A GMO TEST

By Monroe S. Miller

Answers to The Wisconsin Golf Course Quiz are on page 42.

The Greater Milwaukee Open is one of Wisconsin's premier golf events, creating interest among players and golf fans alike. Among WGCSA members, it ranks with the Wisconsin State Amateur and the Wisconsin State Open.

The GMO is also a premier sporting event, significant in a state that boasts the Packers, Badgers, Brewers and Bucks. That is no small accomplishment. The GMO is rightly considered a major league event.

The past year or so has seen lots of copy in both print and electronic media about the future move of the GMO from Tuckaway Country Club to Brown Deer golf course.

Given these facts, it seems appropriate to see how much WGCSA members know about this jewel in the state sports scene.

1. How old is the GMO?
2. Is the move from Tuckaway Country Club to Brown Deer golf course its first move?
3. Name the player who leads the GMO career money list.
4. Where does Wisconsin's two-time U.S. Open champion Andy North rank on the career money list?
5. Who was the GMO's first champion?
6. The golf pros have always enjoyed the excellent GMO playing conditions, which frequently allow them some real scoring opportunities. Who holds the 72-hole scoring record, what was that score and when was it shot?
7. What will the 1993 total purse for the GMO be? What will first place be worth?
8. Of the following players, which ones have played in the GMO and taken home a paycheck?
   Arnold Palmer
   Tom Watson
   Jack Nicklaus
   Lee Trevino
   Sam Snead
   Dennis Tiziani
9. Who has taken home more paychecks from the GMO than anyone? How many?
10. The GMO remains especially unique in the world of PGA tour events. What is it that sets the GMO apart from all of the other stops, except one?

Badger Turf and Grounds Club

Significance of Exchangeable Cation Ratios During Bentgrass Establishment

By Jay C. Packard

Editors Note: *Jay Packard, who wrote of his trials in search of gainful employment in the last issue of THE GRASS ROOTS, is a 1993 grad of Dr. Wayne Kussow's Turf and Grounds Management Program at the University of WIsconsin-Madison. He previously worked at Ozaukee Country Club and Blackhawk Country Club.*

INTRODUCTION

There is a significant difference in how soil testing laboratories interpret exchangeable calcium, magnesium and potassium for turfgrass. Some use the concept that it is essential that the ratios of these cations be maintained within certain limits. Others ignore the ratios and simply assess whether or not there are sufficient quantities of each cation present for unrestricted turfgrass growth.

The idea that soil Ca, Mg, and K have to be in the proper ratios in order to supply turfgrass with adequate amounts of these nutrients dates to the 1940's. New Jersey agronomists (1,7) conducted a series of experiments with alfalfa from which they noted several things. For one, the sum of plant Ca, Mg, and K was fairly constant and increased uptake of one nutrient as a result of liming or fertilization leads to reductions in tissue concentrations of one or both of the other cations. Secondly, the researchers noted that alfalfa yield response to application of one of the three nutrients appeared to be governed in part by the ratio of that nutrient to the other cations on the soil exchange complex. Eventually, the researchers suggested that the "ideal soil" is one in which 65% of the cation exchange sites are occupied by Ca, 10% by Mg, 5% by K and 20% by H. Graham (3) later claimed that crop yields are not affected as long as the cation exchange site saturation of Ca ranges from 65 to 85%, Mg from 6 to 12%, and K from 2 to 5%. These are the values applied most commonly today by soil testing labs that ascribe to the optimum cation ratio concept.

Is this a valid concept, particularly in regard to turfgrass? Many researchers (6, 8, 9) have presented evidence that crop yield responses to applications of Ca, Mg, and K are better predicted by examining the absolute amounts on the soil exchange complex than the ratios or percent saturations of the cations. The cation ratio concept is founded upon the idea that Ca, Mg, and K ions in soil solution need be in the same ratio in which they are required by plants. The inference is that plant uptake of these ions is controlled by their soil solution concentrations. Studies of nutrient uptake processes over the past 10 to 15 years have clearly shown that this is not the case (5). Plant uptake of nutrients is dependent upon much more than the supply in the soil solution. Examples of other factors involved include the growth rate of the plants, soil moisture holding capacity, ion diffusion rates in different soils, plant transpiration rates, root architecture and the numbers and longevity of root hairs, root age, and the mechanism whereby nutrients are transported to root surfaces. Merely the fact that Ca and Mg are transported by one mechanism and K by another is taken as a strong argument that plant uptake of the three nutrients is not controlled by their relative amounts in soil solution and on the exchange complex (4).

Finally, there is the issue of relative plant nutrient requirements. Legumes have high Ca, Mg, and K requirements while grasses have low requirements. This is believed to account for the fact that in those few instances where changes in soil Ca, Mg, and K ratios have altered plant growth, the influences have been observed for legumes but not grasses (2, 6, 8). Application of the cation ratio concept in the interpretation of soil tests for Ca, Mg, and K for turfgrasses has led to some dubious recommendations in Wisconsin. In one instance, the recommendation was that fairways with pH values of 6.7 to 6.9 be treated with 2 tons per acre of gypsum. Another golf course was advised to apply 500 pounds per acre of magnesium sulfate even though long term irrigation with hard water had elevated soil pH to 7.1 to 7.4. Both recommendations were based on the cation balance concept and ignored the fact that the soils contained several-fold more Ca and Mg than the turfgrass could use.

The purpose of the present study was to observe whether or not manipulation of the Ca, Mg, and K saturations of the exchange sites in a putting green rootzone mix significantly affects creeping bentgrass establishment. The study was conducted in a greenhouse environment.

In putting green rootzone mixes prepared with materials that satisfy

USGA specifications, the organic amendment is the predominant source of cation exchange sites and exchangeable cations. Therefore, the approach taken in this study was to create ranges in Ca, Mg, and K saturation by liming acid (pH 2.9) sphagnum peat with liming materials of different compositions, add various amounts of K, and then blend the peat on an 80:20 (v/v) basis with sand. The liming materials used were laboratory grade calcium carbonate, magnesium carbonate, and a 50:50 (w/w) blend of the two. The rate of application was that estimated to be required to adjust the pH of the peat to 6.5.

The pH of the peat stabilized after a 2-month equilibration period during which the limed peat was mixed and its moisture content adjusted on a weekly basis. Each limed peat sample was then air-dried for two days, split into three lots, and each lot moistened with solutions that provided 100, 250, or 500 ppm K. The next day each limed peat-K combination was leached with distilled water to remove excess Ca, Mg, and K. The peat samples were once again allowed to air-dry to a moisture content suitable for blending with sand. Subsamples of the blends were reserved for analysis for pH, cation exchange capacity, and exchangeable Ca, Mg, and K.

The rootzone mixes were packed into one-quart, 6-inch depth ice cream cartons, treated with the equivalent of 2 lb N/M as starter fertilizer (19-26-5) and seeded to 'Penncross' creeping bentgrass at the rate of 3 lb/M. All Ca-Mg-K treatments were replicated three times. The pots were watered daily to the predetermined moisture holding capacity of 12.9% by weight.

When there was sufficient growth, the pots were clipped three times over a two-week period at a height of 1/2 inch. The clippings from each cutting were oven-dried, weighed, and then combined and ground for analysis for Ca, Mg, and K.

RESULTS

The salt pH of the rootzone mixes ranged from 6.35 to 6.45 and the cation exchange capacity from 10.8 to 12.9 milliequivalents/100g (Table 1). Only when the spaghnum peat was limed with calcium carbonate were the Ca saturations in the optimum range of 65 to 85%. All Mg saturations were above the optimum range, indicating that substantial Mg was originally present in the peat and that the ion was very competitive with Ca++ for exchange sites.

Table 1. Analyses of rootzone mixes used.

Liming material	K applied	pH*	CEC+	Exchangeable cations Ca	Mg	K
	ppm		me/100g	percent saturation		
$CaCO_3$	100	6.40	11.3	72	16	0.7
	250			71	17	1.5
	500			71	17	2.0
$MgCO_3$	100	6.35	10.8	46	26	1.1
	250			46	24	1.7
	500			48	22	2.4
50:50 $CaCO_3$ + $MgCO_3$	100	6.45	12.9	60	21	0.7
	250			61	20	1.2
	500			61	19	1.9

*In 0.01 N $CaCl_2$. + At pH 7.0.

Treating the limed peat samples with 500 ppm K was theoretically enough K to provide up to 10% saturation of the exchange complex. The highest saturation achieved was only 2.4%. This demonstrates what has long been known about the relative bonding strengths of cations to organic exchange sites. These sites have a very strong preference for polyvalent cations capable of forming bonds with partial covalent character. Potassium, with its single positive charge, cannot do this. Consequently, K forms weak bonds, leaches readily from rootzone mixes, and it is impractical to try to achieve high soil test K levels in USGA putting green mixes.

During and over the 24-day growth period of the creeping bentgrass, varying the Ca, Mg, and K saturations had no influence on clipping weights (Table 2). Likewise, there were no visual differences among the treatments with regard to bentgrass density or color.

Table 2. Creeping bentgrass growth responses during establishment to various rootzone mix Ca, Mg, and K percent saturations.

Cation saturation Ca	Mg	K	Clipping weight 13 da.	19 da.	24 da.	total
percent			mg/pot			
72	16	0.7	249	211	188	648
71	17	1.5	242	242	171	655
71	17	2.0	200	194	178	572
46	26	1.1	281	236	176	693
46	24	1.7	283	203	171	674
48	22	2.4	251	212	179	642
60	21	0.7	176	228	173	577
61	20	1.2	176	194	169	539
61	19	1.9	153	229	182	564
Duncan's LSD (p=.05)			NS*	NS	NS	NS

*No significant differences.

Clipping concentrations of Ca, Mg, and K varied significantly and, in a general way, seemed to reflect the percent saturations of the cations (Table 3). However, all concentrations of Ca and Mg were within what are believed to be sufficiency ranges for normal turfgrass growth (4). Clipping concentrations of K were consistently high. Thus, over the brief 24-day growth period even K saturations of 0.7%, well below the optimum 2 to 5%, provided the bentgrass with luxury amounts of the nutrient. This is likely another consequence of the weakness of chemical bonds formed between organic exchange sites and K.

Table 3. Effects of different rootzone mix Ca, Mg, and K saturations on creeping bentgrass clipping Ca, Mg, and K concentrations.

Cation saturation Ca	Mg	K	Clipping concentration Ca	Mg	K
percent			percent		
72	16	0.7	0.88	0.40	3.60
71	17	1.5	0.77	0.36	3.93
71	17	2.0	0.77	0.36	4.17
46	26	1.1	0.58	0.65	3.68
46	24	1.7	0.50	0.57	3.72
48	22	2.4	0.51	0.51	4.12
60	21	0.7	0.70	0.50	3.81
61	20	1.2	0.65	0.46	4.45
61	19	1.9	0.60	0.41	4.77
Duncan's LSD (p=.05)			0.06	0.02	0.42

Although the creeping bentgrass showed no growth response to the Ca-Mg-K treatments, the substantial differences in clipping concentrations of the nutrients and their soil test ranges provide data that allowed examination of the relationships between the soil tests and plant uptake of Ca, Mg, and K. This is of considerable interest because a reliable soil test is one that accurately predicts plant uptake of the nutrient in question.

Indications were that Ca and K uptake were equally well and significantly related to their rootzone test values whether expressed in relative terms as percent saturation or in absolute terms as lb/acre (Table 4). In contrast, % Mg saturation did not correlate significantly with Mg uptake while lb Mg/acre did.

There were several instances where uptake of one cation was significantly correlated with soil measures of one or more of the other cations (Table 4). This suggests interacting effects in the sense that uptake of one cation may have been sensitive to the supply of the other cations. This prompted examination of the degree of dependency of Ca, Mg, and K uptake and total clipping weight on rootzone mix levels of the cations. The approach taken was that of multiple regression in which clipping weight of Ca, Mg and K uptakes served as dependent variables and measures of rootzone mix Ca, Mg, and K as independent variables.

Table 4. Correlations between measures of rootzone mix Ca, Mg, and K and bentgrass uptake of the nutrients during establishment.

Measure of rootzone mix Ca, Mg, or K	Nutrient taken up: Ca	Mg	K
		Corr. coeffic., r*	
Percent saturation			
Ca	0.785**	-0.326	-0.068
Mg	-0.696**	0.372	-0.038
K	-0.536*	-0.258	0.621*
Absolute amount, lb/A			
Ca	0.774**	0.190	-0.115
Mg	-0.577**	0.577*	-0.058
K	-0.532*	-0.196	0.631**

* and ** indicate significance at p = 0.05 and 0.01.

The regression analyses revealed that when the rootzone mix Ca, Mg, and K levels were expressed as percent saturations, they reliably predicted the uptake of Ca ($R^2 = 0.855^{**}$) but not of total clipping weight or Mg or K uptake. When expressed in absolute terms (lb/acre), the soil tests reliably predicted uptake of Ca, Mg, K and total clipping weights ($R^2 = 0.679^{*}$ to 0.856^{**}).

SUMMARY AND CONCLUSIONS

In the rootzone mixes used in this study, percent saturations of Ca ranged as low as 29% below optimum, Mg ranged 33 to 117% above optimum, and K was as much as 65% below optimum. Yet, creeping bentgrass clipping weights were not significantly affected and tissue concentrations of the three nutrients were entirely within or above their sufficiency ranges. There were no visual effects of the Ca, Mg, and K treatments on bentgrass density or color during establishment. Correlation and regression analyses indicated that bentgrass uptake of Ca, Mg, and K is more reliably predicted when rootzone mix exchangeable Ca, Mg, and K are viewed in absolute terms as lb/acre than as percentages of the soil cation exchange capacity.

Based on the above evidence, a reasonable conclusion is that the percent Ca-Mg-K saturation approach is unreliable for interpreting soil tests for the purpose of establishment of creeping bentgrass in rootzone mixes prepared from USGA specification sand and organic amendments. A better approach is to base lime and fertilizer recommendations on the absolute amounts of exchangeable Ca, Mg and K present. This has the added advantage of not having to estimate or measure the cation exchange capacity of the mix.

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PEAT IS YOUR BEST OPTION IN ORGANICS

By Tom Levar

Editor's Note: *Tom Levar is principal scientist with North Woods Organics, located in Duluth, Minnesota and now associated with Faulks Bros. of Waupaca. He is a former research scientist with the University of Minnesota and has a graduate degree from there in both soil science and horticulture. He comes to the turfgrass industry well recommended by Dr. Wayne R. Kussow.*

I would like to ask you some basic questions regarding the use of peat materials in the blending of root zone mixtures used on golf courses. I intend to encourage you to view peat and its use more objectively—to ask yourself, "Why do I use peat material in my root zone mix?" and "How can I improve my use of peat?"

Peat is likely our best "organic option" if judiciously used. It can be processed to our specification with technical and economical efficiency for superior turf performance. It can be quality controlled by a competent and cooperative industry, if that is what we require of them.

Our industry needs to adapt and implement standard methods of peat analysis. We also need to better understand the dynamics and function of peat in the root zone environment.

We are responsible for providing specifications to our peat suppliers. We need to become a more discerning market. Over time, we will realize the benefits of peat in root zone mixes, by literally seeing them on our courses.

Conversations with Dr. Norm Hummel of Cornell University, Dr. Wayne Kussow of the University of Wisconsin-Madison, Jim Snow of the USGA Green Section, and other professionals have revealed issues and concerns in the forefront of our industry which are relevant to peat.

These include standardizing laboratory procedures, the use and performance of substitute organic materials, use of finer root zone components, inconsistent properties of peat materials from the same supplier, and the rising costs of construction.

I contend that no universal or "magical" organic exists, but peat is likely the best of its kind to meet the physical needs of a root zone mix. Peat is not a panacea, since its benefits are primarily physical. Gains other than these may be postulated, but are not well defined. Some may include the natural content of biostimulants (i.e. humic substances) and of beneficial microflora and microfauna, and sustained plant nutrient release.

One type of peat cannot provide all the physical and mystical benefits in our root zone mixtures. That bill will be most difficult to fill with any organic material. Any such claim should be highly scrutinized.

My foremost caution is this: the marriage of any organic material with the sand component in your root zone environment should be considered carefully, especially in regard to capillarity and air/water economy.

Root zone mixtures can be designed to optimize air/water balance and water storage, but only with the right components and basic information. Otherwise, we may be faced with unmanageable root zone environments of short duration. The key is selecting the right peat type with your sand and understanding how it works in the root zone over time.

Peat type is descriptive of both the organic material's "botanical origin" and its "degree of decomposition." Botanical origin refers to the identifiable plant remains of the parent material. The can be quantified using microscopic inspection.

Degree of decomposition refers to the natural extent of humification; that is, how "rotted" the peat appears. This is measured by various means, some of which are quite subjective.

Botanical origin and degree of decomposition indicate the material's biological stability in its natural state.

A practical beginning for us is to simplify peat type by grouping it according to botanical origin, as sphagnum moss, reed-sedge, hypnum, transitional, woody, grassy peat and peat humus. In each of these peat types a range of decomposition is found, However, the identifiable "namesake fiber" dominates its makeup.

This simplification serves us well for root zone mixtures, since each of these general types differs markedly in basic physical and chemical proper ties, and in the peatland from which they originate.

I advise you to look at each peat type as a potential component in turfgrass applications. Since all have potential benefits, each will perform differently and all are available from North American producers. But this grouping by peat type is only a beginning.

Why differences between peat types for us in turfgrass culture?

Locally available peat types may be initially inexpensive but may not be physically compatible, especially over time. Some peats are too decomposed or too coarse to match with the selected sand. This affects the root zone mix's mechanical stability, capillarity and structure—free air space and density.

An analogy would be the physical instability and density changes of mixing golf balls and marbles. With any surface activity, a mixture like this would be very unreliable.

Also, some coarse or raw peat materials may not be biologically stable over time and decompose too quickly when exposed to turf practices such as fertility management. This may result in subsidence and surface irregularities, anaerobic conditions and formation of impermeable residues. Proper selection of peat improves dependability and control of your root zone media.

It is most important for our industry to contract laboratories which use USGA standardized test methods and services which fully characterize the root zone components, including the peat. Our industry has made recent strides in the use of standard methods for organic carbon of the mix (using Walkley-Black, 1960) and ash content of the peat, but that effort is not complete.

Additional emphasis should be placed on organic carbon, particle size distribution and the quality of the peat alone. The quality of the peat fiber can be described by its biostability. The carbon:nitrogen ratio is one good indicator of biostability.

Where peat is used in topdressing or core aerification, the compatibility of these materials to those of the original root zone media is also essential. Laboratory and blending services with peat expertise help us produce superior turfgrass media consisting of quality components for lasting performance.

As a golf course superintendent, you may ask, "what are the benefits of being more discerning in my use of peat?"

The use of a specification peat material will ultimately result in lower costs of establishment, maintenance, renovation and general management of your turf. The peat should be consistent, compatible to the sand component in particle size distribution, and free of weed seeds, sticks and phytotoxic residues.

Through proper use of peat, you will realize some of the following benefits in your turfgrass culture and performance: improved green-up and establishment; better rooting stability and wear; reduced compactibility; improved irrigation response and control; better nutrient management; improved gas exchange; increased microbial activity; and, longer life of your root zone media.

The many benefits and advantages of peat warrant our careful attention to its selection and use in turfgrass culture.

A BANDWAGON BUSINESS

By Monroe S. Miller

The sun was high in a deep blue sky when I pulled into the shop yard at the Mendota Bay Country Club. A light breeze accompanied the relatively cool temperature, making it a nearly perfect day, for golf turf and for golf course superintendents.

I was very happy. We had aerified our greens the day before and today, already, the flagsticks were back on the greens.

A quick tour before I left the course reaffirmed that this was probably the best job of putting green aerification we'd ever done. And now that the weather was so perfect, I expected the healing process to take only a few more days.

Normally, aerifying aggravates our members like few other jobs we do. They usually are openly hostile, asking one way or another "why do you have to make such a mess of the golf course?"

Today, our players were smiling and waving and generally in happy spirits. This, too, told me the job we'd completed was well done. How could I not be happy?

The only thing that had gone wrong during the entire cultivation process happened fifteen minutes after we started—our 1973 Ryan Greensaire broke down. Rather than waste time trying to repair it—unlikely anyway since we stock very few Greensaire parts—I call Sandy Grant to see if I could borrow one of Mendota Bay's machines.

I bailed Sandy out of the same predicament several months ago; that made it easier to ask for the same favor.

We have an informal agreement in our town NOT to swap machinery. It leads to too many arguments, hard feelings and disputes over who should fix and pay for what.

But emergencies are different. Nobody hesitates to do whatever has to be done to help out in a time of need, usually desperate need.

So I was returning MBCC's aerifier. I hit the brakes hard as I turned the first corner on the road to the shop. Before me was what seemed to be acres of machinery.

It could have been Wisconsin Turf or Reinders or Hanleys or Horst in early spring. Or a farm machinery auction.

Instead, Sandy was just cleaning house. He's a fussy guy. So when he cleans the golf course buildings, the first thing he does is empty them of their contents. Every single piece of equipment that MBCC owns is pushed or driven out the door and parked.

I pulled up short, wiggled my F-150 into a parking spot along the first building, and got out to find Sandy.

That didn't take long. He and Bogey Calhoun were leaning against the box of Sandy's new Ford pickup.

For as long as I've known Sandy, which goes back to his days as a student at the UW-Madison, he's driven a red vehicle.

"Badger pride," he always said.

The last three or four trucks he has driven have been red and white Fords, the special "Badger Editions". Everybody, and I mean everybody, was shocked to see him cruising around in this new black truck. At least it was a Ford.

"What gives?" I asked him as I folded my arms over the tailgate of his truck. "No one will recognize you. What has happened to your Wisconsin loyalty?"

"Nothing's happened to my loyalty, " Sandy answered somewhat indignantly. "I can't help it if you cannot recognize Wisconsin's other colors."

I stood there, gaping and trying to figure what he was talking about.

Sandy stood back, extended his arm, and with an open palm gestured toward his truck and said, "so how do you like my Wisconsin special edition Ford-Holstein black trimmed in Colby orange?"

Bogey roared, not only at Sandy's wit but my susceptibility to it.

The three of us turned around and surveyed the shop yard. Bogey and I were a little bit jealous.

"This exercise would make quite a picture, Sandy," Bogey offered as we walked through the maze of Mendota Bay's equipment.

"We did take a picture last year," Sandy replied. "It was neat, too, because it was taken from forty feet in the air. Our tree trimmer hoisted me up in the bucket of a skyworker. The view was tremendous. Before you go, take a look at that picture. It's hanging on the wall of my office."

As we wandered through all that iron, I occasionally stopped to look at a particular piece. Usually it was an old machine, something from the past.

"You know what, Sandy, some of these are museum pieces, " I said as I looked at three different spikers. One was an old but nearly mint Ryan walk behind. Another was a very interesting pull behind made by Cushman a quarter of a century ago. And on a pallet sat a set of three spiker units for a Greensking.

(Continued on page 41)

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