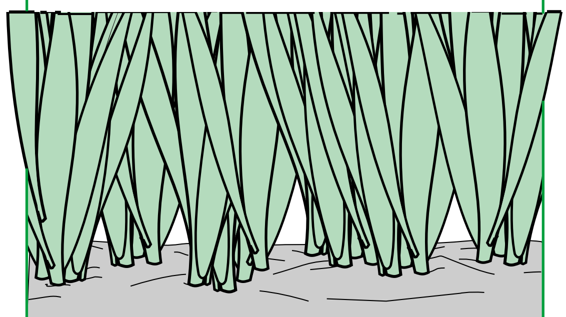
A GUIDE TO TURFGRASS NUTRIENT RECOMMENDATIONS

BASED ON K-STATE SOIL TEST RESULTS

Turfgrass



Soil testing is the basis of a sound fertilization program. It is impossible to know what nutrients must be supplied from fertilizers without first checking levels in the soil. Routine application of unnecessary nutrients can create imbalances that may lead to other problems.

For example, excessive phosphorus can interfere with iron uptake by turfgrass roots and lead to an iron deficiency. Excessive levels of soil nutrients also increase the chances of surface or groundwater contamination. Soil testing makes sense horticulturally and environmentally.

A routine soil test (pH, phosphorus and potassium) is recommended in the following cases:

- Before establishing a new lawn, whether from seed, sod, sprigs or plugs.
- Every three to five years on established turf.
- Annually when attempting to correct a nutrient deficiency or change the soil pH.
- When fertilizers containing phosphate or potash have been used on a regular basis.

Sampling

Sample the upper 3 inches of soil for established turf. Discard thatch. If establishing a new lawn, sample the upper 4 to 6 inches of soil, depending on the depth of soil preparation. Take 12 or more random cores from each area to be tested, combine the cores into a single container, and mix thoroughly. If the samples are too wet or dry, mixing will be difficult, if not impossible. Approximately 1 pint of soil is required for the soil test. Submit separate samples for different lawn areas (for example, front and back yards) only if the soils are obviously different, the turfgrass performs differently or the fertilization history of the areas has not been the same.

Nitrogen (N)

Nitrogen is the nutrient required in greatest quantities by turfgrasses. It is necessary for healthy growth and color. Excessive nitrogen applications can lead to shallow-rooted turfgrass that is more susceptible to diseases and has poor tolerance to environmental stresses such as cold, heat and drought. Soil tests are not normally used for determining turfgrass nitrogen needs. A nitrogen soil test is useful when growth and color are poor for no apparent reason or when past fertilization practices are not known. Use the guidelines in Table 1 for nitrogen applications.

Table 1. Total Annual Nitrogen Requirement
(lbs. N / 1,000 sq. ft.) *

Turfgrass Species	Quality Expectation **		
	Low	Medium	High
Kentucky Bluegrass	1½	3	4–5
Tall Fescue	1	2	3–4
Perennial Ryegrass	2	3	4–5
Bermudagrass	2	3	4
Zoysiagrass	1	1–1½	2
Buffalograss	0–1	2	
Bentgrass Putting Greens	3	4	5

* Do not apply more than 1½ pounds nitrogen (N) in any one application. Refer to Table 3 for application schedules.

** The quality expectation of the lawn largely determines how much nitrogen will be applied. High quality lawns will require more frequent mowing and more careful attention to water needs.

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Table 2. Nitrogen Carriers

Quickly Available (soluble)		Slowly Available (insoluble)	
Ammonium nitrate	33-0-0	UF (ureaformaldehyde or methylene urea)	38-0-0
Ammonium sulfate	21-0-0	IBDU (isobutylidenediurea)	31-0-0
Ammonium phosphate	varies	Sulfur Coated Urea (SCU)	32-0-0
Urea	46-0-0	Activated Sewage Sludge (e.g., Milorganite)	6-2-0

New Turf—Before Planting

If using a soluble N-carrier, incorporate 1 to 1½ pounds N / 1,000 square feet into the surface one to two inches of soil before planting. If growth is slow, supplement the initial application with a second application of 0.5 pound N / 1,000 square feet two weeks after seedlings emerge. Make the second application when the foliage is dry, and water it in immediately to prevent burning the young foliage. If slowly available N-carriers are used, the preplant application should be 2 to 2½ pounds N / 1,000 square feet and the follow-up application after seedling emergence should not be necessary.

Phosphorus (P)

Established turfgrass generally requires less phosphorus than vegetable and field crops. With its fibrous root system, turfgrass is efficient at extracting the immobile phosphorus from the soil. New lawns have a limited root system and require higher levels of phosphorus for healthy seedling development. Soil phosphorus levels are frequently low in new housing developments before turf has been established. Refer to Table 4 for phosphorus fertilizer recommendations. Based on soil test recommendations, phosphorus should be incorporated into the surface 1 to 2 inches of soil before planting.

Phosphorus applications to established turf do not need to be incorporated. Avoid routine phosphorus applications to established turf unless a soil test shows a deficiency. In the absence of a soil test, restrict phosphorus applications to once a year or use a turfgrass fertilizer with a nitrogen-to-phosphorus ratio of at least 3-to-1. Excessive phosphorus can interfere with iron and zinc uptake by turfgrass roots. The concentration of phosphorus in fertilizer is expressed as percent phosphate (P_2O_5), so phosphorus fertilizer recommendations are given in pounds of phosphate per 1,000 square feet.

Potassium (K)

Recommendations for potassium use on turf have changed considerably in the last 10 to 15 years. Potassium is important in improving stress tolerance (such as heat, cold, wear, disease) of turfgrasses and is essential to plant growth. Stress-related responses to potassium seem to occur at higher levels of available soil-potassium than are required for basic plant growth. Traditionally, potassium fertilizer recommendations have relied heavily upon yield and response

Table 3. Fertilization Schedule Based on Total Annual Nitrogen Applied

Cool-Season Grasses—Kentucky Bluegrass, Tall Fescue and Perennial Ryegrass

	lbs N / 1,000 ft²			
Total Annual N (lbs / 1,000 ft²)	September[1]	November[2]	May[3]	Mid-June to early July[4]
1	1			
2	1	1		
3	1	1	1	
4	1	1½	1	½
5	1½	1½	1	1

Warm-Season Grasses—Bermudagrass, Zoysiagrass, and Buffalograss

	lbs N / 1,000 ft²			
Total Annual N (lbs / 1,000 ft²)	May[5]	June[5]	July[5]	Early to mid-August[5]
1		1		
2	1		1	
3	1	1		1
4	1	1	1	1

[1]A fertilizer containing both quickly and slowly available nitrogen is preferred for this application, but quickly available nitrogen is acceptable.

[2]Use quickly available nitrogen.

[3]Use a fertilizer containing at least one fourth of the nitrogen as slowly available nitrogen. A fertilizer containing only slowly available nitrogen is preferred.

[4]If color and growth are acceptable, skip this application. If the application is needed, use only slowly available nitrogen.

[5]Quickly available nitrogen is acceptable for warm-season grasses during the summer, but slowly available nitrogen or a mixture of the two types may be used if preferred.

Table 4. Phosphorus Fertilizer Recommendations for Turfgrass Based on Soil Test Results (for all Kansas turfgrass species)

		lbs. P_2O_5/1,000 sq. ft. /year*		
Soil Test Available P**		**General Turf**	**High-Quality Turf**	**New Turf*****
---ppm---				
0–5	very low	3	4	5
6–10	low	2	3	4
10–20	medium	1	2	3
20–50	high	0	0–1	1–2
50+	very high	0	0	0

* Do not apply more than 2 pounds P_2O_5 / 1,000 square feet to established turf at any one time. Where a range of recommended P_2O_5 rates is given, use the higher rate if the available P from the soil test is in the lower end of its respective range; conversely, use the lower rate if the available P is in the higher end of its respective range.

** Bray P-1 test method.

*** Incorporate into the surface 1 to 2 inches of soil before planting.

Table 5. Potassium Fertilizer Recommendations for Turfgrass Based on Soil Test Results (for all Kansas turfgrass species)

		lbs. K_2O/1,000 sq. ft. /year*	
Soil Test Available K**		**General Turf**	**High-Quality Turf**
---ppm---			
0–40	very low	4	5
41–175	low	2-3	3-4
175–250	medium	0–1	2
250–300	high	0	0–1
300+	very high	0	0

* Do not apply more than 1½ pounds K_2O / 1,000 square feet to established turf at any one time. Where a range of recommended K_2O rates is given, use the higher rate if the available K from the soil test is in the lower end of its respective range. Conversely, use the lower rate if the available K is in the higher end of its respective range.

** Ammonium acetate test method.

data from other crops and may have underestimated the quantities needed for healthy, stress-tolerant turf. The recommendations in Table 5 reflect more current thinking on potassium's role in turf. Much research is still needed in this area, and these recommendations will be revised as new information becomes available.

Even so, most Kansas soils contain adequate potassium with the exceptions of sandy soils and some soils in southeastern Kansas. High-quality turf grown on sandy soils (such as putting greens built on sand rootzones) should be tested regularly for potassium. Potassium readily leaches from sandy soils so turf grown in these soils should be "spoon-fed" more frequently with smaller amounts of potassium. The concentration of potassium in fertilizer is expressed as percent potash (K_2O), so potassium fertilizer recommendations are given in pounds of potash per 1,000 square feet.

Table 6. Relative Susceptibility of Kansas Turfgrasses to Iron Chlorosis*

Kentucky Bluegrass	Moderate to High
Zoysiagrass	Moderate to High
Perennial Ryegrass	Moderate
Bermudagrass	Moderate
Buffalograss	Moderate
Tall Fescue	Moderate to Low

* Cultivars within each species also may vary in their susceptibility to iron chlorosis.

Soil Reaction (pH)

Soil pH is a measure of the acidity or alkalinity of the soil. A pH of 7.0 is neutral, less than 7.0 is acid, and greater than 7.0 is alkaline. The pH is important because it affects the availability of nutrients in the soil. Optimum turfgrass growth usually occurs at pH's of 6.0 to 7.0. Iron chlorosis is a common problem in alkaline soils. Turfgrasses vary in their susceptibility to iron chlorosis as shown in Table 6.

Lime is used to raise the pH of acid soils, whereas sulfur is used to lower the pH of alkaline soils. It is best to incorporate these materials into the soil before planting if they are needed. After planting, lime or sulfur cannot be thoroughly mixed into the soil without destroying the turfgrass stand, and only limited quantities can be used at any one time because they can "burn" the turf (see notes in Table 7).

The process of changing soil pH under an established lawn can be a slow, painstaking process. Most soils with a high percentage of silt and clay resist changes in pH through a process called buffering. Because of the difficulty associated with changing the soil pH under established turfgrass, no adjustment is recommended if the pH is between 5.5 and 7.5.

Table 7. Approximate Amounts of Ground Limestone Needed to Raise pH* for Various Soil Textures.

	lbs. ground limestone/1,000 f^2				
Change in pH desired	Sand	Sandy loam	Loam	Silt loam	Clay loam
4.0 to 6.5	60	115	161	193	230
4.5 to 6.5	51	96	133	161	193
5.0 to 6.5	41	78	106	129	152
5.5 to 6.5	28	60	78	92	106
6.0 to 6.5	14	32	41	51	55

*For NEW lawns, incorporate into soil to a depth of 6 inches before planting. For ESTABLISHED turfgrasses, reduce the rate by half and apply only during spring or fall in conjunction with core cultivation. Do not apply more than 50 pounds / 1,000 square feet at one time. If using calcium oxide (CaO) or calcium hydroxide ($Ca(OH)_2$) do not apply more than 25 pounds / 1,000 square feet at one time.

Fertilizers with relatively high acidifying potentials, such as ammonium sulfate, can be used on slightly alkaline soils in an attempt to gradually lower the pH.

If the soil test shows the pH is less than or equal to 6.4, the K-State soil testing lab also runs a test to determine the lime requirement. This is the amount of lime in pounds per acre needed to adjust the pH to 6.8. It assumes the material used is 100 percent effective calcium carbonate (ECC) and that it will be incorporated to a depth of 6 inches. (100 percent ECC means the material is pure limestone, very finely ground.)

To convert the lime requirement to pounds per 1,000 square feet (the commonly used unit of area for turfgrass applications), divide the number by 43.56. Example: The lime requirement given on the soil test report is 4,000 pounds / acre.

(4000 lb / A) / (43.56) = 91.8 lb. / 1,000 sq. ft.

The assumptions that are used to determine the lime requirement do not hold for every situation, so the lime requirement given on the soil test report may have to be adjusted. For example, agricultural lime with an ECC in the range of 50 to 60 percent is a frequently used liming material. If the ECC of the liming material is 50 percent, twice as much of the material must be applied to have the same acidifying effect as the amount specified under “lime requirement” on the soil test report. In addition, the amount specified under lime requirement only makes sense for newly established lawns where the material can be thoroughly mixed into the soil to a depth of 6 inches.

When applying liming material to an established lawn, the material cannot be thoroughly incorporated. Rather, it must be applied after core cultivation, so it is only feasible to adjust the pH in the surface 3 inches of soil, the maximum depth of penetration of most core cultivators. Adjusting the pH in 3 inches of soil only requires half the material required for 6 inches of soil, so the lime requirement on the soil test report should be divided in half for established lawns. The liming material may have to be applied in two or more small doses to avoid burning established turf (see notes in Table 7). If you do not know the lime requirement, use the guidelines in Table 7.

Sulfur requirements for lowering the pH are listed in Table 8. As with liming, sulfur applications to established lawns should be applied in conjunction with core cultivation. The rates in Table 8 are for new lawns assuming the sulfur will be mixed to a depth of 6 inches. For established lawns, divide the rate by two. Sulfur may have to be applied in two or more small doses to avoid burning established turf (see notes in Table 8).

And *never* apply lime or sulfur unless indicated by a soil test. Also, do not apply either material to established turfgrass if the air temperature is 80 degrees Fahrenheit or higher, because of the risk of burning the turf.

Iron (Fe)

As previously mentioned, iron is the micronutrient most frequently deficient in turf, especially in alkaline

Table 8. Approximate Amounts of Elemental Sulfur Needed to Lower pH* for Various Soil Textures.

	lbs. sulfur/1,000 f^2		
Change in pH desired	Sand	Loam	Clay
8.5 to 6.5	46	57	69
8.0 to 6.5	28	34	46
7.5 to 6.5	11	18	23
7.0 to 6.5	2	4	7

*For NEW lawns, incorporate into soil to a depth of 6 inches before planting. For ESTABLISHED turfgrasses, reduce the rate by half and apply only during spring or fall in conjunction with core cultivation, and do not apply more than 5 pounds / 1,000 square feet at one time. If applying to bentgrass putting greens do not apply more than 2 pounds / 1,000 square feet at one time. If applying to annual bluegrass putting greens do not apply more than 0.8 pound / 1,000 square feet at one time.

soils. Deficiencies of other micronutrients are rare in Kansas. Iron tends to form insoluble precipitates in alkaline soils. Turfgrass roots are unable to absorb iron in this insoluble form. Any condition that restricts or inhibits turfgrass rooting can also induce an iron deficiency. Such conditions may include excessive watering, compaction, excessive nitrogen levels, disease or insect injury. Because iron is required for the synthesis of chlorophyll, a deficiency leads to chlorosis, or yellowing of the turfgrass foliage. This chlorosis normally occurs in a random, patchy pattern. Conversely, chlorosis from a lack of nitrogen appears as a more uniform yellowing of the turfgrass stand.

A foliar application of iron sulfate to an iron-deficient turf at a rate of 0.25 pound Fe / 1,000 square feet will result in green-up within 24 to 48 hours, but the effect may only last a few weeks. Do not make a foliar application of iron if rain is imminent, and do not irrigate for at least three to four hours after the application to allow for uptake of the iron by the turfgrass foliage. Iron chelates can be used at lower rates (e.g., 0.1 pound Fe / 1,000 square feet), but they are more expensive. A longer-lasting solution may be soil applications of chelated iron. If the soil pH is greater than 7.2, use Fe-EDDHA. Other types are ineffective at high soil pHs. The only cure for iron deficiency is to acidify the soil.

Soil tests for iron are not reliable. The most certain diagnostic tool is to spray a small test area with iron sulfate as described above, and observe the area for 48 hours.

Matthew Fagerness
Extension Specialist
Turfgrass

Steve Keeley
Assistant Professor
Turfgrass

David Whitney
Extension State Leader
Department of Agronomy

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