# Should I Be Balancing Soil Cations?

*By* ***Sean P. Hearden and Brian J. Pyszka****, Department of Soil Science, University of Wisconsin-Madison*

As the turf industry continues to expand and new products are being marketed, it's becoming easier and easier to get confused by manufacturers' claims. There are scientific reasons behind every claim made, but it is left up to the consumer to discern whether or not it is "good" or "bad" science that supports a company's assertion. One hot topic in the area of soil fertility is the BSR (Base Saturation Ratio) theory. This is a fertility practice that has been researched since the 1890s by many qualified soil scientists largely on legume crops. The idea behind the theory is that if the base cations (Ca, Mg, K, and Na) are present in the correct saturations of soil cation exchange capacity (CEC), the pH of that soil will automatically adjust itself to 6.0 to 6.5, a range in which all soil nutrients are highly available. The BSR theory recommends that the base cations take up 80% of a soils CEC and that the concentrations of these cations with respect to each other in soil should be in the following ranges: Ca, 65 to 85%; Mg, 6 to 12%; K, 2 to 5%; and Na, 1 to 2%. The remaining 20% of the CEC should be occupied by hydrogen (Albrecht and Smith, 1951). In recent years, this has become a popular soil fertility management practice for turfgrass. In spite of its popularity, there is quite a bit of research that suggests that it is not at all necessary in the management of turfgrass. The remainder of this discussion will look deeper into this research and research just concluded by Brian and myself under the guidance of Dr. Wayne Kussow in order to determine the relevance of BSR theory in bentgrass establishment.

**The Evidence**

Though there are several studies available that could be discussed, we'll limit our discussion to two of these studies. The first of these studies was conducted at Ohio State University by Eckert and McLean (1981). Here, a single soil was treated in several different ways so as to provide a wide range of base saturation ratios for the growth of German millet and alfalfa. The second study is the one reported here, conducted in the spring of 2002. Our research was conducted in the greenhouse and used four different putting green root zone mix amendments to grow creeping bentgrass.

The Eckert and McLean (1981) study divided their results into two categories: highest yield and lowest yield. There was little variance in yield within each of the two categories. They then pitted the soil properties of each group against each other and found that there was not a distinctive set of base saturation ratios coupled with either high or low yields. They also found that soils with the same set of properties may produce high or low yields (Eckert and McLean, 1981). These results indicated that crops act in response to amounts of exchangeable base cations rather than their percent saturations.

Our research builds upon Eckert and McLean's (1981) findings. Our four treatments consisted of pure calcareous sand and three treatments of calcareous sand amended on an 80/20 (v/v) basis with each of these materials: peat, porous ceramic, and zeolite.

**Table 1:** Base cation concentrations in each treatment.

| Treatment | % Ca | % Mg | % K | % Na |
|---|---|---|---|---|
| Sand | 58 | 18 | 20 | 5 |
| Sand + Peat | 53 | 22 | 17 | 3 |
| Sand + Porous Ceramic | 47 | 18 | 32 | 3 |
| Sand + Zeolite | 17 | 7 | 26 | 50 |
| BSR Recommendations | 65 to 85 | 6 to 12 | 2 to 5 | 1 to 2 |

**Table 2:** Nutrient concentrations in plant tissue.

| Treatment | % Ca | % Mg | % K |
|---|---|---|---|
| Sand | 0.74 | 0.45 | 2.4 |
| Sand + Peat | 0.69 | 0.37 | 2.36 |
| Sand + Porous Ceramic | 0.58 | 0.37 | 2.57 |
| Sand + Zeolite | 0.79 | 0.48 | 2.61 |
| Recommended | 0.25 to 0.5 | 0.2 to 0.4 | 1.75 to 2.50 |

**Table 3:** Quantities of exchangeable base cations.

| Treatment | Ca | Mg | K | Na |
|---|---|---|---|---|
| | ------------------- | meq/100 g | ------------------- | |
| Sand | 0.33 | 0.22 | 0.13 | 0.03 |
| Sand + Peat | 0.61 | 0.31 | 0.21 | 0.03 |
| Sand + Porous Ceramic | | | | |
| Sand + Zeolite | 1.9 | 0.77 | 3.95 | 5.55 |

**Table 4:** Clipping mass and cation exchange capacity.

| Treatment | Clipping mass | CEC |
|---|---|---|
| | mg | |
| Sand | 89.7 | 0.59 |
| Sand + Peat | 94.3 | 1.16 |
| Sand + Porous Ceramic | | |
| Sand + Zeolite | 297.3 | 11.17 |

Each treatment was replicated three times and packed into cylinders 12 inches deep and 4 inches in diameter above a layer of pea gravel. At this point, each cylinder received 3 lb K/M as K2SO4 and was then leached to provide differing base saturation ratios. After a day, starter fertilizer was incorporated into the top inch of soil in each treatment and seeded. Each cylinder was uniformly fertilized as needed. After tillering had occurred, all treatments were allowed to grow for an equal amount of time until enough clippings could be acquired for analysis.

The results of this experiment speak volumes. In looking at Table 1, we see that the base saturation ratios of each of the four treatments vary a great deal from those recommended by BSR theory. Table 2 shows plant tissue concentrations of base cations in each treatment. In comparing the two tables, it is obvious that there is wide range of percent saturation of cations in the soil and a narrow range of concentrations of the same cations in plant tissue. This indicates that there is no significant correlation between saturation ratios and plant nutrient uptake. Table 3 shows the quantities of exchangeable cations in the soil. Again, there is a wide range between each of the treatments, which would seem to point out that so long as there is enough nutrient available, the plant will take it up in concentrations in which it is needed. Table 4 compares clipping mass with total soil CEC. Notice that the clipping mass increases as CEC does. This is additional evidence that plant growth is not a function of base saturation in the soil, but the quantities present.

**Conclusions**

It seems evident from both of the studies presented here that BSR theory is not a necessary fertility practice in managing turfgrass. The results do not indicate that strict adherence to the practice is detrimental to turf, but rather that it is simply not an obligatory practice. There is no evidence that BSR theory practices produce a higher quality turf than traditional fertility regimes based on the amounts of exchangeable cations in soils. The true beneficiaries of the theory are not those who employ it, but those who sell it. Save your money and apply only as much K, Ca, and Mg as needed to bring their soil concentrations to the optimum ppm or lb/acre.

**References**

Albrecht, W.A., and G.E. Smith. 1951. Soil acidity as calcium (fertility) deficiency. Missouri Agric. Exp. Stn. Res. Bull. 513.

Eckert, D.J., and E.O. McLean. 1981. Basic cation saturation ratios as a basis for fertilizing and liming agronomic crops. I. Growth chamber studies. Agron. J. 73:795-799.

*Editor's Note: Sean Hearden and Brian Pyszka will graduate in December 2002 from the UW-Madison Turf and Grounds Management Program. Sean is currently interning at the Green Bay Country Club, and Brian at the Atlantic City Country Club. Both men are undergraduate advisees of Professor Wayne R. Kussow.*