Turfgrass nutrition: iron, manganese and magnesium

By Travis Shaddox, Ph.D., J. Bryan Unruh, Ph.D., and Jason Kruse, Ph.D.

Iron (Fe), manganese (Mn) and magnesium (Mg) are plant essential elements just as important to plants as carbon, hydrogen and oxygen. As such, turfgrass grown in the absence of these elements would either die or not be able to complete its lifecycle. This is why Fe, Mn and Mg are likely common components of your nutrient programs. However, it has been our observation that very little thought has been given to the form in which these elements are applied. Foliar versus granular applications vary greatly in their ability to introduce these three elements into the turfgrass system. For example, some herbicides are far more effective when they are applied to the leaf surface (foliar) than when applied to the soil (granular) and vice versa. This same rationale may be true for certain nutrients.

In 2014, we designed an experiment to answer a simple question: "How does bermudagrass respond to different sources of Fe fertilizers?" Little did we realize, that simple question would evolve into 10 separate studies (and counting) spanning the entire state of Florida from the Panhandle to Fort Lauderdale. The expansion of this project was largely due to the interest we received from people like you. Superintendents, landscape professionals, and fertilizer applicators and blenders have been very interested in our findings. Our results are contrary to popular opinion and even to our own initial understanding of the soil/turfgrass system. As the data continues to come in, we may now begin communicating the initial results, provide an explanation and deliver preliminary recommendations. The following is a brief synopsis of our Fe, Mn and Mg research.

STUDIES 1–4: BERMUDAGRASS RESPONSE TO IRON FERTILIZERS

Location: Citra and Jay
Length: Six weeks
Applications: One
Treatments: Untreated control, Fe sulfate liquid, Fe sulfate, Fe sucrate, Fe humate, Fe oxide and Fe chelate (EDTA) (see Figure 1)
Rate: 20 lbs. of Fe per acre (This rate far exceeds the recommended rate for EDTA and foliar applications, but is normal for granular applications.)
Results: In the first year, only Fe sulfate liquid increased turf quality. In the second year, Fe sulfate liquid, Fe EDTA and Fe humate increased turf quality. Granular Fe sulfate, Fe sucrate and Fe oxide did not influence turf quality.

STUDIES 5–6: ST. AUGUSTINEGRASS RESPONSE TO FE, MN AND MG FERTILIZERS

Location: Citra and Jay
Length: Four months
Applications: Monthly
Treatments: Untreated control, Fe sulfate liquid, Fe glucoheptonate, Fe sulfate, Fe sucrate, Mn sulfate liquid, Mn glucoheptonate, Mn sulfate, Mn sucrate, Mg sulfate liquid, Mg glucoheptonate, Mg sulfate and Mg sucrate
Rates: Granulars = 20 lbs. of element per acre; liquids = 2 lbs. of element per acre
Results: Liquid Fe sulfate and Fe glucoheptonate consistently increased

Figure 1. Aerial photograph of Princess bermudagrass three weeks after applying iron. Each dark green rectangle received liquid iron sulfate. All other rectangles received granular iron sources or no iron.

turf quality. After the fourth application, Mg sulfate liquid increased turf quality. Granular forms of Fe, Mn or Mg did not influence turf quality.

STUDY 7: BERMUDAGRASS RESPONSE TO SPARGED, CHELATED MINOR ELEMENTS

Location: Citra
Length: Four months
Applications: Monthly
Treatments: Untreated control, Fe sulfate, Fe sucrate, Fe chelate 13 percent, chelated Fe (13 percent Fe) sparged on gypsum, chelated minors (8 percent Fe, 4 percent Mn, 0.5 percent Mg) sparged on gypsum and chelated minors [7.5 percent Fe, 8 percent Mn, 4.5 percent zinc (Zn), 2.3 percent copper (Cu), 1.3 percent boron (B), 0.04 percent molybdenum (Mo), 13 percent sulfur (S)] sparged on gypsum
Rates: Granulars = 20 lbs. of Fe per acre; sparged = 0.5 lbs. of Fe per acre
Results: None of the treatments increased turf quality.

STUDY 8: BERMUDAGRASS RESPONSE TO VARYING RATES OF SPARGED, CHELATED MINOR ELEMENTS

Location: Gainesville
Length: Six weeks
Applications: One
Treatments: Untreated control, Fe chelate 13 percent, chelated Fe (13 percent Fe) sparged on gypsum, chelated minors (8 percent Fe, 4 percent Mn, 0.5 percent Mg) sparged on gypsum and chelated minors (7.5 percent Fe, 8 percent Mn, 4.5 percent Zn, 2.3 percent Cu, 1.3 percent B, 0.04 percent Mo, 13 percent S) sparged on gypsum
Rates: 0, 1, 5, 10 and 20 lbs. of Fe per acre
Results: Treatments did not increase turf quality at any rate.

STUDY 9: RAPID EXTRACTION OF IRON FERTILIZER SOURCES

Location: Gainesville
Treatments: Fe EDTA, Fe sulfate, Fe humate, Fe sucrate and Fe oxide
Results: Fe extracted from Fe EDTA, Fe sulfate, Fe humate, Fe sucrate and Fe oxide was 313, 103, 35, 4 and 0.5 percent, respectively, of the guaranteed analysis.

STUDY 10: SOLUBILITY OF FE, MN AND MG IN TWO ALKALINE SOILS (INCUBATION STUDY)

Location: Gainesville
Length: Three weeks
Treatments: Untreated control, Fe sulfate, Fe glucoheptonate, Mn sulfate, Mn glucoheptonate, Mg sulfate and Mg glucoheptonate
Results: More than 95 percent of applied Fe became insoluble within one hour of entering the soil solution. Approximately 50 percent of applied Mn became insoluble within one hour. The remaining Mn remained sparingly soluble for three weeks. About 90 percent of applied Mg remained soluble for three weeks. Glucoheptonate did not increase solubility of Fe, Mn or Mg.

SUMMARY DISCUSSION

From the results summarized in Table 1, a few conclusions can be made. First, foliar applications of Fe resulted in more consistent turfgrass response than granular Fe. In fact, the only granular iron sources that resulted in a response were Fe humate and Fe EDTA. If you are using one of these two granular Fe sources, then pat yourself on the back. However, remember that we tested rates that may far exceed the rates you used. For example, you may be applying granular Fe EDTA in a blended fertilizer containing less than 0.5 percent chelated Fe. In this case, you would be applying Fe between 0.5 and 1.5 lbs. per acre. We used 20 lbs. of Fe per acre, which is nearly 40 times higher!

A second conclusion we may draw is that Mn and Mg are less likely to induce a response than Fe. We did not observe Mn to increase turfgrass quality in any

Fertilizer	Form	Derived From	Fe	Mn	Mg	Studies	Response	Response
			Percent			Number		Percent
Fe-Gluco	L	Glucoheptonate	6	0	0	2	2	100
Fe-Sulfate	L	Sulfate	6	0	0	6	6	100
Fe-Sulfate	G	Sulfate	30	0	0	7	0	0
Fe-Sucrate	G	Sucrate	50	0	0	7	0	0
Fe-Chelate	G	EDTA	5	0	0	4	2	50
Fe-Humate	G	Humate	14	0	0	4	1	25
Fe-Oxide	G	Oxide	50	0	0	5	0	0
Mn-Gluco	L	Glucohepatonate	0	5	0	2	0	0
Mn-Sulfate	L	Sulfate	0	5	0	2	0	0
Mn-Sulfate	G	Sulfate	0	32	0	2	0	0
Mn-Sucrate	G	Sucrate	0	50	0	2	0	0
Mg-Gluco	L	Glucoheptonate	0	0	4	2	0	0
Mg-Sulfate	L	Sulfate	0	0	4	2	1	50
Mg-Sulfate	G	Sulfate	0	0	10	2	0	0
Mg-Sucrate	G	Sucrate	0	0	50	2	0	0
Chelated Minors	P	Unknown Chelate	8	4	0.5	2	0	0
Chelated Minors	P	Unknown Chelate	13	0	0	2	0	0
Chelated Minors	P	Unknown Chelate	7.5	8	0	2	0	0
Chelated Minors	P	Unknown Chelate	13	0	0	2	0	0

L = liquid, G = granular, P = sparged powder

Table 1. Summarization of field and greenhouse studies investigating turfgrass responses to various forms of Fe, Mn and Mg

study, whereas foliar Mg sulfate did increase turfgrass quality in one study.

The primary reason why granular forms of Fe and Mn are not increasing turf quality is due to the rapid oxidation of these metals in our soils. Our incubation study clearly found that nearly all Fe was unavailable within one hour of entering the soil solution, and most Mn was insoluble after the first day of application.

In order to increase the amount of soluble Fe and Mn in the soil solution, you may choose to use a chelate. While this decision seems logical, we found that the glucoheptonate is incapable of increasing the solubility of Fe, Mn or Mg in the soil solution. While glucoheptonate formulations of Fe, Mn and Mg may provide other benefits such as foliar absorption and liquid fertilizer stability, they do not provide any advantage or disadvantage with respect to chelation in these soils.

Do not doubt the necessity of Fe, Mn and Mg in turfgrass management. If the plant is deprived of these elements, turfgrass quality will eventually decline, and turfgrass death may occur. However, the methods in which these elements are delivered into the soil turfgrass system greatly influences the plant's ability to uptake these applied nutrients.

Foliar applications of Fe, Mn and Mg are more effective than granular applications for many reasons. First, foliar applications avoid the soil solution where oxidation of these elements renders much of the nutrients unavailable for plant uptake. Second, foliar applications greatly increase the uniformity of nutrient distribution, especially when very small quantities of minor elements are needed. Lastly, leaf absorption can be much more rapid than root uptake. The use of granular Fe, Mn or Mg at rates normally applied in blended fertilizer may not necessarily be detrimental to your turfgrass management program. However, in order to maximize product efficiency and turfgrass quality, foliar-applied Fe, Mn or Mg would be a better choice than granular-applied.

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Rates used in these studies are for experimental purposes. Always follow labeled rates.