Golf Turf - Cool Season Grass Establishment

Crop Highlights
● Target pH: 6.5 ● Follow these guidelines for twelve weeks following early fall or late summer planting of cool season grasses. After this twelve-week establishment period, switch to a maintenance fertilization program. ● Enhanced efficiency nitrogen (N) sources (>30% slow release or water insoluble) are recommended for use at planting to prevent N losses. ● Facilities managed under a Delaware Nutrient Management General Permit are prohibited from applying phosphorus (P) fertilizers at a rate that exceeds 2 lb/1000 ft^2 of P_2O_5. ● Potassium (K) levels determined by a soil test should be sufficient prior to the dormancy period to promote an increase in root mass. ● Soil pH should be corrected prior to or at establishment. ● Micronutrient levels should be sufficient at time of establishment to avoid any deficiencies. If micronutrients are determined to be insufficient, select a turf-grade fertilizer that contains micronutrients. ● All fertilizer and/or liming materials applied at time of establishment should be incorporated into the top 1 inch of soil. ● Soil testing should be done prior to establishment to identify any possible nutrient deficiencies.

Management Notes

These recommendations are valid for the establishment of cool season turfgrasses on golf courses with sand-based or native soils. Use the cool season recommendations when establishing Kentucky bluegrass, tall and fine fescue, bentgrass, Poa annua, or perennial ryegrass. The preferred time for planting cool season grasses is late fall, although cool season grasses can be planted in the spring. The fertilization establishment period for cool season grasses is twelve weeks; after twelve weeks, switch to the recommendations for maintenance of cool season golf turf.

Soil pH and Liming

Target pH: 6.5

Turfgrass species can withstand a rather large range of pH (5.4 to 7.8), but they perform best when soil pH is near the target pH of 6.5. The lime recommendation for a specific site is calculated from the soil pH and Adam-Evans buffer pH measurements using the steps outlined in the UD Extension Fact Sheet ***Calculating the Lime Requirement Using the Adams-Evans Soil Buffer***. Avoid over-liming to prevent deficiency of micronutrients such as iron (Fe).

The recommended liming source is dependent upon Mehlich-3 (M3) soil test calcium (Ca) and magnesium (Mg) reported in University of Delaware fertility index value (FIV) and can be determined using Table 1.

Table 1. Recommended type of lime as a function of Mehlich-3 soil test calcium and magnesium concentrations.

Soil Test Levels	Recommended Lime Type
M3-Mg is less than 50 FIV	Dolomitic
M3-Mg between 50 and 100 FIV AND M3-Mg is less than M3-Ca	Dolomitic
M3-Mg greater than 100 FIV	Calcitic
M3-Mg is greater than 50 FIV AND M3-Mg is greater than M3-Ca	Calcitic

Nitrogen

The University of Delaware recommends the use of enhanced efficiency nitrogen (N) fertilizers (e.g., urea formaldehyde, polyon) over water soluble forms (e.g., ammonium sulfate, urea) whenever possible for the establishment of cool season golf turf. Enhanced efficiency fertilizers typically contain at least 30% of the total N in a slow release or water insoluble form. If preferred, water soluble N sources can be applied through the irrigation system (fertigation) or a sprayer to increase nutrient use efficiency and decrease the potential for nitrogen loss to the environment. Water soluble N sources should be applied more frequently and at lower rates than enhanced efficiency fertilizers.

1. At planting, apply enhanced efficiency N fertilizers (>30% slowly available N) at an N rate of 0.5 to 1.0 lb/1000 ft^2 to feed young plants for the first four weeks after planting. If choosing water soluble (readily available) N sources, split the total N application (1 lb/1000 ft^2) into four weekly applications of N at a rate of 0.25 lb/1000 ft^2.
2. Apply enhanced efficiency N fertilizers (containing >30% slowly available N) bi-weekly to cool season grasses at an N rate of 0.5 lb/1000 ft^2 from four to twelve weeks after planting. Alternatively, apply water soluble N fertilizers weekly at an N rate of 0.25 lb/1000 ft^2 to cool season grasses from four to twelve weeks after planting.
3. When applying water soluble N fertilizers through a sprayer, do not exceed 0.15 lb/1000 ft^2 of N per application. Spray weekly from four to twelve weeks after planting.
4. If applying a starter fertilizer at establishment, use fertilizers with a N-P-K ratio of approximately 2-1-1 (i.e., 10-5-5 or 10-6-4) following the N rates as outlined.

Phosphorus

Phosphorus (P) fertilization is based on the results of a M3 routine soil test (Table 2). Soil test results are reported as a Fertility Index Value (FIV). Phosphorus fertilizers are best applied prior to planting when it can be incorporated into the soil.

Table 2. Recommended broadcast phosphorus application rates for establishment of cool season golf turf based on results of a M3 routine soil test.

	M3-P (UD-FIV)			
	Low (0-25)	Medium (26-50)	Optimum (51-100)	Excessive (>100)
lb P_2O_5/1000 ft^2	2-3	1-2	0-1	0

1. Within each M3 soil test phosphorus (M3-P) category, choose the higher rate when M3-P is at the lower side of the range and the lower rate at the higher side of the range.
2. If M3-P is “Low” (e.g., 25 FIV or less) and P fertilizer is incorporated to a depth greater than 2 inches, the P_2O_5 application rate can be increased to 3 to 4 lb/1000 ft^2.

3. If M3-P is “Excessive” (e.g., greater than 100 FIV), the application of phosphorus fertilizers is NOT RECOMMENDED.
4. Facilities managed under a Delaware Nutrient Management General Permit are prohibited from applying P at a rate that exceeds 2 lb/1000 ft^2 P_2O_5, regardless of M3-P concentration. Higher P_2O_5 rates (>2 lb/1000 ft^2) are restricted to those facilities managed under a nutrient management plan with written justification by a certified nutrient consultant.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 3). Potassium fertilizers are best applied prior to planting when it can be incorporated into the soil.

Table 3. Recommended broadcast potassium application rates for establishment of cool season golf turf based on results of a M3 routine soil test.

	M3-K (UD-FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb K_2O/1000 ft^2	2-3	1-2	0-2	0

1. Within each M3 soil test potassium (M3-K) category, choose the higher rate when M3-K is at the lower side of the range and the lower rate at the higher side of the range.
2. If M3-K is “Low” (e.g., 25 FIV or less) and K fertilizer is incorporated to a depth greater than 2 inches, the application rate can be increased to 3 to 5 lb K_2O/1000 ft^2.

Calcium and Magnesium

Calcium (Ca) and magnesium (Mg) needs for establishment of golf turf are usually met through liming. See above for guidance on liming.

Table 4. Recommended application rates of soluble magnesium as a function of soil test (M3) magnesium.

	M3-Mg (FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb soluble Mg /1000 ft^2	1-2	0.25-1	0	0

1. Magnesium (Mg) is recommended when M3 soil test Mg (M3-Mg) is less than 50 FIV.
2. Within each M3-Mg category, choose the higher rate when M3-Mg is at the lower side of the range and the lower rate at the higher side of the range.
3. If M3-Mg is less than 50 FIV and lime is recommended, use dolomitic limestone.
4. If M3-Mg is less than 50 FIV and lime is not needed, apply soluble Mg (Mg sulfate or Mg chloride) according to the rates in Table 4.

Golf Turf - Warm Season Grass Establishment

Crop Highlights

- Target pH: 6.5
- Follow these guidelines for twelve weeks following early fall or late summer planting of cool season grasses. After this twelve-week establishment period, switch to a maintenance fertilization program.
- Enhanced efficiency nitrogen (N) sources (>30% slow release or water insoluble) are recommended for use at planting to prevent N losses.
- Facilities managed under a Delaware Nutrient Management General Permit are prohibited from applying phosphorus (P) fertilizers at a rate that exceeds 2 lb/1000 ft^2 of P_2O_5.
- Potassium (K) levels determined by a soil test should be sufficient prior to the dormancy period to promote an increase in root mass. Soil test K concentrations above 28 UD-FIV (50 ppm) can promote spring dead spot development on bermudagrass after establishment. Consider managing soil test K at or below 28 UD-FIV if spring dead spot is an issue.
- Soil pH should be corrected prior to or at establishment.
- Micronutrient levels should be sufficient at time of establishment to avoid any deficiencies. If micronutrients are determined to be insufficient, select a turf-grade fertilizer that contains micronutrients.
- All fertilizer and/or liming materials applied at time of establishment should be incorporated into the top 1 inch of soil.
- Soil testing should be done prior to establishment to identify any possible nutrient deficiencies.

Management Notes

These recommendations are valid for the establishment of warm season turfgrasses on golf courses with sand-based or native soils. Use the warm season recommendations when establishing bermudagrass or zoysia. The preferred time for planting warm season grasses is mid-spring to early summer. The fertilization establishment period for warm season grasses is eight weeks; after eight weeks, switch to the recommendations for maintenance of warm season golf turf.

Soil pH and Liming

Target pH: 6.5

Turfgrass species can withstand a rather large range of pH (5.4 to 7.8), but they perform best when soil pH is near the target pH of 6.5. The lime recommendation for a specific site is calculated from the soil pH and Adam-Evans buffer pH measurements using the steps outlined in the UD Extension Fact Sheet ***Calculating the Lime Requirement Using the Adams-Evans Soil Buffer***. Avoid over-liming to prevent deficiency of micronutrients such as iron (Fe).

The recommended liming source is dependent upon Mehlich-3 (M3) soil test calcium (Ca) and magnesium (Mg) reported in University of Delaware fertility index value (FIV) and can be determined using Table 1.

Table 1. Recommended type of lime as a function of Mehlich-3 soil test calcium and magnesium concentrations.

Soil Test Levels	Recommended Lime Type
M3-Mg is less than 50 FIV	Dolomitic
M3-Mg between 50 and 100 FIV AND M3-Mg is less than M3-Ca	Dolomitic
M3-Mg greater than 100 FIV	Calcitic
M3-Mg is greater than 50 FIV AND M3-Mg is greater than M3-Ca	Calcitic

Nitrogen

The University of Delaware recommends the use of enhanced efficiency nitrogen (N) fertilizers (e.g., urea formaldehyde, polyon) over water soluble forms (e.g., ammonium sulfate, urea) whenever possible for the establishment of warm season golf turf. Enhanced efficiency fertilizers typically contain at least 30% of the total N in a slow release or water insoluble form. If preferred, water soluble N sources can be applied through the irrigation system (fertigation) or a sprayer to increase nutrient use efficiency and decrease the potential for nitrogen loss to the environment. Water soluble N sources should be applied more frequently and at lower rates than enhanced efficiency fertilizers.

1. At planting, apply enhanced efficiency N fertilizers (>30% slowly available N) at an N rate of 0.5 to 1.0 lb/1000 ft^2 to feed young plants for the first four weeks after planting. If choosing water soluble (readily available) N sources, split the total N application (1 lb/1000 ft^2) into four weekly applications of N at a rate of 0.25 lb/1000 ft^2.
2. Apply water soluble N fertilizers at a rate of 0.5 to 1.0 lb/1000 ft^2 of N weekly from four to twelve weeks after planting.
3. When applying water soluble N fertilizers through a sprayer, do not exceed 0.25 lb/1000 ft^2 of N per application. Spray weekly from four to twelve weeks after planting.
4. If applying a starter fertilizer at establishment, use fertilizers with a N-P-K ratio of approximately 2-1-1 (i.e., 10-5-5 or 10-6-4) following the N rates as outlined.

Phosphorus

Phosphorus (P) fertilization is based on the results of a M3 routine soil test (Table 2). Soil test results are reported as a Fertility Index Value (FIV). Phosphorus fertilizers are best applied prior to planting when it can be incorporated into the soil.

Table 2. Recommended broadcast phosphorus application rates for establishment of warm season golf turf based on results of a M3 routine soil test.

	M3-P (UD-FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb P_2O_5/1000 ft^2	2-3	1-2	0-1	0

1. Within each M3 soil test phosphorus (M3-P) category, choose the higher rate when M3-P is at the lower side of the range and the lower rate at the higher side of the range.
2. If M3-P is “Low” (e.g., 25 FIV or less) and P fertilizer is incorporated to a depth greater than 2 inches, the P_2O_5 application rate can be increased to 3 to 4 lb/1000 ft^2.
3. If M3-P is “Excessive” (e.g., greater than 100 FIV), the application of phosphorus fertilizers is NOT RECOMMENDED.

4. Facilities managed under a Delaware Nutrient Management General Permit are prohibited from applying P at a rate that exceeds 2 lb/1000 ft^2 P_2O_5, regardless of M3-P concentration. Higher P_2O_5 rates (>2 lb/1000 ft^2) are restricted to those facilities managed under a nutrient management plan with written justification by a certified nutrient consultant.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 3). Potassium fertilizers are best applied prior to planting when it can be incorporated into the soil.

Table 3. Recommended broadcast potassium application rates for establishment of warm season golf turf based on results of a M3 routine soil test.

	M3-K (UD-FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb K_2O/1000 ft^2	2-3	1-2	0-2	0

1. Within each M3 soil test potassium (M3-K) category, choose the higher rate when M3-K is at the lower side of the range and the lower rate at the higher side of the range.
2. If M3-K is “Low” (e.g., 25 FIV or less) and K fertilizer is incorporated to a depth greater than 2 inches, the application rate can be increased to 3 to 5 lb K_2O/1000 ft^2.
3. **For bermudagrass only**: Consider reducing rates in Table 3 by one-half and maintain M3-K levels closer to 28 UD-FIV if spring dead spot is an issue.

Calcium and Magnesium

Calcium (Ca) and magnesium (Mg) needs for establishment of golf turf are usually met through liming. See above for guidance on liming.

Table 4. Recommended application rates of soluble magnesium as a function of soil test (M3) magnesium.

	M3-Mg (FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb soluble Mg /1000 ft^2	1-2	0.25-1	0	0

1. Magnesium (Mg) is recommended when M3 soil test Mg (M3-Mg) is less than 50 FIV.
2. Within each M3-Mg category, choose the higher rate when M3-Mg is at the lower side of the range and the lower rate at the higher side of the range.
3. If M3-Mg is less than 50 FIV and lime is recommended, use dolomitic limestone.
4. If M3-Mg is less than 50 FIV and lime is not needed, apply soluble Mg (Mg sulfate or Mg chloride) according to the rates in Table 4.

Athletic Turf - Cool Season Grass Establishment

Crop Highlights

- Target pH: 6.5
- Follow these guidelines for twelve weeks following early fall or late summer planting of cool season grasses. After this twelve-week establishment period, switch to a maintenance fertilization program.
- Enhanced efficiency nitrogen (N) sources (>30% slow release or water insoluble) are recommended for use at planting to prevent N losses.
- Facilities managed under a Delaware Nutrient Management General Permit are prohibited from applying phosphorus (P) fertilizers at a rate that exceeds 2 lb/1000 ft^2 of P_2O_5.
- Potassium (K) levels determined by a soil test should be sufficient prior to the dormancy period to promote an increase in root mass.
- Soil pH should be corrected prior to or at establishment.
- Micronutrient levels should be sufficient at time of establishment to avoid any deficiencies. If micronutrients are determined to be insufficient, select a turf-grade fertilizer that contains micronutrients.
- All fertilizer and/or liming materials applied at time of establishment should be incorporated into the top 1 inch of soil.
- Soil testing should be done prior to establishment to identify any possible nutrient deficiencies.

Management Notes

These recommendations are valid for the establishment of cool season turfgrasses on athletic fields with sand-based or native soils. Use the cool season recommendations when establishing Kentucky bluegrass, tall and fine fescue, bentgrass, Poa annua, or perennial ryegrass. The preferred time for planting cool season grasses is late fall, although cool season grasses can be planted in the spring. The fertilization establishment period for cool season grasses is twelve weeks; after twelve weeks, switch to the recommendations for maintenance of cool season athletic turf.

Soil pH and Liming

Target pH: 6.5

Turfgrass species can withstand a rather large range of pH (5.4 to 7.8), but they perform best when soil pH is near the target pH of 6.5. The lime recommendation for a specific site is calculated from the soil pH and Adam-Evans buffer pH measurements using the steps outlined in the UD Extension Fact Sheet ***Calculating the Lime Requirement Using the Adams-Evans Soil Buffer***. Avoid over-liming to prevent deficiency of micronutrients such as iron (Fe).

The recommended liming source is dependent upon Mehlich-3 (M3) soil test calcium (Ca) and magnesium (Mg) reported in University of Delaware fertility index value (FIV) and can be determined using Table 1.

Table 1. Recommended type of lime as a function of Mehlich-3 soil test calcium and magnesium concentrations.

Soil Test Levels	Recommended Lime Type
M3-Mg is less than 50 FIV	Dolomitic
M3-Mg between 50 and 100 FIV AND M3-Mg is less than M3-Ca	Dolomitic
M3-Mg greater than 100 FIV	Calcitic
M3-Mg is greater than 50 FIV AND M3-Mg is greater than M3-Ca	Calcitic

Nitrogen

The University of Delaware recommends the use of enhanced efficiency nitrogen (N) fertilizers (e.g., urea formaldehyde, polyon) over water soluble forms (e.g., ammonium sulfate, urea) whenever possible for the establishment of cool season athletic turf. Enhanced efficiency fertilizers typically contain at least 30% of the total N in a slow release or water insoluble form. If preferred, water soluble N sources can be applied through the irrigation system (fertigation) or a sprayer to increase nutrient use efficiency and decrease the potential for nitrogen loss to the environment. Water soluble N sources should be applied more frequently and at lower rates than enhanced efficiency fertilizers.

1. At planting, apply enhanced efficiency N fertilizers (>30% slowly available N) at an N rate of 0.5 to 1.0 lb/1000 ft^2 to feed young plants for the first four weeks after planting. If choosing water soluble (readily available) N sources, split the total N application (1 lb/1000 ft^2) into four weekly applications of N at a rate of 0.25 lb/1000 ft^2.
2. Apply enhanced efficiency N fertilizers (containing >30% slowly available N) bi-weekly to cool season grasses at an N rate of 0.5 lb/1000 ft^2 from four to twelve weeks after planting. Alternatively, apply water soluble N fertilizers weekly at an N rate of 0.25 lb/1000 ft^2 to cool season grasses from four to twelve weeks after planting.
3. When applying water soluble N fertilizers through a sprayer, do not exceed 0.15 lb/1000 ft^2 of N per application. Spray weekly from four to twelve weeks after planting.
4. If applying a starter fertilizer at establishment, use fertilizers with a N-P-K ratio of approximately 2-1-1 (i.e., 10-5-5 or 10-6-4) following the N rates as outlined.

Phosphorus

Phosphorus (P) fertilization is based on the results of a M3 routine soil test (Table 2). Soil test results are reported as a Fertility Index Value (FIV). Phosphorus fertilizers are best applied prior to planting when it can be incorporated into the soil.

Table 2. Recommended broadcast phosphorus application rates for establishment of cool season athletic turf based on results of a M3 routine soil test.

	M3-P (UD-FIV)			
	Low (0-25)	Medium (26-50)	Optimum (51-100)	Excessive (>100)
lb P_2O_5/1000 ft^2	2-3	1-2	0-1	0

1. Within each M3 soil test phosphorus (M3-P) category, choose the higher rate when M3-P is at the lower side of the range and the lower rate at the higher side of the range.
2. If M3-P is “Low” (e.g., 25 FIV or less) and P fertilizer is incorporated to a depth greater than 2 inches, the P_2O_5 application rate can be increased to 3 to 4 lb/1000 ft^2.
3. If M3-P is “Excessive” (e.g., greater than 100 FIV), the application of phosphorus fertilizers is NOT RECOMMENDED.
4. Facilities managed under a Delaware Nutrient Management General Permit are prohibited from applying P at a rate that exceeds 2 lb/1000 ft^2 P_2O_5, regardless of M3-P concentration. Higher P_2O_5 rates (>2 lb/1000 ft^2) are restricted to those facilities managed under a nutrient management plan with written justification by a certified nutrient consultant.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 3). Potassium fertilizers are best applied prior to planting when it can be incorporated into the soil.

Table 3. Recommended broadcast potassium application rates for establishment of cool season athletic turf based on results of a M3 routine soil test.

	M3-K (UD-FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb K_2O/1000 ft^2	2-3	1-2	0-2	0

1. Within each M3 soil test potassium (M3-K) category, choose the higher rate when M3-K is at the lower side of the range and the lower rate at the higher side of the range.
2. If M3-K is “Low” (e.g., 25 FIV or less) and K fertilizer is incorporated to a depth greater than 2 inches, the application rate can be increased to 3 to 5 lb K_2O/1000 ft^2.

Calcium and Magnesium

Calcium (Ca) and magnesium (Mg) needs for establishment of golf turf are usually met through liming. See above for guidance on liming.

Table 4. Recommended application rates of soluble magnesium as a function of soil test (M3) magnesium.

	M3-Mg (FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb soluble Mg /1000 ft^2	1-2	0.25-1	0	0

1. Magnesium (Mg) is recommended when M3 soil test Mg (M3-Mg) is less than 50 FIV.
2. Within each M3-Mg category, choose the higher rate when M3-Mg is at the lower side of the range and the lower rate at the higher side of the range.
3. If M3-Mg is less than 50 FIV and lime is recommended, use dolomitic limestone.
4. If M3-Mg is less than 50 FIV and lime is not needed, apply soluble Mg (Mg sulfate or Mg chloride) according to the rates in Table 4.

Athletic Turf - Warm Season Grass Establishment

Crop Highlights

- Target pH: 6.5
- Follow these guidelines for twelve weeks following early fall or late summer planting of cool season grasses. After this twelve-week establishment period, switch to a maintenance fertilization program.
- Enhanced efficiency nitrogen (N) sources (>30% slow release or water insoluble) are recommended for use at planting to prevent N losses.
- Facilities managed under a Delaware Nutrient Management General Permit are prohibited from applying phosphorus (P) fertilizers at a rate that exceeds 2 lb/1000 ft2 of P_2O_5.
- Potassium (K) levels determined by a soil test should be sufficient prior to the dormancy period to promote an increase in root mass. Soil test K concentrations above 28 UD-FIV (50 ppm) can promote spring dead spot development bermudagrass after establishment. Consider managing soil test K at or below 28 UD-FIV is spring dead spot is an issue.
- Soil pH should be corrected prior to or at establishment.
- Micronutrient levels should be sufficient at time of establishment to avoid any deficiencies. If micronutrients are determined to be insufficient, select a turf-grade fertilizer that contains micronutrients.
- All fertilizer and/or liming materials applied at time of establishment should be incorporated into the top 1 inch of soil.
- Soil testing should be done prior to establishment to identify any possible nutrient deficiencies.

Management Notes

These recommendations are valid for the establishment of warm season turfgrasses on golf courses with sand-based or native soils. Use the warm season recommendations when establishing bermudagrass or zoysia. The preferred time for planting warm season grasses is mid-spring to early summer. The fertilization establishment period for warm season grasses is eight weeks; after eight weeks, switch to the recommendations for maintenance of warm season athletic turf.

Soil pH and Liming

Target pH: 6.5

Turfgrass species can withstand a rather large range of pH (5.4 to 7.8), but they perform best when soil pH is near the target pH of 6.5. The lime recommendation for a specific site is calculated from the soil pH and Adam-Evans buffer pH measurements using the steps outlined in the UD Extension Fact Sheet ***Calculating the Lime Requirement Using the Adams-Evans Soil Buffer***. Avoid over-liming to prevent deficiency of micronutrients such as iron (Fe).

The recommended liming source is dependent upon Mehlich-3 (M3) soil test calcium (Ca) and magnesium (Mg) reported in University of Delaware fertility index value (FIV) and can be determined using Table 1.

Table 1. Recommended type of lime as a function of Mehlich-3 soil test calcium and magnesium concentrations.

Soil Test Levels	Recommended Lime Type
M3-Mg is less than 50 FIV	Dolomitic
M3-Mg between 50 and 100 FIV AND M3-Mg is less than M3-Ca	Dolomitic
M3-Mg greater than 100 FIV	Calcitic
M3-Mg is greater than 50 FIV AND M3-Mg is greater than M3-Ca	Calcitic

Nitrogen

The University of Delaware recommends the use of enhanced efficiency nitrogen (N) fertilizers (e.g., urea formaldehyde, polyon) over water soluble forms (e.g., ammonium sulfate, urea) whenever possible for the establishment of warm season athletic turf. Enhanced efficiency fertilizers typically contain at least 30% of the total N in a slow release or water insoluble form. If preferred, water soluble N sources can be applied through the irrigation system (fertigation) or a sprayer to increase nutrient use efficiency and decrease the potential for nitrogen loss to the environment. Water soluble N sources should be applied more frequently and at lower rates than enhanced efficiency fertilizers.

1. At planting, apply enhanced efficiency N fertilizers (>30% slowly available N) at an N rate of 0.5 to 1.0 lb/1000 ft^2 to feed young plants for the first four weeks after planting. If choosing water soluble (readily available) N sources, split the total N application (1 lb/1000 ft^2) into four weekly applications of N at a rate of 0.25 lb/1000 ft^2.
2. Apply water soluble N fertilizers at a rate of 0.5 to 1.0 lb/1000 ft^2 of N weekly from four to twelve weeks after planting.
3. When applying water soluble N fertilizers through a sprayer, do not exceed 0.25 lb/1000 ft^2 of N per application. Spray weekly from four to twelve weeks after planting.
4. If applying a starter fertilizer at establishment, use fertilizers with a N-P-K ratio of approximately 2-1-1 (i.e., 10-5-5 or 10-6-4) following the N rates as outlined.

Phosphorus

Phosphorus (P) fertilization is based on the results of a M3 routine soil test (Table 2). Soil test results are reported as a Fertility Index Value (FIV). Phosphorus fertilizers are best applied prior to planting when it can be incorporated into the soil.

Table 2. Recommended broadcast phosphorus application rates for establishment of warm season athletic turf based on results of a M3 routine soil test.

	M3-P (UD-FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb P_2O_5/1000 ft^2	2-3	1-2	0-1	0

1. Within each M3 soil test phosphorus (M3-P) category, choose the higher rate when M3-P is at the lower side of the range and the lower rate at the higher side of the range.
2. If M3-P is “Low” (e.g., 25 FIV or less) and P fertilizer is incorporated to a depth greater than 2 inches, the P_2O_5 application rate can be increased to 3 to 4 lb/1000 ft^2.
3. If M3-P is “Excessive” (e.g., greater than 100 FIV), the application of phosphorus fertilizers is NOT RECOMMENDED.

4. Facilities managed under a Delaware Nutrient Management General Permit are prohibited from applying P at a rate that exceeds 2 lb/1000 ft^2 P_2O_5, regardless of M3-P concentration. Higher P_2O_5 rates (>2 lb/1000 ft^2) are restricted to those facilities managed under a nutrient management plan with written justification by a certified nutrient consultant.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 3). Potassium fertilizers are best applied prior to planting when it can be incorporated into the soil.

Table 3. Recommended broadcast potassium application rates for establishment of warm season athletic turf based on results of a M3 routine soil test.

	M3-K (UD-FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb K_2O/1000 ft^2	2-3	1-2	0-2	0

1. Within each M3 soil test potassium (M3-K) category, choose the higher rate when M3-K is at the lower side of the range and the lower rate at the higher side of the range.
2. If M3-K is “Low” (e.g., 25 FIV or less) and K fertilizer is incorporated to a depth greater than 2 inches, the application rate can be increased to 3 to 5 lb K_2O/1000 ft^2.
3. **For bermudagrass only**: Consider reducing rates in Table 3 by one-half and maintain M3-K levels closer to 28 UD-FIV if spring dead spot is an issue.

Calcium and Magnesium

Calcium (Ca) and magnesium (Mg) needs for establishment of golf turf are usually met through liming. See above for guidance on liming.

Table 4. Recommended application rates of soluble magnesium as a function of soil test (M3) magnesium.

	M3-Mg (FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb soluble Mg /1000 ft^2	1-2	0.25-1	0	0

1. Magnesium (Mg) is recommended when M3 soil test Mg (M3-Mg) is less than 50 FIV.
2. Within each M3-Mg category, choose the higher rate when M3-Mg is at the lower side of the range and the lower rate at the higher side of the range.
3. If M3-Mg is less than 50 FIV and lime is recommended, use dolomitic limestone.
4. If M3-Mg is less than 50 FIV and lime is not needed, apply soluble Mg (Mg sulfate or Mg chloride) according to the rates in Table 4.