University of Delaware | College of Agriculture & Natural Resources
SOIL TESTING PROGRAM

Nutrient Recommendations

Alternative and Miscellaneous Crops

Amy Shober
Professor and Extension Specialist
Nutrient Management and Environmental Quality

Karen Gartley
Soil Testing Program Director

Jarrod Miller
Assistant Professor and Extension Specialist
Agronomy

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Hemp and Kenaf for Fiber

Crop Highlights
• Target pH: 6.2 • Split nitrogen (N) applications to increase N use efficiency in hemp and kenaf. Apply a small amount of N (20 to 25%) at planting and the bulk of the N requirement (75 to 80%) when the plants are 12 to 15 inches tall. • Little data is available on hemp production is this region. Recommendations are based on guidelines from nearby states where research is being conducted.

Yield Goal

Yield of hemp and kenaf is influenced by many factors, including the cultivar selected, planting date, weather conditions, soil type, water-holding capacity, nutrient and water availability, weed pressure, and crop management practices. **In a good to average year, a realistic yield for hemp grown for fiber in Delaware soils is 2 to 4 tons dry matter per acre and for kenaf grown for fiber is 4 to 8 tons dry matter per acre.**

Delaware growers should use field history to determine the yield goal for each field and use that information to adjust management decisions and fertility programs accordingly. Delaware nutrient management law requires the use of optimal rolling average for determining the yield goal for a specific field when field history is available. To calculate the optimal rolling average yield, see the UD Extension Fact Sheet ***Estimating Yield Goal for Crops***.

Soil pH and Liming

Target pH: 6.2 for most soils

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 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

Nitrogen fertilization rates are based on regional research on crop response to N fertilizers and not on the results of a routine soil test.

The University of Delaware recommends a total nitrogen (N) application of 50 to 100 lb/ac for hemp and 75 to 125 lb/ac for kenaf. To maximize N use efficiency by the crop, apply 20 to 25% of the total N at planting and sidedress the remainder of the total N when plants are 12 to 15 inches tall.

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. Broadcast phosphorus application rates for hemp or kenaf grown for fiber.

	M3-P (FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb P_2O_5/ac	140	120	100	80	60	40	30	30	30	20	20

1. If M3 soil test phosphorus (M3-P is “Low” (e.g., 25 FIV or less), broadcast and plow down the recommended rate of P prior to planting in the fall.
2. If M3-P is “Medium or “Optimum” (e.g., 26 to 100 FIV), P can topdressed in the fall or the spring.
3. If M3-P is “Excessive” (e.g., greater than 100 FIV), the application of P fertilizers or manures is NOT RECOMMENDED.
4. If P fertilizers are banded, reduce the rates in Table 2 by one-half.

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 application rates for hemp or kenaf for fiber.

	M3-K (FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb K_2O /ac	140	120	100	80	60	40	30	30	30	20	20

1. Broadcast and incorporate or band potash prior to planting.
2. For banded applications, reduce the rates in Table 3 by one-half.
3. To avoid salt injury to seedlings, do not band more than 75 lb K_2O/ac at planting. When N and K_2O are banded together, the sum of the N rate and the K_2O rate should not exceed 75 lb/ac.

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.

Soluble Mg	M3-Mg (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 soil test Mg is less than 40 FIV.
2. 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 according to the rates in Table 4.

Manganese

Manganese (Mn) needs are predicted by an availability index that includes M3 soil test Mn and soil pH. Interpretation is crop specific.

$$MnAI = 101.7 – (15.2 \times \text{soil pH}) + (2.11 \times \text{M3-Mn})$$

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 the manganese availability index.

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, band 8 to 10 lb/ac elemental Mn.
2. In some cases, broadcast applications of acid forming fertilizers may correct Mn deficiency without the application of Mn; however, acid-forming fertilizers may be less effective than Mn fertilizers.
3. If Mn deficiency symptoms appear during the growing season or after an application of lime, a foliar application of Mn sulfate or Mn oxide at a rate of 1.0 to 2.0 lb/ac elemental Mn or chelated Mn (Mn-EDTA) at a rate of 0.5 to 1.0 lb/ac elemental Mn can alleviate the symptoms and restore yield potential. **Apply only when adequate growth is present to aid absorption of foliar Mn.**

Zinc

Zinc (Zn) deficiency is predicted by an availability index that includes M3 soil test Zn, soil pH, and M3 soil test P. It 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.

Table 6. Interpretation of the zinc availability index.

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 unlikely

If zinc 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 (Zn-EDTA) 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 reappear.

Copper

Copper (Cu) deficiency has been observed in hemp or kenaf when grown for fiber in other regions. If Cu deficiency symptoms appear, contact your county agent for assistance with diagnosis and corrective recommendations.

Boron

Boron (B) deficiency is not usually observed in this hemp or kenaf when grown for fiber. If B deficiency symptoms appear, contact your county agent for assistance with diagnosis and corrective recommendations.

Hemp for Seed

Crop Highlights
• Target pH: 6.2 • Split nitrogen (N) applications to increase N use efficiency in hemp. Apply a small amount of N (50 to 75 lb/ac) at planting and the bulk of the N requirement when the plants are 12 to 15 inches tall. • Little data is available on hemp production is this region. Recommendations are based on guidelines from nearby states where research is being conducted.

Yield Goal

Hemp seed yield is influenced by many factors, including the cultivar selected, planting date, weather conditions, soil type, water-holding capacity, nutrient and water availability, weed pressure, and crop management practices. **A realistic yield for hemp grown for seed in Delaware soils is 0.5 to 1 ton/ac in a good to average year.**

Delaware growers should use field history to determine the yield goal for each field and use that information to adjust management decisions and fertility programs accordingly. Delaware nutrient management law requires the use of optimal rolling average for determining the yield goal for a specific field when field history is available. To calculate the optimal rolling average yield, see the UD Extension Fact Sheet ***Estimating Yield Goal for Crops***.

Soil pH and Liming

Target pH: 6.2 for most soils

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 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

Nitrogen fertilization rates are based on regional research on crop response to N fertilizers and not on the results of a routine soil test.

The University of Delaware recommends a total nitrogen (N) application of 100 to 150 lb/ac for hemp and 75 to 125 lb/ac for kenaf. To maximize N use efficiency by the crop, apply 50 to 75 lb./ac of the total N at planting and sidedress the remainder of the total N when plants are 12 to 15 inches tall.

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. Broadcast phosphorus application rates for hemp grown for seed.

	M3-P (FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb P_2O_5/ac	140	120	100	80	60	40	30	30	30	20	20

1. If M3 soil test phosphorus (M3-P is “Low” (e.g., 25 FIV or less), broadcast and plow down the recommended rate of P prior to planting in the fall.
2. If M3-P is “Medium or “Optimum” (e.g., 26 to 100 FIV), P can topdressed in the fall or the spring.
3. If M3-P is “Excessive” (e.g., greater than 100 FIV), the application of P fertilizers or manures is NOT RECOMMENDED.
4. If P fertilizers are banded, reduce the rates in Table 2 by one-half.

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 application rates for hemp or kenaf for fiber.

	M3-K (FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb K_2O /ac	140	120	100	80	60	40	30	30	30	20	20

1. Broadcast and incorporate or band potash prior to planting.
2. For banded applications, reduce the rates in Table 3 by one-half.
3. To avoid salt injury to seedlings, do not band more than 75 lb K_2O/ac at planting. When N and K_2O are banded together, the sum of the N rate and the K_2O rate should not exceed 75 lb/ac.

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.

Soluble Mg	M3-Mg (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 soil test Mg is less than 40 FIV.
2. 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 according to the rates in Table 4.

Manganese

Manganese (Mn) needs are predicted by an availability index that includes M3 soil test Mn and soil pH. Interpretation is crop specific.

$$MnAI = 101.7 – (15.2 \times \text{soil pH}) + (2.11 \times \text{M3-Mn})$$

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 the manganese availability index.

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, band 8 to 10 lb/ac elemental Mn.
2. In some cases, broadcast applications of acid forming fertilizers may correct Mn deficiency without the application of Mn; however, acid-forming fertilizers may be less effective than Mn fertilizers.
3. If Mn deficiency symptoms appear during the growing season or after an application of lime, a foliar application of Mn sulfate or Mn oxide at a rate of 1.0 to 2.0 lb/ac elemental Mn or chelated Mn (Mn-EDTA) at a rate of 0.5 to 1.0 lb/ac elemental Mn can alleviate the symptoms and restore yield potential. **Apply only when adequate growth is present to aid absorption of foliar Mn.**

Zinc

Zinc (Zn) deficiency is predicted by an availability index that includes M3 soil test Zn, soil pH, and M3 soil test P. It 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.

Table 6. Interpretation of the zinc availability index.

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 unlikely

If zinc 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 (Zn-EDTA) 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 reappear.

Copper

Copper (Cu) deficiency has been observed in hemp or kenaf when grown for fiber in other regions. If Cu deficiency symptoms appear, contact your county agent for assistance with diagnosis and corrective recommendations.

Boron

Boron (B) deficiency is not usually observed in this hemp or kenaf when grown for fiber. If B deficiency symptoms appear, contact your county agent for assistance with diagnosis and corrective recommendations.

Hops

Crop Highlights
• Target pH: 6.2 • Little data is available on hops production is this region. Recommendations are based on guidelines from nearby states where research is being conducted. • Apply 75 lb/ac nitrogen (N) during establishment, with equal applications at one, three, and six weeks after planting. • Apply 100 to 170 lb/ac of total N in subsequent seasons. Split applications to increase N use efficiency on sandy soils. • Do not apply N after flowering. • Boron (B) deficiency has been identified on hops grown in the Mid-Atlantic region. Apply 1.0 to 1.5 lb/ac elemental B when Mehlich 3 soil test B <3.0 lb/ac.

Yield Goal

Yield of hops is influenced by many factors, including the variety selected, planting date, weather, soil type and water-holding capacity, nutrient and water availability, pest and disease pressure, and crop management practices. **Yield data is not available for hops grown on Delaware soils. Based on data from nearby states with similar soils and climates, a dry yield of 1,000 to 1,250 lb/ac is a realistic yield goal for an established hops yard in a good to average year** (assuming 8% moisture and a planting density of 1,000 plants per acre). Yields in the first year or two of production will be lower.

Delaware growers should use field history to determine the yield goal for each field and use that information to adjust management decisions and fertility programs accordingly. Delaware nutrient management law requires the use of optimal rolling average for determining the yield goal for a specific field when field history is available. To calculate the optimal rolling average yield, see the UD Extension Fact Sheet ***Estimating Yield Goal for Crops***.

Soil pH and Liming

Target pH: 6.2 for most soils

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 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

Nitrogen fertilization rates are based on regional research on crop response to N fertilizers and not on the results of a routine soil test.

The University of Delaware recommends a nitrogen (N) application of 75 lb/ac to hops in the planting year. Split applications of N are recommended to increase N use efficiency, with equal applications of N at one-, three-, and six-weeks after planting.

Nitrogen recommendations are higher for established hops. **The University of Delaware recommends a total N application of 100 to 150 lb/ac to hops in the second cropping year. After the second year, apply 150 to 180 lb/ac of total N.** Split applications are recommended to improve N use efficiency. Apply 25% of the total N requirement to the crop during the first week of April, the fourth week of April, the third week of May, and the second week of June.

Do not apply N after flowering starts to avoid excessive vegetative growth.

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. Broadcast phosphorus application rates for hops.

	M3-P (FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb P_2O_5/ac	150	110	90	70	50	30	30	20	25	10	0

1. If M3 soil test P (M3-P) is recommended (Table 2), broadcast and incorporate the recommended rate of phosphate prior to planting.
2. If M3-P is “Excessive” (e.g., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED.
3. If P fertilizers are banded, reduce the rates in Table 2 by one-half.

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 application rates for hops.

	M3-K (FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb K_2O/ac	170	140	110	90	70	50	40	30	20	10	0

1. Broadcast and incorporate or band potash prior to planting.
2. For banded applications, reduce the rates in Table 3 by one-half.
3. To avoid salt injury to seedlings, do not band more than 75 lb K_2O/ac at planting. When N and K_2O are banded together, the sum of the N rate and the K_2O rate should not exceed 75 lb/ac.

Magnesium

Table 4. Recommended application rates of soluble magnesium as a function of Mehlich-3 soil test magnesium.

Soluble Mg	M3-Mg (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 soil test Mg is less than 40 FIV.
2. 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 according to the rates in Table 4.

Sulfur

Sulfur (S) deficiency is occasionally observed in hops grown on sandy soils in this region. The use of ammonium sulfate as the N source or the addition of a small amount of ammonium sulfate to liquid UAN can prevent S deficiency from occurring.

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 no-till systems. Also remember that sulfate-S is available for crop uptake immediately after application. If a reduced form of S is applied (e.g., thiosulfate or elemental S), allow adequate time for oxidation of the applied S to the sulfate form to occur.

Boron

Boron (B) deficiency has been observed in hops when grown in nearby states. If B deficiency symptoms appear or M3 soil test B is <3.0 lb/ac, apply 1.0 lb/ac of elemental B to prevent B deficiency. Do not apply B at rates exceeding 1.5 lb/ac, as toxicity may occur.

Malting Barley

Crop Highlights
• Target pH: 6.0 • Split N application to increase N-use efficiency in malting barley. Apply a small amount (20 to 30 lb N/ac) at planting or in late winter and the bulk of the N requirement in two applications in early Spring. Apply the first when growth resumes in the spring and the second at Feekes' growth stage 5. • Use the fall soil nitrate test (FSNT) to determine whether the fall application of N can be reduced or eliminated. • Excessive N application can result in high protein contents, which causes problems during the malting process. Protein content in malting malting barley should be between 9.0 and 12.5%. As such, spring N rates are slightly lower for malting malting barley than for feed malting barley. • Soil test more frequently when straw is removed from the field since soil P and K may decrease more rapidly than when straw is left behind to decompose. • Monitor crop for manganese (Mn) deficiency, **especially** when Mehlich-3 soil test Mn is less than 3.4 lb/ac.

Yield Goal

Malting barley yields are influenced by many factors, including the cultivars selected, planting date, winter weather, soil type and water-holding capacity, nutrient and water availability, weed, insect and disease pressure and crop management practices. **On most Delaware soils, typical malting barley yields in a good to average year range from 60 to 90 bu/ac. On black soils, silt loams and /or when irrigation is used, typical yields range from 85 to 150 bu/ac.**

Delaware growers should use field history to determine the yield goal for each field and use that information to adjust management decisions and fertility programs accordingly. Delaware nutrient management law requires the use of optimal rolling average for determining the yield goal for a specific field when field history is available. To calculate the optimal rolling average yield, see the UD Extension Fact Sheet ***Estimating Yield Goal for Crops***.

Soil pH and Liming

Target pH: 6.0 for most soils

Soils that are high in organic matter ("black" soils) 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.

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 Ca and Mg concentrations.

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

The University of Delaware recommends a total nitrogen (N) rate of 60 to 90 lb N/ac per growing season. The higher end of the range should be utilized for sandy soils or for management systems where a single application will be made to compensate for higher leaching losses. In general, increasing N rate may increase grain production but may also increase lodging, thus reducing harvestable and economic yield. Split applications have been shown to increase N use-efficiency, thus requiring less total N to achieve the same grain yield. For best results, N should be split into two or more applications. Effective N management for winter malting barley is facilitated by soil and plant tissue sampling to ensure sufficient N to produce a healthy crop, but limit yield penalizing effects (e.g., disease and lodging) and leaching losses.

A small amount (up to 30 lb/ac of N) should be applied in the fall or in late winter to promote root growth and fall tillering. Avoid applying more than 30 lb/ac of N in the fall, as plants with excessive fall growth are susceptible to disease and winter kill; fall N applications are also susceptible to leaching below the root zone. A fall soil nitrate test (FSNT) run on a 6-inch composite soil sample is recommended to determine if enough soil N remains to reduce or eliminate the fall N application as follows:

- **NO_3-N <22 lb/ac:** Apply 25 to 30 lb/ac of N to establish the crop
- **NO_3-N >22 lb/ac:** No N fertilizer is needed to establish the crop

Spring N requirements are slightly lower than those for feed barley to prevent protein content from rising above 12.5%. High protein content causes problems during the malting process and therefore, is likely to be rejected. The University of Delaware recommends that growers monitor protein content and adjust N fertility in subsequent growing seasons.

The remainder of the total N requirement should be applied in the spring in two applications. The first should be made at “green up” when growth resumes (approximately Feekes growth stage 3) in the spring based on tiller density measurements as described in Table 2. Do not exceed and N rate of 40 lb/ac at this stage if planning a spring split.

Table 2. Nitrogen rate recommendations for early spring green up application to malting barley at Feekes growth stage 2-3.

	Tiller Density (tillers/ft^2) at Feekes 2-3				
	<50	**75**	**100**	**125**	**>150**
lb N/ac	40	30	20	10	0

Make the second spring application just prior to the period of rapid N uptake at Feekes growth stage 5 (stem elongation) based on results of a whole plant tissue test as described in Table 3. Cut the whole plant ½ inch above the soil line at Feekes 5 growth stage and submit to a reputable lab for analysis. Do not exceed an N rate of 80 lb/ac at this stage, as it increases the risk of high protein content and lodging.

Table 3. Nitrogen rate recommendations for second spring application to malting barley at Feekes growth stage 5.

	Percent N in Tissue from Whole Plant Sampled at Feekes 5				
	<2.50	**2.75**	**3.00**	**3.25**	**>3.5**
lb N/ac	80	60	40	20	0

When planting into fields where manure has been applied, determine the plant available N (PAN) for the manure application and reduce fertilizer N rates as appropriate.

Phosphorus

Phosphorus (P) fertilization is based on the results of a routine soil test (Table 4). Soil test results are reported as a fertility index value (FIV).

Table 4. Broadcast phosphorus application rates for malting barley.

	M3-P (UD FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb P_2O_5/ac	140	120	100	80	60	40	30	30	30	20	20

1. If soil test phosphorus (M3-P) is “Low” (e.g., 25 FIV or less), broadcast and plow down the recommended rate of phosphate prior to planting in the fall.
2. If M3-P is “Medium or “Optimum” (e.g., 26 to 100 FIV), phosphate can topdressed in the fall or the spring.
3. If M3-P is “Excessive” (e.g., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED.
4. Soil test P may decline more rapidly when straw is removed than when straw is left behind as stubble since P removal from the site is greater. Growers may wish to soil test more frequently to monitor changes in soil test P.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 5). Soil test results are reported as a fertility index value (FIV).

Table 5. Recommended potassium application rates for malting barley.

	M3-K (UD FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb K_2O /ac	140	120	100	80	60	40	30	30	30	20	20

1. Broadcast and incorporate or band potash prior to planting.
2. For banded applications, reduce the rates in Table 5 by one-half.
3. To avoid salt injury to seedlings, do not band more than 75 lb/ac of K_2O at planting. When N and K_2O are banded together, the sum of the N rate and the K_2O rate should not exceed 75 lb/ac.
4. Soil test K may decline more rapidly when straw is removed than when straw is left behind as stubble since K removal from the site is greater. Growers may wish to soil test more frequently to monitor changes in soil test K.

Magnesium

The need for magnesium (Mg) fertilization is determined by a routine soil test (Table 6); Mg needs are often met by liming. Soil test results are reported as a fertility index value (FIV).

Table 6. Recommended application rates of soluble magnesium for malting barley as a function of Mehlich-3 soil test Mg fertility index value.

Soluble 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 soil test Mg (M3-Mg) is less than 40
2. 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 according to the rates in Table 6.

Sulfur

Sulfur (S) deficiency is occasionally observed in malting barley grown on Delaware soils. Symptoms include reduced growth and a general yellowing of the plant. To confirm diagnosis, have a tissue test run. Cut the whole plant ½ inch above the soil line at Feekes 5 growth stage and submit to a reputable lab for analysis.

1. If the N:S ratio in the plant tissue is greater than 15:1, apply 25 to 35 lb S/ac with the first N application in the spring.

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 no-till systems. Also remember that sulfate-S is available for crop uptake immediately after application. If a reduced form of S is applied (e.g., thiosulfate or elemental S), allow adequate time for oxidation of the applied S to the sulfate form to occur.

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. Malting barley is a Mn sensitive crop. Soil test Mn results are reported in lb/ac.

$$MnAI = 101.7 - (15.2 \times \text{soil pH}) + (2.11 \times \text{M3-Mn})$$

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 7. Interpretation of manganese availability index for malting barley.

Mn Availability Index	Interpretation
Less than 25	Mn deficiency is likely at this soil pH and soil test Mn concentration
25 to 35	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 35	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 30 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.
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.***

NOTE: When using foliar application to correct Mn deficiency, growers may combine the treatment with a post emergence herbicide application to reduce the number of trips across the field. Sulfate containing forms of Mn (e.g., manganese sulfate [Techmangam] and manganese-lignin-sulfate) may be antagonistic to weed control with Roundup™. To overcome this antagonism, growers should add ammonium sulfate at a rate of 17 lb per 100 gallons of solution. Chelated-Mn (Mn-EDTA) has shown a slight degree of antagonism but little to no reduction in weed control was noted in the field studies.

Zinc

Zinc (Zn) deficiency is predicted by an availability index (ZnAI) that includes M3 soil test Zn, soil pH, and M3 soil test P. Soil test Zn results are reported in lb/ac. 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. Zinc deficiency symptoms often appear early in the season and disappear as root growth increases or environmental conditions improve. See Table 8 to determine if Zn deficiency is predicted for this field.

Table 8. Interpretation of zinc availability index for malting barley.

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

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

Boron

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

Sunflower

Crop Highlights
• Target pH: 6.0 • Split nitrogen (N) application to increase N use efficiency in in sunflower. Apply a small amount at or just prior to planting and the bulk of the N requirement in one or two applications during the growing season. • Monitor crop for manganese (Mn) deficiency, **especially** when soil test Mn is less than 3.4 lb/ac.

Yield Goal

Grain yield of sunflower is influenced by many factors, including the cultivars selected, planting date, winter weather, soil type and water-holding capacity, nutrient and water availability, weed, insect and disease pressure, and crop management practices. **Few yield measurements are available for sunflowers grown on Delaware soils. However, based on data from nearby states with similar soils and climates, 80 bu/ac is a realistic yield goal for sunflower production in a good to average year**.

Delaware growers should use field history to determine the yield goal for each field and use that information to adjust management decisions and fertility programs accordingly. Delaware nutrient management law requires the use of optimal rolling average for determining the yield goal for a specific field when field history is available. To calculate the optimal rolling average yield, see the UD Extension Fact Sheet ***Estimating Yield Goal for Crops***.

Soil pH and Liming

Target pH: 6.0 for most soils

Soils that are high in organic matter ("black" soils) 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 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

Nitrogen fertilization rates are based on regional research on crop response to N fertilizers and not on the results of a routine soil test. **Nitrogen (N) is recommended at a rate of 1 lb/ac per bushel of expected grain yield for sunflower.** Therefore, an expected yield of 80 bu/ac would require a total N application of 80 lb/ac per growing season. Split applications of N have been shown to increase N use efficiency by the crop, thus requiring less total N to achieve the same grain yield.

When a single application is planned, N should be applied as close to planting as possible to reduce the potential loss of N by leaching prior to crop uptake. When a split application is utilized, apply a small portion (20 to 25%) of the total N requirement at or just prior to planting. Apply the remaining N (75 to 80%) in one or more applications during the growing season.

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. Broadcast phosphorus application rates for sunflower.

	M3-P (FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb P_2O_5/ac	130	110	90	70	50	40	30	20	20	0	0

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

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 application rates for sunflower.

	M3-K (FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb K_2O/ac	120	100	80	60	40	30	30	20	20	0	0

1. Broadcast and incorporate or band potash prior to planting.
2. For banded applications, reduce the rates in Table 3 by one-half.
3. To avoid salt injury to seedlings, do not band more than 75 lb K_2O/ac at planting. When N and K_2O are banded together, the sum of the N rate and the K_2O rate should not exceed 75 lb/ac.

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 Mehlich 3 soil test magnesium.

Soluble 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 soil test Mg is less than 40 FIV.
2. If M3 soil test Mg is less than 40 FIV and lime is recommended, use dolomitic limestone.
3. If M3 soil test Mg is less than 40 FIV and lime is not needed, apply soluble Mg according to the rates in Table 4.

Sulfur

Sulfur (S) deficiency is occasionally observed in sunflower grown on sandy soils in this region. The use of ammonium sulfate as the N source or the addition of a small amount of ammonium sulfate to liquid UAN can prevent S deficiency from occurring.

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 no-till systems. Also remember that sulfate-S is available for crop uptake immediately after application. If a reduced form of S is applied (e.g., thiosulfate or elemental S), allow adequate time for oxidation of the applied S to the sulfate form to occur.

Manganese

Manganese (Mn) needs are predicted by an availability index that includes M3 soil test Mn and soil pH. Interpretation is crop specific.

$$MnAI = 101.7 – (15.2 \times \text{soil pH}) + (2.11 \times \text{M3-Mn})$$

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.

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. Manganese deficiency is more likely for soils with a MnAI between 17 and 25 if soils were recently limed and the M3-Mn concentration is <3.4 lb/ac.
2. If Mn deficiency is predicted or was observed in the previous growing season, broadcast 20 to 30 lb/ac elemental Mn.
3. In some cases, broadcast applications of acid forming fertilizers may correct Mn deficiency without the application of Mn; however, acid-forming fertilizers may be less effective than Mn fertilizers.
4. If Mn deficiency symptoms appear during the growing season or after an application of lime, a foliar application of Mn sulfate or Mn oxide at a rate of 1.0 to 2.0 lb/ac elemental Mn or chelated Mn (Mn-EDTA) at a rate of 0.5 to 1.0 lb/ac elemental Mn can alleviate the symptoms and restore yield potential. **Apply only when adequate growth is present to aid absorption of foliar Mn.**

NOTE: When using a foliar application to correct Mn deficiency, growers may combine the treatment with a post emergence herbicide application to reduce the number of trips across the field. Sulfate containing forms of Mn (e.g., manganese sulfate [Techmangam] and manganese-lignin-sulfate) may be antagonistic to weed control with Roundup™. To overcome this antagonism, growers should add ammonium sulfate at a rate of 17 lb per 100 gallons of solution. Chelated-Mn (Mn-EDTA) has shown a slight degree of antagonism but little to no reduction in weed control was noted in the field studies.

Wildlife Food Plots - Deer

Crop Highlights

- Target pH: 6.2
- Plant cool season crops (e.g., small grains, legumes, and forbs) in fall and warm season crops (e.g., corn, soybean, buckwheat, chufa) in spring or summer to attract deer.
- Soil pH may be very acidic on newly cleared forest land (< 5.0). If looking to establish food plots on newly cleared land, consider testing for pH and making recommended lime applications several months in advance of establishment.
- Fertility recommendations are based on establishment, not yield; therefore, nutrient recommendations are lower for these species than for grain or forage production
- Total nitrogen (N) application rates of 30 to 60 lb/ac are typically recommended, with higher rates used for stands containing less than 25% legumes.
- Choose low or no phosphorus (P) fertilizers for soils with optimum to excessive soil test P.
- Rates of common fertilizers needed to meet N needs are included in Table 5.

Management Notes

Wildlife food plots can provide feed for deer in the winter during a time of limited food quality and quantity or in summer to supply a high protein food source to promote milk, fawn, and antler production. Common cool season plantings for fall or winter deer food plots may include small grains (e.g., oats, rye, triticale, or wheat), legumes, or forbs. Common warm season plantings for spring/summer deer food plots may include corn, legumes, buckwheat, or chufa. Wildlife food plots can be planted as a monoculture or as a mixture of species. For example, alfalfa performs best when planted as a monoculture, while small grain species will perform well when planted with other small grains or legumes. Table 1 includes a list of common species planted to attract deer with suggested planting dates and potential companion plantings.

Yield Goal

Yield goals are not made for wildlife food plots to attract deer. These nutrient recommendations are designed to encourage good establishment and adequate growth of the desired plant species to support the needs of local wildlife, while maintaining soil fertility, rather than for obtaining maximum economic yield.

Target pH: 6.2

Wildlife food plots often contain multiple species, which may have different target pH values (Table 1). As such, we recommend a target pH of 6.2, as most crops planted in wildlife food plots will produce acceptable growth at this soil pH. The exception is when alfalfa is grown as the food source; alfalfa performs best when soil pH is near neutral (6.8).

Test soil pH several months in advance of plot establishment if planting winter feed plots on newly cleared forest land or land with limited history of fertility management; soil pH values are often very acidic (pH < 5.0) under these conditions. If lime is recommended, apply as far in advance of establishment as possible to allow maximum time for lime applications to neutralize soil pH.

Table 1. Common crops, recommended planting dates, soil pH range, and suitable companion plantings for wildlife food plots to attract deer.

Crop	pH range	Planting Date	Planting Mix Compatibility
Cool Season Annual Grasses			
Oats	5.8 to 6.5	Mid-Aug to Mid-Oct; Mid-Feb to Mid-Mar	Other cool season annual grasses, most cool season legumes
Rye	5.8 to 6.5	Mid-Aug to Mid-Oct	Other cool season annual grasses, most cool season legumes
Triticale	5.8 to 6.5	Mid-Aug to Mid-Oct	Other cool season annual grasses, most cool season legumes
Wheat	5.8 to 6.5	Mid-Aug to Mid-Oct	Other cool season annual grasses, most cool season legumes
Cool Season Legumes			
Alfalfa	6.5 to 7.5	Mid-Aug to Mid-Oct; Mid-Feb to Early May	None; performs best as monoculture
Arrowleaf clover	5.8 to 6.8	Mid-Aug to Mid-Oct	Cool season annual grasses, crimson clover
Austrian winter pea	5.6 to 7.0	Mid-Aug to Mid-Oct	Cool season annual grasses
Ball Clover	5.5 to 7.0	Mid-Aug to Mid-Oct	Cool season grasses, specifically oats and wheat
Birdsfoot treefoil	5.5 to 7.0	Mid-Aug to Mid-Oct	Cool season annual grasses, vetch
Crimson clover	5.5 to 7.5	Mid-Aug to Mid-Oct	Cool season annual grasses, most cool season legumes
Ladino white clover	5.5 to 7.5	Mid-Aug to Mid-Oct; Mid-Feb to Early May	Cool season annual grasses, red clover; high production varieties perform best as monoculture
Red clover	5.8 to 7.0	Mid-Aug to Mid-Oct; Mid-Feb to Early May	Performs best as a monoculture; can be planted with cool season annual grasses or ladino white clover
Subterranean clover	5.8 to 7.0	Mid-Aug to Mid-Oct	Cool season annual grasses, vetch
Vetch	5.4 to 6.8	Mid-Aug to Mid-Oct; Mid-Feb to Early May	Cool season annual grasses
Other Cool Season Species			
Brassicas (kale, rape, turnips)	5.5 to 7.0	Early Aug to Mid-Oct	Performs best as a monoculture; can be planted with cool season annual grasses or Austrian winter pea
Small burnett	6.0 to 7.0	Mid-Aug to Mid-Oct; Early Mar to Early May	Clovers
Chicory	5.5 to 7.0	Mid-Aug to Mid-Oct; Early Mar to Early May	Cool season grasses (oats or wheat), clovers (Ladino white or red)
Warm Season Grasses			
Corn	5.8 to 7.0	Early Apr to Mid-May	Cowpea, soybean
Egyptian wheat	6.0 to 7.0	Mid-Apr to Mid-Jun	Cowpea, soybean
Warm Season Legumes			
Alyceclover	5.5 to 7.0	Early Apr to Mid-Jun	Cowpea, deer jointvetch
Cowpea	5.2 to 7.5	Early Apr to Mid-Jun	Corn, cowpea, Egyptian wheat
Deer jointvetch	5.0 to 6.5	Early Apr to Mid-Jun	Alyceclover
Soybean	5.5 to 7.0	Early Apr to Mid-Jun	Corn, Egyptian wheat
Other Warm Season Species			
Buckwheat	6.0 to 7.0	Mid-Apr to Mid-Aug	Sunflower, millets, grain sorghum
Chufa	5.5 to 7.0	Mid-Apr to Early Jun	Performs best as a monoculture

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).

Recommended Liming Source

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 2.

Table 2. 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 a total nitrogen (N) rate of 30 to 60 lb/ac (0.75 to 1.25 lb/1000 ft^2) per growing season for wildlife food plots for deer. The higher end of the range should be used for plantings that do not contain legumes.

1. Nitrogen application is not required for legumes or for seeding mixes containing legumes, however, up to 30 lb/ac (0.75 lb /1000 ft^2) of total N can be applied to encourage growth without having a negative impact on N fixation.
2. If planting a legume or seeding mix containing legumes, apply the appropriate inoculant and/or use inoculated seed.
3. For plantings that do not contain legumes, apply up to 30 lb/ac (0.75 lb/1000 ft^2) of total N at planting.
4. For late summer or fall planted cool season non-legume species, an additional N application of 30 lb/ac (0.75 lb/1000 ft^2) can be made at “green up” in spring. Spring N application is not recommended for cool season species if the stand contains at least 25% legumes. Applied N makes the grasses more competitive and can result in the loss of legumes.
5. For spring or summer planted warm season non-legume species, an additional N application of 30 lb/ac (0.75 to 1.25 lb/1000 ft^2) can be applied at approximately 30 days post emergence.

Phosphorus

Phosphorus (P) fertilization is based on the results of a routine soil test (Table 3). Soil test results are reported as a fertility index value (FIV).

Table 3. Recommended broadcast phosphorus application rates for establishment and productivity of wildlife food plots to attract deer.

	M3-P (UD FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb P_2O_5/ac	70-120	30-70	0-30	0
lb P_2O_5/ 1000 ft^2	1.5-2.75	0.75-1.5	0-0.75	0

1. Within each Mehlich 3 (M3) soil test phosphorus (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 (Table 3).
2. If M3-P is “Low” or “Medium” (e.g., 50 FIV or less), broadcast and plow down the recommended rate of phosphate prior to seeding.
3. If M3-P is “Optimum” (e.g., 51 to 100 FIV), broadcast and incorporate phosphate prior to seeding or surface broadcast at or shortly after planting.
4. If M3-P is “Excessive” (e.g., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED. Choose fertilizers that do not contain P when establishing plots on soils with M3-P concentrations in the excessive range.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 4). Soil test results are reported as a fertility index value (FIV).

Table 4. Recommended potassium for establishment and productivity of wildlife food plots to attract deer.

	M3-K (FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb K_2O/ac	75-120	30-70	0-30	0
lb K_2O/ 1000 ft^2	1.75-2.75	0.75-1.5	0-0.75	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. Broadcast and incorporate potash at or prior to seeding.

Fertilizer Selection

It is common for land managers to use fertilizers that are already on-hand at the operation or easily available from the local farm supply store for wildlife food plots rather than requesting custom blends from a fertilizer dealer. Table 5 presents rates of common fertilizer materials and blends needed to supply N at a rate of 30 lb/ac (0.75 lb/1000 ft^2) to wildlife food plots and lists scenarios for which these materials are appropriate. Please note that the list of materials is not exhaustive. Avoid applying fertilizers with high P concentration to soils with optimum to excessive soil test P concentrations (>50 FIV) to prevent negative environmental effects.

Table 5. Amount of common fertilizer materials needed to apply 30 lb/ac of total N to wildlife food plots for deer.

Fertilizer Source	Fertilizer Rate (lb/ac)	Amount of P_2O_5 applied (lb P_2O_5/ac)	Amount of K_2O applied (lb K_2O/ac)	Recommended Conditions for Use
10-10-10	300	30	30	Low to Medium P; Optimum K
5-10-5	600	60	30	Low to Medium P; Optimum K
8-32-16	375	120	60	Low P; Low to Medium K
20-20-20	150	30	30	Low to Medium P; Optimum K
8-0-24	375	0	90	Optimum or Excessive P; Low K
11-52-0	272	141	0	Low P; Optimum K
18-46-0	167	77	0	Low P; Optimum K
10-34-0	300	102	0	Low P; Optimum K
15-60-0	200	120	0	Low P; Optimum K
11-37-0	272	101	0	Low P; Optimum K
21-0-0-24S	143	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes); Sulfur needed
32-0-0	94	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes)
46-0-0	65	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes)

Magnesium

The need for magnesium (Mg) fertilization is determined by a routine soil test (Table 6); Mg needs are often met by liming. Soil test results are reported as a fertility index value (FIV).

Table 6. Recommended application rates of soluble magnesium to wildlife food plots for deer as a function of soil test magnesium.

	M3-Mg (FIV)			
	Low (0-25)	Medium (26-50)	Optimum (51-100)	Excessive (>100)
lb soluble Mg/ac	30-80	0-30	0	0
lb soluble Mg/ 1000 ft^2	0.75-1.75	0-0.75	0	0

1. Magnesium (Mg) is recommended when M3 soil test Mg (M3-Mg) is less than 40 FIV.
2. 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 6.

Sulfur

Wildlife food plots established on sandy, low organic matter soils may benefit from applications of supplemental sulfur (S). Consider choosing a fertilizer source like ammonium sulfate, which contains both N and S.

Wildlife Food Plots - Game Birds

Crop Highlights

- Target pH: 6.2
- Plant cool season crops (e.g., small grains, legumes, and forbs) in fall to attract quail; plant warm season crops (e.g., corn, millets, buckwheat, sunflower) in spring or summer to attract quail or doves.
- Soil pH may be very acidic on newly cleared forest land (< 5.0). If looking to establish food plots on newly cleared land, consider testing for pH and making recommended lime applications several months in advance of establishment.
- Fertility recommendations are based on establishment, not yield; therefore, nutrient recommendations are lower for these species than for grain or forage production
- Total nitrogen (N) application rates of 30 to 60 lb/ac are typically recommended, with higher rates used for stands containing less than 25% legumes.
- Choose low or no phosphorus (P) fertilizers for soils with optimum to excessive soil test P.
- Rates of common fertilizers needed to meet N needs are included in Table 5.

Management Notes

Wildlife food plots are useful to provide feed for bobwhite quail year-round and for mourning doves in spring and summer. Quail prefer expansive, open landscapes rather than thick cover, so reducing the presence of perennial grasses may be necessary. Cool season plantings for bobwhite quail may include small grains (like oats, rye, triticale, or wheat), legumes, or chicory. Warm season plantings for bobwhite quail may include corn, millets, sorghum, legumes, buckwheat, or sunflower. Mourning doves mainly eat seeds, preferring loose seed in recently harvested fields. Planting single species in rows is often beneficial for attracting doves. Warm season plantings for mourning dove food plots include corn, millets, sorghum, soybean, buckwheat, or sunflower. Table 1 includes a list of common species planted to attract game birds with suggested planting dates and potential companion plantings.

Yield Goal

Yield goals are not made for wildlife food plots to attract game birds. These nutrient recommendations are designed to encourage good establishment and adequate growth of the desired plant species to support the needs of local wildlife, while maintaining soil fertility, rather than for obtaining maximum economic yield.

Target pH: 6.2

Wildlife food plots often contain multiple species, which may have different target pH values (Table 1). As such, we recommend a target pH of 6.2, as most crops planted in wildlife food plots will produce acceptable growth at this soil pH. The exception is when alfalfa is grown as the food source; alfalfa performs best when soil pH is near neutral (6.8).

Test soil pH several months in advance of plot establishment if planting winter feed plots on newly cleared forest land or land with limited history of fertility management; soil pH values are often very acidic (pH < 5.0) under these conditions. If lime is recommended, apply as far in advance of establishment as possible to allow maximum time for lime applications to neutralize soil pH.

Table 1. Common crops, recommended planting dates, soil pH range, and suitable companion plantings for wildlife food plots to attract game birds.

Crop	pH range	Planting Date	Planting Mix Compatibility
Cool Season Annual Grasses			
Oats	5.8 to 6.5	Mid-Aug to Mid-Oct; Mid-Feb to Mid-Mar	Other cool season annual grasses, most cool season legumes
Rye	5.8 to 6.5	Mid-Aug to Mid-Oct	Other cool season annual grasses, most cool season legumes
Triticale	5.8 to 6.5	Mid-Aug to Mid-Oct	Other cool season annual grasses, most cool season legumes
Wheat	5.8 to 6.5	Mid-Aug to Mid-Oct	Other cool season annual grasses, most cool season legumes
Cool Season Legumes			
Alfalfa	6.5 to 7.5	Mid-Aug to Mid-Oct; Mid-Feb to Early May	None; performs best as monoculture
Birdsfoot treefoil	5.5 to 7.0	Mid-Aug to Mid-Oct	Cool season annual grasses, vetch
Ladino white clover	5.5 to 7.5	Mid-Aug to Mid-Oct; Mid-Feb to Early May	Cool season annual grasses, red clover; High production varieties perform best as monoculture
Red clover	5.8 to 7.0	Mid-Aug to Mid-Oct; Mid-Feb to Early May	Performs best as a monoculture; can be planted with cool season annual grasses or ladino white clover
Subterranean clover	5.8 to 7.0	Mid-Aug to Mid-Oct	Cool season annual grasses, vetch
Vetch	5.4 to 6.8	Mid-Aug to Mid-Oct; Mid-Feb to Early May	Cool season annual grasses
Other Cool Season Species			
Chicory	5.5 to 7.0	Mid-Aug to Mid-Oct; Early Mar to Early May	Cool season grasses (oats or wheat), clovers (Ladino white or red)
Warm Season Grasses			
Browntop millet†	5.0 to 7.0	Mid-Apr to Mid-Jul	Planted in strips with grain sorghum, Japanese millet, or sunflower
Corn†	5.8 to 7.0	Early Apr to Mid-May	Cowpea, soybean
Egyptian wheat†	6.0 to 7.0	Mid-Apr to Mid-Jun	Cowpea, soybean
Foxtail millet†	5.5 to 7.0	Mid-Apr to Mid-Jun	Performs best as a monoculture (outcompetes other grasses)
Grain sorghum†	5.6 to 7.0	Mid-Apr to Mid-Jun	Browntop millet, corn, cowpea, sunflower
Japanese millet†	5.2 to 7.0	Early May to Early Aug	Performs best as a monoculture; can be planted with browntop millet
Proso millet†	5.5 to 7.0	Mid-Apr to Mid-Jun	Performs best as a monoculture
Warm Season Legumes			
Cowpea	5.2 to 7.5	Early Apr to Mid-Jun	Corn, cowpea, egyptian wheat, grain sorghum, or partridge pea
Deer jointvetch	5.0 to 6.5	Early Apr to Mid-Jun	Alyceclover
Lespedeza	5.8 to 6.5	Mid-Feb to Mid-Jun	Warm season grasses, partridge pea
Partridge Pea	4.8 to 7.5	Mid-Feb to Mid-Jun	Lespedeza, warm season grasses
Soybean†	5.5 to 7.0	Early Apr to Mid-Jun	Corn, Egyptian wheat, grain sorghum
Other Warm Season Species			
Buckwheat†	6.0 to 7.0	Mid-Apr to Mid-Aug	Sunflower, millets, grain sorghum
Sunflower†	5.4 to 7.0	Mid-Apr to Mid-May	Planted in strips with millets or grain sorghum

†Indicates species that will also attract Mourning Doves. All species are suitable for attracting Bobwhite quail.

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).

Recommended Liming Source

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 2.

Table 2. 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 a total nitrogen (N) rate of 30 to 60 lb/ac (0.75 to 1.25 lb/1000 ft^2) per growing season for wildlife food plots for game birds. The higher end of the range should be used for plantings that do not contain legumes.

1. Nitrogen application is not required for legumes or for seeding mixes containing legumes, however, up to 30 lb/ac (0.75 lb /1000 ft^2) of total N can be applied to encourage growth without having a negative impact on N fixation.
2. If planting a legume or seeding mix containing legumes, apply the appropriate inoculant and/or use inoculated seed.
3. For plantings that do not contain legumes, apply up to 30 lb/ac (0.75 lb/1000 ft^2) of total N at planting.
4. For late summer or fall planted cool season non-legume species, an additional N application of 30 lb/ac (0.75 lb/1000 ft^2) can be made at “green up” in spring. Spring N application is not recommended for cool season species if the stand contains at least 25% legumes. Applied N makes the grasses more competitive and can result in the loss of legumes.
5. For spring or summer planted warm season non-legume species, an additional N application of 30 lb/ac (0.75 to 1.25 lb/1000 ft^2) can be applied at approximately 30 days post emergence.

Phosphorus

Phosphorus (P) fertilization is based on the results of a routine soil test (Table 3). Soil test results are reported as a fertility index value (FIV).

Table 3. Recommended broadcast phosphorus application rates for establishment and productivity of wildlife food plots to attract game birds.

	M3-P (UD FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb P_2O_5/ac	70-120	30-70	0-30	0
lb P_2O_5/ 1000 ft^2	1.5-2.75	0.75-1.5	0-0.75	0

1. Within each Mehlich 3 (M3) soil test phosphorus (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 (Table 3).
2. If M3-P is “Low” or “Medium” (e.g., 50 FIV or less), broadcast and plow down the recommended rate of phosphate prior to seeding.
3. If M3-P is “Optimum” (e.g., 51 to 100 FIV), broadcast and incorporate phosphate prior to seeding or surface broadcast at or shortly after planting.
4. If M3-P is “Excessive” (e.g., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED. Choose fertilizers that do not contain P when establishing plots on soils with M3-P concentrations in the excessive range.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 4). Soil test results are reported as a fertility index value (FIV).

Table 4. Recommended potassium for establishment and productivity of wildlife food plots to attract game birds.

	M3-K (FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb K_2O/ac	75-120	30-70	0-30	0
lb K_2O/ 1000 ft^2	1.75-2.75	0.75-1.5	0-0.75	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. Broadcast and incorporate potash at or prior to seeding.

Fertilizer Selection

It is common for land managers to use fertilizers that are already on-hand at the operation or easily available from the local farm supply store for wildlife food plots rather than requesting custom blends from a fertilizer dealer. Table 5 presents rates of common fertilizer materials and blends needed to supply N at a rate of 30 lb/ac (0.75 lb/1000 ft^2) to wildlife food plots and lists scenarios for which these materials are appropriate. Please note that the list of materials is not exhaustive. Avoid applying fertilizers with high P concentration to soils with optimum to excessive soil test P concentrations (>50 FIV) to prevent negative environmental effects.

Table 5. Amount of common fertilizer materials needed to apply 30 lb/ac of total N to wildlife food plots for deer.

Fertilizer Source	Fertilizer Rate (lb/ac)	Amount of P_2O_5 applied (lb P_2O_5/ac)	Amount of K_2O applied (lb K_2O/ac)	Recommended Conditions for Use
10-10-10	300	30	30	Low to Medium P; Optimum K
5-10-5	600	60	30	Low to Medium P; Optimum K
8-32-16	375	120	60	Low P; Low to Medium K
20-20-20	150	30	30	Low to Medium P; Optimum K
8-0-24	375	0	90	Optimum or Excessive P; Low K
11-52-0	272	141	0	Low P; Optimum K
18-46-0	167	77	0	Low P; Optimum K
10-34-0	300	102	0	Low P; Optimum K
15-60-0	200	120	0	Low P; Optimum K
11-37-0	272	101	0	Low P; Optimum K
21-0-0-24S	143	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes); Sulfur needed
32-0-0	94	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes)
46-0-0	65	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes)

Magnesium

The need for magnesium (Mg) fertilization is determined by a routine soil test (Table 6); Mg needs are often met by liming. Soil test results are reported as a fertility index value (FIV).

Table 6. Recommended application rates of soluble magnesium to wildlife food plots for game birds as a function of soil test magnesium.

	M3-Mg (FIV)			
	Low (0-25)	Medium (26-50)	Optimum (51-100)	Excessive (>100)
lb soluble Mg/ac	30-80	0-30	0	0
lb soluble Mg/ 1000 ft^2	0.75-1.75	0-0.75	0	0

1. Magnesium (Mg) is recommended when M3 soil test Mg (M3-Mg) is less than 40 FIV.
2. 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 6.

Sulfur

Wildlife food plots established on sandy, low organic matter soils may benefit from applications of supplemental sulfur (S). Consider choosing a fertilizer source like ammonium sulfate, which contains both N and S.

Wildlife Food Plots - Rabbits

Crop Highlights

- Target pH: 6.2
- Plant cool season crops (e.g., small grains, clovers) in fall to attract rabbits; warm-season plantings are less common.
- Soil pH may be very acidic on newly cleared forest land (< 5.0). If looking to establish food plots on newly cleared land, consider testing for pH and making recommended lime applications several months in advance of establishment.
- Fertility recommendations are based on establishment, not yield; therefore, nutrient recommendations are lower for these species than for grain or forage production
- Total nitrogen (N) application rates of 30 to 60 lb/ac are typically recommended, with higher rates used for stands containing less than 25% legumes.
- Choose low or no phosphorus (P) fertilizers for soils with optimum to excessive soil test P.
- Rates of common fertilizers needed to meet N needs are included in Table 5.

Management Notes

Wildlife food plots are especially useful to provide feed for rabbits in fall and winter. Rabbits prefer brushy cover; as such, prescribed burns are recommended to manage quality rabbit habitat. Cool season plantings to attract rabbits may include small grains (e.g., oats, rye, wheat), legumes (especially clovers), and brassicas. Warm season plantings to attract rabbits are less common and typically include alyceclover, cowpea, soybean, or buckwheat. Table 1 includes a list of common species planted to attract rabbits with suggested planting dates and potential companion plantings.

Yield Goal

Yield goals are not made for wildlife food plots to attract rabbits. These nutrient recommendations are designed to encourage good establishment and adequate growth of the desired plant species to support the needs of local wildlife, while maintaining soil fertility, rather than for obtaining maximum economic yield.

Target pH: 6.2

Wildlife food plots often contain multiple species, which may have different target pH values (Table 1). As such, we recommend a target pH of 6.2, as most crops planted in wildlife food plots will produce acceptable growth at this soil pH. The exception is when alfalfa is grown as the food source; alfalfa performs best when soil pH is near neutral (6.8).

Test soil pH several months in advance of plot establishment if planting winter feed plots on newly cleared forest land or land with limited history of fertility management; soil pH values are often very acidic (pH < 5.0) under these conditions. If lime is recommended, apply as far in advance of establishment as possible to allow maximum time for lime applications to neutralize soil pH.

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).

Table 1. Common crops, recommended planting dates, soil pH range, and suitable companion plantings for wildlife food plots to attract rabbits.

Crop	pH range	Planting Date	Planting Mix Compatibility
Cool Season Annual Grasses			
Oats	5.8 to 6.5	Mid-Aug to Mid-Oct; Mid-Feb to Mid-Mar	Other cool season annual grasses, most cool season legumes
Rye	5.8 to 6.5	Mid-Aug to Mid-Oct	Other cool season annual grasses, most cool season legumes
Triticale	5.8 to 6.5	Mid-Aug to Mid-Oct	Other cool season annual grasses, most cool season legumes
Wheat	5.8 to 6.5	Mid-Aug to Mid-Oct	Other cool season annual grasses, most cool season legumes
Cool Season Legumes			
Alfalfa	6.5 to 7.5	Mid-Aug to Mid-Oct; Mid-Feb to Early May	None; performs best as monoculture
Arrowleaf clover	5.8 to 6.8	Mid-Aug to Mid-Oct	Cool season annual grasses, crimson clover
Birdsfoot treefoil	5.5 to 7.0	Mid-Aug to Mid-Oct	Cool season annual grasses, vetch
Crimson clover	5.5 to 7.5	Mid-Aug to Mid-Oct	Cool season annual grasses, most cool season legumes
Ladino white clover	5.5 to 7.5	Mid-Aug to Mid-Oct; Mid-Feb to Early May	Cool season annual grasses, red clover; High production varieties perform best as monoculture
Red clover	5.8 to 7.0	Mid-Aug to Mid-Oct; Mid-Feb to Early May	Performs best as a monoculture; can be planted with cool season annual grasses or ladino white clover
Subterranean clover	5.8 to 7.0	Mid-Aug to Mid-Oct	Cool season annual grasses, vetch
Vetch	5.4 to 6.8	Mid-Aug to Mid-Oct; Mid-Feb to Early May	Cool season annual grasses
Other Cool Season Species			
Brassicas (e.g., rape, turnips)	5.5 to 7.0	Early Aug to Mid-Oct	Performs best as a monoculture; can be planted with cool season annual grasses
Small burnett	6.0 to 7.0	Mid-Aug to Mid-Oct; Early Mar to Early May	Clovers
Warm Season Legumes			
Alyceclover	5.5 to 7.0	Early Apr to Mid-Jun	Cowpea
Cowpea	5.2 to 7.5	Early Apr to Mid-Jun	Performs best as a monoculture
Soybean	5.5 to 7.0	Early Apr to Mid-Jun	Performs best as a monoculture
Other Warm Season Species			
Buckwheat	6.0 to 7.0	Mid-Apr to Mid-Aug	Performs best as a monoculture

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).

Recommended Liming Source

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 2.

Table 2. 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 a total nitrogen (N) rate of 30 to 60 lb/ac (0.75 to 1.25 lb/1000 ft^2) per growing season for wildlife food plots for rabbits. The higher end of the range should be used for plantings that do not contain legumes.

1. Nitrogen application is not required for legumes or for seeding mixes containing legumes, however, up to 30 lb/ac (0.75 lb /1000 ft^2) of total N can be applied to encourage growth without having a negative impact on N fixation.
2. If planting a legume or seeding mix containing legumes, apply the appropriate inoculant and/or use inoculated seed.
3. For plantings that do not contain legumes, apply up to 30 lb/ac (0.75 lb/1000 ft^2) of total N at planting.
4. For late summer or fall planted cool season non-legume species, an additional N application of 30 lb/ac (0.75 lb/1000 ft^2) can be made at “green up” in spring. Spring N application is not recommended for cool season species if the stand contains at least 25% legumes. Applied N makes the grasses more competitive and can result in the loss of legumes.
5. For spring or summer planted warm season non-legume species, an additional N application of 30 lb/ac (0.75 to 1.25 lb/1000 ft^2) can be applied at approximately 30 days post emergence.

Phosphorus

Phosphorus (P) fertilization is based on the results of a routine soil test (Table 3). Soil test results are reported as a fertility index value (FIV).

Table 3. Recommended broadcast phosphorus application rates for establishment and productivity of wildlife food plots to attract rabbits.

	M3-P (UD FIV)			
	Low (0-25)	Medium (26-50)	Optimum (51-100)	Excessive (>100)
lb P_2O_5/ac	70-120	30-70	0-30	0
lb P_2O_5/ 1000 ft^2	1.5-2.75	0.75-1.5	0-0.75	0

1. Within each Mehlich 3 (M3) soil test phosphorus (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 (Table 3).
2. If M3-P is “Low” or “Medium” (e.g., 50 FIV or less), broadcast and plow down the recommended rate of phosphate prior to seeding.

3. If M3-P is “Optimum” (e.g., 51 to 100 FIV), broadcast and incorporate phosphate prior to seeding or surface broadcast at or shortly after planting.
4. If M3-P is “Excessive” (e.g., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED. Choose fertilizers that do not contain P when establishing plots on soils with M3-P concentrations in the excessive range.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 4). Soil test results are reported as a fertility index value (FIV).

Table 4. Recommended potassium for establishment and productivity of wildlife food plots to attract rabbits.

	M3-K (FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb K_2O/ac	75-120	30-70	0-30	0
lb K_2O/ 1000 ft^2	1.75-2.75	0.75-1.5	0-0.75	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. Broadcast and incorporate potash at or prior to seeding.

Fertilizer Selection

It is common for land managers to use fertilizers that are already on-hand at the operation or easily available from the local farm supply store for wildlife food plots rather than requesting custom blends from a fertilizer dealer. Table 5 presents rates of common fertilizer materials and blends needed to supply N at a rate of 30 lb/ac (0.75 lb/1000 ft^2) to wildlife food plots and lists scenarios for which these materials are appropriate. Please note that the list of materials is not exhaustive. Avoid applying fertilizers with high P concentration to soils with optimum to excessive soil test P concentrations (>50 FIV) to prevent negative environmental effects.

Table 5. Amount of common fertilizer materials needed to apply 30 lb/ac of total N to wildlife food plots for deer.

Fertilizer Source	Fertilizer Rate (lb/ac)	Amount of P_2O_5 applied (lb P_2O_5/ac)	Amount of K_2O applied (lb K_2O/ac)	Recommended Conditions for Use
10-10-10	300	30	30	Low to Medium P; Optimum K
5-10-5	600	60	30	Low to Medium P; Optimum K
8-32-16	375	120	60	Low P; Low to Medium K
20-20-20	150	30	30	Low to Medium P; Optimum K
8-0-24	375	0	90	Optimum or Excessive P; Low K
11-52-0	272	141	0	Low P; Optimum K
18-46-0	167	77	0	Low P; Optimum K
10-34-0	300	102	0	Low P; Optimum K
15-60-0	200	120	0	Low P; Optimum K
11-37-0	272	101	0	Low P; Optimum K
21-0-0-24S	143	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes); Sulfur needed
32-0-0	94	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes)
46-0-0	65	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes)

Magnesium

The need for magnesium (Mg) fertilization is determined by a routine soil test (Table 6); Mg needs are often met by liming. Soil test results are reported as a fertility index value (FIV).

Table 6. Recommended application rates of soluble magnesium to wildlife food plots for rabbits as a function of soil test magnesium.

	M3-Mg (FIV)			
	Low (0-25)	Medium (26-50)	Optimum (51-100)	Excessive (>100)
lb soluble Mg/ac	30-80	0-30	0	0
lb soluble Mg/ 1000 ft^2	0.75-1.75	0-0.75	0	0

1. Magnesium (Mg) is recommended when M3 soil test Mg (M3-Mg) is less than 40 FIV.
2. 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 6.

Sulfur

Wildlife food plots established on sandy, low organic matter soils may benefit from applications of supplemental sulfur (S). Consider choosing a fertilizer source like ammonium sulfate, which contains both N and S.

Wildlife Food Plots - Turkey

Crop Highlights

- Target pH: 6.2
- Plant cool season crops (e.g., small grains, legumes, and forbs) in fall and warm season crops (e.g., corn, soybean, millets, legumes, buckwheat, chufa) in spring or summer to attract turkey.
- Soil pH may be very acidic on newly cleared forest land (< 5.0). If looking to establish food plots on newly cleared land, consider testing for pH and making recommended lime applications several months in advance of establishment.
- Fertility recommendations are based on establishment, not yield; therefore, nutrient recommendations are lower for these species than for grain or forage production
- Total nitrogen (N) application rates of 30 to 60 lb/ac are typically recommended, with higher rates used for stands containing less than 25% legumes.
- Choose low or no phosphorus (P) fertilizers for soils with optimum to excessive soil test P.
- Rates of common fertilizers needed to meet N needs are included in Table 5.

Management Notes

Wildlife food plots are useful to provide turkey feed year-round. However, success of food plots for turkey is heavily dependent on the presence of adequate cover for nesting and brooding. Common cool season plantings for turkey fall or winter food plots may include small grains (e.g., oats, rye, triticale, or wheat), legumes, or forbs. Common warm season seeding mixes for spring or summer turkey food plots include corn, millets, sorghum, legumes, buckwheat, sunflower, and chufa. Wildlife food plots can be planted as a monoculture or as a mixture of species. For example, alfalfa performs best when planted as a monoculture. In contrast, small grain species will perform well when planted with other small grains or legumes. Table 1 includes a list of common species planted to attract turkey with suggested planting dates and potential companion plantings.

Yield Goal

Yield goals are not made for wildlife food plots to attract turkey. These nutrient recommendations are designed to encourage good establishment and adequate growth of the desired plant species to support the needs of local wildlife, while maintaining soil fertility, rather than for obtaining maximum economic yield.

Target pH: 6.2

Wildlife food plots often contain multiple species, which may have different target pH values (Table 1). As such, we recommend a target pH of 6.2, as most crops planted in wildlife food plots will produce acceptable growth at this soil pH. The exception is when alfalfa is grown as the food source; alfalfa performs best when soil pH is near neutral (6.8).

Test soil pH several months in advance of plot establishment if planting winter feed plots on newly cleared forest land or land with limited history of fertility management; soil pH values are often very acidic (pH < 5.0) under these conditions. If lime is recommended, apply as far in advance of establishment as possible to allow maximum time for lime applications to neutralize soil pH.

Table 1. Common crops, recommended planting dates, soil pH range, and suitable companion plantings for wildlife food plots to attract turkey.

Crop	pH range	Planting Date	Planting Mix Compatibility
Cool Season Annual Grasses			
Oats	5.8 to 6.5	Mid-Aug to Mid-Oct; Mid-Feb to Mid-Mar	Other cool season annual grasses, most cool season legumes
Rye	5.8 to 6.5	Mid-Aug to Mid-Oct	Other cool season annual grasses, most cool season legumes
Triticale	5.8 to 6.5	Mid-Aug to Mid-Oct	Other cool season annual grasses, most cool season legumes
Wheat	5.8 to 6.5	Mid-Aug to Mid-Oct	Other cool season annual grasses, most cool season legumes
Cool Season Legumes			
Alfalfa	6.5 to 7.5	Mid-Aug to Mid-Oct; Mid-Feb to Early May	None; performs best as monoculture
Arrowleaf clover	5.8 to 6.8	Mid-Aug to Mid-Oct	Cool season annual grasses, crimson clover
Austrian winter pea	5.6 to 7.0	Mid-Aug to Mid-Oct	Cool season annual grasses
Ball Clover	5.5 to 7.0	Mid-Aug to Mid-Oct	Cool season grasses, specifically oats and wheat
Birdsfoot treefoil	5.5 to 7.0	Mid-Aug to Mid-Oct	Cool season annual grasses, vetch
Crimson clover	5.5 to 7.5	Mid-Aug to Mid-Oct	Cool season annual grasses, most cool season legumes
Ladino white clover	5.5 to 7.5	Mid-Aug to Mid-Oct; Mid-Feb to Early May	Cool season annual grasses, red clover; High production varieties perform best as monoculture
Red clover	5.8 to 7.0	Mid-Aug to Mid-Oct; Mid-Feb to Early May	Performs best as a monoculture; can be planted with cool season annual grasses or ladino white clover
Subterranean clover	5.8 to 7.0	Mid-Aug to Mid-Oct	Cool season annual grasses, vetch
Vetch	5.4 to 6.8	Mid-Aug to Mid-Oct; Mid-Feb to Early May	Cool season annual grasses
Other Cool Season Species			
Brassicas (e.g., rape, turnips)	5.5 to 7.0	Early Aug to Mid-Oct	Performs best as a monoculture; can be planted with cool season annual grasses or Austrian winter pea
Chicory	5.5 to 7.0	Mid-Aug to Mid-Oct; Early Mar to Early May	Cool season grasses (oats or wheat), clovers (Ladino white or red)
Warm Season Grasses			
Browntop millet	5.0 to 7.0	Mid-Apr to Mid-Jul	Planted in strips with grain sorghum, Japanese millet, or sunflower
Corn	5.8 to 7.0	Early Apr to Mid-May	Cowpea, soybean
Egyptian wheat	6.0 to 7.0	Mid-Apr to Mid-Jun	Cowpea, soybean
Foxtail millet	5.5 to 7.0	Mid-Apr to Mid-Jun	Performs best as a monoculture (outcompetes other grasses)
Grain sorghum	5.6 to 7.0	Mid-Apr to Mid-Jun	Browntop millet, corn, cowpea, sunflower
Japanese millet	5.2 to 7.0	Early May to Early Aug	Performs best as a monoculture; can be planted with browntop millet
Proso millet	5.5 to 7.0	Mid-Apr to Mid-Jun	Performs best as a monoculture
Warm Season Legumes			
Cowpea	5.2 to 7.5	Early Apr to Mid-Jun	Corn, Egyptian wheat, grain sorghum, partridge pea
Deer jointvetch	5.0 to 6.5	Early Apr to Mid-Jun	Performs best as a monoculture
Lespedeza	5.8 to 6.5	Mid-Feb to Mid-Jun	Warm season grasses, partridge pea
Partridge Pea	4.8 to 7.5	Mid-Feb to Mid-Jun	Lespedeza, warm season grasses
Soybean	5.5 to 7.0	Early Apr to Mid-Jun	Corn, Egyptian wheat, or grain sorghum

Table 1 (Cont). Common crops, recommended planting dates, soil pH range, and suitable companion plantings for wildlife food plots to attract turkey.

Other Warm Season Species			
Buckwheat	6.0 to 7.0	Mid-Apr to Mid-Aug	Sunflower, millets, grain sorghum
Sunflower	5.4 to 7.0	Mid-Apr to Mid-May	Planted in strips with millets or grain sorghum
Chufa	5.5 to 7.0	Mid-Apr to Early Jun	Performs best as a monoculture

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).

Recommended Liming Source

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 2.

Table 2. 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 a total nitrogen (N) rate of 30 to 60 lb/ac (0.75 to 1.25 lb/1000 ft^2) per growing season for wildlife food plots for turkey. The higher end of the range should be used for plantings that do not contain legumes.

1. Nitrogen application is not required for legumes or for seeding mixes containing legumes, however, up to 30 lb/ac (0.75 lb /1000 ft^2) of total N can be applied to encourage growth without having a negative impact on N fixation.
2. If planting a legume or seeding mix containing legumes, apply the appropriate inoculant and/or use inoculated seed.
3. For plantings that do not contain legumes, apply up to 30 lb/ac (0.75 lb/1000 ft^2) of total N at planting.
4. For late summer or fall planted cool season non-legume species, an additional N application of 30 lb/ac (0.75 lb/1000 ft^2) can be made at “green up” in spring. Spring N application is not recommended for cool season species if the stand contains at least 25% legumes. Applied N makes the grasses more competitive and can result in the loss of legumes.
5. For spring or summer planted warm season non-legume species, an additional N application of 30 lb/ac (0.75 to 1.25 lb/1000 ft^2) can be applied at approximately 30 days post emergence.

Phosphorus

Phosphorus (P) fertilization is based on the results of a routine soil test (Table 3). Soil test results are reported as a fertility index value (FIV).

Table 3. Recommended broadcast phosphorus application rates for establishment and productivity of wildlife food plots to attract turkey.

	M3-P (UD FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb P_2O_5/ac	70-120	30-70	0-30	0
lb P_2O_5/ 1000 ft^2	1.5-2.75	0.75-1.5	0-0.75	0

1. Within each Mehlich 3 (M3) soil test phosphorus (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 (Table 3).
2. If M3-P is “Low” or “Medium” (e.g., 50 FIV or less), broadcast and plow down the recommended rate of phosphate prior to seeding.
3. If M3-P is “Optimum” (e.g., 51 to 100 FIV), broadcast and incorporate phosphate prior to seeding or surface broadcast at or shortly after planting.
4. If M3-P is “Excessive” (e.g., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED. Choose fertilizers that do not contain P when establishing plots on soils with M3-P concentrations in the excessive range.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 4). Soil test results are reported as a fertility index value (FIV).

Table 4. Recommended potassium for establishment and productivity of wildlife food plots to attract turkey.

	M3-K (FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb K_2O/ac	75-120	30-70	0-30	0
lb K_2O/ 1000 ft^2	1.75-2.75	0.75-1.5	0-0.75	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. Broadcast and incorporate potash at or prior to seeding.

Fertilizer Selection

It is common for land managers to use fertilizers that are already on-hand at the operation or easily available from the local farm supply store for wildlife food plots rather than requesting custom blends from a fertilizer dealer. Table 5 presents rates of common fertilizer materials and blends needed to supply N at a rate of 30 lb/ac (0.75 lb/1000 ft^2) to wildlife food plots and lists scenarios for which these materials are appropriate. Please note that the list of materials is not exhaustive. Avoid applying fertilizers with high P concentration to soils with optimum to excessive soil test P concentrations (>50 FIV) to prevent negative environmental effects.

Table 5. Amount of common fertilizer materials needed to apply 30 lb/ac of total N to wildlife food plots for deer.

Fertilizer Source	Fertilizer Rate (lb/ac)	Amount of P_2O_5 applied (lb P_2O_5/ac)	Amount of K_2O applied (lb K_2O/ac)	Recommended Conditions for Use
10-10-10	300	30	30	Low to Medium P; Optimum K
5-10-5	600	60	30	Low to Medium P; Optimum K
8-32-16	375	120	60	Low P; Low to Medium K
20-20-20	150	30	30	Low to Medium P; Optimum K
8-0-24	375	0	90	Optimum or Excessive P; Low K
11-52-0	272	141	0	Low P; Optimum K
18-46-0	167	77	0	Low P; Optimum K
10-34-0	300	102	0	Low P; Optimum K
15-60-0	200	120	0	Low P; Optimum K
11-37-0	272	101	0	Low P; Optimum K
21-0-0-24S	143	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes); Sulfur needed
32-0-0	94	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes)
46-0-0	65	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes)

Magnesium

The need for magnesium (Mg) fertilization is determined by a routine soil test (Table 6); Mg needs are often met by liming. Soil test results are reported as a fertility index value (FIV).

Table 6. Recommended application rates of soluble magnesium to wildlife food plots for turkey as a function of soil test magnesium.

	M3-Mg (FIV)			
	Low (0-25)	Medium (26-50)	Optimum (51-100)	Excessive (>100)
lb soluble Mg/ac	30-80	0-30	0	0
lb soluble Mg/ 1000 ft^2	0.75-1.75	0-0.75	0	0

1. Magnesium (Mg) is recommended when M3 soil test Mg (M3-Mg) is less than 40 FIV.
2. 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 6.

Sulfur

Wildlife food plots established on sandy, low organic matter soils may benefit from applications of supplemental sulfur (S). Consider choosing a fertilizer source like ammonium sulfate, which contains both N and S.

Wildlife Food Plots - Waterfowl

Crop Highlights

- Target pH: 6.2
- It is ILLEGAL to bait for waterfowl; food plots can not be manipulated to attract waterfowl. Warm-season plantings containing millets, corn, sorghum, or chufa may attract waterfowl.
- Soil pH may be very acidic on newly cleared forest land (< 5.0). If looking to establish food plots on newly cleared land, consider testing for pH and making recommended lime applications several months in advance of establishment.
- Fertility recommendations are based on establishment, not yield; therefore, nutrient recommendations are lower for these species than for grain or forage production
- Total nitrogen (N) application rates of 30 to 60 lb/ac are typically recommended, with higher rates used for stands containing less than 25% legumes.
- Choose low or no phosphorus (P) fertilizers for soils with optimum to excessive soil test P.
- Rates of common fertilizers needed to meet N needs are included in Table 5.

Management Notes

IMPORTANT: Waterfowl are federally protected. It is ILLEGAL to bait for waterfowl. It is, however, legal to harvest waterfowl over planted food plots or harvested fields. Please consult the US Fish and Wildlife Service and review state waterfowl hunting and baiting regulations prior to establishing food plots to attract waterfowl. Wildlife food plots for waterfowl can provide food to waterfowl in late summer and early fall when migration begins. Wildlife food plots for waterfowl are often flooded with 6 to 18 inches of water. Warm season plantings to attract waterfowl may contain millets, corn, sorghum, or chufa. Soybean is not a good food source for waterfowl. It may be beneficial to encourage establishment of native plants that prefer moist or wet soils. Table 1 includes a list of common species planted to attract waterfowl with suggested planting dates and potential companion plantings.

Yield Goal

Yield goals are not made for wildlife food plots to attract waterfowl. These nutrient recommendations are designed to encourage good establishment and adequate growth of the desired plant species to support the needs of local wildlife, while maintaining soil fertility, rather than for obtaining maximum economic yield.

Target pH: 6.2

Wildlife food plots often contain multiple species, which may have different target pH values (Table 1). As such, we recommend a target pH of 6.2, as most crops planted in wildlife food plots will produce acceptable growth at this soil pH.

Test soil pH several months in advance of plot establishment if planting winter feed plots on newly cleared forest land or land with limited history of fertility management; soil pH values are often very acidic (pH < 5.0) under these conditions. If lime is recommended, apply as far in advance of establishment as possible to allow maximum time for lime applications to neutralize soil pH.

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).

Table 1. Common crops, recommended planting dates, soil pH range, and suitable companion plantings for wildlife food plots to attract waterfowl.

Crop	pH range	Planting Date	Planting Mix Compatibility
Browntop millet	5.0 to 7.0	Mid-Apr to Mid-Jul	Grain sorghum, Japanese millet
Corn	5.8 to 7.0	Early Apr to Mid-May	Cowpea, soybean
Grain sorghum	5.6 to 7.0	Mid-Apr to Mid-Jun	Browntop millet, corn
Japanese millet	5.2 to 7.0	Early May to Early Aug	Performs best as a monoculture; can be planted with browntop millet
Proso millet	5.5 to 7.0	Mid-Apr to Mid-Jun	Performs best as a monoculture
Chufa	5.5 to 7.0	Mid-Apr to Early Jun	Performs best as a monoculture; can broadcast with Japanese millet

Recommended Liming Source

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 2.

Table 2. 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 a total nitrogen (N) rate of 30 to 60 lb/ac (0.75 to 1.25 lb /1000 ft^2) per growing season for wildlife food plots for waterfowl. The higher end of the range should be used for plantings that do not contain legumes.

1. Nitrogen application is not required for legumes or for seeding mixes containing legumes, however, up to 30 lb/ac (0.75 lb /1000 ft^2) of total N can be applied to encourage growth without having a negative impact on N fixation.
2. If planting a legume or seeding mix containing legumes, apply the appropriate inoculant and/or use inoculated seed.
3. For plantings that do not contain legumes, apply up to 30 lb/ac (0.75 lb/1000 ft^2) of total N at planting.

4. For late summer or fall planted cool season non-legume species, an additional N application of 30 lb/ac (0.75 lb/1000 ft^2) can be made at “green up” in spring. Spring N application is not recommended for cool season species if the stand contains at least 25% legumes. Applied N makes the grasses more competitive and can result in the loss of legumes.
5. For spring or summer planted warm season non-legume species, an additional N application of 30 lb/ac (0.75 to 1.25 lb/1000 ft^2) can be applied at approximately 30 days post emergence.

Phosphorus

Phosphorus (P) fertilization is based on the results of a routine soil test (Table 3). Soil test results are reported as a fertility index value (FIV).

Table 3. Recommended broadcast phosphorus application rates for establishment and productivity of wildlife food plots to attract waterfowl.

	M3-P (UD FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb P_2O_5/ac	70-120	30-70	0-30	0
lb P_2O_5/ 1000 ft^2	1.5-2.75	0.75-1.5	0-0.75	0

1. Within each Mehlich 3 (M3) soil test phosphorus (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 (Table 3).
2. If M3-P is “Low” or “Medium” (e.g., 50 FIV or less), broadcast and plow down the recommended rate of phosphate prior to seeding.
3. If M3-P is “Optimum” (e.g., 51 to 100 FIV), broadcast and incorporate phosphate prior to seeding or surface broadcast at or shortly after planting.
4. If M3-P is “Excessive” (e.g., greater than 100 FIV), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED. Choose fertilizers that do not contain P when establishing plots on soils with M3-P concentrations in the excessive range.

Potassium

The need for potassium (K) fertilization is determined by a routine soil test (Table 4). Soil test results are reported as a fertility index value (FIV).

Table 4. Recommended potassium for establishment and productivity of wildlife food plots to attract waterfowl.

	M3-K (FIV)			
	Low (0-25)	**Medium (26-50)**	**Optimum (51-100)**	**Excessive (>100)**
lb K_2O/ac	75-120	30-70	0-30	0
lb K_2O/ 1000 ft^2	1.75-2.75	0.75-1.5	0-0.75	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. Broadcast and incorporate potash at or prior to seeding.

Fertilizer Selection

It is common for land managers to use fertilizers that are already on-hand at the operation or easily available from the local farm supply store for wildlife food plots rather than requesting custom blends from a fertilizer dealer. Table 5 presents rates of common fertilizer materials and blends needed to supply N at a rate of 30 lb/ac (0.75 lb/1000 ft^2) to wildlife food plots and lists scenarios for which these materials are appropriate. Please note that the list of materials is not exhaustive. Avoid applying fertilizers with high P concentration to soils with optimum to excessive soil test P concentrations (>50 FIV) to prevent negative environmental effects.

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Fertilizer Source	Fertilizer Rate (lb/ac)	Amount of P_2O_5 applied (lb P_2O_5/ac)	Amount of K_2O applied (lb K_2O/ac)	Recommended Conditions for Use
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8-32-16	375	120	60	Low P; Low to Medium K
20-20-20	150	30	30	Low to Medium P; Optimum K
8-0-24	375	0	90	Optimum or Excessive P; Low K
11-52-0	272	141	0	Low P; Optimum K
18-46-0	167	77	0	Low P; Optimum K
10-34-0	300	102	0	Low P; Optimum K
15-60-0	200	120	0	Low P; Optimum K
11-37-0	272	101	0	Low P; Optimum K
21-0-0-24S	143	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes); Sulfur needed
32-0-0	94	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes)
46-0-0	65	0	0	Optimum or Excessive P; Optimum K; Spring N application (non-legumes)

Magnesium

The need for magnesium (Mg) fertilization is determined by a routine soil test (Table 6); Mg needs are often met by liming. Soil test results are reported as a fertility index value (FIV).

Table 6. Recommended application rates of soluble magnesium to wildlife food plots for waterfowl as a function of soil test magnesium.

	M3-Mg (FIV)			
	Low (0-25)	Medium (26-50)	Optimum (51-100)	Excessive (>100)
lb soluble Mg/ac	30-80	0-30	0	0
lb soluble Mg/ 1000 ft^2	0.75-1.75	0-0.75	0	0

1. Magnesium (Mg) is recommended when M3 soil test Mg (M3-Mg) is less than 40 FIV.
2. 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 6.

Sulfur

Wildlife food plots established on sandy, low organic matter soils may benefit from applications of supplemental sulfur (S). Consider choosing a fertilizer source like ammonium sulfate, which contains both N and S.