9	13.3	655.7
LSD	ns	ns	ns	ns	ns

Thatch= mm depth to bottom of matt/rhizome plane. $ subsamples /plot, 4 replications each.
Shoots = # shoots per 4.0 inch diameter plug. @ subsamples/plot, 4 replications each.
% straw = amount of plot exhibiting symptoms. Mean of 4 replications.
Test Mean = mean of all tretaments on that date event.
LSD= Least significant differeance mean separation statistic. Ns=non significant, no value applicable.

Table 7. Degee Chlorosis and Percent Plot Chlorosis on a 'Sea Isle 1' Paspalum Fairway Under Select Mowing Height and Fertilization Regimes. Summer 2000, 2001, Karsten Turfgrass Research Facility, University of Arizona.

	degree chlorosis					%-chlorosis					
	27-Jun	*28-Jul*	*28-Aug*	*27-Sep*	*30-Oct*	*27-Jun*	*28-Jul*	*28-Aug*	*27-Sep*	*30-Oct*	*30-Oct*
Mow Height											
3/8"	2.9	1.9	1.5	2.0	1.8	20.8	6.3	6.9	7.5	5.4	5.7
5/8"	3.1	2.1	2.8	3.1	2.1	17.2	13.3	14.5	16.3	7.9	8.2
Test Mean	3.0	2.0	2.1	2.5	1.9	19.0	9.8	10.7	11.9	6.7	7.0
LSD	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
Fertilizer Rate (nitrogen /1000 ft^2)											
0 lb.	2.7	1.8	1.7	1.8	1.7	15.0	4.2	3.7	7.5	3.3	4.3
0.33 lb.	3.8	2.2	2.3	2.3	1.8	20.8	8.3	8.7	11.7	5.8	6.8
0.66 lb.	2.8	2.2	2.3	3.0	2.0	20.8	12.5	15.8	14.2	8.3	8.4
0.99 lb.	2.7	1.8	2.4	3.0	2.2	19.3	14.2	16.2	14.2	9.2	8.5
Test Mean	3.0	2.0	2.2	2.5	1.9	19.0	9.8	11.1	11.9	6.7	**7.0**
LSD	0.59	ns	ns	ns	ns	ns	ns	ns	ns	4.92	

Degree chlorosis 1-6. 1= none, 4= moderate, 6 = severe. Values are the meanof 4 replications
% plot chlorosis= (0-100% of plot surface exhibiting any chlorosis).
Test Mean = mean of all tretaments on that date event.
LSD= Least significant differeance mean separation statistic. Ns=non significant, no value applicable.