Results of a Three-Year Study on Improving Soil Health with Chandler Products

Introduction

The field selected for this study is a 160 acre tract situated a few miles northeast of Geneseo in northern Henry County, Illinois. The field is nearly level and has moderately heavy soil that has clay to clay-loam texture. At the time we started the study in 2011, the soil was heavily compacted and poorly drained with relatively low organic matter for this soil type. Much of the trouble with the farm was due to excess magnesium (Mg) from the local lime sources, and the field had been over-limed for several years prior to 2011. The new landowner was familiar with the Chandler products and asked us to recommend treatments.

	West side	East side
Clay	52.8%	28.8%
Sand	27.2%	25.2%
Silt	20.0%	46.0%
Texture	Clay	Clay loam

The traditional treatment for high-magnesium soils is to increase calcium (Ca) sharply in order to improve the amount of air space or flocculation in the soil, which should help to leach out the excess Mg over time. Based on our previous experience with similar soils, we know that problems with compaction and limited air and water movement may also be reduced by increasing soil biological activity. The microbes flocculate the soil by increasing soil colloid formation, and their activity could also help to leach the excess Mg from the soil.

In spring 2011, we began applying Chandler Soil at the 16 ounce per acre rate in fall and spring, which is twice the recommended rate per year. Over the three-year study period, the total cost of the double-rate Chandler Soil treatments was $60 per acre ($10 per acre for each treatment multiplied by 6 treatments), which was half the cost of the recommended gypsum application of 3 tons per acre ($120 per acre). We also applied Chandler Biocat 1000 at the 16 ounce per acre rate each fall to accelerate residue decay on the field.

Changes in Soil Penetrometer Readings

A penetrometer measures the force required to penetrate the soil profile, and it is useful for evaluating the degree of soil compaction. The penetrometer readings are stated in pounds per square inch (PSI), and a reading of 100 PSI at a particular depth indicates that only 66.7% of plant roots could penetrate this soil layer. Soil layers that exhibit 200 PSI of pressure only allow 33.3% of the roots to penetrate, and 300 PSI corresponds to zero root penetration.

We insert the penetrometer into the soil and measure the depth where the penetrometer gauge first reaches 200 PSI. The readings are taken at 12 distinct locations in the field, and we use the same locations each year. The average depth and the range of depth measurements from the past three years are listed in the table. Higher depth readings indicate that the soil is less compact and the roots have more potential to grow deeply in the soil.

	Average	Range
June, 2011	4 inches	3 to 6 inches
Sept., 2012	8 inches	6 to 9 inches
Sept., 2013	15 inches	13 to 21 inches
June, 2014	21 inches	15 to 25 inches
Oct., 2014	27 inches	27 inches

Soil depth where penetrometer first reaches 200 PSI. Higher readings indicate the soil is less compacted.

When we first started working with this field, the soil was heavily compacted and the average penetrometer reading was only 4 inches. After one year, the average depth of uncompacted soil had increased to 8 inches. This improvement of 4 inches of uncompacted soil in one year is actually less than our long-term average (6 inches per year), but it reflects the poor initial condition of the soil in this field. However, the improvements accelerated after the first year, and the average depth of uncompacted soil increased by 7 inches per year in the second year and by 12 inches per year in the third year. These above-average gains during the last are due to the improved biological activity generated by the fall and spring applications of Chandler Soil plus the fall-only application of Chandler Biocat 1000. When we took the last set of measurements in October, 2014, all of the readings were 27 inches, which is the full-length of the penetrometer probe. At this point, there was no evidence of heavy soil compaction at any location in the field.

Changes in Soil Tests from 2012 to 2014

We conducted complete soil tests in Fall 2012 (after one year) and again in Fall 2014 (after three years), and the summary of results is presented in the following table. The east and west soil samples were collected from the same field locations during 2012 and 2014, and the samples were analyzed by AgSource Harris Labs.

Mg and Ca base saturation --- in 2012, the sums of the Ca and Mg base saturation percentages for both sides of the field were over 90%, which is well over the 80% maximum threshold for most soils. By increasing the microbial activity in the field with Chandler Soil, we were able to reduce the Mg levels without adding Ca, and the sum of the Mg and Ca base saturation percentages have fallen to about 75%. We don't want the Ca percentage to decline much more, but the Mg percentage could decline by another 5 to 10%.

CEC, sulfate, and pH --- as the Mg and Ca base saturation percentages decline, the cation exchange capacity (CEC) and pH of the soil decline. Soils with high CEC tend to be compacted and poorly drained, so modest declines in CEC from high levels are desirable. The excess Mg attaches to sulfate ions and leaches out of the soil, so some of the decline in sulfate levels from 2012 to 2014 is due to the removal of excess Mg. The soil is a bit more acidic due to the loss of the cations, but pH is still in the desired range. Now that the soil structure is open, gypsum (calcium sulfate) could be used to amend the Ca, sulfate, and pH levels as needed in the future.

Organic matter, NKP, and zinc --- one of the most impressive gains in both sides of the field is the large jump in organic matter. We typically see an increase in soil organic matter over time as the degree of microbial activity increases with regular applications of both Chandler Soil and Biocat 1000. The landowner has noticed the improved rate of residue breakdown in the field over the past few years, which helps to make more nutrients available. Accordingly, the available nitrate nitrogen has increased on the west (corn-on-corn) side of the field since 2012. On both sides of the field, the available phosphorus has more than doubled, the available potassium has increased by about 33%, and the available zinc has increased from low to adequate levels.

Sodium --- high sodium levels are a sign that water is not able to move through the soil layers. The sodium levels in both sides of the field have declined in the past two years due to the improved soil structure.

	West side of the field		**East side of the field**		**Comments**
	2012	**2014**	**2012**	**2014**	
Buffer pH	7.0	6.4	6.9	6.6	Preferred range is 6.4 to 6.9
Organic matter	2.2%	4.4%	2.2%	3.2%	Higher OM% is better
Cation exchange	32.9	29.9	35.4	24.9	Typically 29 to 40 for clay loam
Bulk density	1.2	1.2	1.2	1.2	BD > 1.5 restricts root growth
Sodium	113 ppm	17 ppm	59 ppm	14 ppm	Higher sodium values indicate poor water infiltration
Elemental Analysis (parts per million, ppm)					
Nitrate	3.0	4.4	8.2	3.3	East side in beans during 2014
Phosphorus	14	34	5	12	15-40 ppm is adequate
Potassium	219	299	165	221	200 to 300 ppm is adequate
Sulfate	19	5	3	3	5 to 25 ppm is adequate
Zinc	0.9	1.5	1.2	1.4	1.3 to 3.0 ppm is adequate
Base Saturation (percent)					
Magnesium	37.3	24.8	29.4	25.4	Preferred range is 15 to 20
Calcium	59.6	48.9	61.9	52.1	Preferred range is 60 to 75
Mg plus Ca	96.9	73.7	91.3	77.5	Mg+Ca > 80 means excess Mg