SULFUR IS THE MISSING INGREDIENT IN MANY FORAGE STANDS

Forage crops, where sulfur (S) has often been overlooked, are increasingly responding to applied S. For generations, growers enjoyed "free" S from atmospheric deposition and impurities in commercial fertilizer. However, cleaner air and more concentrated nitrogen (N) and phosphorus sources have diminished those "free" inputs.

By the early 2000s, Dr. Ev Thomas, who at the time was soil scientist at The Miner Institute in Chazy, N.Y., estimated that atmospheric depositions in his area were down to just 30 to 40 percent of what they had been a decade before. A University of Wisconsin forage bulletin written by extension soil scientists John Peters and Dr. Carrie Laboski reported that growers in the Badger State received only one-third of the aerially deposited S in 2013 compared to what was received 30 years ago.

As a result, S deficiency has become common in many fields traditionally non-responsive to S fertilization. A 1999-2001 University of Wisconsin study of alfalfa tissue samples found that more than one-third of the samples were low in S. In a study Laboski conducted 10 years later, she found low tissue S levels in 88 percent of the samples. A sobering note was that 58 percent of the S-deficient tissue samples came from fields that did not show visual symptoms of S shortages.

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>
> *– Dr. Carrie Laboski, University of Wisconsin*

First Time in Memory

Even where symptoms of S deficiency were apparent, Laboski's 2010-2011 study revealed that sulfur deficiency was not always recognized by farmers who had not encountered the yellowing and stunting before.

"In the southwest part of the state, at that time, we were seeing a lot more sulfur deficiency popping up, and people weren't really familiar with that," she recalled. "Now, people are more familiar with the issue. They're either using sulfate prophylactically — 'I know I've had problems with this field' — or taking a wait-and-see approach."

Yield Boost

As farmers began recognizing the need to apply S on some fields, many began to observe yield increases where sulfur was applied to crops on S-deficient soils, said Dr. Rob Kallenbach, forage extension researcher and assistant dean at the University of Missouri.

"We started seeing responses to sulfur in high-protein crops like alfalfa," Kallenbach said. "We also know our cool-season grasses have a sulfur requirement as well."

Kallenbach recently presented a 2015 study of tall fescue pastures he conducted at the university's Forage Systems Research Center near Linneus, Mo. Among 27 treatment combinations, the only significant yield response came from S-containing products, which increased yields by 600 to 700 pounds of forage per acre. He is currently sorting through palatability data from the trial.

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Big Users

Alfalfa and many other forages are highly susceptible to S deficiency because they demand a lot of sulfur. While at the Miner Institute, Thomas compiled a chart in the early 2000s noting that per ton of forage alfalfa hay and most grasses actually remove significantly more sulfur than corn silage (see Table 1).

Table 1: Crop Removal of Sulfur by Different Forages

Forage	Pounds S/Ton
Alfalfa hay	5
Most grasses	4-6
Ryegrass	8
Corn silage	1

Source: Dr. Ev Thomas, The Miner Institute, 2003.

Sulfur trials on Wisconsin farms that exhibited patchy S deficiency led to significant yield improvements in the second and third cuttings, Laboski noted.

"There were easily one-ton yield responses from just 25 pounds of sulfur in the sulfate form," she said. "One site was close to two tons. A one-ton yield bump more than pays for that fertilizer and application."

A Cornell University study measured an average yield increase of 17 percent in alfalfa on S-deficient fields that were treated with sulfur.

Farther upstate, near the Canadian border, Thomas had conducted S trials with a forage grass blend, finding a 17-percent increase in yield where 100 pounds of N were applied as ammonium sulfate (AS) rather than ammonium nitrate on a timothy/orchardgrass/canarygrass mix even back in 1996. In a 2003 corn silage study, Thomas reported the increase in forage yield produced by using ammonium sulfate rather than calcium nitrate as source of 40 pounds of N in the starter fertilization led to an increase in milk production of 680 pounds per acre – all plots were sidedressed with 100 pounds of N in the form of urea-ammonium nitrate (UAN) solution (see Figure 1).

Fast Turnaround

Eric Young, who is the Miner Institute's current soil scientist, noted that manure is a principal source of S on forage crops in his region. In Wisconsin, Laboski frequently sees manure applied when alfalfa is seeded, but pointed out that many producers are concerned about damaging their crops with clumps of manure or crown damage from spreader traffic, so S levels in some alfalfa stands can steadily decline if fields are not topdressed.

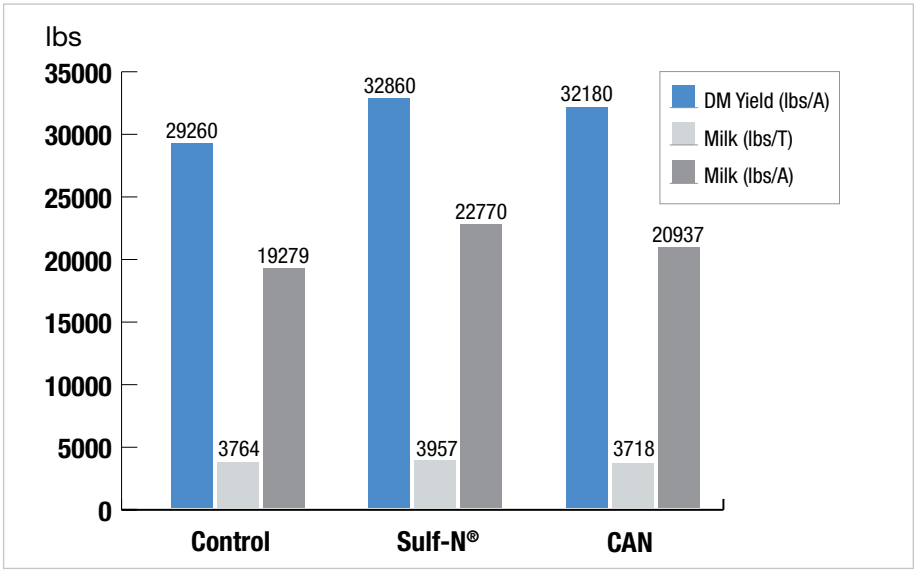
In alfalfa, Laboski recommends 25 to 50 pounds of S per acre at seeding or 15 to 25 pounds topdressed. She noted that sulfate-S can have a rapid impact on deficiencies in alfalfa.

"It turns around pretty fast," she said. "If before your first cut you find out there was a problem, and you come right back with a buggy, the regrowth comes back so much better."

Applying elemental-S would not yield the same quick results, Laboski cautioned.

"Soil bacteria need to convert it from elemental sulfur to sulfate," she explained. "If you have a problem in the field today, you want to fix it as soon as possible and that can be done with the sulfate form (of sulfur). If you apply right after first cut, by second cut you will not see any differences (associated to sulfur deficiency) in the field."

Figure 1: Ammonium Sulfate Effect on Corn Silage and Milk Yields



Source: Dr. Ev Thomas, The Miner Institute, 2003.

Ammonium Sulfate Is Immediately Available

One of the most popular sources of S fertilizer on pastures and forage crops is ammonium sulfate, which delivers sulfate-S and ammonium-N. Throughout the eastern half of the United States, ammonium sulfate is applied over the top of pastures and forage grasses without the need for a volatilization inhibitor.

Though N fertilization is not as necessary for alfalfa, ammonium sulfate is often recommended the seeding year to give the crop a boost while nodulation is getting started. The deep-rooted crop will also put to use any N applied after each cut, and ammonium-N can actually help boost S uptake. Kallenbach noted that the sulfate-S in ammonium sulfate is immediately available to plants and that ammonium nutrition promotes uptake of all anions, including sulfate-S.

In a three-year study Kallenbach conducted with colleagues at Missouri's Southwest Research and Extension Center near Mt. Vernon, Mo., ammonium sulfate ranked in the top-producing group at nearly all harvests and locations (see Table 2).

Table 2: Effect of Nitrogen Source on Tall Fescue Dry Matter Yield Averaged Across Three Years

Nitrogen Source (75 lbs N/Acre)	Dry Matter Yield – Mt. Vernon, MO (lbs/Acre)
Ammonium Sulfate	5,667
Urea + NBPT	5,319
Ammonium Nitrate	5,233
Urea	4,866
Polymer-coated Urea	4,206
No N Check	2,483

Source: Alternative Nitrogen Fertilizers to Ammonium Nitrate for Tall Fescue Pastures. Alliance of Crop, Soil and Environmental Science Societies. Poster 339-1405, 2016.

Know Your Soil

Laboski emphasizes to farmers the importance of knowing their soils to help decide whether they need to apply S. Wisconsin is home to a wide range of soil types, from sandy soils with less than one percent organic matter to rich, deep prairie soils with five percent organic matter, she noted, pointing out that many fields are underlain with a finer subsoil that can catch sulfate and hold it for crop roots to pick up later in the season, so it is very important to understand soils in each field. She added that it is also worthwhile to pay attention to contributions from manure or even atmospheric deposition in a few areas that may still be downwind of significant emitters.

The key, Laboski emphasized, is being aware that the days of "free" S are over. "You just need to keep soil testing," Laboski said. "Keep your eye on what's happening."

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September 2019-3, Printed in U.S.A.

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