

volume basis; the 60:20:20 mix is 60% sand, 20% peat and 20% loamy topsoil. Plots receiving coring treatments were topdressed with sand after coring twice a year. Frequent quality ratings taken during the season are given in Table 7. Some amendment (peat or peat and soil) with the sand resulted in higher quality ratings on certain dates, but not on others. The twice a year treated plots often ranked better than the light frequent treatments. As pointed out earlier infrequent sand topdressing usually results in layers which create management problems in the future. Turf color ratings taken from these plots during the growing season reflected the same observations as from the quality ratings.

After two years of these topdressing treatments there have been some differences in the amount of organic matter found in the thatch layer as seen in Table 6. Those treatments receiving the soil-based mix had higher organic matter contents. When plots were cored previous to sand application the organic matter content was lower than most other treatments. There was no meaningful effect on stimpmeter readings on these plots.

Three different studies on the use of Sand-Aid in the management of putting greens were initiated in 1985 at the Hancock Turfgrass Research Center. The first was established on a Penncross creeping bentgrass putting green growing on a pure sand base (Purrwick). Plot size was 4 feet by 6 feet with 3 replications. Sand topdressing was applied at approximately three week intervals at the rate of 3 cubic feet per 1000 square feet. Sand Aid was included at the rate of 5 or 10% of the topdressing rate by volume as outlined in Table 8. Coring treatments with a Ryan's Greensaire were made three times a year: spring, summer and fall. At the time of coring, Sand Aid was applied at rates of 15 or 30 pounds Sand Aid per 1000 square feet on each date. The Sand Aid and sand were worked into the turf by brushing on these small plots. Evaluations for this study are given in Tables 9 through 11.

Sand topdressing alone has resulted in poorer quality turf on most dates compared to most other treatments (Table 9). Adding Sand Aid with the sand topdressing improved quality ratings compared to sand topdressing alone on all dates especially at the 10% by volume rate of application. When core cultivation was practiced there was no consistent effect from Sand Aid applications on turf quality. Turf color ratings (not shown) were relatively consistent with quality ratings, but differences were smaller than with quality ratings.

Effects of treatments on the thatch layer (Table 9) pointed out that sand topdressing results in a faster buildup of the sand/thatch layer than from no treatment as would be expected. When the plots were cored there was no difference between the depth of the thatch layer and the untreated plots. It is interesting to note that cored plots had less total organic matter than either topdressed or check plots. This is likely due to the small amount of thatch removed with coring and to the reduced growth caused by the injury and exposure caused by coring.

Rooting in the Sand Aid treated plots was evaluated by sampling the amount of roots in a 2 inch by 2 inch tube pushed into the soil. Three samples from each plot were separated into the 0-1, 1-2, 2-3, and 3-6 inch depths to determine if treatments influenced rooting. Sampling was done on August 30 (Table 10). Small or no differences in rooting were found.

Table 8. Effect of Sand Aid treatments on turfgrass quality rating of a Penn-cross creeping bentgrass green grown on sand. Treatments were initiated in 1985. Quality rating scale of 1 to 9 with 9 = highest quality turf. Averages for 3 replications.

Sand Aid	Treatment		Turfgrass quality ratings (9 = best)				
	Auxiliary		June 1	July 17	Aug 14	Sept 9	Oct 1
5%	Sand topdress		7.3ac*	6.5a	8.3a	8.0a	6.8b
10%	Sand topdress		8.2a	6.8a	8.0a	7.8a	7.7a
None	Sand topdress		5.0c	4.5b	6.3c	4.7c	5.2d
15 lbs	Coring		5.7bc	5.7ab	6.7bc	5.7bc	5.8cd
30 lbs	Coring		7.5ab	6.5a	6.7bc	6.3b	6.3bc
None	Coring		7.2ac	5.7ab	6.3c	6.2b	5.5d
None	None		7.0ac	4.8ab	7.2ac	6.3b	5.7cd

* - Means in columns followed by the same letter are not significantly different from each other using Duncan's Multiple Range Test (5%).

Table 9. Effect of Sand Aid treatments on the "thatch" layer of a Penn-cross creeping bentgrass green grown on sand. Treatments were initiated in 1985. Averages for 3 replications.

Sand Aid	Treatment		Thickness mm	Organic matter in "thatch"	
	Auxiliary			%	grams
5%	Sand topdress		32.6ab*	7.7bc	2.1a
10%	Sand topdress		34.7a	7.7bc	2.1a
None	Sand topdress		29.4ac	6.9d	1.9a
15 lbs	Coring		23.7ad	8.3b	1.6b
30 lbs	Coring		22.8bd	7.9bc	1.6b
None	Coring		17.2d	7.3cd	1.6b
None	None		20.1cd	10.4a	1.9a

* - Means in columns followed by the same letter are not significantly different from each other using Duncan's Multiple Range Test (5%).

Table 10. Effect of Sand Aid treatments on rooting by depth of a Penncross creeping bentgrass green grown on sand. Sampled August 30, 1987. Treatments initiated in 1985. Averages for 3 replications.

Sand Aid	Treatment		Root weight by depth, grams			
	Auxiliary		0-1 inch	1-2 inch	2-3 inch	3-6 inch
5%	Sand topdress		.77a*	.22a	.10b	.10a
10%	Sand topdress		.90a	.26a	.12ab	.11a
None	Sand topdress		1.14a	.26a	.12ab	.10a
15 lbs	Coring		1.08a	.30a	.17a	.12a
30 lbs	Coring		.83a	.29a	.13ab	.11a
None	Coring		.71a	.27a	.12ab	.09a
None	None		.79a	.22a	.13ab	.11a

* - Means in columns followed by the same letter are not significantly different from each other using Duncan's Multiple Range Test (5%).

Table 11. Effect of Sand Aid treatments on soil tests of a sand green. Treatments initiated 1985. Averages for 3 replications.

Sand Aid	Treatment		pH	P	K	Ca	Mg
	Auxiliary						
Available nutrient, lbs/A							
5%	Sand topdress		7.2d*	12a	152ab	1215ab	189b
10%	Sand topdress		7.1e	16a	251a	1598a	218ab
None	Sand topdress		7.1e	12a	210a	1480a	216ab
15 lbs	Coring		7.4b	12a	142ab	1185ab	211ab
30 lbs	Coring		7.4b	13a	211a	1508a	245a
None	Coring		7.5a	15a	87b	1067b	189b
None	None		7.3c	15a	144ab	1185ab	204ab

* - Means in columns followed by the same letter are not significantly different from each other using Duncan's Multiple Range Test (5%).

There were few effects of treatments on soil tests on this sand green (Table 11). The most marked effect was on soil pH. Sand topdressing caused pH to drop slightly while coring increased pH. Differences in pH were small but consistent. There were no effects on soil tests which were considered meaningful.

A similar study was established on a Penncross creeping bentgrass green growing on a loamy sand at the Hancock Turfgrass Research Center in 1985. While Sand Aid treatments at higher rates had higher quality ratings than at lower rates or where no Sand Aid was applied, differences were small and not significant (Table 12). Turf color ratings (not shown) were not affected by treatment.

Topdressing consistently increased the thickness of the thatch/sand layer compared to other treatments (Table 13). And coring treatments increased this measurement compared to the untreated check. As with other observations when treatments were applied on the sand green (Table 11) there was no difference in the total amount of organic matter in the "thatch" layer in this study with the numbers being remarkably consistent. In this study the untreated plot had a high percent (36%) of organic matter in the thatch layer.

Rooting data taken from samples obtained August 14 (Table 14) and September 16 gave evidence that sand topdressed plots had higher root weights in the "thatch layer" than cored or untreated plots, but there was little effect of Sand Aid treatment on rooting on either date.

As on the sand green, sand topdressing caused a small, but consistent, lowering of pH (Table 15). There was a tendency for plots receiving coring treatments to have higher levels of available nutrients, particularly for calcium and magnesium. This may result from bringing soil to the surface with cultivation which has a higher nutrient level than exists in untreated plots or where sand has been applied which contains essentially no available nutrients.

Another Sand Aid topdressing study has been conducted since 1985 on Penncross creeping bentgrass growing on a native soil (heavy sandy loam). No meaningful differences have been observed on this green as caused by treatments.

It is our opinion that the benefits of use of a product like Sand Aid will likely become apparent over the long term. In this third year of the study some responses have appeared indicating benefit from the use of Sand Aid, particularly when applied with sand topdressing. At this time the nature of the cause for these positive responses is not clear.

Long Term Fertility Studies

The long term nitrogen fertility study on Penncross, Penneagle and Emerald creeping bentgrasses maintained under greens conditions was established in 1982. The treatments applied are outlined in Table 16. Plot size was 4 feet by 6 feet. Note that treatments 7 and 8 include late fall nitrogen applications for urea and Milorganite, respectively. The higher nitrogen treatments had higher turf quality ratings (Tables 17-19) and color ratings