Bermudagrass - New Seeding

Crop Highlights
• Target pH: 6.5 • Establishment by sprigging is more successful than by seeding. • Do not apply nitrogen (N) at seeding to avoid stimulating weed competition; apply N when crop is 2 to 4 inches tall. • Monitor forage and hay crops for S deficiency or use ammonium sulfate as the N source to provide S. • Forage and hay crops are moderately sensitive to manganese (Mn) deficiency.

Management Notes

Success establishing bermudagrass stands using seed is limited. If seeding, use newer, cold-tolerant, seeded-type hybrids; avoid Arizona common and Giant type common. Best results occur when bermudagrass is sprigged, especially with irrigation. Avoid turf-type bermudagrass hybrids as they are not productive in a hay system. Bermudagrass is not tolerant of shading by other species, including weeds. During the first season of establishment, mow as needed to control weeds.

Yield Goal

Yield goals are not made for new seedings of perennial forages. Instead, these recommendations are designed to promote good establishment of the forage for future productivity and discourage weed competition.

Target pH: 6.5

Soils that are high in organic matter (e.g., "black" soils; soil organic matter >6.0%) have a lower target pH (5.6) because organic matter moderates some of the negative effects of excessive soil acidity (e.g., aluminum toxicity).

The lime recommendation for a specific field 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 manganese (Mn).

The recommended liming source is dependent upon Mehlich-3 (M3) soil test calcium (Ca) and magnesium (Mg) reported as a 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 (M3-Ca) and magnesium (M3-Mg) 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

Nitrogen fertilization rates are based on regional research on crop response to N fertilizers and not on the results of a routine soil test. Follow these recommendations for new seedings only. Switch to nutrient recommendations for established hay after the first cutting or established forage after the first grazing cycle. Do not apply N at seeding to avoid stimulating weed competition.

1. When seedlings are 2 to 4 inches tall and if weed pressure is not at a competitive level, broadcast 20 lbs N/ac.
2. At 4 weeks after planting/sprigging, an additional 20 to 40 lb/ac can be applied if weed pressure is not at a competitive level.
3. Cease N applications at least 4 to 6 weeks prior to Bermudagrass entering winter dormancy (generally early October).

Phosphorus

Phosphorus (P) fertilization is based on the results of a routine soil test (Table 2). Soil test results are reported as a fertility index value (FIV).

Table 2. Recommended phosphorus rate to reach optimum Mehlich-3 soil test phosphorus (M3-P) levels to support good forage establishment and future productivity.

	M3-P (UD FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb P_2O_5/ac	120	110	100	85	75	65	50	40	25	10	0

1. If M3 soil test P (M3-P) is “Low” or “Medium” (i.e., 50 FIV or less), broadcast and plow down the recommended rate of phosphate (P_2O_5) fertilizer prior to seeding.
2. If M3-P is “Optimum” (i.e., 51 to 100 FIV), broadcast and incorporate P_2O_5 fertilizer prior to seeding or surface broadcast at or shortly after planting.
3. If M3-P is “Excessive” (i.e., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 3). Soil test results are reported as a fertility index value (FIV).

Table 3. Recommended potassium rate to reach optimum Mehlich-3 soil test potassium (M3-K) levels to support good forage establishment and future productivity.

	M3-K (UD FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb K_2O/ac	180	165	150	135	120	105	90	75	60	45	0

1. Broadcast and incorporate potash (K_2O) fertilizer at or prior to seeding.
2. Application rates of 120 lb/ac of K_2O or higher should be split into two applications. Apply ½ of the recommended rate after the first cutting and the remainder in late August or September.

Magnesium

The need for magnesium (Mg) fertilization is determined by a routine soil test (Table 4); Mg needs are often met by liming. Soil test results are reported as a fertility index value (FIV).

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

	M3-Mg (UD FIV)								
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**
lb soluble Mg/ac	80	70	60	50	40	30	20	10	0

1. Magnesium (Mg) is recommended when M3-Mg is less than 40 FIV.
2. Use dolomitic limestone if M3-Mg is less than 40 FIV and lime is recommended, use dolomitic limestone.
3. If M3-Mg is less than 40 FIV and lime is not needed, apply soluble Mg (Mg sulfate or Mg chloride) according to the rates in Table 4.

Sulfur

Sulfur (S) deficiency is occasionally observed in bermudagrass grown on Delaware soils. Symptoms include reduced growth and a general yellowing of the plant. Newly planted forage crops are susceptible to S deficiency because their shallow root systems do not allow the crop to tap into subsoil stores of S.

1. Apply S at a rate of 20 to 40 lb/ac to ensure that adequate sulfur is available to meet crop needs.
2. Broadcast S prior to seeding or use ammonium sulfate as an N source to supply needed S.
3. Sulfate-S is available immediately for crop uptake immediately after application. If a reduced form of S is applied (e.g., thiosulfate or elemental S), allow adequate time for the applied S to oxidize to the sulfate form.

Prediction of S deficiency is difficult. Currently available soil tests are not good predictors of S deficiency situations because only surface soil samples are analyzed. Many Delaware soils have a supply of plant available S in subsoil horizons that will not be detected in soil samples taken from shallower depths. Subsoil sampling to a depth of 24 inches is highly recommended as a means of identifying soils with subsoil reserves of S.

Long-term applications of ammonium sulfate or other acid-forming fertilizers may lower pH of the soil surface and require correction with lime. Monitor surface pH with a 0- to 2-inch soil sample, especially in pasture systems.

Manganese

Manganese (Mn) needs are predicted by an availability index (MnAI) that includes M3 soil test Mn (M3-Mn) and soil pH. Interpretation of MnAI is crop specific (Table 5). Forage crops are moderately sensitive to Mn deficiency. Soil test Mn results are reported in lb/ac.

MnAI = 101.7 – (15.2 × soil pH) + (2.11 × M3-Mn)

Where:

MnAI = Mn availability index
Soil pH = Soil pH measured in water (1:1 V:V)
M3-Mn = Mehlich 3 soil test Mn in lb/ac

Table 5. Interpretation of manganese availability index for bermudagrass.

Mn Availability Index	Interpretation
Less than 17	Mn deficiency is likely at this soil pH and soil test Mn concentration
17 to 25	Mn deficiency is possible at this soil pH and soil test Mn concentration. Monitor the crop for symptoms, especially if liming has been recommended.
Greater than 25	Mn deficiency is unlikely.

1. If Mn deficiency is predicted or was observed in the previous growing season, broadcast Mn at a rate of 20 to 40 lb/ac.
2. Broadcast applications of acid forming fertilizers may correct Mn deficiency without the actual application of Mn in some cases but may be less effective than applications of Mn. Long term application of acid forming fertilizers will require pH correction with lime.
3. If Mn deficiency symptoms appear during the growing season or after an application of lime, a foliar application of 1.0 to 2.0 lb/ac actual Mn as Mn sulfate, Mn oxide or chelated Mn can alleviate the symptoms and restore yield potential. Foliar applications can be applied before fall dormancy or after growth resumes in the spring. ***Apply only when adequate growth is present to aid absorption of foliar Mn.*** Foliar application can be repeated if symptoms reappear.

Zinc

Zinc (Zn) deficiency is predicted by an availability index that includes M3 soil test Zn, soil pH, and M3 soil test P. Zinc deficiency is most common on soils with a pH of 6.5 or higher and high soil test P concentrations but may also be induced by environmental conditions such as cold, wet soils that may limit root growth. See Table 6 to determine if Zn deficiency is predicted for this field.

Table 6. Interpretation of zinc availability index for bermudagrass.

Soil Test Criteria	Interpretation
M3-Zn is less than 1.9 lb/ac	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is higher than 7.0	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is 6.6 or higher **AND** M3-P is 100 FIV or higher	Zn deficiency is predicted
M3-Zn is 3.2 lb/ac or higher	Zn deficiency is NOT predicted

If Zn deficiency is predicted by the availability index or was observed the previous year, one of the following treatments can be applied:

1. Broadcast Zn sulfate or Zn oxide at a rate of 10 to 12 lb/ac elemental Zn or Zn chelate (Zn-EDTA) at a rate of 2 to 3 lb/ac elemental Zn. Broadcast applications should correct Zn deficiency for several years.
2. Foliar application of Zn sulfate or Zn oxide at a rate of 1 lb/ac elemental Zn or Zn chelate at a rate of 0.5 lb/ac elemental Zn in 20 to 50 gallons of water. **Apply only when adequate growth is present to aid in the adsorption of foliar Zn.** Foliar Zn application should be repeated if symptoms re-appear.

Boron

Boron (B) deficiency is not usually observed in bermudagrass. If B deficiency symptoms appear, contact your county agent for assistance with diagnosis and corrective recommendations.

Big Bluestem - New Seeding

Crop Highlights
• Target pH: 6.2 • Light, chaffy seed requires a special drill or attachment for successful seeding if seed is not debearded. • Do not apply nitrogen (N) at seeding to avoid stimulating weed competition; apply N when crop is 2 to 4 inches tall. • Monitor forage and hay crops for S deficiency or use ammonium sulfate as the N source to provide S. • Forage and hay crops are moderately sensitive to manganese (Mn) deficiency.

Management Notes

Big bluestem has light, chaffy seed; a special drill or attachment is required to successfully seed this species if seed is not debearded. This species is slow to establish; weed competition can be a problem. During the establishment phase or the first growing season, mow no closer than the top of the warm-season grass to remove weed seed heads. Do not cut or mow big bluestem during the first growing season (establishment phase) unless it produces a seed head. When cutting, leave 6 to 8 inches of stubble to improve regrowth potential.

Yield Goal

Yield goals are not made for new seedings of perennial forages. Instead, these recommendations are designed to promote good establishment of the forage for future productivity and discourage weed competition.

Target pH: 6.2

Soils that are high in organic matter (e.g., "black" soils; soil organic matter >6.0%) have a lower target pH (5.6) because organic matter moderates some of the negative effects of excessive soil acidity (e.g., aluminum toxicity).

The lime recommendation for a specific field 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 manganese (Mn).

The recommended liming source is dependent upon Mehlich-3 (M3) soil test calcium (Ca) and magnesium (Mg) reported as a 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 (M3-Ca) and magnesium (M3-Mg) 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

Nitrogen fertilization rates are based on regional research on crop response to N fertilizers and not on the results of a routine soil test. Follow these recommendations for new seedings only. Switch to nutrient recommendations for established hay after the first cutting or established forage after the first grazing cycle. Do not apply N at seeding to avoid stimulating weed competition.

1. When seedlings are 2 to 4 inches tall and if weed pressure is not at a competitive level, broadcast 20 lbs N/ac.

Phosphorus

Phosphorus (P) fertilization is based on the results of a routine soil test (Table 2). Soil test results are reported as a fertility index value (FIV).

Table 2. Recommended phosphorus rate to reach optimum Mehlich-3 soil test phosphorus (M3-P) levels to support good forage establishment and future productivity.

	M3-P (UD FIV)										
	0	10	20	30	40	50	60	70	80	90	100
lb P_2O_5/ac	120	110	100	85	75	65	50	40	25	10	0

1. If M3 soil test P (M3-P) is “Low” or “Medium” (i.e., 50 FIV or less), broadcast and plow down the recommended rate of phosphate (P_2O_5) fertilizer prior to seeding.
2. If M3-P is “Optimum” (i.e., 51 to 100 FIV), broadcast and incorporate P_2O_5 fertilizer prior to seeding or surface broadcast at or shortly after planting.
3. If M3-P is “Excessive” (i.e., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 3). Soil test results are reported as a fertility index value (FIV).

Table 3. Recommended potassium rate to reach optimum Mehlich-3 soil test potassium (M3-K) levels to support good forage establishment and future productivity.

	M3-K (UD FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb K_2O/ac	180	165	150	135	120	105	90	75	60	45	0

1. Broadcast and incorporate potash (K_2O) fertilizer at or prior to seeding.
2. Application rates of 120 lb/ac of K_2O or higher should be split into two applications. Apply ½ of the recommended rate after the first cutting and the remainder in late August or September.

Magnesium

The need for magnesium (Mg) fertilization is determined by a routine soil test (Table 4); Mg needs are often met by liming. Soil test results are reported as a fertility index value (FIV).

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

	M3-Mg (UD FIV)								
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**
lb soluble Mg/ac	80	70	60	50	40	30	20	10	0

1. Magnesium (Mg) is recommended when M3-Mg is less than 40 FIV.
2. Use dolomitic limestone if M3-Mg is less than 40 FIV and lime is recommended, use dolomitic limestone.
3. If M3-Mg is less than 40 FIV and lime is not needed, apply soluble Mg (Mg sulfate or Mg chloride) according to the rates in Table 4.

Sulfur

Sulfur (S) deficiency is occasionally observed in big bluestem grown on Delaware soils. Symptoms include reduced growth and a general yellowing of the plant. Newly planted forage crops are susceptible to S deficiency because their shallow root systems do not allow the crop to tap into subsoil stores of S.

1. Apply S at a rate of 20 to 40 lb/ac to ensure that adequate sulfur is available to meet crop needs.
2. Broadcast S prior to seeding or use ammonium sulfate as an N source to supply needed S.
3. Sulfate-S is available immediately for crop uptake immediately after application. If a reduced form of S is applied (e.g., thiosulfate or elemental S), allow adequate time for the applied S to oxidize to the sulfate form.

Prediction of S deficiency is difficult. Currently available soil tests are not good predictors of S deficiency situations because only surface soil samples are analyzed. Many Delaware soils have a supply of plant available S in subsoil horizons that will not be detected in soil samples taken from shallower depths. Subsoil sampling to a depth of 24 inches is highly recommended as a means of identifying soils with subsoil reserves of S.

Long-term applications of ammonium sulfate or other acid-forming fertilizers may lower pH of the soil surface and require correction with lime. Monitor surface pH with a 0- to 2-inch soil sample, especially in pasture systems.

Manganese

Manganese (Mn) needs are predicted by an availability index (MnAI) that includes M3 soil test Mn (M3-Mn) and soil pH. Interpretation of MnAI is crop specific (Table 5). Forage crops are moderately sensitive to Mn deficiency. Soil test Mn results are reported in lb/ac.

MnAI = 101.7 – (15.2 × soil pH) + (2.11 × M3-Mn)

Where:

MnAI = Mn availability index
Soil pH = Soil pH measured in water (1:1 V:V)
M3-Mn = Mehlich 3 soil test Mn in lb/ac

Table 5. Interpretation of manganese availability index for big bluestem.

Mn Availability Index	Interpretation
Less than 17	Mn deficiency is likely at this soil pH and soil test Mn concentration
17 to 25	Mn deficiency is possible at this soil pH and soil test Mn concentration. Monitor the crop for symptoms, especially if liming has been recommended.
Greater than 25	Mn deficiency is unlikely.

1. If Mn deficiency is predicted or was observed in the previous growing season, broadcast Mn at a rate of 20 to 40 lb/ac.
2. Broadcast applications of acid forming fertilizers may correct Mn deficiency without the actual application of Mn in some cases but may be less effective than applications of Mn. Long term application of acid forming fertilizers will require pH correction with lime.
3. If Mn deficiency symptoms appear during the growing season or after an application of lime, a foliar application of 1.0 to 2.0 lb/ac actual Mn as Mn sulfate, Mn oxide or chelated Mn can alleviate the symptoms and restore yield potential. Foliar applications can be applied before fall dormancy or after growth resumes in the spring. ***Apply only when adequate growth is present to aid absorption of foliar Mn.*** Foliar application can be repeated if symptoms reappear.

Zinc

Zinc (Zn) deficiency is predicted by an availability index that includes M3 soil test Zn, soil pH, and M3 soil test P. Zinc deficiency is most common on soils with a pH of 6.5 or higher and high soil test P concentrations but may also be induced by environmental conditions such as cold, wet soils that may limit root growth. See Table 6 to determine if Zn deficiency is predicted for this field.

Table 6. Interpretation of zinc availability index for big bluestem.

Soil Test Criteria	Interpretation
M3-Zn is less than 1.9 lb/ac	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is higher than 7.0	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is 6.6 or higher **AND** M3-P is 100 FIV or higher	Zn deficiency is predicted
M3-Zn is 3.2 lb/ac or higher	Zn deficiency is NOT predicted

If Zn deficiency is predicted by the availability index or was observed the previous year, one of the following treatments can be applied:

1. Broadcast Zn sulfate or Zn oxide at a rate of 10 to 12 lb/ac elemental Zn or Zn chelate (Zn-EDTA) at a rate of 2 to 3 lb/ac elemental Zn. Broadcast applications should correct Zn deficiency for several years.
2. Foliar application of Zn sulfate or Zn oxide at a rate of 1 lb/ac elemental Zn or Zn chelate at a rate of 0.5 lb/ac elemental Zn in 20 to 50 gallons of water. **Apply only when adequate growth is present to aid in the adsorption of foliar Zn.** Foliar Zn application should be repeated if symptoms re-appear.

Boron

Boron (B) deficiency is not usually observed in big bluestem. If B deficiency symptoms appear, contact your county agent for assistance with diagnosis and corrective recommendations.

Eastern Gamagrass - New Seeding

Crop Highlights
• Target pH: 6.5 • Seed is very large and requires cold scarification for germination. • Do not apply nitrogen (N) at seeding to avoid stimulating weed competition; apply N when crop is 2 to 4 inches tall. • Monitor forage and hay crops for S deficiency or use ammonium sulfate as the N source to provide S. • Forage and hay crops are moderately sensitive to manganese (Mn) deficiency.

Management Notes

Eastern gamagrass seed is very large and requires cold scarification for germination. Unscarified seed has been successfully planted when seeded in December once soil temperature falls below 50° F. Plant seeds using a corn planter on 30-inch row spacing. Eastern gamagrass can be harvested 3 to 4 times a year if a 6- to 8-inch stubble is left to assist recovery.

Yield Goal

Yield goals are not made for new seedings of perennial forages. Instead, these recommendations are designed to promote good establishment of the forage for future productivity and discourage weed competition.

Target pH: 6.5

Soils that are high in organic matter (e.g., "black" soils; soil organic matter >6.0%) have a lower target pH (5.6) because organic matter moderates some of the negative effects of excessive soil acidity (e.g., aluminum toxicity).

The lime recommendation for a specific field 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 manganese (Mn).

The recommended liming source is dependent upon Mehlich-3 (M3) soil test calcium (Ca) and magnesium (Mg) reported as a 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 (M3-Ca) and magnesium (M3-Mg) 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

Nitrogen fertilization rates are based on regional research on crop response to N fertilizers and not on the results of a routine soil test. Follow these recommendations for new seedings only. Switch to nutrient recommendations for established hay after the first cutting or established forage after the first grazing cycle. Do not apply N at seeding to avoid stimulating weed competition.

1. When seedlings are 2 to 4 inches tall and if weed pressure is not at a competitive level, broadcast 20 lbs N/ac.
2. Harvest when the crop reaches 30 to 36 tall or begins to show seed head development. Leaving 6 to 8 inches of stubble. Apply an additional N application of 40 to 60 lb/ac after harvest.

Phosphorus

Phosphorus (P) fertilization is based on the results of a routine soil test (Table 2). Soil test results are reported as a fertility index value (FIV).

Table 2. Recommended phosphorus rate to reach optimum Mehlich-3 soil test phosphorus (M3-P) levels to support good forage establishment and future productivity.

	M3-P (UD FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb P_2O_5/ac	120	110	100	85	75	65	50	40	25	10	0

1. If M3 soil test P (M3-P) is “Low” or “Medium” (i.e., 50 FIV or less), broadcast and plow down the recommended rate of phosphate (P_2O_5) fertilizer prior to seeding.
2. If M3-P is “Optimum” (i.e., 51 to 100 FIV), broadcast and incorporate P_2O_5 fertilizer prior to seeding or surface broadcast at or shortly after planting.
3. If M3-P is “Excessive” (i.e., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 3). Soil test results are reported as a fertility index value (FIV).

Table 3. Recommended potassium rate to reach optimum Mehlich-3 soil test potassium (M3-K) levels to support good forage establishment and future productivity.

	M3-K (UD FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb K_2O/ac	180	165	150	135	120	105	90	75	60	45	0

1. Broadcast and incorporate potash (K_2O) fertilizer at or prior to seeding.
2. Application rates of 120 lb/ac of K_2O or higher should be split into two applications. Apply ½ of the recommended rate after the first cutting and the remainder in late August or September.

Magnesium

The need for magnesium (Mg) fertilization is determined by a routine soil test (Table 4); Mg needs are often met by liming. Soil test results are reported as a fertility index value (FIV).

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

	M3-Mg (UD FIV)								
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**
lb soluble Mg/ac	80	70	60	50	40	30	20	10	0

1. Magnesium (Mg) is recommended when M3-Mg is less than 40 FIV.
2. Use dolomitic limestone if M3-Mg is less than 40 FIV and lime is recommended, use dolomitic limestone.
3. If M3-Mg is less than 40 FIV and lime is not needed, apply soluble Mg (Mg sulfate or Mg chloride) according to the rates in Table 4.

Sulfur

Sulfur (S) deficiency is occasionally observed in eastern gamagrass grown on Delaware soils. Symptoms include reduced growth and a general yellowing of the plant. Newly planted forage crops are susceptible to S deficiency because their shallow root systems do not allow the crop to tap into subsoil stores of S.

1. Apply S at a rate of 20 to 40 lb/ac to ensure that adequate sulfur is available to meet crop needs.
2. Broadcast S prior to seeding or use ammonium sulfate as an N source to supply needed S.
3. Sulfate-S is available immediately for crop uptake immediately after application. If a reduced form of S is applied (e.g., thiosulfate or elemental S), allow adequate time for the applied S to oxidize to the sulfate form.

Prediction of S deficiency is difficult. Currently available soil tests are not good predictors of S deficiency situations because only surface soil samples are analyzed. Many Delaware soils have a supply of plant available S in subsoil horizons that will not be detected in soil samples taken from shallower depths. Subsoil sampling to a depth of 24 inches is highly recommended as a means of identifying soils with subsoil reserves of S.

Long-term applications of ammonium sulfate or other acid-forming fertilizers may lower pH of the soil surface and require correction with lime. Monitor surface pH with a 0- to 2-inch soil sample, especially in pasture systems.

Manganese

Manganese (Mn) needs are predicted by an availability index (MnAI) that includes M3 soil test Mn (M3-Mn) and soil pH. Interpretation of MnAI is crop specific (Table 5). Forage crops are moderately sensitive to Mn deficiency. Soil test Mn results are reported in lb/ac.

MnAI = 101.7 – (15.2 × soil pH) + (2.11 × M3-Mn)

Where:

MnAI = Mn availability index
Soil pH = Soil pH measured in water (1:1 V:V)
M3-Mn = Mehlich 3 soil test Mn in lb/ac

Table 5. Interpretation of manganese availability index for eastern gamagrass.

Mn Availability Index	Interpretation
Less than 17	Mn deficiency is likely at this soil pH and soil test Mn concentration
17 to 25	Mn deficiency is possible at this soil pH and soil test Mn concentration. Monitor the crop for symptoms, especially if liming has been recommended.
Greater than 25	Mn deficiency is unlikely.

1. If Mn deficiency is predicted or was observed in the previous growing season, broadcast Mn at a rate of 20 to 40 lb/ac.
2. Broadcast applications of acid forming fertilizers may correct Mn deficiency without the actual application of Mn in some cases but may be less effective than applications of Mn. Long term application of acid forming fertilizers will require pH correction with lime.
3. If Mn deficiency symptoms appear during the growing season or after an application of lime, a foliar application of 1.0 to 2.0 lb/ac actual Mn as Mn sulfate, Mn oxide or chelated Mn can alleviate the symptoms and restore yield potential. Foliar applications can be applied before fall dormancy or after growth resumes in the spring. ***Apply only when adequate growth is present to aid absorption of foliar Mn.*** Foliar application can be repeated if symptoms reappear.

Zinc

Zinc (Zn) deficiency is predicted by an availability index that includes M3 soil test Zn, soil pH, and M3 soil test P. Zinc deficiency is most common on soils with a pH of 6.5 or higher and high soil test P concentrations but may also be induced by environmental conditions such as cold, wet soils that may limit root growth. See Table 6 to determine if Zn deficiency is predicted for this field.

Table 6. Interpretation of zinc availability index for eastern gamagrass.

Soil Test Criteria	Interpretation
M3-Zn is less than 1.9 lb/ac	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is higher than 7.0	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is 6.6 or higher **AND** M3-P is 100 FIV or higher	Zn deficiency is predicted
M3-Zn is 3.2 lb/ac or higher	Zn deficiency is NOT predicted

If Zn deficiency is predicted by the availability index or was observed the previous year, one of the following treatments can be applied:

1. Broadcast Zn sulfate or Zn oxide at a rate of 10 to 12 lb/ac elemental Zn or Zn chelate (Zn-EDTA) at a rate of 2 to 3 lb/ac elemental Zn. Broadcast applications should correct Zn deficiency for several years.
2. Foliar application of Zn sulfate or Zn oxide at a rate of 1 lb/ac elemental Zn or Zn chelate at a rate of 0.5 lb/ac elemental Zn in 20 to 50 gallons of water. **Apply only when adequate growth is present to aid in the adsorption of foliar Zn.** Foliar Zn application should be repeated if symptoms re-appear.

Boron

Boron (B) deficiency is not usually observed in eastern gamagrass. If B deficiency symptoms appear, contact your county agent for assistance with diagnosis and corrective recommendations.

Indian Grass - New Seeding

Crop Highlights
• Target pH: 6.2 • Chaffy seed requires a special drill for successful seeding if seed is not debearded. • Do not apply nitrogen (N) at seeding to avoid stimulating weed competition; apply N when crop is 2 to 4 inches tall. • Monitor forage and hay crops for S deficiency or use ammonium sulfate as the N source to provide S. • Forage and hay crops are moderately sensitive to manganese (Mn) deficiency.

Management Notes

Indian grass, a native warm season grass that heads late in the summer. Indian grass has chaffy seed; a special drill is required to successfully seed this species if seed is not debearded. New stands can take two years to establish before cutting for hay or grazing is recommended. During the establishment phase or the first growing season, mow no closer than the top of the warm-season grass to remove weed seed heads. Do not cut or mow indiangrass during the first growing season (establishment phase) unless it produces a seed head. When cutting, leave 6 to 8 inches of stubble to improve regrowth potential. Once established, limit cuttings to maintain stand. This grass requires high stubble (at least a minimum 6 to 8 inches) and adequate recovery time before frost.

Yield Goal

Yield goals are not made for new seedings of perennial forages. Instead, these recommendations are designed to promote good establishment of the forage for future productivity and discourage weed competition.

Target pH: 6.2

Soils that are high in organic matter (e.g., "black" soils; soil organic matter >6.0%) have a lower target pH (5.6) because organic matter moderates some of the negative effects of excessive soil acidity (e.g., aluminum toxicity).

The lime recommendation for a specific field 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 manganese (Mn).

The recommended liming source is dependent upon Mehlich-3 (M3) soil test calcium (Ca) and magnesium (Mg) reported as a 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 (M3-Ca) and magnesium (M3-Mg) 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

Nitrogen fertilization rates are based on regional research on crop response to N fertilizers and not on the results of a routine soil test. Follow these recommendations for new seedings only. Switch to nutrient recommendations for established hay after the first cutting or established forage after the first grazing cycle. Do not apply N at seeding to avoid stimulating weed competition.

1. When seedlings are 2 to 4 inches tall and if weed pressure is not at a competitive level, broadcast 20 lbs N/ac.

Phosphorus

Phosphorus (P) fertilization is based on the results of a routine soil test (Table 2). Soil test results are reported as a fertility index value (FIV).

Table 2. Recommended phosphorus rate to reach optimum Mehlich-3 soil test phosphorus (M3-P) levels to support good forage establishment and future productivity.

	M3-P (UD FIV)										
	0	10	20	30	40	50	60	70	80	90	100
lb P_2O_5/ac	120	110	100	85	75	65	50	40	25	10	0

1. If M3 soil test P (M3-P) is “Low” or “Medium” (i.e., 50 FIV or less), broadcast and plow down the recommended rate of phosphate (P_2O_5) fertilizer prior to seeding.
2. If M3-P is “Optimum” (i.e., 51 to 100 FIV), broadcast and incorporate P_2O_5 fertilizer prior to seeding or surface broadcast at or shortly after planting.
3. If M3-P is “Excessive” (i.e., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 3). Soil test results are reported as a fertility index value (FIV).

Table 3. Recommended potassium rate to reach optimum Mehlich-3 soil test potassium (M3-K) levels to support good forage establishment and future productivity.

	M3-K (UD FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb K_2O/ac	180	165	150	135	120	105	90	75	60	45	0

1. Broadcast and incorporate potash (K_2O) fertilizer at or prior to seeding.
2. Application rates of 120 lb/ac of K_2O or higher should be split into two applications. Apply ½ of the recommended rate after the first cutting and the remainder in late August or September.

Magnesium

The need for magnesium (Mg) fertilization is determined by a routine soil test (Table 4); Mg needs are often met by liming. Soil test results are reported as a fertility index value (FIV).

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

	M3-Mg (UD FIV)								
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**
lb soluble Mg/ac	80	70	60	50	40	30	20	10	0

1. Magnesium (Mg) is recommended when M3-Mg is less than 40 FIV.
2. Use dolomitic limestone if M3-Mg is less than 40 FIV and lime is recommended, use dolomitic limestone.
3. If M3-Mg is less than 40 FIV and lime is not needed, apply soluble Mg (Mg sulfate or Mg chloride) according to the rates in Table 4.

Sulfur

Sulfur (S) deficiency is occasionally observed in indian grass grown on Delaware soils. Symptoms include reduced growth and a general yellowing of the plant. Newly planted forage crops are susceptible to S deficiency because their shallow root systems do not allow the crop to tap into subsoil stores of S.

1. Apply S at a rate of 20 to 40 lb/ac to ensure that adequate sulfur is available to meet crop needs.
2. Broadcast S prior to seeding or use ammonium sulfate as an N source to supply needed S.
3. Sulfate-S is available immediately for crop uptake immediately after application. If a reduced form of S is applied (e.g., thiosulfate or elemental S), allow adequate time for the applied S to oxidize to the sulfate form.

Prediction of S deficiency is difficult. Currently available soil tests are not good predictors of S deficiency situations because only surface soil samples are analyzed. Many Delaware soils have a supply of plant available S in subsoil horizons that will not be detected in soil samples taken from shallower depths. Subsoil sampling to a depth of 24 inches is highly recommended as a means of identifying soils with subsoil reserves of S.

Long-term applications of ammonium sulfate or other acid-forming fertilizers may lower pH of the soil surface and require correction with lime. Monitor surface pH with a 0- to 2-inch soil sample, especially in pasture systems.

Manganese

Manganese (Mn) needs are predicted by an availability index (MnAI) that includes M3 soil test Mn (M3-Mn) and soil pH. Interpretation of MnAI is crop specific (Table 5). Forage crops are moderately sensitive to Mn deficiency. Soil test Mn results are reported in lb/ac.

MnAI = 101.7 – (15.2 × soil pH) + (2.11 × M3-Mn)

Where:

MnAI = Mn availability index
Soil pH = Soil pH measured in water (1:1 V:V)
M3-Mn = Mehlich 3 soil test Mn in lb/ac

Table 5. Interpretation of manganese availability index for indian grass.

Mn Availability Index	Interpretation
Less than 17	Mn deficiency is likely at this soil pH and soil test Mn concentration
17 to 25	Mn deficiency is possible at this soil pH and soil test Mn concentration. Monitor the crop for symptoms, especially if liming has been recommended.
Greater than 25	Mn deficiency is unlikely.

1. If Mn deficiency is predicted or was observed in the previous growing season, broadcast Mn at a rate of 20 to 40 lb/ac.
2. Broadcast applications of acid forming fertilizers may correct Mn deficiency without the actual application of Mn in some cases but may be less effective than applications of Mn. Long term application of acid forming fertilizers will require pH correction with lime.
3. If Mn deficiency symptoms appear during the growing season or after an application of lime, a foliar application of 1.0 to 2.0 lb/ac actual Mn as Mn sulfate, Mn oxide or chelated Mn can alleviate the symptoms and restore yield potential. Foliar applications can be applied before fall dormancy or after growth resumes in the spring. ***Apply only when adequate growth is present to aid absorption of foliar Mn.*** Foliar application can be repeated if symptoms reappear.

Zinc

Zinc (Zn) deficiency is predicted by an availability index that includes M3 soil test Zn, soil pH, and M3 soil test P. Zinc deficiency is most common on soils with a pH of 6.5 or higher and high soil test P concentrations but may also be induced by environmental conditions such as cold, wet soils that may limit root growth. See Table 6 to determine if Zn deficiency is predicted for this field.

Table 6. Interpretation of zinc availability index for indian grass.

Soil Test Criteria	Interpretation
M3-Zn is less than 1.9 lb/ac	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is higher than 7.0	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is 6.6 or higher **AND** M3-P is 100 FIV or higher	Zn deficiency is predicted
M3-Zn is 3.2 lb/ac or higher	Zn deficiency is NOT predicted

If Zn deficiency is predicted by the availability index or was observed the previous year, one of the following treatments can be applied:

1. Broadcast Zn sulfate or Zn oxide at a rate of 10 to 12 lb/ac elemental Zn or Zn chelate (Zn-EDTA) at a rate of 2 to 3 lb/ac elemental Zn. Broadcast applications should correct Zn deficiency for several years.
2. Foliar application of Zn sulfate or Zn oxide at a rate of 1 lb/ac elemental Zn or Zn chelate at a rate of 0.5 lb/ac elemental Zn in 20 to 50 gallons of water. **Apply only when adequate growth is present to aid in the adsorption of foliar Zn.** Foliar Zn application should be repeated if symptoms re-appear.

Boron

Boron (B) deficiency is not usually observed in indian grass. If B deficiency symptoms appear, contact your county agent for assistance with diagnosis and corrective recommendations.

Little Bluestem - New Seeding

Crop Highlights
• Target pH: 6.2 • Chaffy seed requires a special drill for successful seeding if seed is not debearded. • Do not apply nitrogen (N) at seeding to avoid stimulating weed competition; apply N when crop is 2 to 4 inches tall. • Monitor forage and hay crops for S deficiency or use ammonium sulfate as the N source to provide S. • Forage and hay crops are moderately sensitive to manganese (Mn) deficiency.

Management Notes

Little bluestem has chaffy seed; a special drill is required to successfully seed this species if seed is not debearded. Plant after soil temperatures reach 60°F (approximately mid-May to early June). Little bluestem is much shorter in stature than other warm-season grasses and, therefore, is lower yielding. New stands may take two years to establish sufficiently before they can be cut for hay or grazed. During the establishment phase or the first growing season, mow no closer than the top of the warm-season grass to remove weed seed heads. Do not cut or mow little bluestem during the first growing season (establishment phase) unless it produces a seed head. When cutting, leave 6 to 8 inches of stubble to improve regrowth potential.

Yield Goal

Yield goals are not made for new seedings of perennial forages. Instead, these recommendations are designed to promote good establishment of the forage for future productivity and discourage weed competition.

Target pH: 6.2

Soils that are high in organic matter (e.g., "black" soils; soil organic matter >6.0%) have a lower target pH (5.6) because organic matter moderates some of the negative effects of excessive soil acidity (e.g., aluminum toxicity).

The lime recommendation for a specific field 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 manganese (Mn).

The recommended liming source is dependent upon Mehlich-3 (M3) soil test calcium (Ca) and magnesium (Mg) reported as a 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 (M3-Ca) and magnesium (M3-Mg) 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

Nitrogen fertilization rates are based on regional research on crop response to N fertilizers and not on the results of a routine soil test. Follow these recommendations for new seedings only. Switch to nutrient recommendations for established hay after the first cutting or established forage after the first grazing cycle. Do not apply N at seeding to avoid stimulating weed competition.

1. When seedlings are 2 to 4 inches tall and if weed pressure is not at a competitive level, broadcast 20 lbs N/ac.

Phosphorus

Phosphorus (P) fertilization is based on the results of a routine soil test (Table 2). Soil test results are reported as a fertility index value (FIV).

Table 2. Recommended phosphorus rate to reach optimum Mehlich-3 soil test phosphorus (M3-P) levels to support good forage establishment and future productivity.

	M3-P (UD FIV)										
	0	10	20	30	40	50	60	70	80	90	100
lb P_2O_5/ac	120	110	100	85	75	65	50	40	25	10	0

1. If M3 soil test P (M3-P) is “Low” or “Medium” (i.e., 50 FIV or less), broadcast and plow down the recommended rate of phosphate (P_2O_5) fertilizer prior to seeding.
2. If M3-P is “Optimum” (i.e., 51 to 100 FIV), broadcast and incorporate P_2O_5 fertilizer prior to seeding or surface broadcast at or shortly after planting.
3. If M3-P is “Excessive” (i.e., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 3). Soil test results are reported as a fertility index value (FIV).

Table 3. Recommended potassium rate to reach optimum Mehlich-3 soil test potassium (M3-K) levels to support good forage establishment and future productivity.

	M3-K (UD FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb K_2O/ac	180	165	150	135	120	105	90	75	60	45	0

1. Broadcast and incorporate potash (K_2O) fertilizer at or prior to seeding.
2. Application rates of 120 lb/ac of K_2O or higher should be split into two applications. Apply ½ of the recommended rate after the first cutting and the remainder in late August or September.

Magnesium

The need for magnesium (Mg) fertilization is determined by a routine soil test (Table 4); Mg needs are often met by liming. Soil test results are reported as a fertility index value (FIV).

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

	M3-Mg (UD FIV)								
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**
lb soluble Mg/ac	80	70	60	50	40	30	20	10	0

1. Magnesium (Mg) is recommended when M3-Mg is less than 40 FIV.
2. Use dolomitic limestone if M3-Mg is less than 40 FIV and lime is recommended, use dolomitic limestone.
3. If M3-Mg is less than 40 FIV and lime is not needed, apply soluble Mg (Mg sulfate or Mg chloride) according to the rates in Table 4.

Sulfur

Sulfur (S) deficiency is occasionally observed in little bluestem grown on Delaware soils. Symptoms include reduced growth and a general yellowing of the plant. Newly planted forage crops are susceptible to S deficiency because their shallow root systems do not allow the crop to tap into subsoil stores of S.

1. Apply S at a rate of 20 to 40 lb/ac to ensure that adequate sulfur is available to meet crop needs.
2. Broadcast S prior to seeding or use ammonium sulfate as an N source to supply needed S.
3. Sulfate-S is available immediately for crop uptake immediately after application. If a reduced form of S is applied (e.g., thiosulfate or elemental S), allow adequate time for the applied S to oxidize to the sulfate form.

Prediction of S deficiency is difficult. Currently available soil tests are not good predictors of S deficiency situations because only surface soil samples are analyzed. Many Delaware soils have a supply of plant available S in subsoil horizons that will not be detected in soil samples taken from shallower depths. Subsoil sampling to a depth of 24 inches is highly recommended as a means of identifying soils with subsoil reserves of S.

Long-term applications of ammonium sulfate or other acid-forming fertilizers may lower pH of the soil surface and require correction with lime. Monitor surface pH with a 0- to 2-inch soil sample, especially in pasture systems.

Manganese

Manganese (Mn) needs are predicted by an availability index (MnAI) that includes M3 soil test Mn (M3-Mn) and soil pH. Interpretation of MnAI is crop specific (Table 5). Forage crops are moderately sensitive to Mn deficiency. Soil test Mn results are reported in lb/ac.

MnAI = 101.7 – (15.2 × soil pH) + (2.11 × M3-Mn)

Where:

MnAI = Mn availability index
Soil pH = Soil pH measured in water (1:1 V:V)
M3-Mn = Mehlich 3 soil test Mn in lb/ac

Table 5. Interpretation of manganese availability index for little bluestem.

Mn Availability Index	Interpretation
Less than 17	Mn deficiency is likely at this soil pH and soil test Mn concentration
17 to 25	Mn deficiency is possible at this soil pH and soil test Mn concentration. Monitor the crop for symptoms, especially if liming has been recommended.
Greater than 25	Mn deficiency is unlikely.

1. If Mn deficiency is predicted or was observed in the previous growing season, broadcast Mn at a rate of 20 to 40 lb/ac.
2. Broadcast applications of acid forming fertilizers may correct Mn deficiency without the actual application of Mn in some cases but may be less effective than applications of Mn. Long term application of acid forming fertilizers will require pH correction with lime.
3. If Mn deficiency symptoms appear during the growing season or after an application of lime, a foliar application of 1.0 to 2.0 lb/ac actual Mn as Mn sulfate, Mn oxide or chelated Mn can alleviate the symptoms and restore yield potential. Foliar applications can be applied before fall dormancy or after growth resumes in the spring. ***Apply only when adequate growth is present to aid absorption of foliar Mn.*** Foliar application can be repeated if symptoms reappear.

Zinc

Zinc (Zn) deficiency is predicted by an availability index that includes M3 soil test Zn, soil pH, and M3 soil test P. Zinc deficiency is most common on soils with a pH of 6.5 or higher and high soil test P concentrations but may also be induced by environmental conditions such as cold, wet soils that may limit root growth. See Table 6 to determine if Zn deficiency is predicted for this field.

Table 6. Interpretation of zinc availability index for little bluestem.

Soil Test Criteria	Interpretation
M3-Zn is less than 1.9 lb/ac	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is higher than 7.0	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is 6.6 or higher **AND** M3-P is 100 FIV or higher	Zn deficiency is predicted
M3-Zn is 3.2 lb/ac or higher	Zn deficiency is NOT predicted

If Zn deficiency is predicted by the availability index or was observed the previous year, one of the following treatments can be applied:

1. Broadcast Zn sulfate or Zn oxide at a rate of 10 to 12 lb/ac elemental Zn or Zn chelate (Zn-EDTA) at a rate of 2 to 3 lb/ac elemental Zn. Broadcast applications should correct Zn deficiency for several years.
2. Foliar application of Zn sulfate or Zn oxide at a rate of 1 lb/ac elemental Zn or Zn chelate at a rate of 0.5 lb/ac elemental Zn in 20 to 50 gallons of water. **Apply only when adequate growth is present to aid in the adsorption of foliar Zn.** Foliar Zn application should be repeated if symptoms re-appear.

Boron

Boron (B) deficiency is not usually observed in little bluestem. If B deficiency symptoms appear, contact your county agent for assistance with diagnosis and corrective recommendations.

Switchgrass - New Seeding

Crop Highlights
• Target pH: 6.2 • Seed can be planted with most drills; no special equipment needed. • Do not apply nitrogen (N) at seeding to avoid stimulating weed competition; apply N when crop is 2 to 4 inches tall. • Monitor forage and hay crops for S deficiency or use ammonium sulfate as the N source to provide S. • Forage and hay crops are moderately sensitive to manganese (Mn) deficiency.

Management Notes

Switchgrass is a native warm season grass that heads earlier than bluestems or Indiangrass. Seed is non-chaffy, hard, and has a shiny or oily appearance. Unlike bluegrasses or Indiangrass, switchgrass seed can be planted with most drills. Plant after soil temperatures reach 60° F (about mid-May to early June). New stands may take two years to establish sufficiently before they can be cut for hay or grazed. During the establishment phase (first growing season), mow no closer than the top of the warm-season grass to remove weed seed heads. Do not cut or mow little bluestem during the first growing season (establishment phase) unless it produces a seed head. When cutting, leave 6 to 8 inches of stubble to improve regrowth potential.

Yield Goal

Yield goals are not made for new seedings of perennial forages. Instead, these recommendations are designed to promote good establishment of the forage for future productivity and discourage weed competition.

Target pH: 6.2

Soils that are high in organic matter (e.g., "black" soils; soil organic matter >6.0%) have a lower target pH (5.6) because organic matter moderates some of the negative effects of excessive soil acidity (e.g., aluminum toxicity).

The lime recommendation for a specific field 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 manganese (Mn).

The recommended liming source is dependent upon Mehlich-3 (M3) soil test calcium (Ca) and magnesium (Mg) reported as a 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 (M3-Ca) and magnesium (M3-Mg) 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

Nitrogen fertilization rates are based on regional research on crop response to N fertilizers and not on the results of a routine soil test. Follow these recommendations for new seedings only. Switch to nutrient recommendations for established hay after the first cutting or established forage after the first grazing cycle. Do not apply N at seeding to avoid stimulating weed competition.

1. When seedlings are 2 to 4 inches tall and if weed pressure is not at a competitive level, broadcast 20 lbs N/ac.

Phosphorus

Phosphorus (P) fertilization is based on the results of a routine soil test (Table 2). Soil test results are reported as a fertility index value (FIV).

Table 2. Recommended phosphorus rate to reach optimum Mehlich-3 soil test phosphorus (M3-P) levels to support good forage establishment and future productivity.

	M3-P (UD FIV)										
	0	10	20	30	40	50	60	70	80	90	100
lb P_2O_5/ac	120	110	100	85	75	65	50	40	25	10	0

1. If M3 soil test P (M3-P) is “Low” or “Medium” (i.e., 50 FIV or less), broadcast and plow down the recommended rate of phosphate (P_2O_5) fertilizer prior to seeding.
2. If M3-P is “Optimum” (i.e., 51 to 100 FIV), broadcast and incorporate P_2O_5 fertilizer prior to seeding or surface broadcast at or shortly after planting.
3. If M3-P is “Excessive” (i.e., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 3). Soil test results are reported as a fertility index value (FIV).

Table 3. Recommended potassium rate to reach optimum Mehlich-3 soil test potassium (M3-K) levels to support good forage establishment and future productivity.

	M3-K (UD FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb K_2O/ac	180	165	150	135	120	105	90	75	60	45	0

1. Broadcast and incorporate potash (K_2O) fertilizer at or prior to seeding.
2. Application rates of 120 lb/ac of K_2O or higher should be split into two applications. Apply ½ of the recommended rate after the first cutting and the remainder in late August or September.

Magnesium

The need for magnesium (Mg) fertilization is determined by a routine soil test (Table 4); Mg needs are often met by liming. Soil test results are reported as a fertility index value (FIV).

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

	M3-Mg (UD FIV)								
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**
lb soluble Mg/ac	80	70	60	50	40	30	20	10	0

1. Magnesium (Mg) is recommended when M3-Mg is less than 40 FIV.
2. Use dolomitic limestone if M3-Mg is less than 40 FIV and lime is recommended, use dolomitic limestone.
3. If M3-Mg is less than 40 FIV and lime is not needed, apply soluble Mg (Mg sulfate or Mg chloride) according to the rates in Table 4.

Sulfur

Sulfur (S) deficiency is occasionally observed in switchgrass grown on Delaware soils. Symptoms include reduced growth and a general yellowing of the plant. Newly planted forage crops are susceptible to S deficiency because their shallow root systems do not allow the crop to tap into subsoil stores of S.

1. Apply S at a rate of 20 to 40 lb/ac to ensure that adequate sulfur is available to meet crop needs.
2. Broadcast S prior to seeding or use ammonium sulfate as an N source to supply needed S.
3. Sulfate-S is available immediately for crop uptake immediately after application. If a reduced form of S is applied (e.g., thiosulfate or elemental S), allow adequate time for the applied S to oxidize to the sulfate form.

Prediction of S deficiency is difficult. Currently available soil tests are not good predictors of S deficiency situations because only surface soil samples are analyzed. Many Delaware soils have a supply of plant available S in subsoil horizons that will not be detected in soil samples taken from shallower depths. Subsoil sampling to a depth of 24 inches is highly recommended as a means of identifying soils with subsoil reserves of S.

Long-term applications of ammonium sulfate or other acid-forming fertilizers may lower pH of the soil surface and require correction with lime. Monitor surface pH with a 0- to 2-inch soil sample, especially in pasture systems.

Manganese

Manganese (Mn) needs are predicted by an availability index (MnAI) that includes M3 soil test Mn (M3-Mn) and soil pH. Interpretation of MnAI is crop specific (Table 5). Forage crops are moderately sensitive to Mn deficiency. Soil test Mn results are reported in lb/ac.

MnAI = 101.7 – (15.2 × soil pH) + (2.11 × M3-Mn)

Where:

MnAI = Mn availability index
Soil pH = Soil pH measured in water (1:1 V:V)
M3-Mn = Mehlich 3 soil test Mn in lb/ac

Table 5. Interpretation of manganese availability index for switchgrass.

Mn Availability Index	Interpretation
Less than 17	Mn deficiency is likely at this soil pH and soil test Mn concentration
17 to 25	Mn deficiency is possible at this soil pH and soil test Mn concentration. Monitor the crop for symptoms, especially if liming has been recommended.
Greater than 25	Mn deficiency is unlikely.

1. If Mn deficiency is predicted or was observed in the previous growing season, broadcast Mn at a rate of 20 to 40 lb/ac.
2. Broadcast applications of acid forming fertilizers may correct Mn deficiency without the actual application of Mn in some cases but may be less effective than applications of Mn. Long term application of acid forming fertilizers will require pH correction with lime.
3. If Mn deficiency symptoms appear during the growing season or after an application of lime, a foliar application of 1.0 to 2.0 lb/ac actual Mn as Mn sulfate, Mn oxide or chelated Mn can alleviate the symptoms and restore yield potential. Foliar applications can be applied before fall dormancy or after growth resumes in the spring. ***Apply only when adequate growth is present to aid absorption of foliar Mn.*** Foliar application can be repeated if symptoms reappear.

Zinc

Zinc (Zn) deficiency is predicted by an availability index that includes M3 soil test Zn, soil pH, and M3 soil test P. Zinc deficiency is most common on soils with a pH of 6.5 or higher and high soil test P concentrations but may also be induced by environmental conditions such as cold, wet soils that may limit root growth. See Table 6 to determine if Zn deficiency is predicted for this field.

Table 6. Interpretation of zinc availability index for switchgrass.

Soil Test Criteria	Interpretation
M3-Zn is less than 1.9 lb/ac	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is higher than 7.0	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is 6.6 or higher **AND** M3-P is 100 FIV or higher	Zn deficiency is predicted
M3-Zn is 3.2 lb/ac or higher	Zn deficiency is NOT predicted

If Zn deficiency is predicted by the availability index or was observed the previous year, one of the following treatments can be applied:

1. Broadcast Zn sulfate or Zn oxide at a rate of 10 to 12 lb/ac elemental Zn or Zn chelate (Zn-EDTA) at a rate of 2 to 3 lb/ac elemental Zn. Broadcast applications should correct Zn deficiency for several years.
2. Foliar application of Zn sulfate or Zn oxide at a rate of 1 lb/ac elemental Zn or Zn chelate at a rate of 0.5 lb/ac elemental Zn in 20 to 50 gallons of water. **Apply only when adequate growth is present to aid in the adsorption of foliar Zn.** Foliar Zn application should be repeated if symptoms re-appear.

Boron

Boron (B) deficiency is not usually observed in switchgrass. If B deficiency symptoms appear, contact your county agent for assistance with diagnosis and corrective recommendations.