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Nitrogen Fertilization: How Much Is Enough?

You may think there is a simple answer to how much nitrogen is needed to fertilize turf. At this time soil or tissue testing are not reliable means of determining the amount of nitrogen to apply. Often the color, density and the amount of clipping growth are used to judge the need for nitrogen. Many people also use published standard application rates as a guide, but textbooks give a large range of possible annual nitrogen amounts for each cool-season grass species or level of maintenance.

For example, in the only turfgrass textbook on soil fertility, *Turfgrass Soil Fertility and Chemical Problems: Assessment and Management*, by Carrow, Waddington and Rieke, published in 2001, the authors recommended nitrogen fertilizer amounts ranging from a low of 0.9–1.5 lbs. N/1,000 sq.ft. for a low level of maintenance, to a high of 3–6 lbs. N/1,000 sq.ft. for high maintenance turf during a six month growing season for areas like Upstate New York. The levels were slightly higher for the longer growing season in Southeastern New York.

Cornell University's recommendations for nitrogen fertilizer amounts for New York lawns in are in *Lawn Care and Water Quality Almanac* by Gussack and Rossi, published in 2000, where the amounts depend on the species of grass: Kentucky bluegrass at 3–4 lbs. N/1,000 sq.ft./yr., perennial ryegrass at 2–6 lbs. N/1,000 sq.ft./yr,, tall fescue at 2–4 lbs. N/1,000 sq.ft./yr,, and fine fescues at 1–2 lbs. N/1,000 sq.ft./yr.

Why So Different?

The range in nitrogen rates reflects that fact that site conditions and expectations vary from site to site. Factors that are important in determining the amount of nitrogen required include: soil properties (such as drainage), level of traffic, extent of irrigation, amount of sunlight, age of site (determined by how much organic matter is present), how the clippings are managed, and the desired level of quality (equivalent to the amount of maintenance). Some examples: sandy, well-drained sights may require more nitrogen; more traffic requires more nitrogen; irrigated lawns need more nitrogen; shady lawns need less nitrogen; older lawns need less nitrogen; removing clippings requires more nitrogen; and the higher the expectation of lawn quality the more nitrogen is often needed.

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Nitrogen Fertilization

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To be sure that turfgrass quality is always high, why not fertilize at the highest nitrogen rate listed? Some turfgrass managers do follow this philosophy, especially if they are guaranteeing high quality or may be responsible for only part of the maintenance, like fertilizing and pest control, and are only on-site occasionally. In some cases the highest rate may overfertilize the grass, leading to several consequences such as lowering the stress tolerance and increasing the likelihood of some diseases. Also, fertilizers are costly and may use a lot of natural resources to produce. Thus, over-fertilization can be very wasteful and possibly hazardous to turf.

Water Quality Problems

Excess nitrogen also can have a very harmful effect on drinking water sources and aquatic habitats. Parts of New York, such as Long Island, have had decades of groundwater quality problems associated with nitrogen, especially as a drinking water source where nitrate-nitrogen levels above 10 mg L^{-1} are considered unsafe. In marine habitats, nitrogen is often the nutrient limiting algae growth that damages marine life and is thus of great concern in coastal areas of southeastern New York. In consideration, some golf courses on eastern Long Island are volunteering to lower nitrogen applications, where possible, and to have total nitrogen in the groundwater under their course not to be above 2 mg L^{-1} , or a fifth of the drinking water standard, in order to protect the health of the estuaries. To accomplish this, golf courses need to average no more than 2.9 lbs. N/1,000 sq.ft./yr. on the areas they fertilize.

There is also public concern about how much nitrogen is used to fertilize lawns on eastern Long Island. One might ask, why fertilize lawns at all? Yes, there are aesthetic reasons for fertilizing—you get a dark green color with fewer weeds—but there are good environmental reasons for fertilizing as well. According to a 2004 article I wrote with Zach Easton, unfertilized turf had greater amounts of phosphorus runoff compared to lawns (after establishment) that were fertilized with a range of different fertilizers.

So, How Much?

Back to the central question, how much should lawns be fertilized with nitrogen. Using the amounts shown for different grasses is one way. If the lawn is dominated by fine fescue then fertilize from 1–2 lbs. N/1,000 sq.ft./yr. If the lawn is dominated by Kentucky bluegrass, more nitrogen should be used, 3–4 lbs. N/1,000 sq.ft./yr. With perennial ryegrass the highest level should be applied, 2–6 lbs. N/1,000 sq.ft./yr.

What does the latest research show on how much nitrogen is needed by lawns? The New York State Turfgrass Association has been funding a project that Joann Gruttadaurio, Jeff Barlow and I have been conducting for the past

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Table 1. Impact of nitrogen application rates on average turfgrass quality.

Site	Nutrient Applied	Annual Rate lbs. N/1,000 sq.ft./yr.	Visual Quality
Ithaca (2 year average)	N	0	6.2*
		2	7.1
		4	6.9
		8	7.1
	N-K	8-1.8	7.2
		LSD (P≤0.05)	0.3
Long Island (1 year average)	N	0	5.6
		2	5.7
		4	5.9
		8	6.1
	N-P-K	8-1.8-3.6	6.1
		LSD (P≤0.05)	0.3
Lake Placid (2 year average)	N	0	5.3
		2	5.3
		4	6.3
		8	5.9
	N-P-K	8-1.8-3.6	7.1
		LSD (P≤0.05)	1.0

* Visual quality on a scale of 1-9, where 6.5 is considered acceptable.

two years. The study involves soil test calibration for phosphorus and potassium but also contains treatments with different nitrogen rates of 0, 2, 4, and 8 lbs. N/1,000 sq.ft./yr. The study is being conducted at three sites: in Central New York at the Robert Trent Jones Golf Course at Cornell University in Ithaca, on Hudson silty clay loam; in northern New York at the Lake Placid Resort Club in Lake Placid, on a Monadnock sandy loam; and the third in southeastern New York at Bethpage State Park in Farmingdale, on an Enfield silt loam.

The sites were seeded with a mixture of typical lawns grasses (70:20:10, by weight, of Kentucky bluegrass varieties "Midnight", "Total Eclipse" and "Washington"; "Attila" Hard Fescue; and "Manhattan III" perennial ryegrass. We found (see Table 1): at Ithaca only 2 lbs. N/1,000 sq.ft./yr. was needed to have acceptable turf (>6.5), whereas on Long Island even 8 lbs. N/1,000 sq.ft./yr. did not produce season-long acceptable quality. At Lake Placid, 8 lbs. N/1,000 sq.ft./yr., along with additional phosphorus and potassium, was needed to have acceptable turf. This is a long-term study and there will be updates to help answer the question of how much nitrogen is enough.

Other Research

Research also has been done at other northeastern universities. At Connecticut, Kopp and Guillard reported in 2002 on the influence of nitrogen rate and soil factors on lawn quality, using 35% Kentucky bluegrass, 35% creeping red fescue and 30% perennial ryegrass. Nitrogen was applied at 0, 2, 4, 6, and 8 lbs. N/1,000 sq.ft./yr. The study had two sites, one with a fine sandy loam soil with good water holding capacity and the other was a gravelly sandy loam that was excessively well drained and droughty.

On the first site, turfgrass quality was always acceptable at 2 lbs. N/1,000 sq.ft./yr., where even the unfertilized plots had acceptable quality during a dry summer period. On the excessively well drained site, only 50% of the time did applying nitrogen improve the quality—and not even 8 lbs. N/1,000 sq.ft./yr. consistently produce acceptable quality lawns. Kopp and Guillard also compared the effect of clipping removal and turfgrass quality. On the excessively well drained soil, returning clippings had no effect on turfgrass quality, but on the site with soils having better water holding capacity, only a third of the time turfgrass quality was better when clippings were returned. This information illustrates the need to consider a range of nitrogen applications since site factors like soil properties can dramatically influence quality and the amount of nitrogen that is needed to produce an acceptable quality lawn.

Environmental Concerns

Environmentally, what do we know about the effect of lawn fertilizing on water quality? For example, what if you fertilize a Kentucky bluegrass lawn at the highest recommended rate (4 lbs. N/1,000 sq.ft./yr.), what would the influence be on groundwater quality? I conducted a three year study to answer this question, where Kentucky bluegrass was fertilized either twice a year or 4 times per year for a total of 4 lbs. N/1,000 sq.ft./yr. The study, reported in 2004, was conducted at Riverhead, Long Island, with ten different nitrogen sources.

During a dry or normal precipitation year, nitrogen leaching for water-soluble sources ranged from 0.9–5% of the amount applied, whereas slow-release sources had 0.5–7.4% leaching. During a year with 11 inches of rainfall more than normal, water-soluble sources had nitrogen leaching values 12–29% of the amount applied whereas slow-release sources had much less leaching (2–7%). The average of all sources over all three years was 5.2% of the amount of nitrogen applied was leached. This amount of leaching would have resulted in an estimated groundwater nitrate-nitrogen concentration of 1.8 mg L^{-1}, far below the drinking water standard of 10 mg L^{-1} and less than the target set by eastern Long Island golf courses.

Summary

Understanding how much to fertilize lawns with nitrogen is complex. Site factors such as the species of turf (sometimes even cultivars) and soil properties drastically affect the amount of nitrogen needed to have an acceptable quality lawn. At least for Kentucky bluegrass, fertilizing at a rate within the recommended range did not drastically affect ground water quality.

Researchers are working on a better way to judge nitrogen fertilization responses and environmental impacts by measuring the amount of nitrate collected in the soil by anion exchange membranes. Some day this or other techniques may be used to allow us to refine nitrogen applications on site-by-site case and remove the range of rates now commonly used.

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