Carbonate and Organic Amendment Stability in Sand Putting Greens

By Dr. Wayne R. Kussow and Michael Carlson, *Department of Soil Science, University of Wisconsin-Madison, and Golf Course Superintendent, Virginia Country Club*

Prior to 2004, the USGA recommendations for golf putting green construction cautioned against use of calcareous sands. No mention is made of calcareous sands in the 2004 revised recom-mendations. The earlier concern was that carbonates in construction sands would decompose over time, releasing the silt- and clay-sized particles bound by the carbonates that would then adversely affect putting green porosity and water infiltration. Is it valid to ignore these possible effects of carbonates on the long term performance of sand-based putting greens?

Organic materials are commonly blended with putting green construction sand to increase water and nutrient retention. If the organic amendment in root zone mixes is subject to rapid micro-biological decomposition, the water and nutrient holding properties of the amendment would disappear over time and management strategies would have to be modified accordingly. This perceived instability in putting green performance is part of the logic behind construction of putting greens with pure sand root zones. Is this something we need to be concerned about?

In 1991, we constructed a putting green at the O.J. Noer Turfgrass Research and Education Facility with a calcareous sand and several different amendments. Analysis of these root zone mixes over time has afforded the opportunity to examine changes in carbonate and organic matter contents over a period of 10 years. A few of the properties of the organic amendments used in our 80/20 (v/v) root zone mixes are shown in Table 1.

Before looking at how carbonate contents in the root zone mixes changed over time, we posed the

question "What would happen to the particle size distribution of calcareous construction sands if the carbonates decomposed completely?" To answer this question, we chose two widely used Wisconsin sands, one with 1.17% carbonates and one with 4.43% carbonates. We determined particle size distributions before and after destruction of the carbonates with acid.

The particle size analyses in Table 2 clearly show that the residual material from the carbonates was predominantly clay-sized particles. In sand #1 with 1.17% carbonates, destruction of the carbonates resulted in 5.0% in clay content of the sand, which is 2.0% higher than that recommended by the USGA. However, the sum of very fine sand + silt + clay did not exceed the USGA allowance of 10%, suggesting that for this low carbonate sand destruction of the carbonates may not have noticeable effects on putting green performance.

For sand #2 with 4.43% carbonates, destruction of the carbonates led to a particle size distribution that exceeded USGA allowances for clay and fine sand + silt + clay by substantial amounts. In this case, it is not unreasonable to predict that carbonate dissolution in this sand has the potential for leading to putting green failure over time.

This brings us to the issue of carbonate stability in sand putting greens. Our analyses of several of the root zone mixes used in our study proved very interesting. In the first year after construction, the carbonate contents of the root zone mixes declined, but then increased gradually over 5 and 10 years (Table 3). The decreases in carbonates during the first year were proportional to the amounts of acidity in the various organic amendments (Table 1). Therefore, we surmise that it was the acidity in the amendments that led to breakdown of some of the carbonates in the construction sand.

The assumption is that carbonates in putting greens will be slowly destroyed by the acidity produced when microorganisms convert fertilizer-derived ammonium to nitrate-nitrogen. This did not happen in our study.

Table 1. Root zone amendment properties.

Amendment	Organic matter	C:N ratio	pH	Acidity
	%			meq/lb
Sphagnum peat				
Canadian	93	53:1	4.0	203
Michigan	95	54:1	2.9	400
Wisconsin	83	50:1	3.3	213
Reed sedge peat	85	53:1	6.2	4
Fermented rice hulls	77	104:1	4.9	23

Table 2. Effects of carbonate destruction on construction sand particle size distributions.

	Sand #1		Sand #2	
Particle size	Original	— CO_3 †	Original	— CO_3 †
	% dry weight			
Fine gravel	0	0	0.1	0.1
Very coarse sand	7.6	6.4	5.5	2.0
Coarse sand	62.2	60.1	52.2	37.8
Medium sand	28.1	26.8	28.0	42.1
Fine sand	0.9	0.7	12.1	5.6
Very fine sand	0.5	0.2	0.8	2.2
Silt	0.5	0.6	0.5	1.7
Clay	0.2	5.2	0.8	9.4

† 1.2% carbonates in sand #1; 4.4% in sand #2.

Over 10 years, the carbonate contents of the root zone mixes progressively increased 11 to 36% (Table 3). The reason for this lies in the analysis of our irrigation water. As in all areas of the state where groundwater has percolated through limestone, well water has a high pH and correspondingly high concentrations of bicarbonates and calcium. Irrigation water at the Noer Facility typically has a pH of 8.2, a bicarbonate content of 310 to 360 ppm, and a rather stable 69 ppm calcium. It turns out that this irrigation water chemistry not only renders carbonates virtually insoluble, but actually favors carbonate formation. The bottom line here is anyone irrigating with high pH, high bicarbonate and calcium laden well water need not be concerned about the carbonates in their putting greens decomposing and liberating large amounts of clay-sized particles.

But what if you have putting greens constructed with calcareous sand and your irrigation water has a neutral or slightly acid pH? In this case, the primary source of acidity is the nitrogen fertilizer being applied. By making a few assumptions, one can calculate how much fertilizer N would be required to theoretically generate enough acidity to destroy all the carbonates in a given putting green. We won't burden you with the calculations, but simply note that for our construction sand with 1.17% carbonates, you would have to apply 4 lb N/1,000 ft/year for about 50 years to generate enough acidity to dissolve all the carbonate in the putting green. For the construction sand with 4.4% carbonates Table 1), the time frame is more like 185 years for complete dissolution.

Speaking of carbonates, you have probably heard the claim that high bicarbonate irrigation water causes calcium deficiencies due to formation of insoluble calcium carbonates. This concept is the leading sales pitch for application of amino acid complexed calcium. Is this a valid claim? Absolutely not! There are two reasons for this. First is the fact that calcareous soils always contain and sustain much higher solution concentrations of calcium than do non-calcareous soils. Second, the amino acids complexing the calcium and purportedly preventing its precipitation as calcium carbonate are highly prized by soil microorganisms as nitrogen and energy sources. They are to soil microorganisms what a 16-oz prime rib is to a hungry golf course superintendent. The lifetimes of amino acids in soil are measured in hours to days, not weeks or months.

The rate of microbial decomposition of organic matter in soil is determined primarily by moisture supply, temperature, and the C:N ratio of the organic soil material. Given the frequency of irrigation of putting greens, we can discount moisture supply as a limiting factor. The C:N ratio of the organic matter comes into play because when this ratio is above 30:1, the organic matter contains too little N to meet the needs of microorganisms. The soil microbes have to forage for other sources of nitrogen and this slows the decomposition process. As shown in Table 1, the commonly used putting green root zone amendments have C:N ratios well above 30:1. But with frequent, light applications of N, microorganisms should have little difficulty in finding adequate supplemental N. This leaves us with soil temperature as one of the most prominent factors controlling microbial decomposition of amendments. It is not just soil temperatures at certain times of the year, but throughout the year. Indeed, even sphagnum peat moss with its high C:N ratio has been found to undergo rapid decomposition in

Table 3. Changes in the carbonate contents of various root zone mixes over time.

	Time		
Mix amendment	1 year	5 years	10 years
	------ % change in carbonate content †-------		
Sphagnum peats			
Canadian	– 8.5	+ 7.7	+ 35.9
Michigan	– 28.2	+12.0	+ 24.8
Wisconsin	– 6.8	+12.0	+ 24.8
Reed sedge peat	+ 0.8	+ 6.0	+ 13.7
Fermented rice hulls	0	+ 4.3	+ 11.1

† Based on 1.17% carbonates originally in the construction sand.

Table 4. Organic matter contents of various root zone mixes over time.

	Time		
Mix amendment	0 years	5 years	10 years
	---------- % organic matter ----------		
Sphagnum peats			
Canadian	0.64	0.52	0.48
Michigan	0.72	0.53	0.51
Wisconsin	0.96	0.62	0.49
Reed sedge peat	1.06	0.88	0.53
Fermented rice hulls	1.42	0.21	0.08

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What has not been clearly documented is the rate of decomposition of organic root zone amendments in temperate climates where soil temperature limits microbial activity for 5 to 6 months of each year. By measuring root zone organic matter levels over time, we found 10-year organic amendment decomposition rates to vary from 25 to 94% (Table 4). The Canadian and Michigan sphagnum peats were the most stable among those tested while the fermented rice hulls were very unstable. In fact, it became difficult to find even fragments of rice hulls in the root zone mix after only 5 years.

Rate of decomposition of the amendments tested slowed substantially after 5 years. This is to be expected because microorganisms attack those organic compounds from which they can derive the most energy from the decomposition process. What remains are compounds less and less susceptible to microbial composition. The compounds remain for long periods of time and are responsible for soil organic matter levels stabilizing over time. Judging from plots of percent organic matter versus years, we have arrived at the conclusion that organic matter levels in our putting greens would have stabilized after about 15 years. At that time, organic matter contents in the Canadian and Michigan sphagnum peat greens would be at 70 to 72% of their original levels. In the meantime, organic matter will have increased in the turfgrass rooting zone due to constant root dieback and regrowth.

Based on our observations, we see little reason to reject a putting green construction sand simply because it contains carbonates. Likewise, we cannot advocate not amending the sand with an organic amendment even though the root zone mix organic matter contents will transition over time to somewhat lower levels than in the original mix. Putting greens constructed with organically amended root zones are much more forgiving than pure sand. We had a pure sand root zone in our study that not only required overseeding and constant hand-watering during grow-in, but more precise N and K management in subsequent years.

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The Season Upcoming

By Pat Norton, *Golf Course Superintendent, Nettle Creek Country Club*

When a guy is battling...he simply reacts and goes. When he is stranded...and then stranded again...he has too much time to think. This past week, I had the chore, er, the opportunity to venture into the Chicago suburbs not once, but twice. Each occasion proved to be most interesting and quite educational...both on the freeway and during the seminars.

When I have to enter the traffic jungle that is Chicago...I find out rather quickly that I am somewhat of a small town bumpkin. I am not used to driving so aggressively...so I decide to adapt, react, and go! Then suddenly...there are red brake lights up ahead...demanding your immediate attention...and you find yourself stranded...and stranded again...with lots of time to think.

On the way into the suburbs...it is simply a matter of getting there...hopefully on time. My little half ton Chevy has only six cylinders...and seems like a real truck...until I go up against all of the BMWs, Acuras, monster SUVs...and the big guys with 18 wheels. After some battling and some early AM thinking...I reached my ultimate destination.

LESCO and BASF co-sponsored a really good disease control seminar on Wednesday, March 8 at Butterfield Country Club in Oak Brook. These guys don't mess around...bringing in speakers like Bruce Clarke, Joe Vargas, and our own Randy Kane and Lee Miller, of the Chicago District Golf Association. I guess that I merit an invitation due to my generally heavy purchasing from LESCO over the years...or maybe because I responded early enough. I do know that if I receive an invitation to a FREE seminar...I will certainly accept.

These fine plant pathologists all combined to provide an excellent, thought provoking series of ideas concerning fungus disease management. Of particular interest was the discussion of dollar spot...my personal nemesis. I distinctly remember spraying fairways only 3-4 apps/season during my Cedar Creek days back in beautiful Onalaska in the early 1990's. These days here in beautiful??? Morris, IL, we annually pump out six tank mix combinations...and could probably spray a 7th app in early October should the Fert&Chem budget permit.

Of particular use recently was the report that I received back from CDGA concerning DMI resistance on my golf course. As a result of submitting samples last fall...the plant doctors of the CDGA tell me that we have moderate dollar spot resistance to the DMIs. Upon scanning their report to me, I realized rather quickly that I needed to rethink my fungicide program for the season upcoming. All winter long I resisted ordering anything on a pre-season basis as I waited for the results of our fall sampling. Their report showed that the isolates from NCCC were still very sensitive to the dicarboxamides, but moderately resistant to the DMIs. No more LESCO Spectator or Banner Maxx for me. The systemic fungicide component to be considered should be Emerald, at least for greens and tees. Excellent longevity, but very expensive. Or maybe Iprodione...at best a local systemic...whatever that means...which can be obtained these days at a very attractive price.

Lots to think about on the way home Wednesday...battling the traffic...and preparing in my mind for the upcoming season.

Then on Thursday...a return trip back upon the exact same expressway route to a Toro irrigation seminar at TPEC in Itasca, Il. Just a friendly, yet strong day-long reminder of the fact that irrigation technology has far surpassed our vintage central and field controllers. I have actually applied to put them all on the National Register of Historic Places...

During the seminar, I had plenty of time to reflect back to June 2005 when Midwest Irrigation was on our property replacing our ground rods with new copper plates. At that time they offered to replace our 16 station LTC satellites with 64 station LTC Plus satellites. These units were only one year old...and including

labor...would have been half price as compared to new units. After many years of dealing with those older satellites...I was poised and ready to accept their offer. Alas, our owner could not be convinced of the wisdom of replacement. I regret the fact that we could not afford those replacement satellites...three years of flat or even declining revenue will make any owner skeptical about spending money impulsively.

Once again...lots to think about as I exited Toroland...wound my way back out of Chicago and headed for Corn Country USA. Down here in IlliniLand...we are making final preparations for opening our courses. We have this fantasy that once we declare ourselves to be open...golfers will flock to us...with the line of cars stretching out for miles...just like in *Field of Dreams*. I muse about all of that as I battle the flatlanders...jockeying for expressway position...then exiting onto I-80 west...and enjoying the countryside more and more as it becomes more rural.

We are having fits and starts of beautiful spring weather down here in early March. Interspersed are days and nights of beautiful stormy, rainy conditions...making me grateful that although we didn't fertilize late last fall...we did apply a nice quality greens grade 14-3-6 on our greens, tees, and fairways. Of course, this was only possible due to clearance pricing and June 1 terms...

Considered in early March...the season upcoming is always a time for excitement. It's a stretch of time in which everybody starts to reawaken and reconnect. Managers quicken their step...golfers reacquaint themselves with the club, and employees reappear for another season...looking very pale and in need of a paycheck, a bit of work...and fresh air. Discussions and decisions become much more lively and urgent...because decisions must be made and work carried out.

Like everybody, we start slowly each spring. After having completed about 75% of the winter work by March 1, we now experience a mixture of the interior and the exterior. Jake is still busy with equipment...somebody else is painting or woodworking nearby...and a couple of guys are usually making nice progress out on the course. Mr. Superintendent keeps tabs on everybody...watches the happenings up at the clubhouse...and daily sees his world and his responsibilities come back to life. The springtime golf course demands begin to stretch his managerial ability a little bit...which feels great after too many weeks of relative inactivity.

We temper ourselves...and hold back a bit...after the initial rush of new activity. The weather gets better week by week...but we know that operating

funds right now are basically being borrowed from the bank. So we occupy ourselves with the necessities and the basics...and let our great wintertime planning ideas sort themselves out...and find their own way to the back burner. Right now, its all about simply getting the course open...praying for some unseasonably warm weekend weather...and hoping that the telephone begins to ring...frequently.

Although it's an exciting time, I really begin now to priortize...asking myself that were I the owner...would I expect this much spring time money to be spent so soon? Typically not. They are concerned with the basics...like cash flow and early season expense control. They don't want to be confronted with too many invoices just yet...so those improvement projects and those extra employees may have to lay dormant just a bit longer.

Speaking of the season upcoming, today I had a meeting with my favorite fertilizer sales rep. He and I have been friends for many years...during which I have bought from him at a very brisk pace. His prices are usually very good, his service is great, and his company really appreciates our business. This season, however, may be different. Over the winter I prepared a more detailed quote list than normal...in response to tightening the budget belt a bit more. The responses from eight different suppliers were quite interesting. As you might guess, some suppliers hold the line...while others are quite willing to be very aggressive on their pricing and terms. My friend today had to accept the fact that he was simply and honestly beat out...and quite badly...by more, substantially more, aggressive pricing by the bigger suppliers.

Naturally, our responsibility concerning buying for our clubs is to make the best deal possible. We must make tough, proper and ethical buying decisions. We cannot let friendship or favoritism come into play. We had better not let ourselves be bought off with points or goodies...which should separate us from our less ethical brethren who work behind the golf counters. It sickens me to witness the ease with which golf professionals and their assistants accept golf equipment and golf balls...and it amazes me that owners tolerate this in their employees.

If the golf professional owns his own shop...more power to him. He deserves all of the goodies that he can amass...hopefully to put them out for sale and enhance his business. Lots of golf professionals, though, are simply salaried managers. They are listening too much to the offers of free goodies...of being on staff with whoever...and getting yet another huge, personalized golf bag...which all amounts to basically...being bribed. I guess that they werent listening in their Business Law & Ethics class that the PGA required them to attend. We superintendents need to remember the lessons taught by our mentors...and not rationalize the acceptance of the points, the gifts, and the goodies.

Today also I witnessed the initial first flush of greening on the golf course. Turfgrass slowly emerges from dormancy until that decisive stretch of really nice rainfall...followed by 48-72 hours of relative heat. Over the past five days, that has been our March weather scenario. This morning dawned balmy, wet, and humid. The golf course was green! The feeling of appreciation, satisfaction, and warmth lasted for about three to four hours! Then the forecasted cold front began to slam into Illinois...to the point that I'm now typing to the warmth and the sound of my fireplace. It is an attribute to be able to adapt well to change.

All of these scenarios...are part of the beginnings of the season upcoming. It is only a matter of a few weeks until Daylight Savings Time reconnects us to the growing season...and to the golf season. Enjoy the season upcoming...and try to forget the frigid days and nights of recent weeks and months. At this point...winter is basically over. Good. Great. Send it on down to the southern hemisphere. We here in the north are going to enjoy the season upcoming.

It's All About The Weather

By Monroe S. Miller, *Golf Course Superintendent, Blackhawk Country Club*

It is almost uncanny — there almost always is lousy weather during the state high school basketball tournament-time in Madison. There was a considerable dose of winter on Thursday and Friday of that week in our town again this year. We always wonder if it will be winter's last hurrah.

And it should be winter's last hurrah. March is, after, the first month of spring. The birds are coming back, the sun has returned, leaves and grasses unfurl and turn green. It's no wonder spring is called "spring!"

There are all kinds of holidays in March and April - St. Patrick's, Maundy Thursday, Good Friday, Easter, Passover, Arbor Day and Patriot's Day (April 19,1775 — the day Americans and British clashed on the Lexington green).

But an important day, if not a holiday, happens for us in golf in Wisconsin these two months — Opening Day!

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Before we start wondering and worrying about the 2006 weather, the Wisconsin Field Office of the USDA's National Agricultural Statistics Service summary of temperatures and precipitation is tabulated here for last year's growing season. The data confirms what we know — it was warmer and drier, by far, than normal. It was a tough year. First we dealt with winter injury and then the heat and drought arrived. The only upside was for those among us who had course construction going on, especially in the fall. For them, it was perfect weather.

That weather has continued this winter for areas of the southwest; from Alabama to California, it is bone dry with some places in exceptional drought conditions. The worst areas are in Arizona and New Mexico. Phoenix has literally gone months without a drop of rainfall.

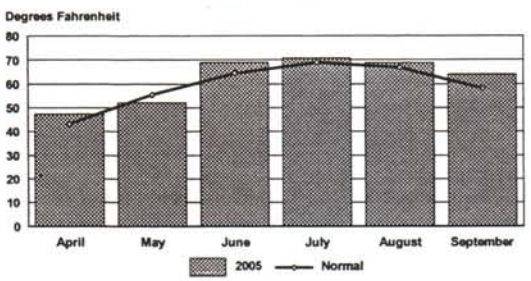
Some fear the drought is moving north this spring to areas immediately south and west of Wisconsin. The National Drought Monitor, which tracks national conditions, lists abnormal to severe drought for all of Kansas, most of Nebraska, Iowa, Missouri and Illinois, much of South Dakota and eastern Colorado.

La Nina, a weather pattern that sends more storms to the Northwest but fewer across the southern US, has heightened the dryness and heat.

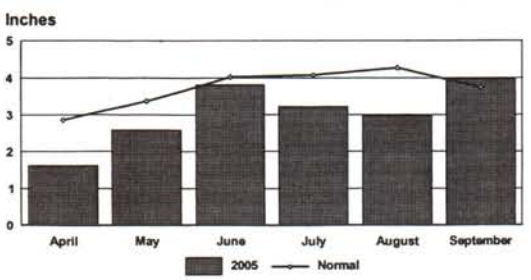
In fact, the record warmth in January helped boost the winter of 2005-2006 to the fifth warmest on record, 1.2 degrees above the average of 36.290 degrees. The warmest winter on record was 1999 - 2000 (36.96 degrees). It was followed by 1998-00, 1991-92 and 1997 - 98.

During this winter, 41 states had temperatures

AVERAGE MONTHLY TEMPERATURE WISCONSIN, 2005



AVERAGE MONTHLY RAINFALL, WISCONSIN, 2005



SOIL MOISTURE RATINGS, WISCONSIN, 2005