



# Influences of Base Saturation Ratios on Creeping Bentgrass Establishment

By **J.A. Sabel and Dr. W.R. Kussow**, Department of Soil Science, University of Wisconsin-Madison

## INTRODUCTION

Various turf consultants and soil testing laboratories recommend application of base saturation ratio (BSR) theory in turf management. The BSR theory maintains that optimal soil conditions for plant growth are not achieved until soils are adjusted to "ideal" base saturations and exchangeable cation ratios. These ideal conditions begin with 80 to 90% occupancy ("saturation") of soil cation exchange sites with the "basic" cations calcium, magnesium, potassium, and sodium. Then, the first three cations have to occupy the cation exchange sites as follows: 65 to 85% Ca, 6 to 12% Mg, and 2 to 5% K. Finally, the ratio of exchangeable Ca to Mg needs to be

around 6.5 to 7.0.

Kussow (2000) reviewed literature pertaining to the BSR theory and noted that:

1. Crop responses to changes in soil base saturation and soil pH do not differ.

2. Crops are much more responsive to changes in the amounts of exchangeable cations in soil than their percent saturations.

Kussow (2000) also reviewed research on crop responses to variations in cation saturations and ratios and concluded that there are no ideal base saturations, cation saturations, or cation ratios that maximize crop yields. He then went on to quote research showing that once soil supplies of cations are adequate,

plants take up only what they need and do not respond to cation saturations or ratios on the exchange sites. Finally, Kussow (2000) pointed out that there are no published research reports regarding turfgrass responses to soil base or cation saturations or cation ratios.

The purpose of the present study was to determine if and when soil base saturation, cation saturation, and cation ratios influence the growth and nutrient status of turfgrass. The study was restricted to creeping bentgrass during its first few weeks of growth.

## METHODS

A pH 5.1 sandy loam soil whose particle size distribution meets

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Table 1. Soil chemical properties.

Treatment	pH	Actual CEC	Exchangeable cations				H †
			K	Ca	Mg	Na	
			cmol(+)/kg ‡				
10	5.08	2.61	0.12	1.70	0.43	0.24	4.12
11	5.00	2.98	0.19	1.62	0.79	0.32	3.69
12	4.94	3.08	0.17	1.92	0.52	0.39	3.61
20	5.72	4.31	0.07	3.43	0.48	0.36	2.27
21	5.78	4.55	0.16	3.13	0.89	0.34	2.09
22	5.77	4.05	0.15	3.09	0.53	0.31	2.53
30	6.44	5.82	0.05	4.91	0.47	0.38	0.81
31	6.51	5.65	0.15	4.38	0.88	0.22	0.98
32	6.54	5.61	0.15	4.55	0.56	0.42	0.93

† = pH 7.0 CEC of 6.61 cmol(+)/kg - Σ exchangeable cations.

‡ cmol(+)/kg = meq/100 g.

Table 2. Soil base and cation saturations† and ratios.

Treatment	Base saturation %	Cation saturations			Ratio Ca:Mg
		K	Ca	Mg	
		%			
10	38	1.8	26	6.5	4.0
11	44	2.9	24	12.0	2.0
12	45	2.6	29	7.9	3.7
20	66	1.0	52	7.3	7.1
21	68	2.4	47	13.5	3.5
22	62	2.3	47	8.0	5.8
30	88	0.8	74	7.1	10.4
31	85	2.3	66	13.3	5.0
32	86	2.3	69	8.5	8.1

† AT pH 7.0 CEC of 6.61 cmol(+)/kg.

USGA standards for a putting green root zone was first limed with colloidal CaCO<sub>3</sub> to establish three different pH levels. The soil at each pH was then leached with solutions containing different quantities of Ca, Mg, and K. The end result was soil pH values of 5.0, 5.8, and 6.5 and, at each pH, three different combinations of exchangeable Ca, Mg, and K (Table 1).

The relationship between soil pH and cation exchange capacity (CEC) was then used to calculate a CEC of 6.61 cmol(+)/kg (6.61 meq/100 g) at pH 7.0. This CEC was then used to calculate percent base saturation and the saturations of Ca, Mg, and K (Table 2).

The treated soils were weighed into pots, fertilized with turf starter fertilizer, and seeded with 'Penncross' creeping bentgrass at

the rate of 1.5 lb PLS/M. The pots were then arranged on a greenhouse bench into four randomized complete blocks.

Starting at 2 weeks after seeding, the bentgrass was clipped weekly at a height of 0.5 inch for a total of 8 weeks. The clippings were oven-dried, weighed, and ground for analysis. Analysis of the clippings was performed by the Soil and Plant Analysis Laboratory.

Six weeks into the study, the bentgrass began showing mild symptoms of K deficiency in several of the treatments. This prompted application of the equivalent of 0.15 cmol(+)/kg of K as K<sub>2</sub>SO<sub>4</sub> and collection of data for 2 additional weeks.

**RESULTS AND DISCUSSION**

Bentgrass growth, when measured in terms of clipping eight, was not significantly related to soil per-

cent base saturation (Fig. 1). In fact, the top three weights were recorded at base saturations ranging from 45 to 88%.

Soil Ca:Mg ratios likewise had no consistent or significant influence on bentgrass growth (Fig. 2). If one were to identify an optimum Ca:Mg ratio from this figure, it would be in the range of 2.0 to 5.8 and not the values of 6.5 to 7.0 touted by the BSR theory.

In this study, because we used only one soil, we cannot separate any possible effects of percent cation saturation from the effects of the actual amounts of exchangeable cations on bentgrass growth. Thus, it is immaterial whether we refer to soil Ca, Mg, and K as their percent saturations or as the amounts exchangeable.

There were no significant influences of the amounts of exchangeable Ca or Mg on bentgrass clipping weights. This observation indicates that soil exchangeable Ca as low as 1.62 cmol(+)/kg or 24% saturation supplied all of the Ca the bentgrass required. The lowest values for Mg in the study were 0.43 cmol(+)/kg (Table 1), or a saturation of 6.5% (Table 2). The bentgrass showed no growth response to any higher values.

Soil K levels exhibited a significant influence on bentgrass clipping weight (Fig. 3). While not a strong relationship, indications from this figure are that in this study the optimum soil K level was about 0.15 cmol(+)/kg, or a saturation of around 2.2%, which is within the range specified by BSR theory.

Bentgrass clipping Ca concentrations ranged from 0.57 at 24% soil Ca saturation to 1.87% at 74% soil Ca saturation. According to Jones (1980), the Ca sufficiency range for turfgrass is 0.5 to 1.2%. This, plus the fact that we saw no bentgrass growth response to increasing soil Ca levels, suggests that soil Ca levels can be slightly less than 24% saturation or 1.62 cmol(+)/kg (around 320 ppm) without adversely affecting bent-

grass growth during establishment.

Magnesium concentrations in the bentgrass clippings ranged from 0.22 to 0.45%. Jones (1980) cites 0.2 to 0.6% as being adequate. Given that all of our treatments appeared to supply adequate amounts of Mg, it is understandable why we saw no growth response to the different levels of soil Mg, all of which were within or above the percent saturation range specified by BSR theory.

Clipping K concentrations ranged from 1.48 to 3.08% before supplemental fertilizer K was added to the pots. After the K addition, clipping K concentrations ranged from 2.72 to 3.32%. All of these are considered adequate by Jones (1980), but he points out that his adequacy range of 1.0 to 2.5% K may not apply to all turfgrasses. While our data do not clearly define a range of adequate tissue K levels, indications were that for bentgrass the adequacy range begins at about 2.2% K. This requirement was met in all treatments wherein soil K levels exceeded 0.15 cmol(+)/kg of exchangeable K, which equates to about 60 ppm K or 2.3% saturation in our soil. Clipping K concentrations reach a maximum of around 3.2% when exchangeable K levels were in excess of 0.32 cmol(+)/kg or 125 ppm.

Soil base saturation and Ca:Mg ratios were found to have no influence on bentgrass clipping Mg and K concentrations. This tends to dispel the notion that adequate Mg and K nutrition cannot be achieved unless the soil contains the proper ratios of exchangeable Ca, Mg, and K. On the contrary, this is further evidence that as long as soil Ca, Mg, and K are present in adequate amounts, their ratios are, at best, of minor importance.

#### SUMMARY AND CONCLUSIONS

Creeping bentgrass was grown for 8 weeks in a sandy loam soil treated to provide base saturations of 38 to 86%, Ca saturations of 24 to 74%, Mg saturations of 6.5 to 13.3%, K saturations of 0.8 to 5.2% and Ca:Mg ratios

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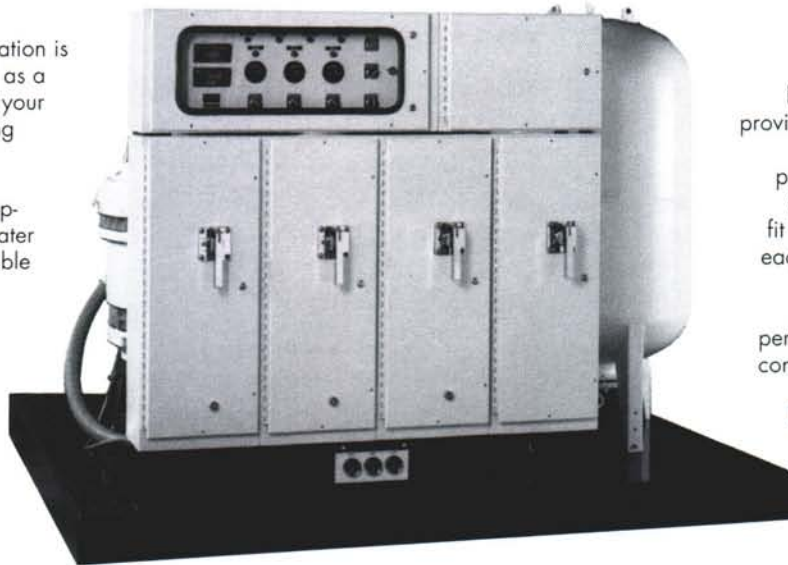
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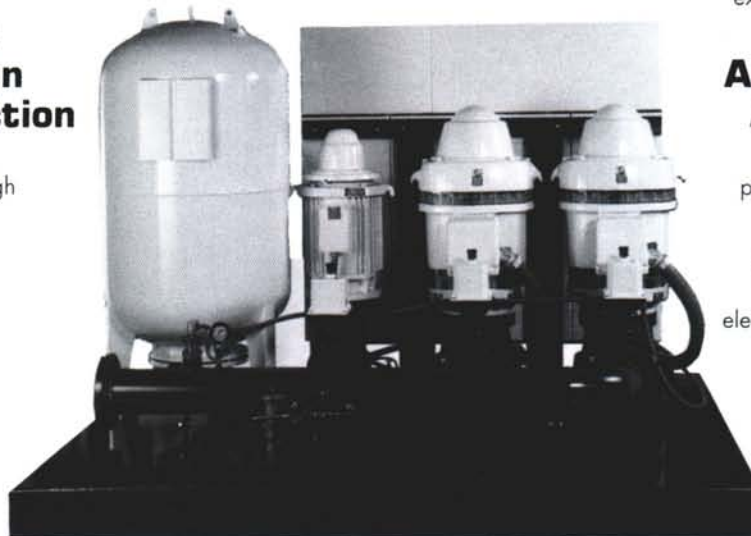
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of 2.0 to 10.4. There were no significant influences of soil percent base saturation or Ca:Mg ratio on clipping production or clipping concentrations of Mg and K. Maximum clipping production was observed at percent Ca saturations above 24%, well below the optimum of 65 to 80% saturation stipulated by base saturation ratio theory. There was no response to a percent Mg saturation of greater than 6.5 (the lowest in the study) to a K saturation above 2.3%.

In working with a single soil, one cannot differentiate between the influences of percent cation saturation and the amount of exchangeable cation present on plant growth or nutrient content. Relationships between clipping weights and Ca, Mg, and K concentrations and between exchangeable soil Ca, Mg, and K clipping percent Ca, Mg, and K were used to identify optimum growing conditions. Indications were that soil containing at least 320 ppm exchangeable Ca and 60 ppm exchangeable K will meet the nutritional requirements of creeping bentgrass during establishment. Conditions of the study did not allow for clear definition of the minimal soil Mg requirement, but it appeared to be around 70 ppm.

The results of this study failed to validate the BSR theory. On the contrary, there was considerable evidence that application of the theory in turfgrass management can easily lead to applications of Ca or Mg that have no remunerative value. Rather, turfgrass managers should focus on the amounts of exchangeable Ca, Mg, and K in soil and not their saturation percentages.

**REFERENCES**

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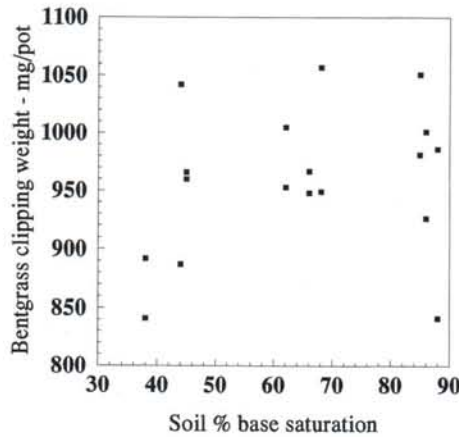


Figure 1. Relationship between soil percent base saturation and bentgrass clipping weights.

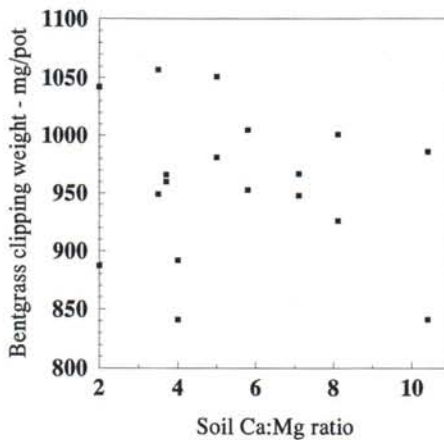


Figure 2. Relationship between soil Ca:Mg ratio and bentgrass clipping weights.

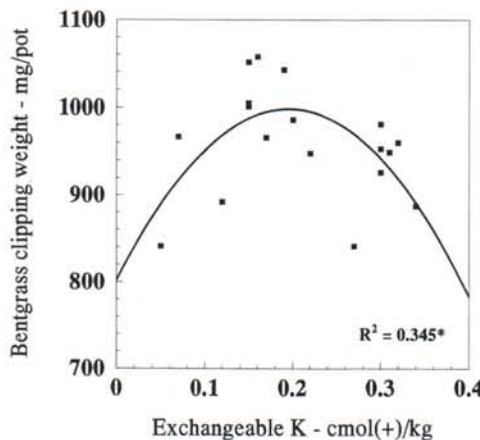


Figure 3. Relationship between exchangeable soil K and bentgrass clipping weights.

J.A. Sabel is a May 2000 graduate of the UW Turf and Grounds Management Program. He is now the Assistant Superintendent at the North Shore Golf Club. W.R. Kussow was his academic advisor.



# 10 Years + 58 Columns + 61 Personalities = Lots of Memories

By Lori Ward Bocher

Up until about 10 years ago, I paid as much attention to turf as the average person. I mowed lawn. I enjoyed parks. I played and watched some sports. Never was a golfer.

But then I had the privilege of meeting Monroe Miller. We were both serving on the WALSAA board (Wisconsin Agriculture and Life Sciences Alumni Association.). His enthusiasm for his job and profession was contagious! So when he asked me if I'd like to write a "Personality Profile" column for *The Grass Roots*, I gratefully agreed.

Now, 58 columns later, I find myself writing my "10th Anniversary" column. Fifty-eight columns! Fifty-eight personalities – 61 if you count all four of The Shaw Boys – and I guess they are four different characters.

In 10 years, I missed only two columns – once after the birth of my daughter and a second time after the birth of my son. A few times each year I'd call Monroe, asking, "Who's next for the Personality Profile?" And he'd always have a name or two or three to keep me busy. Most of the interviews were conducted over the telephone, but a few were done in person.

Although I write this column, it really belongs to Monroe. It was his idea 10 years ago – a way to honor and to get to know many of the people who work in this industry. He seriously considers who he wants to include in each issue. If he opens one "category" of personalities – say, University personnel who touch the industry – he wants to be sure to include everyone who fits in that category.

He's struggled the most with whether or not to include his colleagues, golf course superinten-

dents. He's opened the door a bit, with retired past presidents of the WGCSA and a few other notable exceptions, but he still hasn't pushed that door wide open.

And so, with special thanks to Monroe for putting me in touch with some really great personalities, I'd like to share with you some of my highlights from writing the Personality Profile for 10 years.

### **Most memorable professor...**

Two articles stand out as the most memorable. One was with J.R. Love. As most of you know, J.R. Love was a professor of soil science at the University of Wisconsin-Madison from 1954 to 1986. He also started and headed the department's turf and grounds program beginning in 1960. When Monroe asked me to interview Dr. Love, a touch of fear hit me. You know, the kind of fear you feel when you dream it's time for final exams and you haven't studied all semester?

This fear stemmed from the fact that I had Dr. Love for Soils 301 back in 1981. I was a dairy science major, but my advisor strongly recommend-

ed this course. Other students recommended against it; the course, and the professor, were tough, they said. Thankfully, I followed the advice of my advisor. Yes, the course was tough. I dreaded the exams, especially the lab exams where we had to identify soils.

But the professor wasn't tough. He just had high standards – and a contagious enthusiasm for soils! I never knew I could learn so much or like so much about soils!

Back to the article. Why else is this one so memorable? Because J.R. Love has one of the most sparkling personalities of anyone I've interviewed to date. As I stated in the article, he has an "unending zest for life." Ever the teacher, he told me about his home town of Ruby, ND, being the geographical center of North America. He told me about the grid layout of Chicago streets. He gave me his opinion on many educational topics. There's nothing wishy-washy about this man!

The telephone interview with Dr. Love was the longest I've ever had. And he's the only person who has actually called me back with more

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information. Apparently readers of *The Grass Roots* liked the article, too. Monroe gave the article one of his "best" awards in 1992 – the Best Grass Roots Article. He usually doesn't single out articles. "But the exception comes this year," he wrote. "It is the result of the tremendous feedback from Lori's feature from the July/August issue entitled, 'Even his name shows his Love for life.'"

"Professors Love's following is still formidable and scores of friends and former students were pleased to read about his life in retirement," Monroe continued. "In her story, Lori captured the essence of the man we've known so well for so long."

Thanks for the memories, Dr. Love.

### **Most memorable and emotional history...**

The other "most memorable" article was with Terry Ward. Terry was advertising and sales manager for the Milorganite Division of the Milwaukee Metropolitan Sewerage District. He was quite surprised when asked to do the interview. "My life's dull and boring and I'd like to keep it that way," he said.

But I found him to be one of my more interesting "subjects." As I wrote in the article, "Terry Ward is a slice of American history. He lived through, or was affected by, many of the major events of post World War II America."

A child of the stable and prosperous 1950's, most of his relatives worked in agriculture. But his father, a World War II veteran, came home from the war, got a good job with the Kohler Company, and worked there the rest of his career – typical in the U.S. at that time.

After graduating from high school in 1964, Terry enrolled at the University of Wisconsin-Madison mainly to avoid the military draft, he admitted. But a football injury forced him to drop out of school, so he lost his 2S draft classification, and he was drafted in 1966. And where did he end up? Viet Nam. In the

thick of things.

This is where the emotion comes in. Terry was unable to tell me about his war experiences. His voice cracked as he spoke. "This is what I don't want to talk about," he said. "There have been a couple of things that I endured that shall not be repeated. They're not thought about."

He was badly injured and heavily decorated from the war. When he returned to the U.S., his path was slightly different from his father's return from World War II. Terry went back to college, got a business degree, and then went through a series of jobs. His first job he lost due to a company buy-out. His second job he chose to leave for a new challenge at another company. He lost this third job when the company couldn't compete with Japanese imports and went out of business. Doesn't this sound typical of corporate America in the 1970's and 1980's? After several years with Milorganite, Terry is now working for another company and living in central Wisconsin.

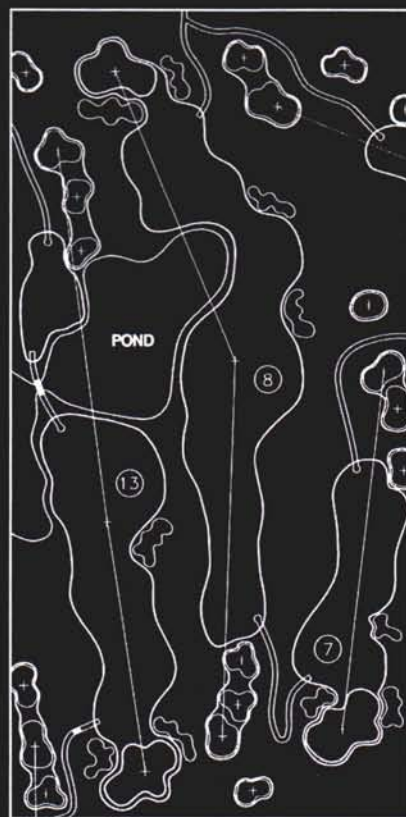
In spite of life's difficulties – or maybe because of them – Terry has remained upbeat about life. "So long as they aren't shooting at us, so long as they aren't too close, that makes for a pretty good day here," he said. "I think that's why I'm always upbeat. I know the worst days are behind me. Every day is a good day. Believe me, I know what a bad day is."

Thanks for the memories, and the reality check, Terry.

Golf course superintendents...

As I mentioned earlier, Monroe has been reluctant to feature too many golf course superintendents. If you do one, you have to do them all, right? But he has made a few exceptions. First he had me interview three WGCSA past presidents who were retired – Woody Voigt, Al Vrana and Bill Sell. Since then, Al and Bill have passed away. When Charles Shiley passed away, Monroe asked me to contact his widow, Mary, for an

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article – my first “memorial” article.

Randy Smith was an “exception” to the don’t-interview-current-superintendents rule. Monroe had me feature him because he was retiring from his superintendent’s role at a fairly young age. Mike Lee was another exception; he was hosting the U.S. Women’s Open at Black Wolf Run. And then there was Mark Kienert. I interviewed him when he was elected WGCSA president in 1995. Monroe usually interviews the new presidents, but I think he was behind and needed some help this time!

And who can forget The Shaw Boys – Dan, Jim, Charlie, and Pat. They were an obvious exception; it’s not often you find four brothers in the same profession.

**By phone or in person...**

Most of the 58 interviews I’ve conducted have been over the telephone. It just takes too much time and money to drive all over the state. But there have been a few notable exceptions in this category, too.

Back to The Shaw Boys. I couldn’t imagine trying to interview four people on the telephone at once. How would I know who was saying what? And to interview each one separately – then I’d miss out on the interaction between them. So I decided to interview them in person. Pat had the difficult job of getting all four brothers to be at the same place at the same time – in summer, no less.

We met at the shop at Chenequa Country Club, Hartland, where Dan and Jim work. The comradery I felt as the four brothers bantered back and forth, throwing in a quip here and there, was wonderful. And it was heart-warming to see how much they all appreciated being able to work in the same profession.

Bill Sell, a retired superintendent and former WGCSA president, was another exception because he lived in Appleton, only 25 minutes away from my house. If I hadn’t gone there in person, I never would have seen his extensive golf ball collection.

In my first year of writing the column, I did visit most of the people in person. My visit to Egon Herrmann of Kellogg Seeds stands out in my memory. It was a challenge to find the place in an industrial section of Milwaukee. The old building, with wooden floors worn smooth from wear and the smell of seed in the air,

reminded me of childhood trips to the feed mill. And Egon was a real charm. I remember him giving me practical advice on how to grow a better lawn.

**Miscellaneous categories...**

Which brings me to another category: **Best Accents.** Egon



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Herrmann wins in this category. It was a joy to listen to his heavy German accent. A close second goes to both Lois and Jim Latham with their Texas draws.

Speaking of accents, Geunhwa Jung, the new assistant professor of turfgrass pathology at the UW-Madison, had the most challenging accent. A native of Korea, he admits that he still struggles with his adopted language. But he was kind and patient with me, repeating or spelling words that I didn't understand. I encourage all of you to be kind and patient with Geunhwa when you hear him speak at industry meetings.

Then there's the **Small World** category. I remember my shock when I called Prof. Ed Hasselkus of the horticulture department at the UW-Madison. I had never met the man before. But when I called and introduced myself, he asked, "Is your maiden name Ward?"

"Yes," I answered.

"Is Bill Ward your dad?" he questioned.

"Ahh, yes," I replied, dumbfounded.

"Your father and I figured a out a few years ago that we're very distantly related on the Lean side," he told me.

Although we share the Ward name, Terry Ward and I are not related. But he did remember being on

my family's farm back in the 1970's when he worked for the Murphy Products Division of the Schlitz Brewing Company. This division produced a trademarked product that was drier and had a longer shelf life than wet brewers grains and was sold to cattle farmers.

And I can't forget Woody Voigt, another retired superintendent and WGCSA past president. He was superintendent for the Ozaukee County Park Commission which included two golf courses. My husband, Luke, worked for Woody for two summers at Hawthorne Hills, and he well remembered Woody's ever-present cigar. And my father-in-law, who worked for the Ozaukee County Highway Department, also had fond memories of Woody through their connection as county employees.

**In conclusion...**

After writing for 10 years about people connected to the turf industry, I've made a few observations.

One, most people are really glad to be working in the industry. Some are downright excited! I sensed that most of my "subjects" are very dedicated to their professions and enjoy the challenges that they face.

Two, most people like to talk about themselves. It's very flattering to have an article written about you, and all but two of my "subjects" were very accommodating. Some were modest and had to be questioned a bit more.

Others spoke freely and volunteered lots of information. But all were genuinely flattered to be featured.

Three, everyone has a story to tell. Granted, some are more eventful than others. But everyone seems to belong where they are, whether by choice or by chance. Everyone's life is important.

So thanks for giving me the opportunity to write the Personality Profile these past 10 years. I hope you've enjoyed getting to know these 61 personalities as much as I have. ♣



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