Spreading the Word

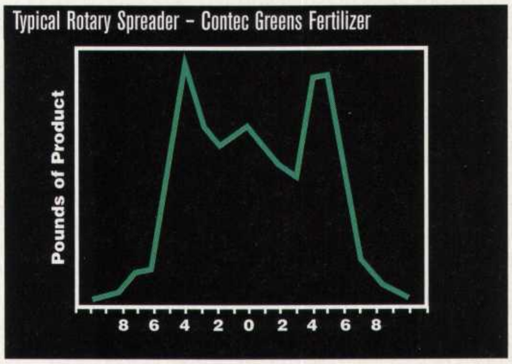
Streaks, skips, speckling and time-consuming reapplications are often the result of fertilizer formulations with poor uniformity, widely varying bulk densities and poor flowability. Sometimes, however, the fertilizer itself is not the culprit. The fertilizer spreader and the applicator are variables that are sometimes overlooked when troubleshooting an application that has gone awry.

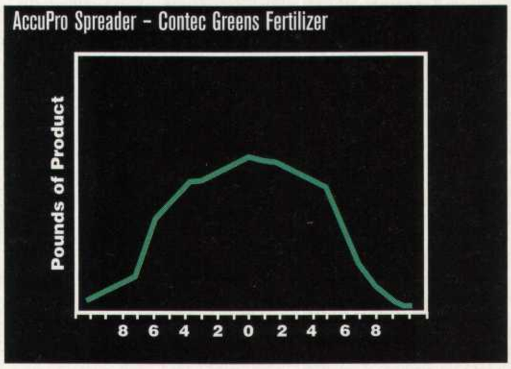
Today's low-cut greens, tees, and fairways are frequently maintained at reduced fertility levels and are less forgiving when an inappropriate rate of fertilizer is applied. Under these circumstances, the role of the applicator and the fertilizer spreader become all the more crucial. Fertilizer spreader walking-speed demos conducted by The Andersons at field days this spring indicated that as many as half of the applicators walked at least .5 mph faster than the three miles per hour required by the label. Application errors of this type result in insufficient product applied. This can result in particle speckling, skewing and poor turf response.

The Andersons rotary spreaders (AccuPro 2000 and SR 2000) can't compensate for improper walking speed. But its patented, adjustable helical cone does compensate for a range of particle densities and weights, by placing larger granule products closer to the center of the impeller and smaller lighter granule products closer to the edge. This insures a more uniform distribution of nutrients across the spreader pattern. Pneumatic tires, stainless-steel bearings, grease fittings in major wear areas, heavy-duty gears and welded frames are additional features designed to insure years of easy operation and reliable service.

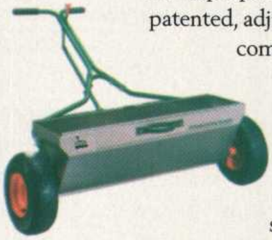
Proper calibration is essential to achieve consistently accurate applications. Verifying calibration is simple when a calibration "key" is used and the steps outlined in The Andersons Rotary Spreaders poster are followed. Contact your Andersons distributor to obtain a calibration "key" and Rotary Spreaders poster. The Andersons Rotary Spreader poster provides graphically illustrated, easy-to-understand descriptions of how to set the spreader, calibration, maintenance and the importance of correct walking speed. A fertilizer "collection box" can also be used to help insure the most accurate calibration.

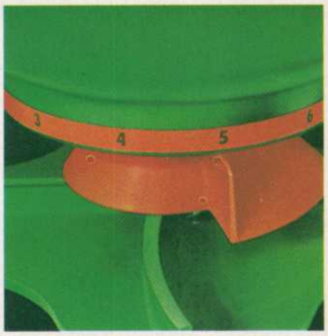
For maximum accuracy, The Andersons offers the SS-2 Drop Spreader equipped with a stainless-steel hopper, pneumatic tires and precision calibration. It is ideal for applying soil amendments, seeding greens and tees and applying Andersons FFII 14-3-3 for snow-mold protection this fall.





The graphs above illustrate the difference in the spread pattern of a rotary spreader without a pattern regulator with the spread pattern of the AccuPro 2000 with a helical cone adjustment. The smoothly feathered edges of the AccuPro spread pattern helps to minimize streaking.





The unique helical cone adjusts to control the spread pattern for particles of different sizes.

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TABLE 1

Key turfgrass pests, their host plants, symptoms, and suggested damage thresholds.[a]

Arthropod pests	Preferred hosts	Damage symptoms	Suggested damage thresholds
Bermudagrass mite	Bermudagrass	Yellowed leaf tips, shortened internodes resulting in tufted growth.	Not determined
Billbugs ▪ Bluegrass, Denver, Hunting, Phoenician)	Cool-season grasses, bermudagrass, zoysiagrass	Larvae burrow down grass stems to the plant crown,killing stems and larger turf areas. Often misdiagnosed as drought, other insects or disease.	1 to 6 billbugs per sq. ft.
Caterpillars			
▪ Armyworm	Many grasses, small grains, legumes	Skeletonized or completely consumed foliage, with circular bare spots.	3 to 4 larvae per sq. ft.
▪ Cutworm	Many grasses and crops	Circular spots of clipped or dead grass near holes.	Not determined
▪ Fall armyworm	Bermudagrass, cool-season grasses, grains	Skeletonized or completely consumed foliage.	Not determined
▪ Sod webworm	Cool-season grasses, small grains	Small patches of chewed leaves or stems.	Not determined
▪ Tropical sod webworm	Most warm-season grasses	Notched leaves, ragged appearance.	5 to 8 larvae per sq. ft.
Chinch bugs ▪ (Hairy, Southern, Common)	Cool-season grasses, St. Augustinegrass	Foliage yellows, wilts and dies in small spots,then larger patches.	15 to 25 chinch bugs per sq. ft.
Mole crickets ▪ (*Scapteriscus* spp.)	Bermudagrass,bahiagrass, other warm-season grasses	Tunneling below the soil surface and root feeding result in bare patches of turf.	2 to 4 tunnels per sq. ft.
Spittlebugs	Centipedegrass, St. Augustinegrass	Purple-red striping in turf, wet and spongy to walk on.	Not determined
White grubs			
▪ Black turfgrass ataenius	Annual bluegrass Kentucky bluegrass, bentgrasses	Root feeding, resulting in wilting and gradual thinning of turf.	40 to 100 grubs per sq. ft.
▪ Green June beetles	Kentucky bluegrass, tall fescue, bermudagrass, thin-skinned fruits	Root feeding results in wilting and dying grass. Grubs make mounds.	5 to 7 grubs per sq. ft.
▪ Japanese beetle	Most grasses	Grubs feed on roots and root hairs, resulting in turf wilting and thinning. Adults skeletonize tree and shrub leaves.	10 to 20 grubs per sq. ft.
▪ Masked chafers	Pasturegrasses and turfgrasses	Larval root feeding weakens grass, resulting in wilting and dieback. Adults do not feed.	10 to 20 grubs per sq. ft.
▪ May and June beetles	Many grasses	Grubs feed on roots,resulting in wilting and dieback. Adults eat leaves of grasses, herbs, shrubs and trees.	3 to 6 grubs per sq. ft.
▪ Oriental beetle	Turfgrasses and sugarcane	Grubs feed on roots near the soil surface. Adults feed on several flowering plants.	6 to 8 grubs per sq. ft.

[a] Thresholds vary depending on the condition and use of the turf.

Continued from page 40

Flotation — Floating is a kind of a flushing technique used to sample those insects that live in thatch, such as chinch bugs. There are two ways to do flotation. One way is to use a metal coffee can, cut both ends out, insert one end about 2 inches into the soil at the edge of damage and add warm water. Keep the water just at the tip of the grass blades and continually add water for a few minutes. Count the number of insects that float to the top. Or, using a hole cutter, remove a sample of turf and soil, place it into a bucket, and slowly add warm water to the top of the grass blades. Let the soil and turf core soak for several minutes, and then count the number of insects that emerge.

Soil sampling — For insects that live in the soil and do not respond to flushing or flotation, the main alternative is to dig into the soil with a spade or hole cutter and sift through the soil to find the insects. This is especially true for white grubs. Looking in the soil is important if the above-ground symptoms are difficult to diagnose.

Visual observations — The best monitoring technique is to be familiar with the signs and symptoms of insect injury. The more aware turf managers are of their environments, the better they will respond to pest problems.

Buss has been the turfgrass and landscape entomologist and extension specialist at the University of Florida since 2001.

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Survey Says: Iron Is A Must For Southwest Superintendents

By Connie Falk, Richard Ng, and John G. Mexal

Usually Southwest soils are calcareous (contain high levels of calcium) and have pH values ranging from 7 to 9. They are typically deficient in iron (Fe), manganese, zinc, and copper. Iron-deficient leaves become chlorotic due to reduced chlorophyll production and leaves are nearly white in advanced stages of Fe deficiency. The most common means of correcting deficiencies is Fe applications (Waddington et al., 1992).

Despite the importance of using Fe to avoid chlorotic turfgrass, managers often use nitrogen (N) to ensure green turfgrass. Excessive application of N, however, increases mowing costs and susceptibility to environmental stresses and diseases — and may adversely affect rooting (Turgeon, 1991).

Yust et al. (1984) found that during cool, wet periods following application, turfgrass color was enhanced through Fe applications without N, but only lasting two to three weeks. Application following cool dry periods resulted in color enhancement that lasted several months. Iron chelate, compared to ferrous sulfate ($FeSO_4$), produced the best overall results. Combining Fe with N can result in acceptable turfgrass color with lower rates of N.

Since relatively small actual quantities of micronutrients are needed by turfgrass plants, toxicities may result from over application of Fe or complex interactions with other essential elements (Waddington et al., 1992). Small quantities of fertilizers can be sprayed as chelates or sulfate on the leaves of the turfgrass to combat micronutrient deficiencies, ensuring quick absorption (Snyder and Schmidt, 1974). Chelates are expensive, so they are more often used as foliar sprays, which allows low application rates. Furthermore, foliar sprays are often better in the Southwest because plants there have difficulty absorbing micronutrients from the high pH soil.

The study

Large-scale copper mining was conducted on the Tohono O'odham Nation (TO) reservation, the largest in Arizona, in the 1970s. One result from the mining was a 100-acre settling lagoon containing a tailings stockpile of over 5 million tons of material whose arsenic (3 mg/kg) and lead (126 mg/kg) content is below the EPA limit for loading to agricultural soil, which is 41 mg arsenic/kg and 300 mg lead/kg. While these tail-

TABLE 1

Characteristics of Superintendents and Golf Courses Surveyed

		SUPERINTENDENT				GOLF COURSE								
State	No.	Yrs as Super. in this course		Yrs as Super.		Age of golf course in years			Number of Acres			Soil pH		
		MEAN	SD*	MEAN	SD*	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX
AZ	56	2.75	7.06	10	11.45	16.5	.5	73	100	42	485	7.8	6.5	8.8
CA	7	3	1.63	6	4.65	20	5	42	165	85	240	7.5	7	8.1
CO	66	5.25	7.87	11	9.14	16.5	.6	92	110	8	400	7.45	5.5	8.2
NM	8	6	6.77	13.5	15.61	40	6	50	100	75	260	7.98	7.4	8.25
NV	14	2	5.15	9	8.85	11.5	2	43	132	70	300	7.8	5.8	8.4
UT	15	8	7.51	15	9.58	31	2	90	120	72.5	220	7.8	6.8	9
Total	166													

*SD= Standard Deviation

ings contain no hazardous materials, they do have high amounts of iron (8 percent), and small amounts of other nutrients (2 percent sulfur, 4 percent magnesium, and 2 percent potassium and .8 percent copper) (Mexal et al., 2000). In addition, since cadmium, chromium and mercury are not present in the TO tailings, they would be suitable for land application if a beneficial use was found (Mexal et al., 2000).

In the event that the tailings are effective as a fertilizer, it would help clean up the landscape in the reservation area. In addition, the project could generate jobs and income for the tribe.

Foliar sprays are often better in the Southwest because plants there have difficulty absorbing nutrients from the high pH soil.

A niche for the TO tailings was thought to exist within the golf course market for several reasons. A local Helena Chemical Co. representative indicated that Ionate Co. products had been recently removed from the market (Blaeser, 2001). Ionate was an iron product derived from mining slag that had been treated with an acid to extract the iron. The acidification process also made the iron more available to plants because Ionate acidified the soil. However, the source material was high in lead and arsenic, and these heavy metal components were partially responsible for the dissolution of the company, which had operated in El Paso, Texas, since the 1950s (Blaeser, 2001).

Another reason the golf course market was targeted was because consumer branding, merchandising and advertising requirements were perceived as less challenging in the golf course market than in the home lawn care market.

The objective of this study was to assess the market potential of a new iron supplement fertilizer for use at golf courses in the Southwest. Superintendent use of and preferences for fertilizers, particularly Fe, in Southwestern golf courses were investigated through a mail survey to superintendents in Arizona, California, Colorado, New Mexico, Nevada and Utah during the summer to early fall of 2001.

The United States has an estimated 16,365 golf courses and 26.4 million golfers (GCSAA, 2000). At the time of the survey, there were 1,974 golf courses in the six-state Southwestern region: 336 in Arizona, 1,058 in southern California, 246 in Colorado, 100 in New Mexico, 116 in Nevada and 118 in Utah (*golfcourse.com*). Although there were 1,058 courses in Southern California, only 88 golf courses from one association in Southern California were surveyed. Generally, these states and regions were selected because they have soil conditions that most likely require Fe applications.

TABLE 2

Most commonly used brands by state

Brands	Total	AZ	CA	CO	NM	NV	UT
	# of respondents who use this product						
Ferromec® AC Liquid Iron	70	26	2	23	3	7	9
Milorganite	64	19	2	27	3	4	9
Fe 8%® iron chelate	56	19	1	30	2	3	1
Roots® 1-2-3	52	12	1	31	3	4	1
Ironite™	43	24	1	4	5	2	7
ironROOTS 2™ concentrate	30	6	0	20	2	2	0
Sulfate	20	11	0	5	2	0	2
Agriplex 2™ micro-mix	19	4	1	10	1	3	0
Ruffin liquid	10	1	0	9	0	0	0

TABLE 3

Price sensitivity for Greens (G) and Fairways, Roughs, & Tees (FRT)

State	Very Price Sensitive		Moderately Price Sensitive		Somewhat Price Sensitive		Not Sensitive		No Answer	
	G	FRT	G	FRT	G	FRT	G	FRT	G	FRT
	# of respondents concerned about price									
AZ	9	21	19	15	15	13	7	0	7	6
CA	3	5	3	0	1	0	0	0	0	1
CO	3	15	12	24	26	14	17	4	8	9
NM	2	5	1	0	3	3	2	0	0	0
NV	2	3	5	10	4	0	2	0	0	0
UT	3	5	4	9	5	1	3	0	0	0
Mean	3.67	9	7.33	9.67	9	5.17	5.17	0.67	2.5	2.67

The results

From 876 surveys mailed, 166 were returned, an average 19 percent return rate across the six states. Colorado's return rate was highest at 28.5 percent, and California and New Mexico had the lowest return rates of 8 percent each.

Superintendents tend to stay at the same golf

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course for more than two years and some have had more than six years experience (Table 1). Most of the golf courses have been operating for more than 10 years but a few of them were less than six months old at the time of survey. Most golf courses ranged from 100 acres to 130 acres for all states except for California, which had a mean size of 165 acres. The soil pH reported was similar in all states, averaging 7.5.

Almost all the superintendents in the six states indicated they apply fertilizer containing Fe to their golf courses. Only 11 of the 166 respondents indicated they do not include Fe in their fertilizer.

Because green grass is vital to golf course appearance, it is no surprise most superintendents (107 of 166) rated it as very important. Only four rated golf course appearance as "not important."

Suppliers that superintendents use were investigated to identify the manufacturers, brands and distributors in highest demand. United Horticulture Supply (UHS) was the distributor cited most often by respondents, followed by Golf Enviro Systems, Simplot Partners, Wilbur Ellis Co., Helena Chemical, American Pride Co-Op, LESCO and The Scotts Co. and The Andersons. Simplot, Wilbur Ellis, Helena, LESCO and Scotts and The Anderson all engage in custom blending of products.

The question of whether organic matter could be added to the TO materials arose after an interview with a local superintendent, who indicated he preferred iron supplements that contained other nutrients. Regarding interest in using fertilizer that not only contains Fe, but also organic matter, 122 of 166 superintendents were either interested or very interested.

The top nine brands of most commonly used fertilizer products in the six states were identified. The top two popular iron source products were Ferromec AC Liquid Iron and Milorganite. Use of these two products ranged from 29 percent (New Mexico) to 65 percent (Utah) of the respondents (Table 2).

The objective of this study was to assess the market potential of a new iron supplement fertilizer for use at golf courses in the Southwest.

The superintendents were asked to rank the criteria for selecting fertilizers for greens, fairways, roughs and tees. In both cases, effectiveness was ranked the most important, followed by ingredients, solubility, price and availability. Size of package and advertising were ranked least important. When asked to rank reasons for switching brands, effectiveness was again ranked highest. Company recommendation and size of package were less important.

Most superintendents had low ratings for price sensitivity for greens (Table 3). But for fairways, rough, and tees, most superintendents were price sensitive to moderately price sensitive.

Most superintendents indicated they might try a new product once or twice a year. The local university superintendent said he does not try a product unless the product has been tested by an independent source and reported in a scientific journal (Erhard).

Falk is a professor of agricultural economics and agricultural business at New Mexico State University. Ng completed his MS in agricultural economics at New Mexico State University. Mexal is a professor of horticulture at New Mexico State University.

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How Alternative Materials Can Affect Soil pH and Turfgrass Performance

By David A. Munn

Low pH soils of golf courses in the North Central and Northeastern United States need periodic treatment (every three to six years) with liming materials to correct soil acidity, enhance nutrient availability and microbial activity, and to restore the supplies of exchangeable calcium and magnesium ions that are depleted with time by leaching and crop removal (McLean and Brown, 1984).

Turfgrass management texts routinely suggest a soil pH of 6 to 7 be maintained for optimum turfgrass nutrition and quality (Beard 2001, Emmons, 1984, Turgeon, 2001, and Turner and Hummel, 1992). The same introductory turfgrass management texts and widely used extension materials recommend fertilization at annual rates of 3 pounds to 6 pounds of nitrogen per 1,000 square feet. This robust nitrogen fertilization has the long-term consequence of increasing the soil's acidity thereby lowering the soil pH.

At the same time, Ohio and the North Central and Northeastern United States have acidic precipitation. Palazzo and Duel (1974) evaluated a number of grasses and legumes in their response to varied soil reaction. They reported optimal dry matter yield at a pH range of 5.5 to 6.5 for Kentucky bluegrass and 6 to 6.8 for perennial ryegrass.

Murray and Foy (1979) evaluated the differential ability of many turfgrass cultivars to tolerate aluminum (Al) stress and toxicity. They found the relationship noted in the literature for other crops was true in turfgrass. The problem of Al toxicity increases greatly in mineral soils as the pH is reduced below pH 5.5. Turner (1980) reported no beneficial or detrimental effects of limestone application on soils with an initial pH of 5.6 and 5.1 on established stands of perennial ryegrass and Kentucky bluegrass, respectively.

In their review paper, Turner and Hummel (1992) concluded that "the overall effect of soil reaction and liming becomes a complex issue with species, cultivars, soil texture, nitrogen (N) source applied and pest problems prevalent all influencing optimum soil pH levels."

FIGURE 1

Soil pH for various treatments 1998-2001

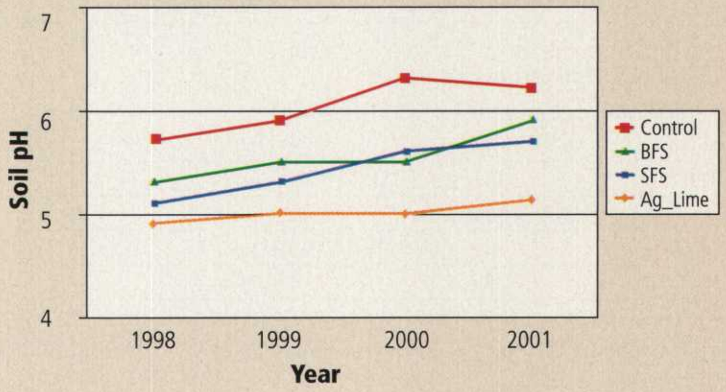
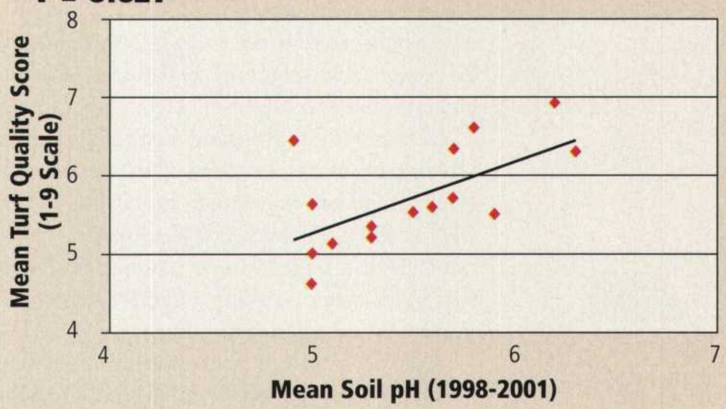


FIGURE 2

Turf Quality vs Soil pH
r = 0.621*



Steel and turf

Beyond the hills and ponds of its golf courses, Ohio and its neighboring states have significant steelmaking capacity. Slags are nonmetallic byproducts of iron and steel making. Typically, a blast furnace with an ore feed with 60 percent to 66 percent

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TABLE 1

Chemical and physical characteristics of slags and agricultural lime used in these studies.

Identification	Steel Furnace Slag SFS	Blast Furnace Slag BFS	Agricultural lime
pH	12.5	10.3	8.2
CaCO3 Equiv (%)	79.8	81.1	97
ECCE[z]	22	27	77
Ca (%)	22.2	25.2	21.1
Mg (%)	5.53	5.07	12.6
Al (%)	1.64	3.79	.03
P (mg kg-1)	23	59	34
Fe (%)	15.9	.88	.16
Particle size distribution of slags[y] and lime[x]			
Mesh Size		(%)	
>8	51 ± 1	36 ± 6.1	-
8-20	18 ± 2.1	35 ± 5	1
20-60	18 ± 2.8	23 ± 5.5	33
60-100	6.7 ± .3	5.9 ± 2.6	6
<100	6.5 ± 2	4 ± 1.6	60
Fineness effect.[w]	28	33	79

[z]ECCE (Effective CaCO3 equivalent = fineness efficiency @ CaCO3 equivalent, Troeh and Thompson, 1993)

[y]Mean and standard deviation of four replicate sieving analyses.

[x]Product guarantee for "Nutralime" on bag prior to pelletizing.

[w]Fineness efficiency (>8 mesh x 0.0, 8-60 mesh x .40, <60 mesh x 1.0, Troeh and Thompson, 1993)

Continued from page 47

iron would generate slag outputs approximately 20 percent (by weight) of steel output (Kalyoncu and Kaiser, 1998). These slags are comprised of calcium (Ca) and magnesium (Mg) silicates, which can meet the criteria of liming materials (for example, are they able to supply Ca^{+2} and/or Mg^{+2} and to neutralize acidity). Ornamental horticulture can benefit from economical liming materials, while making effective use of an important industry's byproduct.

The U.S. steel industry reported annual sales averaging 12.6 million metric tons of blast furnace slag (BFS) and 19.3 million metric tons of steel furnace slags (SFS) in 1996-98, according to United States Geological Survey reports (Kalyoncu and Kaiser, 1998 and Kalyoncu, 1999). Their data indicates that more than half of U.S. iron and steel slag sales are generated in the North Central states of Illinois, Indiana, Michigan and Ohio.

The use of steel industry slags as a substitute for traditional limestone has a substantial history in Ohio (Williams, 1946, Volk et al., 1952 and Jones, 1968). Volk et al. (1952) evaluated granulated slag (water-quenched), air-cooled slag, and dolomitic limestone reconstituted by combinations of various sieve sizes into "agricultural screenings," "agricultural meal" and "agricultural ground" size grades as defined by Ohio's limestone law. They compared the three materials in both field and greenhouse studies with mixed alfalfa-timothy hay and corn (maize).

In field studies the average hay yields were higher for granulated slag than for air-cooled slag or limestone at each size gradation (screenings, meal and agricultural-ground).

Air-cooled slag and dolomitic limestone were equally effective when they had the same particle size distribution.

In the greenhouse studies, granulated slag and dolomitic limestone were more effective at correcting soil acidity than air-cooled slag. Since air-cooled slags produced crop yields quite comparable to limestone and yet did not raise pH as effectively, it indicated that crop-yield response to the slags involved more than simply soil acidity correction.

Jones (1963) reevaluated the effectiveness of granulated steel industry slag in field studies on acid Canfield silt loam (pH 5.5) that was cropped with a corn (maize), wheat and two years of alfalfa-hay rotation. He compared the performance of slag to comparable rates of calcitic and dolomitic limestone and concluded that granulated slag was as effective at the two rates used (1.5 tons per acre and 3 tons per acre) as either type of limestone.

The purpose of this four-year study was to compare the effectiveness of two steel industry byproduct slags with a dolomitic pelletized agricultural lime product when used on established turf as agricultural liming materials on acid (pH 4.9) Canfield silt loam soil. The slags are somewhat specific to the steels of which they are a byproduct. These contemporary slag materials may be valuable and economical aids to turf managers in managing soil pH on their landscapes. I also wanted to be sure there were no problems associated with their use.

Methods and materials

Two steel industry slags were supplied by either Stein Inc. in Broadview Heights, Ohio, from LTV Steel in Cleveland, or USS Kobe in Lorain, Ohio. Table 1 gives particle size and chemical proper-

Continued on page 50

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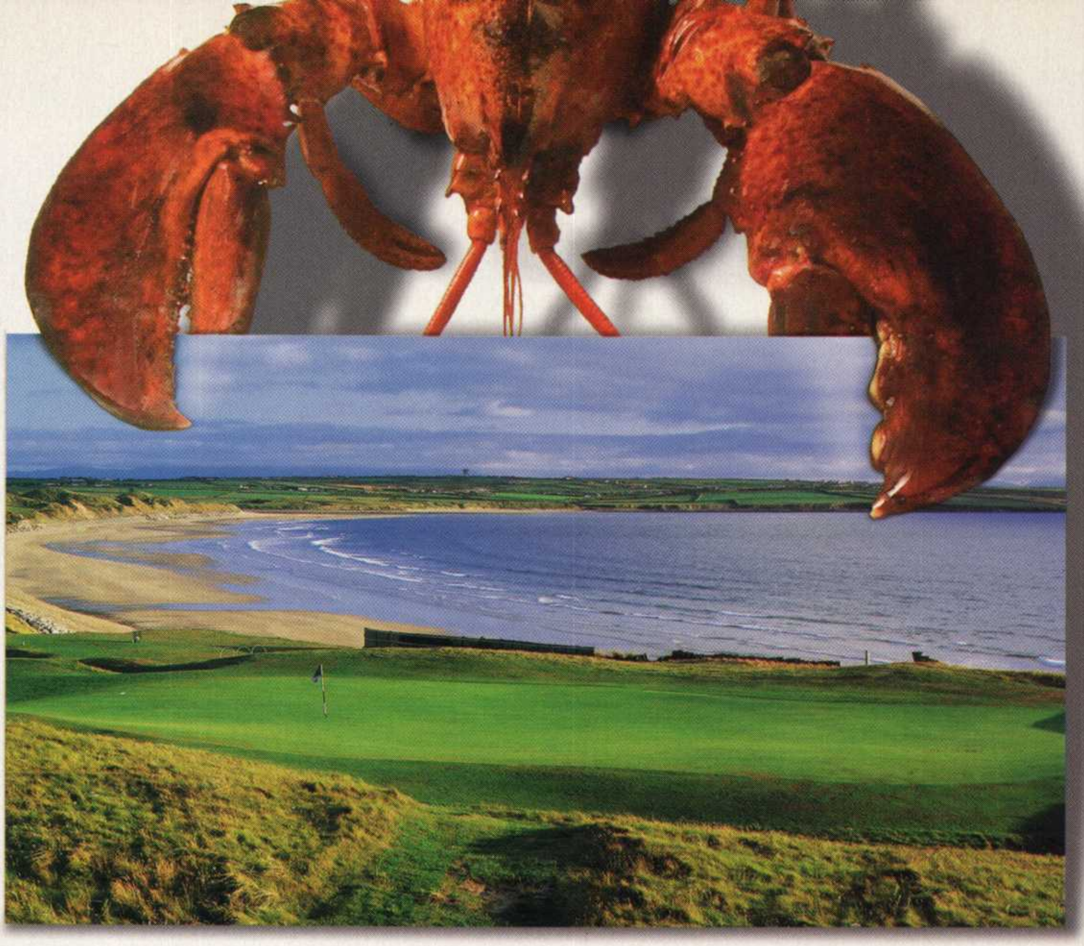

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TABLE 2

Turfgrass clippings dry matter yield and visual quality evaluation summaries.

Treatment	Turf DM	Turf Visual Quality
2000		
Control	121	5
BFS	116	5.6
SFS	122	5.5
Agricultural Lime	118	6.3
LSD (.05)	Ns	ns
Two Way ANOVA Treatment Prob F	.979	.23

TABLE 3

Plant mineral analyses turf plant tops (2.5-10 cm height).

Treatment	P	Ca	Mg	Mn	Fe	Al
		(%)			(ppm)	
Turf 2000						
Control	.33	.37	.22	138	299	185
Ag Lime	.35	.41	.26	58	109	37
BFS	.35	.45	.24	85	133	53
SFS	.36	.44	.23	82	115	40
LSD (.05)	.02	.05	.02	31	ns	ns
Sufficient Range‡	.3-.55	.5-1.25	.2-.6	25-150	35-100	—

‡ Turner and Hummel (1992).

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ties of the slags and an agricultural lime product "Nutralime." This agricultural lime was a pelletized material (Mineral Processing, Carey, Ohio) with a manufacturer reported calcium carbonate ($CaCO_3$) equivalent of 97 percent with 21 percent Ca and 12 percent Mg derived from $CaCO_3$ and magnesium carbonate ($MgCO_3$).

The particle size data was obtained by sieving the slags and from the label guarantee for the Nutralime prior to its being pelletized. The chemical analyses were performed by The Ohio State University Research and Extension Analytical Laboratory (REAL) in Wooster, Ohio, and the Penn State Ag Analytical Laboratory, University Park, Pa., on samples digested in concentrated perchloric or nitric acid.

Soil tests were conducted in 1998 at REAL using 1 mole (M) of ammonium acetate for the exchangeable cations potassium (K), Ca and Mg (Brown and Warncke, 1988) and the Bray P1 test for extractable phosphorus (P) (Knudsen and Beegle, 1988). REAL closed to the public in December 1998 and the lab work was shifted to Penn State's Ag Analytical Lab using Mehlich III for soil P and extractable cations (Wolf and Beegle, 1995). Both labs used the (1:1) pH in water plus SMP Buffer test (Eckert and Sims, 1995) to assess the soil active and exchangeable acidity, respectively.

The experiment was arranged in a randomized complete block design with four treatments repeated in four blocks. Statistical analyses were performed using the General Linear Model of SAS to perform two-way ANOVA and mean separation procedures appropriate for the treatments. Plot size was 10 feet by 20 feet. Treatments were control, agricultural lime, blast furnace slag (BFS) and steel furnace slag (SFS), all at 2 tons per acre.

The appropriate experimental materials were applied to plots on the campus lawn by hand broadcasting after the last mowing operation of the fall on Nov. 13, 1997. This allowed frost action and winter rain and snow to carry the applied materials into the soil.

The first visual quality ratings and clippings for dry matter yield comparisons were performed on Oct. 14, 1998. On Nov. 12, 1998, after the growing and mowing season was over, the plots were treated with another two tons/acre of each material in the same manner as the previous year.

The turf was a perennial ryegrass-Kentucky bluegrass mix. The soil was Canfield silt loam with a 2 percent to 6 percent slope. The turf treatments received 2 pounds to 3 pounds N per 1,000 square feet annually in the form of broadcast urea. Turf was treated for broadleaf weeds with 2,4-D, dicamba and MCPP. The plots received 43 pounds per acre of phosphoric acid and potassium oxide during the spring of 2000.

The experimental area was a low-traffic area of the campus lawn. Turf yield and tissue samples were collected on Oct. 14, 1998, Oct. 7, 1999, Oct. 12, 2000, and Oct. 18, 2001, by harvesting a 21-inch width from the length of each plot with a hand powered reel mower and catch pan.

Soil samples were taken to a 4-inch depth on the turf plots in October 1998, October 1999, October 2000 and October 2001. At least 10 cores were collected from each plot and mixed to form a composite sample. My forage crops students assisted with this work and rated the visual quality of the plots.

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