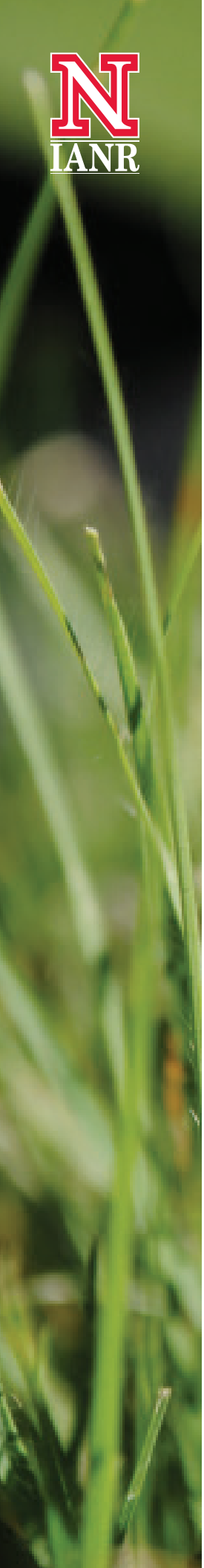

What's the ideal fertilizer ratio for turfgrass?

University of Nebraska–Lincoln Turfgrass Science Program | turf.unl.edu Pub. Turf 2014a Pro Series

Do you ever wonder why there are so many different fertilizer ratios on the market? The intuitive answer is different fertilizer sources contain different amounts of nutrient. For example, a urea molecule $CO(NH_2)_2$ contains 46% nitrogen (N) by weight and roughly 27% oxygen, 20% carbon, and 7% hydrogen. Ammonium sulfate is 21% N and 79% O, S, and H by weight. Add a coating to a fertilizer prill and the nutrient percentage declines. While phosphorus (P) and potassium (K) are slightly more difficult to calculate because they are expressed as P_2O_5 and K_2O, it's easy to see how there could be a wide assortment in fertilizer ratios when looking only at one specific fertilizer source. However, most turfgrass fertilizers are a blend of several different fertilizer sources. This allows manufactures to alter N release characteristics and add other nutrients to the fertilizer bag. So why is there such diversity in N-P_2O_5-K_2O ratios of blended fertilizer products? More specifically, is there an ideal fertilizer ratio for turfgrass?

To find the ideal fertilizer ratio we first need to recognize that nutrient uptake is controlled by plant nutrient demand and not fertilizer applications. Roots are fairly selective for different nutrients. Adding a nutrient doesn't mean levels in the plant will change unless the soil was already low in that nutrient. This isn't a new concept, Waddington and others (1978) showed P fertilization did not affect tissue P content when soil test values were greater than 24 ppm. Recently, Kussow and others (2012) also showed fertilizing with P and K is a waste of resources when the soil tests reports indicate nutrient levels are already adequate. Briefly, a creeping bentgrass fairway plot was fertilized with four pounds of N per 1000 ft^2 annually. The plots were grown on native soil with more than sufficient levels of P and K (62 and 180 ppm, respectively). They then added either 1 lb of P_2O_5, 3 lbs of K_2O, or both annually and monitored leaf tissue N, P, and K content. After three years, there were no statistical differences between any of the fertilizer treatments because the soil already satisfied plant demand for both P and K (Fig. 1).

Plants control nutrient uptake

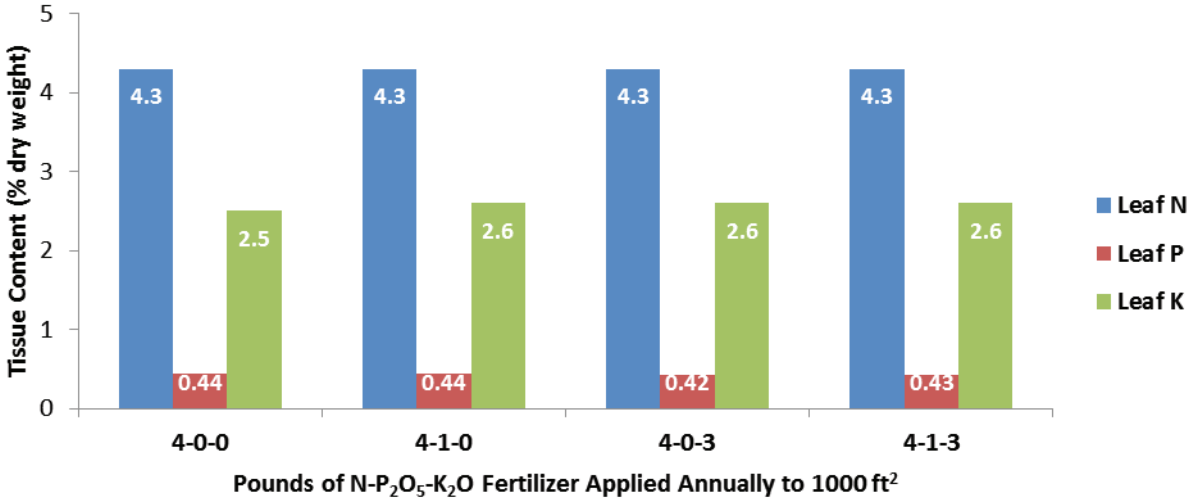

Figure 1. Creeping bentgrass leaf tissue nitrogen, phosphorus, and potassium content were not statistically affected by either phosphorus or potassium fertilization because the soil contained enough of both nutrients to satisfy plant nutrient demand. Source: Kussow et al., 2012.

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Based on this information, an ideal fertilizer ratio could be all N and zero P_2O_5 and K_2O (N-0-0) because the extra nutrients aren't benefiting the turf. While I generally encourage N only fertilization, it really depends on soil test values. Think of the soil as a nutrient bank. When fertilization exceeds plant nutrient demand and other mechanisms of nutrient loss (leaching, denitrification, fixation) then soil test nutrient levels increase. Likewise, soil test nutrient levels will decline when plant uptake and nutrient loss exceed fertilization. While a sole N fertilization program can be very effective, future problems may occur as the soil nutrient bank slowly declines. An ideal fertilizer ratio would replace P and K and keep soil test levels static (annual fertilization = removal/loss).

Nitrogen drives turfgrass nutrient demand

Uptake of all soil nutrients is dependent on turfgrass growth rate. Rapid growth requires more nutrients to sustain growth. This translates into higher nutrient demand. Since turfgrass is chronically N deficient, N fertilization promotes leaf growth and increases demand for other nutrients. The Kussow group demonstrated N-driven nutrient demand on creeping bentgrass fairway turf (2012). Increased N fertilization increased demand and uptake of other nutrients, even increasing their content within the plant (Fig. 2). Increased nutrient uptake lowered soil test nutrient levels (Fig. 3). Bray-1 soil test P and K levels dropped 6 and 25 ppm over three years when the turf received 2 lbs of N per 1000 ft^2 annually and 17 and 57 ppm when fertilized with 6 lbs of N per 1000 ft^2 annually. That's a 27% and 32% decline in soil test P and K over three years at 6 lbs of N. Clearly the 25-5-10 fertilizer used in the study wasn't replacing the P and K. An ideal ratio needs to have a more P and K to sustain soil fertility levels.

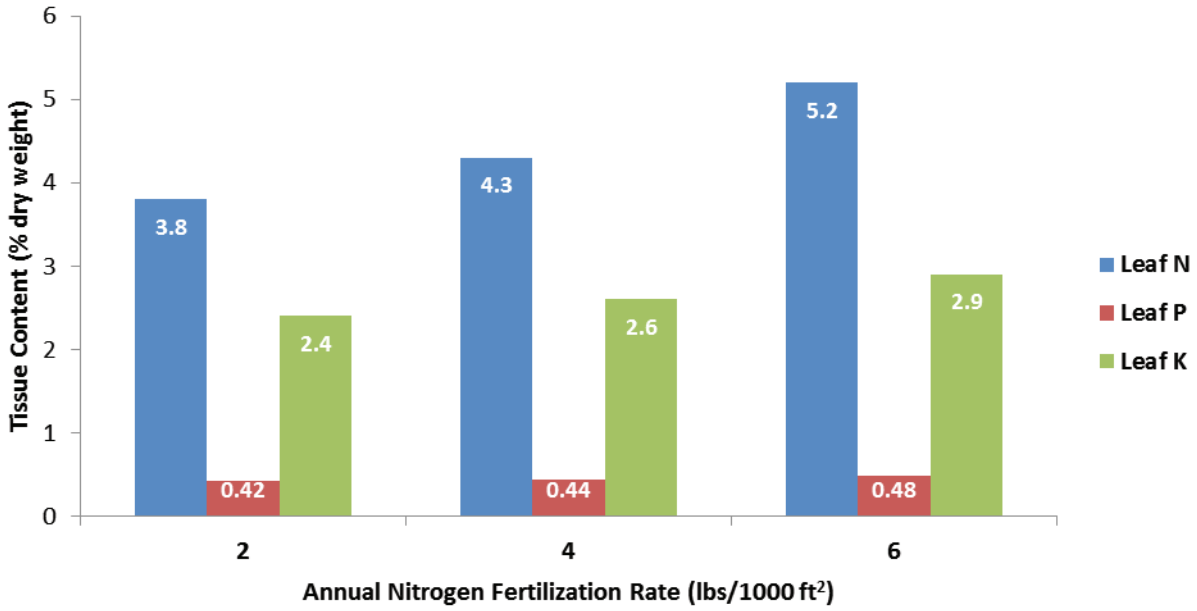

Figure 2. Creeping bentgrass leaf tissue nitrogen, phosphorus, and potassium content influenced by annual nitrogen fertilization rate. Plant nutrient demand is a function of growth rate which is influenced by nitrogen fertilization when other nutrients aren't limiting. Source: Kussow et al., 2012.

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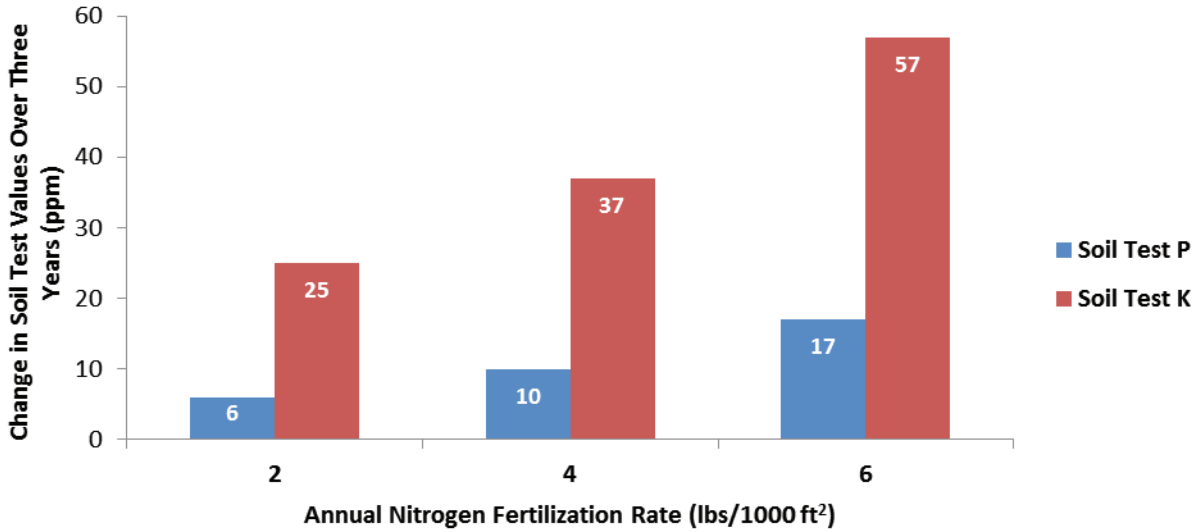

Figure 3. Nitrogen fertilization rate influence Bray-1 soil test phosphorus and potassium values over the course of three years. The initial soil test P and K values were 62 and 180 ppm, respectively. Plots were fertilized with a 25-5-10 product. A higher ratio of P and K to N is required to sustain soil test nutrient levels.

Ideal fertilization ratios

To recap, turfgrass plants selectively control nutrient uptake; it depends on growth rate which is commonly influenced by N rate. Therefore, N fertilization increases demand and uptake of other soil nutrients which will slowly deplete soil test values. An ideal fertilizer ratio should replenish soil nutrients lost from plant uptake and processes such as leaching and fixation. After analyzing years of turfgrass growth, uptake, and soil test data, Dr. Kussow proposed a few ideal fertilizer ratios which I've adapted for various management scenarios (Table 1). We'll continue to verify these ideal ratios under different management scenarios and soil types into the future.

Fertilizing to these ideal fertilizer ratios is a good way to sustain soil test P and K levels regardless of how much N is applied. Fertilizing above these ratios, with products such organic fertilizers with high P_2O_5 and low N, will cause soil test values to increase. Alternatively, fertilizing below these ideal ratios will cause soil test P and K levels to decline over time. This may be fine, especially at sites with high soil test levels. I encourage you to compare your Mehlich-3 soil test results with the Minimum Levels for Sustainable Nutrition (MLSN) guidelines generated by PACE Turf and the Asian Turfgrass Center (http://www.paceturf.org/PTRI/Documents/1202_ref.pdf). Briefly, if soil test P is much greater than 21 ppm and K is much greater than 37, then there is little reason to apply anything other than straight N (PACE Turf, 2014). Then use soil testing to monitor the decline in soil test P and K over many years. Adjust the ratios as needed to sustain soil test values and conditions at your particular location. Supplement N spoon-feeding with granular P and K once soil test levels approach MLSN recommendations. As you calculate your annual fertilizer additions, take a moment to see how close you came to an ideal ratio of N:P_2O_5:K_2O. Try to use the diversity of fertilizer ratios to your advantage.

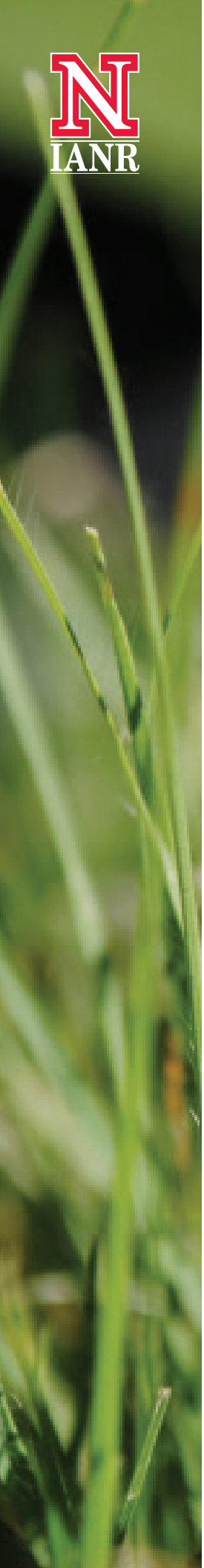

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Table 1. Proposed ideal fertilizer ratios for different cool-season species and management scenarios. Soil test to confirm soil test nutrient levels are static and adjust these ratios as necessary for your particular situation.

Grass Species	Root Zone Soil	Mowing Clipping Management	Ideal Fertilizer Ratio Total N:P_2O_5:K_2O
Cool-season lawn and athletic field species (Kentucky bluegrass, perennial ryegrass)	Native soil	Clippings Removed	4-1-3
		Clippings Returned	8-1-4
	Sand-based soil	Clippings Removed	4-1-4
		Clippings Returned	8-1-8
Creeping bentgrass turf	Native soil	Clippings Removed	4-1-3
		Clippings Returned	6-1-4
	Sand-based soil	Clippings Removed	4-1-4
		Clippings Returned	6-1-6

Additional sources of information

1. Kussow, W. R., D.J. Soldat, W.C. Kreuser, & S.M. Houlihan. 2012. Evidence, regulation, and consequences of nitrogen-driven nutrient demand by turfgrass. Available at http://downloads.hindawi.com/journals/isrn/2012/359284.pdf (verified on 13 October 2014). ISRN Agronomy.

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3. Waddington, D. V., T. R. Turner, J. M. Duich, and E. L. Moberg. 1978. Effect of fertilization on Penncross creeping bentgrass. Agron. J. 70:713-718.

Author: Bill Kreuser, Assistant Professor, Department of Agronomy & Horticulture, University of Nebraska–Lincoln.