Fertility Considerations for Sod Production [1]

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There are almost as many sod fertility management programs in Florida as there are sod producers. This is not necessarily without justification, because of the diverse conditions under which sod is produced. In this discussion, we will attempt to point out some of the scientific principles which are relevant to the efficient production of quality sod. As with all growing plants, actively growing sod takes up rather large quantities of the primary nutrients N, P, and K. Much of this discussion of sod fertility management will deal with these three nutrients. In addition, we also will discuss secondary nutrients and micronutrients. Before planting sod on any site, it is essential to have the soil analyzed. This analysis should include a test for pH, lime requirement, organic matter, Ca, Mg, P, K, Zn, Mn, and Cu. The nutrient analyses beyond those normally required for home lawn or grass pasture establishment are to ensure that unanticipated deficiencies or toxicities do not limit returns on the sod production investment at the site.

Soil Analysis and Interpretation

You can get a representative soil sample from the production area by taking 15 to 20 small plugs at random over the entire area. Most plant roots are located in the top four inches of soil; therefore, limit sampling depth to four inches. Thoroughly mix the 15 to 20 soil plugs and send approximately one pound of the mixed sample to the UF/IFAS Extension Soil Testing Laboratory for chemical analysis. Bags and mailing boxes are available from your local UF/IFAS Extension office. UF/IFAS Extension agents can also supply additional information on proper technique for sampling and submitting a soil sample.

A soil analysis supplies a wealth of information on the nutritional status of a soil, and also should help detect potential problems which could limit turfgrass growth. A typical soil analysis supplies information on soil acidity and on the status of phosphorus, potassium, calcium, and magnesium in the soil. The level of nitrogen is not determined because nitrogen leaches so readily in Florida soils that regular applications are required to supply the needs of most plants.

The levels of Mehlich III (the extractant currently used by the Florida Extension Soil Testing Laboratory) extractable nutrients considered adequate for optimum turfgrass growth are shown in Table 1.

A soil that tests below these recommended levels normally requires the addition of fertilizer or lime in order to supply the nutritional needs of turfgrass (Table 1). In most cases, turfgrass yield and quality will not be enhanced by adding nutrients if the soil tests above recommended levels.

Adjusting the Soil Reaction (pH)

Turfgrasses differ in their adaptability to soil acidity. The pH ranges that are recommended for southern turfgrasses are shown in Table 2.

A large amount of bahiagrass sod is produced on the flatwoods soils of Florida. These flatwoods soils are acid, sandy, and somewhat poorly drained. If the pH of these soils is less than 5.0, lime may be required. It is not recommended that these soils be limed in excess of pH 6.0

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for bahiagrass and centipedegrass sod production. Most native flatwoods soils have a pH of less than 5.0 and should be limed prior to sod production to reduce the nutrient leaching potential of these soils. When St. Augustinegrass is produced on flatwoods soils, a better quality sod can be produced in a shorter period of time by liming to a pH of 6.5 to 7.0. Flatwoods soils are highly porous and nutrients may leach rapidly, especially when the soil pH is below 5.0. Monitor them often to assure that the proper balance of nutrients and soil pH is being maintained.

Most organic soils in Florida are near neutral in pH and do not require lime. The few acidic organic soils that do exist generally have a pH of between 4.0 and 5.0 and very low levels of extractable Al. Therefore, it is unlikely that liming will provide an economic benefit for sod production. Production of St. Augustine sod on organic soils of low pH has not been improved by liming. Almost without exception it is bad economic policy to lime an organic soil for sod production.

Normally, soil is limed to increase pH and supply essential nutrients such as calcium and magnesium. The two most commonly-available liming materials are calcitic and dolomitic limestones (Table 3). When the soil tests low in magnesium, dolomitic limestone should be used.

Generally, about six months reaction time is needed for calcitic or dolomitic lime to have its maximum effect on soil acidity. If more immediate results are desired, burned or hydrated lime can be used. In most cases, these materials are not recommended because they can easily and severely damage the grass if improperly used. Lime recommendations are typically made on a calcitic limestone basis. If another liming material is used, adjust the application rate according to the neutralization equivalents given in Table 3. Basic slag is a slow-reacting product which also contains large amounts of phosphorus; however, cost and availability limit its use.

Organic Matter

Analyze the soil for organic matter content if it is a sand or is a predominantly organic soil. The organic matter content of a soil is an important parameter in sod production which can influence the levels of fertilizer and herbicides applied. Sandy soils generally contain very little organic matter, so more N will have to be applied to sod growing on these soils than on organic soils. The organic matter content of acid sands is also very important relative to the retention of essential nutrients and water. Additionally, it is important to lime sandy acid soils because, at a pH of 5.5 to 6.0, the organic matter of the sandy soils is much more active and retains more nutrients than at pH 4.5 to 5.0.

General Fertilization Programs

A soil analysis following sod establishment furnishes information about the magnesium, phosphorus and potassium status of the soil. Adjustments should be made in the fertilization and liming program to take advantage of information derived from the soil test. A routine soil analysis does not include nitrogen, sulfur, or micronutrient analyses. Micronutrients, such as iron, manganese, copper, zinc, boron, and molybdenum, are required in small amounts and need to be applied only occasionally. Soil samples sent to the Extension Soil Testing Laboratory are not analyzed for Fe because of difficulties in analysis and in interpretation. Generally, soils testing below pH 6.5 are not limiting in Fe and no additional Fe is required. However, sod growing on high pH soils that is pale green and does not respond to N application may respond to foliar Fe applications. Granular Fe should only be used if the Fe is chelated as EDTA, DTPA, or EDDHA. No other form of granular Fe has resulted in a turfgrass response in Florida. Nitrogen, which is used in larger quantities than any of the other applied nutrients, must be applied on a regular basis. In addition, most Florida soils may also require the application of supplemental phosphorus and potassium during the turfgrass growing season.

Applications of fertilizer should be uniformly spaced over the growing season, depending upon turfgrass type and level of maintenance desired. In North Florida, you can fulfill the phosphorus and potassium requirements of most turfgrasses by the application of a complete fertilizer in March and September. South Florida sod growers should apply the complete fertilizer in February and September based on a recent soil test.

General fertilizer recommendations for N, P, and K are presented in Table 4 and Table 5. These recommended levels should be adjusted according to the information obtained from your soil test report. Generally speaking, 100% of the recommended rates should be applied to soils testing low, and 50% to soils testing medium for the nutrient in question. Turfgrasses growing on soils testing high in a given nutrient are less likely to respond to the application of that nutrient.

The recommendations in Tables 4 and 5 are based on a soil testing low in P and K by the Mehlich III extractant and the state is divided into three arbitrary production regions of North, Central, and South. The North region includes all counties north of a line drawn parallel to the northern border of Marion County across the state from coast to coast. The South region includes all counties south of a line drawn parallel to the southern border of Polk county across the state from coast to coast. All counties between the two borders are considered as being in the Central region.

Nitrogen Fertilization

The quantity of N to be applied during sod production depends on several factors. The organic matter content of the soil, as mentioned above, is very important, but the grass species and desired growth rate and the region of the state you are in are also important. As a general rule, St. Augustinegrass will respond more positively to N fertilization than will centipedegrass or bahiagrass. A quality St. Augustinegrass sod can be produced with 280 lbs of N/acre each year in South Florida. If production is in central or north Florida, N fertilization levels are adjusted downward in response to the shorter growing season, ie. 240 and 200 lbs/acre/yr, respectively. A number of different soluble and slow-release materials can be used to supply N. A soluble N fertilizer such as NH_4NO_3 (ammonium nitrate), urea, or $(NH_4)_2$ SO_4 (ammonium sulfate) should be used in conjunction with slow release N sources such as SCU, UF, Polyon, or biosolids. A blended mixture of 70% soluble and 30% slow-release N sources is recommended for environmental concerns. Inclusion of slow-release N sources in the N fertilization program during the hot summer months is highly recommended to limit chinch bug infestations. A highly succulent St. Augustinegrass sod is susceptible to chinch bug damage during the hot, high-humidity summer months; therefore, the N content of the grass should be kept to a minimum during this period. In addition, the slow-release N sources are much less susceptible to leaching losses and negative environmental impact.

In contrast, centipedegrass and bahiagrass require only 120 lbs of N/acre each year for optimum growth in North Florida. Due to the acid loving nature of these grasses, an acid-producing fertilizer such as ammonium sulfate or ammonium nitrate is recommended. Ammonium sulfate is particularly effective for centipedegrass, since it also supplies the sulfur which is often deficient for this grass. If the centipedegrass sod is not marketed when initially ready for harvest one should reduce the N application rate to prevent decline problems due to excessive N fertilization.

Nitrogen promotes vegetative growth. Generally, the more N supplied the greater the growth of the grass. This is beneficial when you are attempting to generate ground cover, but may cause undue stress during cool- or dry-season growth. Grass foliage containing high levels of N is also more susceptible to frost damage than is foliage containing low levels of N. Additionally, a grass which is growing excessively may not produce an adequate root system for nutrient- and water-accumulation during times of stress. A balanced well-timed fertilization program is required for optimum sod production.

Phosphorus Fertilization

Native organic and flatwoods soils are characteristically low in available P. Phosphorus promotes root growth and maturity in the plant and must be applied to sod as part of the regular fertilization program. Because of the nature of the organic and flatwoods soils, P can leach from such soils. Because of the soluble nature of P under acidic conditions, mineral flatwoods soils should be limed to more than pH 5.5 to help the soil retain P.

Organic soils are negatively charged and negatively charged phosphate ions leach through them readily; therefore, most organic soils tend to be low in readily available (soluble) P. Supplemental P is almost always required for sod production on organic soils. Mixing a source of P in the soil prior to sprigging or planting of the sod can be beneficial for root growth and stolon production. Phosphorus is absolutely required for the development of a strong root-stolon system that will promote lifting of the sod; therefore, annual applications of fertilizer P should be made based on a soil test and the recommended levels of P presented in Table 4. If the soil tests low, apply the recommended annual rate divided into two applications. If the soil tests medium use only 1/2 of the recommended amount in Table 4 on an annual basis. This P can be supplied by the use of a number of different P sources, including monoammonium phosphate (MAP) and diammonium phosphate (DAP). In the recent past limited quantities of triple superphosphate have been manufactured and may not be available for use. DAP is a good and economically feasible P source for application to ribbons during grow-in.

During the cool, low light conditions of early spring, bahiagrass may often exhibit P deficiency symptoms, even on high P soils. This is caused by excessive vegetative growth relative to root growth, with subsequent positional unavailability of P. Warm weather, which promotes root growth, tends to correct this problem without need for fertilization. Additionally, the growth and quality of centipedegrass has been shown to be negatively impacted by high P fertilization; therefore, apply P to centipedegrass when identified by a soil test as being required and at the rate recommended in Table 4.

Potassium Fertilization

Potassium promotes root growth, plant maturity, disease resistance and, in some instances, cold hardiness. Potassium is very important for sod production, because it influences root growth and the formation of a mat essential for sod lifting. In this respect, K may have as much influence on the production period of sod as does N. A minimum amount of research has been done to date on the influence of K on sod production, however, anecdotal observations suggest that proper K fertilization may limit disease problems and enhance the quality of sod.

Potassium leaches rapidly from flatwoods soils. It is difficult, if not impossible, to build up a K reserve in such soils. Liming aids in reducing K loss, most probably by increasing the soils cation exchange capacity. This is another reason for properly liming the soil before sod establishment. Fortunately, K is not recognized as an element of impairment, thus it is not considered a pollutant in our water bodies and streams. However, it is a natural resource that should be conserved and recent price increases in K sources may cause the sod grower to scrutinize his rates of K application.

Organic soils are not depleted of K by leaching as rapidly as are flatwoods soils, due to the more highly charged nature of the organic matter. Because potassium is weakly held by the organic matter, it can be easily displaced by other ions such as Ca and Mg. Thus, long-term availability of K in organic soils is low, and K must be applied on a regular basis.

Potassium fertilization is particularly important when producing bahiagrass seed. Fruiting and seed production are strongly influenced by soil K level. A low or marginal level of K may cause inferior seed production. The most commonly used K source, KCl (potassium chloride), has been shown to leach rapidly in acidic flatwoods soils. Potassium sulfate (K_2SO_4), and K_2CO_3 (potassium carbonate) have been shown to leach less rapidly than KCl on these soils. Potassium sulfate may be a better source of K for sod even though it usually costs more than KCl.

Micronutrient Fertilization

Organic and flatwoods soils are commonly deficient in one or more of the micronutrients that are essential for plant growth. The micronutrient most commonly deficient in organic soils is copper (Cu).

An application of 3 to 5 lbs Cu/acre as $CuSO_4$ (copper sulfate) should correct any Cu deficiency. Manganese is also typically deficient in some flatwoods soils. Manganese sulfate should be applied at 20 to 30 lbs Mn/acre to correct any Mn deficiency. On occasion, Zn and Fe also may be deficient in these soils, but the soil should be tested for micronutrients before sod establishment in lieu of the "wholesale application" of micronutrients. After application, Fe and Mn rapidly become unavailable due to their interaction with dissolved oxygen in the soil solution (Shaddox et al. 2016). Soils are not typically analyzed for Fe; however, a tissue analysis for Fe should detect Fe deficiency problems. If the turfgrass tissue tests less than 50 ppm Fe it would generally be considered as deficient. Since soil applications of Fe to high pH soils is generally ineffective, a foliar application of Fe may produce better results. A spray application of 1–1.5 lbs Fe/acre as iron sulfate should correct the deficiency. This practice may have to be repeated depending on the severity of the deficiency and the rate of growth of the turfgrass prior to harvesting.

Reference

Shaddox, T.W., J.B. Unruh, J.K. Kruse, and N.G. Restuccia. 2016. "Solubility of Iron, Manganese, and Magnesium Sulfates and Glucoheptonates in Two Alkaline Soils." *Soil Sci. Soc. Am. J.* 80: 765–770. doi:10.2136/sssaj2015.10.0382.

Table 1. Suggested Mehlich III soil-nutrient levels for turfgrasses in Florida.

Grass	ppm		
	Mg	P	K
Bermuda	20	30	60
Zoysia			
St. Augustine			
Bahia	20	20	60
Carpet			
Centipede			

Table 2. Turfgrasses and recommended pH ranges.

Turf grasses	Desirable pH range
Bahiagrass	5.0–6.0
Bermudagrass	5.0–7.0
Carpet grass	5.0–6.0
Centipedegrass	5.0–6.0
Fescue	6.0–7.0
Italian rye Paspalum	5.5–6.5 5.5–6.5
St. Augustinegrass	6.0–7.5
Zoysia	5.5–7.0

Table 3. Chemical composition and neutralization equivalents (N.E.) of common liming materials

Material	Chemical Composition	N.E.*
Burned lime	CaO	56
Hydrated lime	$Ca(OH)_2$	74
Dolomitic limestone	$CaCO_3$*$MgCO_3$	92
Calcitic limestone	$CaCO_3$	100
Basic slag	$CaSiO_3$	135
*The number of pounds of the material being used that are required to give the same neutralizing value as 100 pounds of pure calcium carbonate		

Table 4. Fertilizer recommendations for sod production on soils testing low in P_2O_5 and K_2O.

Grass Species	**Annual Application Rates (lb/acre)**		
	N	**P_2O_5**	**K_2O**
North Florida			
Bermuda	240	60	160
St. Augustine Zoysia	200	50	150
Paspalum	160	0	125
Centipede Bahia	120	20	100
Central Florida			
Bermuda	280	70	180
St. Augustine Zoysia	240	60	160
Paspalum	200	40	140
Centipede Bahia	150	25	120
South Florida			
Bermuda	320	80	200
St. Augustine Zoysia	280	60	180
Paspalum	240	50	160
Centipede Bahia	180	30	140
Muck Soil Production—Reduce N application by 180 lb/acre			

Table 5. Fertilizer recommendations for sod production on soils testing low in P_2O_5 and K_2O.

Grass Species	Dates	Rate (lb/acre)	Analysis	Quantities of Nutrients Applied (lb/acre)		
				N	P_2O_5	K_20
NORTH FLORIDA						
Bermuda	March 15	250	16-12-16	40	30	40
	April 15	250	16-0-8	40		20
	May 15	250	16-0-8	40		20
	June 15	250	16-0-8	40		20
	Aug 1	250	16-0-8	40		20
	Sep 1	250	16-12-16	40	30	40
			Totals	240	60	160
St. Augustine Zoysia	March 15	250	16-10-12	40	25	30
	May 1	250	16-0-12	40		30
	June 15	250	16-0-12	40		30
	Aug 1	250	16-0-12	40		30
	Sep 15	250	16-10-12	40	25	30
			Totals	240	50	150
Paspalum	March 15	250	16-6-10	40	15	25
	May 1	250	16-0-10	40		25
	June 15	125	20-0-20	25		25
	Aug 1	125	20-0-20	25		25
	Sep 15	250	12-6-10	30	15	25
			Totals	160	30	125
Centipede Bahia	March 15	250	16-4-8	40	10	20
	May 1	200	10-0-10	20		20
	June 15	200	10-0-10	20		20
	Aug 1	200	10-0-10	20		20
	Sep 15	250	8-4-8	20	10	20
			Totals	120	20	100
CENTRAL FLORIDA						
Bermuda	March 1	250	16-14-16	40	35	40
	April 1	250	16-0-8	40		20
	May 1	250	16-0-16	40		40
	June 1	250	16-0-8	40		20
	July 1	250	16-0-8	40		20
	Aug 1	250	16-0-8	40		20
	Sep 1	250	16-14-8	40	35	20
			Totals	280	70	180
St. Augustine Zoysia	March 1	250	16-12-16	40	30	40

Grass Species	Dates	Rate (lb/acre)	Analysis	Quantities of Nutrients Applied (lb/acre)		
				N	P_2O_5	K_20
	April 1	250	16-0-8	40		20
	May 1	250	16-0-8	40		20
	June 15	250	16-0-8	40		20
	Aug 1	250	16-0-8	40		20
	Sep 15	250	16-12-16	40	30	40
			Totals	240	60	160
Paspalum	March 1	250	16-4-16	40	20	40
	April 1	250	16-0-8	40		20
	May 1	250	16-0-8	40		20
	June 15	125	16-0-16	20		20
	Aug 1	125	16-0-16	20		20
	Sep 15	250	16-8-8	40	20	20
			Totals	200	40	140
Centipede Bahia	March 1	250	16-4-16	40	10	40
	April 15	125	24-0-16	30		20
	June 1	125	16-0-16	20		20
	July 15	125	16-0-16	20		20
	Sep 1	250	16-4-16	40	10	20
			Totals	150	20	120
SOUTH FLORIDA						
Bermuda	Feb 1	400	10-10-10	40	40	40
	March 1	250	16-0-8	40		20
	April 1	250	16-0-8	40		20
	May 1	250	16-8-8	40	20	20
	June 1	250	16-0-8	40		20
	July 1	250	16-0-8	40		20
	Aug 1	250	16-0-8	40		20
	Sep 1	250	16-8-16	40	20	40
			Totals	320	80	200
St. Augustine Zoysia	Feb 1	250	16-12-16	40	30	40
	March 1	250	16-0-8	40		20
	April 1	250	16-0-8	40		20
	May 15	250	16-0-8	40		20
	July 1	250	16-0-8	40		20
	Aug 15	250	16-0-8	40		20
	Oct 1	250	16-12-16	40	30	40
			Totals	280	60	180

Grass Species	Dates	Rate (lb/acre)	Analysis	Quantities of Nutrients Applied (lb/acre)		
				N	P_2O_5	K_20
Paspalum	Feb 1	250	16-10-16	40	25	40
	March 1	250	16-0-8	40		20
	April 15	250	16-0-8	40		20
	June 1	250	16-0-8	40		20
	July 15	250	16-0-8	40		20
	Sep 1	250	16-10-16	40	25	40
			Totals	240	50	200
Centipede Bahia	Feb 1	250	12-10-12	30	15	30
	March 1	250	12-0-8	30		20
	April 15	250	12-0-8	30		20
	June 1	250	12-0-8	30		20
	July 15	250	12-0-8	30		20
	Sep 1	250	12-10-12	30	15	30
			Totals	180	30	140

All of the fertilizer grades are to be formulated with at least 30% of the total guaranteed N being in a slow-release source form.

Any fertilizer grade can be substituted for the proposed fertilizer grades as long as the rate of application is adjusted not to exceed the recommended rate of application of N, P_2O_5 and K_2O. In no case should more than 1 lb soluble N/1000 sq ft be applied per application.