

# NUTRIENT RECOMMENDATIONS BY CROP

Source: University of Maryland Cooperative Extension, November 2009  
Regulatory Citation: COMAR 15.20.08.05

## AGRONOMIC CROP NUTRIENT RECOMMENDATIONS BASED ON SOIL TESTS AND YIELD GOALS

The Maryland Cooperative Extension Soil Testing Laboratory analyzed soil samples and generating plant nutrient application recommendations from 1954 until its closing in 2003. Over the years, fertility recommendations have been updated as improved laboratory methodologies have been developed, as cropping systems and crop genetics have improved, and as our understanding of the relationship between laboratory soil test results and crop yields has advanced.

### Philosophy of Soil Testing

There are several philosophies that may be embraced when developing crop nutrient recommendations. Some of these different approaches involve attempting to Abalance@ the levels of nutrients in the soil, while others aim at maintaining a constant soil fertility level. One unwavering component of Maryland's plant nutrient recommendation program has been a continuous commitment to the sufficiency level philosophy of soil testing. The sufficiency level concept is based on long-term calibrations of soil tests with field yield response data that reveal soil test levels above which no yield response to applied nutrients is observed. At soil test levels below the sufficiency level, field calibration data determine the quantity of applied nutrient that is necessary to obtain maximum yield under local growing conditions.

### Crop Yield Goals

Crop yield potential, or yield goal, also changed over the years as a reflection of the cumulative advances in crop production practices and management expertise. Practical, realistic yield goals are now included as a vital component in the development of agronomic crop nutrient

recommendations based on soil testing. Realistic crop yield goals will differ among farms, among fields within a farm, and with different levels of management of a given field. A yield goal should be a realistic target yield that is achievable given favorable growing conditions.

### Soil Testing Procedures

The Maryland Cooperative Extension Soil Testing Laboratory employed the Mehlich 1 (e.g. double-acid) procedure for determining the levels of soil test phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), manganese (Mn), copper (Cu), and zinc (Zn). A hot water soil extract is used for boron (B) determination and an acidic monocalcium phosphate solution is used to extract sulfate sulfur (SO<sub>4</sub>-S). All nitrogen recommendations are based on crop nitrogen requirements and yield goals.

### Soil Test Interpretive Categories

The Maryland Cooperative Extension Soil Testing Laboratory generated numerical values, or soil test results, that describe the relative availability of a given nutrient to the crop and the expected crop response to application of that nutrient to the soil. The soil test results were grouped into four interpretive categories, "Low," "Medium," "Optimum" and "Excessive."

**Low:** The nutrient concentration in the soil is inadequate for optimum growth of most crops and will very likely limit plant growth and yield. There is a high probability of a favorable economic response to additions of the nutrient.

**Medium:** The nutrient concentration in the soil may or may not be adequate for optimum growth of most crops. Plant growth and yield may be limited by the availability of this nutrient. There is

a low to moderate probability of a favorable economic response to additions of the nutrient.

**Optimum:** The nutrient concentration in the soil is adequate for optimum growth of most crops. There is a very low probability of a favorable economic response to additions of the nutrient.

**Excessive:** The nutrient concentration in the soil is more than adequate for optimum growth of most crops. Nutrient additions most likely will be unprofitable and may have undesirable effects on growth of some crops.

### **Fertility Index Values**

The actual numerical soil test values are products of laboratory procedures that determine the concentrations of extractable plant nutrients in a measured volume of soil (mg nutrient per dm<sup>3</sup> soil). Thus, soil-test values are merely arbitrary index numbers and not measures of the actual quantity of plant available nutrients present in a soil.

Historically, these numerical soil test values have been converted to units of “pounds per acre” of soil test nutrient or as a concentration of the nutrient in the soil, such as parts per million (ppm).

An alternative method for expressing the relative level of plant available nutrients measured by soil testing uses “fertility index values” (FIV). Fertility index values comprise a continuous

relative scale that is calculated from the concentration of extractable nutrients measured in the laboratory, where the highest concentration within the “optimum” range is set equal to a fertility index value of 100 (FIV = 100). Thus, the FIV ranges for the four soil test interpretive categories are: low = 0 to 25; medium = 26 to 50; optimum = 51 to 100; and excessive = >100.

The numerical values generated by different soil testing procedures employed by different soil testing laboratories can be easily converted to the FIV scale for relative comparison. For more information on converting soil test results from one laboratory to another, see “Converting among Soil Test Analyses Frequently Used in Maryland,” SFM-4, which is available from your Maryland Cooperative Extension county office, or online at <http://anmp.umd.edu>.

### **Agronomic Plant Nutrient Recommendations**

Agronomic plant nutrient recommendations based on soil tests and yield goals for the major agronomic crops grown in Maryland are presented in Tables 1 through 10. These recommendations are based on the cumulative knowledge derived from decades of soil fertility research. Where ranges of applied nutrients are indicated, the amount of plant nutrient required depends on the exact numerical soil test value within the soil test category.

**Table 1. Plant Nutrient Recommendations Based on Soil Tests and Yield Goals for Corn Grain and Sorghum Grain Production**

Crop	Nitrogen (N) pounds per acre	N if no P&K recommended	Recommended Nutrients Based on Soil Tests								Suggested methods of application
			Soil Phosphorus Index				Soil Potassium Index				
			Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive	
			P <sub>2</sub> O <sub>5</sub> pounds per acre				K <sub>2</sub> O pounds per acre				
<b>Field Corn for Grain</b>											
Yield goal 140 b/A											
<b>Conventional Tillage*</b>	<b>140</b>	<b>140</b>	<b>65-135</b>	<b>30-65</b>	<b>20-30</b>	<b>0</b>	<b>110-180</b>	<b>60-110</b>	<b>20-60</b>	<b>0</b>	<b>Total</b> Broadcast Banded with planter Sidedress
	30	30	35-95	0-25	0	0	80-140	30-70	0-30	0	
	30	0	30-40	30-40	20-30	0	30-40	30-40	20-30	0	
	80	110	0	0	0	0	0	0	0	0	
<b>No tillage*</b>											
<b>A. Alternating No-tillage/Conventional Tillage</b>											
	<b>140</b>	<b>140</b>	<b>65-135</b>	<b>30-65</b>	<b>20-30</b>	<b>0</b>	<b>110-180</b>	<b>60-110</b>	<b>20-60</b>	<b>0</b>	<b>Total</b> Broadcast Banded with planter Sidedress
	30	30	35-95	0-25	0	0	80-140	30-70	0-30	0	
	30	0	30-40	30-40	20-30	0	30-40	30-40	20-30	0	
	80	110	0	0	0	0	0	0	0	0	
<b>B. Continuous No-tillage**</b>											
	<b>140</b>	<b>140</b>	<b>75-180</b>	<b>30-70</b>	<b>20-30</b>	<b>0</b>	<b>110-180</b>	<b>50-110</b>	<b>20-50</b>	<b>0</b>	<b>Total</b> Broadcast Banded with planter Sidedress
	30	30	45-140	0-35	0	0	50-110	30-80	0-20	0	
	30	0	30-40	30-40	20-30	0	30-40	20-30	20-30	0	
	80	110	0	0	0	0	0	0	0	0	
<b>Grain sorghum</b>											
Yield goal 100 bu/A											
	<b>75</b>	<b>75</b>	<b>65-135</b>	<b>30-65</b>	<b>20-30</b>	<b>0</b>	<b>80-150</b>	<b>30-80</b>	<b>20-30</b>	<b>0</b>	<b>Total</b> Broadcast Banded with planter
	45	75	35-95	0-25	0	0	50-110	0-40	0	0	
	30	30	30-40	30-40	20-30	0	30-40	30-40	20-30	0	

**NOTES:**

\* Recommendations assume that soil samples were taken from the conventional plow layer depth (0-8 inches) of all fields, including conventional, conservation, reduced and rotational tillage, as well as no-tillage management systems.

\*\* For continuous no-tillage, a separate soil sample should be collected from the 0-2 inch depth to monitor surface soil acidity (pH only).

Where ranges of nutrients are indicated for phosphorus and potassium, precise amount of plant nutrient required depends upon the numerical soil test index value for that nutrient.

A starter fertilizer is normally suggested, even on those soils testing optimum or excessive in phosphate and/or potash and where little or no total P<sub>2</sub>O<sub>5</sub> & K<sub>2</sub>O is recommended by soil test. A starter is often beneficial in stimulating early plant growth, especially on cold wet soils. A complete starter fertilizer should supply 20 to 30 lbs/A of N, P<sub>2</sub>O<sub>5</sub>, and K<sub>2</sub>O.

**Field Corn For Grain**

Apply 1.0 lb N / bushel of expected grain yield up to 250 bu/A. No additional nitrogen is recommended for yield goals above 250 bu/A. Nitrogen recommendations assume split applications (sidedress or fertigation).

A pre-sidedress soil nitrogen test (PSNT) may be useful in determining whether additional nitrogen is needed for corn crops on fields that have received manure or other organic nutrient sources in the past. See University of Maryland Extension Publication SFM-2, for details.

For conventional-tillage or no-tillage corn:

- Where N solution (UAN) is the N source, N rate assumes injection or subsurface band placement.
- If UAN is surface broadcast at planting, increase rate by 15-20%.
- If sidedress UAN is dribbled or streamed on the soil surface, increase rate by 5-10%.
- If sidedress N source is granulated urea, increase rate by 25%.

Notes for Table 1 continue on page 4.

**Table 1. Notes, continued from page 3.**

**For corn yield goals above 140 bu / A, adjust P2O5 as follows:**

- If phosphorus soil test index is less than 51, increase P2O5 0.6 lb / A for each bushel of expected yield above 140 bushels.
- If phosphorus soil test index is between 51 and 100 lb / A, increase P2O5 0.3 lb / A for each bushel of expected yield above 140 bushels.
- If phosphorus soil test index is greater than 100, no adjustment is necessary.

**For corn yield goals above 140 bu / A, adjust K2O as follows:**

- If potassium soil test index is less than 51, increase K2O 0.8 lb / A for each bushel of expected yield above 140 bu / A.
- If potassium soil test index is between 51 and 100 lb / A, increase K2O 0.4 lb / A for each bushel of expected yield above 140 bu / A.
- If potassium soil test index is greater than 100, no adjustment is necessary.

**Grain Sorghum**

For grain sorghum, apply 0.75 lb N / bushel of expected yield up to 125 bu / A. No additional nitrogen is recommended for yields above 125 bu / A.

For no-tillage grain sorghum:

Where N solution (UAN) is the N source, N rate assumes injection or subsurface band placement.

- If UAN is surface broadcast at planting, increase rate by 15-20%.
- If sidedress UAN is dribbled or streamed on the soil surface, increase rate by 5-10%.
- If sidedress N source is granulated urea, increase rate by 25%.

**For grain sorghum yield goals above 100 bu / A, adjust P2O5 as follows:**

- If phosphorus soil test index is less than 51, increase P2O5 by 0.4 lb / A for every bushel of expected yield over 100 bu/A.
- If phosphorus soil test index is between 51 and 100, increase P2O5 by 0.2 lb / A for every bushel of expected yield over 100 bu/A.
- If phosphorus soil test index is greater than 100, no adjustment is necessary.

**For grain sorghum yield goals above 100 bu / A, adjust K2O as follows:**

- If potassium soil test index is less than 51, increase K2O by 0.6 lb / A for every bushel of expected yield over 100 bu/A.
- If potassium soil test index is between 51 and 100, increase K2O by 0.3 lb / A for every bushel of expected yield over 100 bu/A.
- If potassium soil test index is greater than 100, no adjustment is necessary.

**Table 2. Plant Nutrient Recommendations Based on Soil Tests and Yield Goals for Corn Silage Production**

Crop	Nitrogen (N) pounds per acre	N if no P&K recommended	Recommended Nutrients Based on Soil Tests								Suggested methods of application	
			Soil Phosphorus Level				Soil Potassium Level					
			Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive		
			P <sub>2</sub> O <sub>5</sub> pounds per acre				K <sub>2</sub> O pounds per acre					
<b>Corn Silage</b>												
Yield goal 20 tons/A	<b>120</b>	<b>120</b>	<b>55-125</b>	<b>35-55</b>	<b>20-35</b>	<b>0</b>	<b>150-250</b>	<b>80-150</b>	<b>20-80</b>	<b>0</b>	<b>Total</b>	
<b>Conventional tillage *</b>	30	30	30-85	0	0	0	120-210	60-120	0-50	0	Broadcast	
	20	0	25-40	35-55	20-35	0	30-40	20-30	20-30	0	Banded with planter	
	70	90	0	0	0	0	0	0	0	0	Sidedress	
<b>No-tillage **</b>												
<b>A. Alternating no-tillage with conventional tillage</b>	<b>120</b>	<b>120</b>	<b>55-125</b>	<b>35-55</b>	<b>20-35</b>	<b>0</b>	<b>150-250</b>	<b>80-150</b>	<b>20-80</b>	<b>0</b>	<b>Total</b>	
	30	30	30-85	0	0	0	120-210	60-120	0-50	0	Broadcast	
	20	0	25-40	35-55	20-35	0	30-40	20-30	20-30	0	Banded with planter	
	70	90	0	0	0	0	0	0	0	0	Sidedress	
<b>B. Continuous no-tillage</b>	<b>120</b>	<b>120</b>	<b>95-165</b>	<b>35-95</b>	<b>20-35</b>	<b>0</b>	<b>150-250</b>	<b>80-150</b>	<b>20-80</b>	<b>0</b>	<b>Total</b>	
	30	30	55-125	0-55	0	0	120-210	60-120	0-50	0	Broadcast	
	20	0	40	35-40	20-35	0	30-40	20-30	20-30	0	Banded with planter	
	70	90	0	0	0	0	0	0	0	0	Sidedress	

**NOTES:**

\* Recommendations assume that soil samples were taken from the conventional plow layer depth (0-8 inches) of all fields, including conventional, conservation, reduced and rotational tillage, as well as no-tillage management systems.

\*\* For continuous no-tillage, a separate soil samples should be collected from the 0-2 inch depth to monitor surface soil acidity (pH only).

Where ranges of nutrients are indicated for phosphorus and potassium, precise amount of plant nutrient required depends upon the numerical soil test index value for that nutrient.

A starter fertilizer is normally suggested, even on those soils testing optimum or excessive in phosphate and/or potash and where little or no total P<sub>2</sub>O<sub>5</sub> & K<sub>2</sub>O is recommended by soil test. A starter is often beneficial in stimulating early plant growth, especially on cold wet soils. A complete starter fertilizer should supply 20 to 30 lbs/A of N, P<sub>2</sub>O<sub>5</sub>, and K<sub>2</sub>O.

Nitrogen recommendations assume split applications (sidedress or fertigation).

**No-tillage corn silage:**

Where N solution (UAN) is the N source, N rate assumes injection.

- If sidedress UAN is broadcast after planting using drop nozzles, increase rate by 15%.
- If sidedress UAN is dribbled after planting, increase rate by 5-10%.
- If sidedress N source is granulated urea, increase rate by 25%.

**For corn silage yields above 20 tons / A, adjust N as follows:**

- Increase nitrogen rate by 7 lb / ton for each ton of expected yield between 20 and 40 tons / A.
- For expected corn silage yields greater than 40 tons / A, no additional nitrogen is recommended.

**For corn silage yields above 20 tons / A, adjust P<sub>2</sub>O<sub>5</sub> as follows:**

- If phosphorus soil test index is less than 51, increase P<sub>2</sub>O<sub>5</sub> 5 lbs / A for each additional ton of expected yield over 20 tons / A.
- If phosphorus soil test index is between 51 and 100, increase P<sub>2</sub>O<sub>5</sub> 2.5 lbs / A for each additional ton of expected yield over 20 tons / A.
- If phosphorus soil test index is greater than 100, no adjustment is necessary.

**For corn silage yields above 20 tons / A, adjust K<sub>2</sub>O as follows:**

- If potassium soil test index is less than 100, increase K<sub>2</sub>O 7 lbs / A for each additional ton of expected yield over 20 tons / A.
- If potassium soil test index is greater than 100, no adjustment is necessary.

**Table 3. Plant Nutrient Recommendations Based on Soil Tests and Yield Goals for Small Grain Production**

Crop	Nitrogen (N) pounds per acre	Recommended Nutrients Based on Soil Tests								Suggested methods of application
		Soil Phosphorus Level				Soil Potassium Level				
		Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive	
		P <sub>2</sub> O <sub>5</sub> pounds per acre				K <sub>2</sub> O pounds per acre				
<b>Wheat, Barley, Rye, Oats *</b>										
<b>A. Lodging not expected</b>	<b>70-100</b>	<b>60-100</b>	<b>40-60</b>	<b>20-40</b>	<b>0</b>	<b>60-100</b>	<b>40-60</b>	<b>20-40</b>	<b>0</b>	<b>Total</b> Broadcast and disk in or drill with seed Topdress
20-40	60-100	40-60	20-40	0	60-100	40-60	20-40	0		
50-60	0	0	0	0	0	0	0	0		
<b>B. Lodging expected</b>	<b>50-80</b>	<b>60-100</b>	<b>40-60</b>	<b>20-40</b>	<b>0</b>	<b>60-100</b>	<b>40-60</b>	<b>20-40</b>	<b>0</b>	<b>Total</b> Broadcast and disk in or drill with seed Topdress
0-20	60-100	40-60	20-40	0	60-100	40-60	20-40	0		
50-60	0	0	0	0	0	0	0	0		
<b>Spring Oats</b> Yield goal 60-65 bu / A	<b>30-60</b>	<b>60-100</b>	<b>40-60</b>	<b>20-40</b>	<b>0</b>	<b>60-100</b>	<b>40-60</b>	<b>20-40</b>	<b>0</b>	<b>Broadcast and disk in or drill with seed</b>
<b>Small Grain - Double Crop Soybeans (Double-crop recommendation)</b>										
<b>A. Lodging not expected</b>	<b>70-100</b>	<b>140-265</b>	<b>85-140</b>	<b>20-85</b>	<b>0</b>	<b>145-255</b>	<b>75-145</b>	<b>20-75</b>	<b>0</b>	<b>Total</b> Broadcast or drill in fall Topdress
20-40	70-165	45-100	20-85	0	75-155	35-105	20-75	0		
50-60	70-100	40	0	0	70-100	40	0	0		
<b>B. Lodging expected</b>	<b>50-80</b>	<b>140-265</b>	<b>85-140</b>	<b>20-85</b>	<b>0</b>	<b>145-255</b>	<b>75-145</b>	<b>20-75</b>	<b>0</b>	<b>Total</b> Broadcast or drill in fall Topdress
0-20	70-165	45-100	20-85	0	75-155	35-105	20-75	0		
50-60	70-100	40	0	0	70-100	40	0	0		
<b>Small Grain – Legume Interseeded</b>	<b>20-40</b>	<b>75-125</b>	<b>50-75</b>	<b>20-50</b>	<b>0</b>	<b>75-120</b>	<b>45-75</b>	<b>20-45</b>	<b>0</b>	<b>Total</b> Broadcast or drill in fall Topdress
0-20	75-125	50-75	20-50	0	75-120	45-75	20-45	0		
0-20	0	0	0	0	0	0	0	0		
<b>ICM Wheat (Intensive Crop Management)</b> Yield goal 100 bu / A	<b>100-120</b>	<b>100-140</b>	<b>80-100</b>	<b>20-80</b>	<b>0</b>	<b>100-140</b>	<b>80-100</b>	<b>20-80</b>	<b>0</b>	<b>Total</b> Broadcast at planting Topdress **
20-40	100-140	80-100	20-80	0	100-140	80-100	20-80	0		
80-100**	0	0	0	0	0	0	0	0		
<b>ICM Wheat ** - Double Crop Soybeans (Intensive Crop Management)</b> Yield goal 100 bu / A	<b>100-120</b>	<b>140-265</b>	<b>85-140</b>	<b>20-85</b>	<b>0</b>	<b>145-255</b>	<b>85-145</b>	<b>20-85</b>	<b>0</b>	<b>Total</b> Broadcast at planting Topdress **
20-40	70-165	45-100	20-85	0	75-155	35-95	20-85	0		
80-100**	70-100	40	0	0	70-100	50	0	0		

See Table 3 Notes on Page 7

**TABLE 3. NOTES:**

Where ranges of nutrients are indicated for phosphorus and potassium, the precise amount of plant nutrient required depends upon the numerical soil test index value for that nutrient.

\* Use these recommendations for wheat yield goals of 60-70 bu / A, barley yield goals of 80-100 bu / A, winter oat yield goals of 70-80 bu / A, and rye yield goals of 30-35 bu / A. For higher yield goals, use ICM Wheat management practices.

\*\* Split topdress N application. Apply half at green-up and half at Feekes growth stage 5-6.

**For ICM wheat (Intensive Crop Management Wheat):**

Total nitrogen application rate is 1.0 lb N / bushel of expected wheat yield plus 20 lb N / acre when yield goal is between 80 and 120 bushels.

**For all small grains production systems (conventional-tillage or no-tillage):**

- If topdress N solution (UAN) is surface broadcast, increase rate by 15-20%.
- If topdress UAN is dribbled or streamed on the soil surface, increase rate by 5-10%.
- If topdress N source is granulated urea, increase rate by 25%.

**For ICM wheat yield goals above 100 bu / A, adjust P2O5 as follows:**

- If phosphorus soil test index is less than 51, increase P2O5 by 1 lb / A for each bushel of expected yield above 100 bu / A.
- If phosphorus soil test index is between 51 and 100, increase P2O5 by 0.5 lb / A for each bushel of expected yield above 100 bu / A.
- If phosphorus soil test index is greater than 100, no adjustment is necessary.

**For ICM wheat yield goals above 100 bu / A, adjust K2O as follows:**

- If potassium soil test index is less than 51, increase K2O by 1 lb K2O / A for each bushel of expected yield above 100 bu / A.
- If potassium soil test index is between 51 and 100, increase K2O by 0.5 lb K2O / A for each bushel of expected yield above 100 bu / A.
- If potassium soil test index is greater than 100, no adjustment is necessary.

**For all small grain - double-crop soybean rotation with double-crop soybean yield goal above 40 bu / A, adjust P2O5 as follows:**

- If phosphorus soil test index is less than 51, increase P2O5 by 1.5 lb / A for every bushel of expected double-crop soybean yield over 40 bu / A.
- If phosphorus soil test index is between 51 and 100, increase P2O5 by 0.75 lb / A for every bushel of expected double-crop soybean yield over 40 bu / A.
- If phosphorus soil test index is greater than 100, no adjustment is necessary.

**For all small grain - double-crop soybean rotation with double-crop soybean yield goal above 40 bu / A, adjust K2O as follows:**

- If potassium soil test index is less than 51, add 3 lb / A K2O for every bushel of expected double-crop soybean yield over 40 bu / A.
- If potassium soil test index is between 51 and 100, add 1.5 lb / A K2O for every bushel of expected double-crop soybean yield over 40 bu / A.
- If potassium soil test index is greater than 100, no adjustment is necessary.

**Table 4. Plant Nutrient Recommendations Based on Soil Tests and Yield Goals for Soybean and Other Oilseed Production**

Crop	Nitrogen (N) pounds per acre	Recommended Nutrients Based on Soil Tests								Suggested methods of application
		Soil Phosphorus Level				Soil Potassium Level				
		Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive	
		P <sub>2</sub> O <sub>5</sub> pounds per acre				K <sub>2</sub> O pounds per acre				
<b>Soybean (full season)</b> (40 bu / A yield goal)	<b>0*</b>	<b>80-120</b>	<b>45-80</b>	<b>20-45</b>	<b>0</b>	<b>80-125</b>	<b>40-80</b>	<b>20-40</b>	<b>0</b>	<b>Broadcast or banded at planting</b>
<b>Canola</b>										
<b>A. Lodging not expected</b>	<b>120-150</b> 20-40 100-110	<b>60-80</b> 60-80 0	<b>40-60</b> 40-60 0	<b>20-40</b> 20-40 0	<b>0</b> 0 0	<b>60-80</b> 60-80 0	<b>40-60</b> 40-60 0	<b>20-40</b> 20-40 0	<b>0</b> 0 0	<b>Total</b> Broadcast Topdress
<b>B. Lodging expected</b>	<b>70-100</b> 20-40 50-60	<b>60-80</b> 60-80 0	<b>40-60</b> 40-60 0	<b>20-40</b> 20-40 0	<b>0</b> 0 0	<b>60-80</b> 60-80 0	<b>40-60</b> 40-60 0	<b>20-40</b> 20-40 0	<b>0</b> 0 0	<b>Total</b> Broadcast Topdress
<b>Sunflower</b> (0.5 ton seed / A yield goal)	<b>50</b>	<b>30</b>	<b>20</b>	<b>0</b>	<b>0</b>	<b>30</b>	<b>20</b>	<b>0</b>	<b>0</b>	<b>Broadcast at planting</b>

**NOTES:**

\* Nitrogen application is not recommended for soybean production, however, use of commercially available fertilizer formulations may result in application of up to 50 lb N/acre when fertilizer formulation and application rate is determined by crop P2O5, K2O, S, or other nutrient needs.

Organic waste nitrogen application to full-season soybean is not recommended because it is an agronomically inefficient use of applied nutrients. Organic wastes should only be applied to small grain - double-crop soybean rotations at rates and timings to supply the recommended nitrogen rate to the small-grain crop.

**For full-season soybean yield goals above 40 bu / A, adjust P2O5 as follows:**

- If phosphorus soil test index is less than 51, increase P2O5 by 1.5 lb/acre for each additional bushel of expected yield over 40 bu / A.
- If phosphorus soil test index is between 51 and 100, increase P2O5 by 0.75 lb / A for each additional bushel of expected yield over 40 bu / A.
- If phosphorus soil test index is greater than 100, no adjustment is necessary.

**For full-season soybean yield goals above 40 bu / A, adjust K2O as follows:**

- If potassium soil test index is less than 51, increase K2O by 3 lb / A for each bushel of expected yield over 40 bu / A.
- If potassium soil test index is between 51 and 100, increase K2O by 1.5 lb / A for each bushel of expected yield over 40 bu / A.
- If potassium soil test index is greater than 100, no adjustment is necessary.

**For all small grain - double-crop soybean rotation with double-crop soybean yield goal above 40 bu / A, adjust P2O5 as follows:**

- If phosphorus soil test index is less than 51, increase P2O5 by 1.5 lb / A for every bushel of expected double-crop soybean yield over 40 bu / A.
- If phosphorus soil test index is between 51 and 100, increase P2O5 by 0.75 lb / A for every bushel of expected double-crop soybean yield over 40 bu / A.
- If phosphorus soil test index is greater than 100, no adjustment is necessary.

**For all small grain - double-crop soybean rotation with double-crop soybean yield goal above 40 bu / A, adjust K2O as follows:**

- If potassium soil test index is less than 51, add 3 lb / A K2O for every bushel of expected double-crop soybean yield over 40 bu / A.
- If potassium soil test index is between 51 and 100, add 1.5 lb / A K2O for every bushel of expected double-crop soybean yield over 40 bu / A.
- If potassium soil test index is greater than 100, no adjustment is necessary.

**For sunflower seed yield goals between 0.5 and 1.5 tons / A, adjust as follows:**

- Add 25 lb N / A for each 0.25 tons / A of expected yield above 0.5 tons / A.
- Add 5 lb P2O5 / A for each 0.25 tons / A of expected yield above 0.5 tons / A.
- Add 10 lb K2O / A for each 0.25 tons / A of expected yield above 0.5 tons / A.
- For expected yields greater than 1.5 tons / A, no additional nutrients are necessary.



**Table 5. Plant Nutrient Recommendations Based on Soil Tests and Yield Goals for Establishment of Hay, Pasture, and Silage Crops.**

Crop	Nitrogen (N) pounds per acre	Recommended Nutrients Based on Soil Tests								Suggested methods of application
		Soil phosphorus Index				Soil potassium Index				
		Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive	
		P <sub>2</sub> O <sub>5</sub> pounds per acre				K <sub>2</sub> O pounds per acre				
<b>NEWLY SEEDED</b>										
<b>Alfalfa, Alfalfa-Grass Mix</b>										
<b>A. Spring seeded</b>	15-30 *	110-205	70-110	20-70	0	185-295	115-185	20-115	0	Broadcast and disk in
<b>B. Fall seeded</b>	15-30 *	155-280	100-155	60-100	0	205-300	140-205	80-140	0	Total Broadcast and disk in
	15-30 *	60	60	60	0	60	60	60	0	Topdress following spring
	0	95-220	40-95	20-40	0	145-240	80-145	20-80	0	
<b>Clover, Clover-Grass Mix, Hairy Vetch, Birdsfoot Trefoil</b>	15-30	60-100	40-60	20-40	0	60-100	40-60	20-40	0	Broadcast and disk in
<b>Lespedeza, Lespedeza-Grass Mix</b>	15-20	35-60	20-35	20	0	40-65	25-40	25	0	Broadcast and disk in
<b>Cool Season Perennial Grasses**</b>										
<b>A. Spring seeded mid-March to mid-April</b>	40-60	60-100	40-60	20-40	0	60-100	40-60	20-40	0	Broadcast or disk in
<b>B. Late summer seeded Aug 10-Sep 10, except Garret Co. Aug 1-Sep 1</b>	15-30	60-100	40-60	20-40	0	60-100	40-60	20-40	0	Broadcast or disk in
<b>Timothy</b>										
<b>A. Spring seeded</b>	40-60	60-100	40-60	20-40	0	60-100	40-60	20-40	0	Broadcast or disk in
<b>B. Late summer seeded</b>	15-30	60-100	40-60	20-40	0	60-100	40-60	20-40	0	Broadcast or disk in
<b>Warm Season Perennial Grasses ***</b>	0	40-60	20-40	0	0	60-90	20-60	0	0	Broadcast and disk in
<b>Annual Ryegrass and/or Cereal Grain For Grazing</b>										
<b>A. Seeded September</b>	50	60-150	20-60	20	0	110-200	50-110	20-50	0	Broadcast and disk in
<b>B. Seeded October-November</b>	15-30	60-150	20-60	20	0	110-200	50-110	20-50	0	Broadcast and disk in
<b>Cereal Grain For Silage</b>	75-100	50-100	25-50	25	0	50-100	25-50	25	0	Total Broadcast before seeding
	15-20	50-100	25-50	25	0	50-100	25-50	25	0	Topdress at greenup
	60-80	0	0	0	0	0	0	0	0	
<b>Buckwheat</b>	15-20	30-50	20-30	20	0	30-50	20-30	20	0	Broadcast and disk in

**NOTES:**

Where ranges of nutrients are indicated for phosphorus and potassium, the precise amount of plant nutrient required depends upon the numerical soil test index value for that nutrient. Nutrient recommendations for most forages were developed for hay production systems. Where no grazing designation for a crop is given, pasture-based producers may modify the timing and rate of nutrient applications as long 1) the total annual application rate does not exceed the total annual recommendation for each nutrient, and 2) nutrient application timing complies with "Nutrient Application Guidelines," Section I-D, of this manual.

\* Organic waste nitrogen application for alfalfa establishment in excess of 30 lb / A of plant available nitrogen is not recommended due to inhibition of nodulation.

\*\* Cool Season Perennial Grasses: orchardgrass, timothy, bromegrass, tall fescue, reed canarygrass, annual ryegrass, perennial ryegrass.

\*\*\* Warm Season Perennial Grasses: bermudagrass, switchgrass, eastern gamagrass, indiagrass, weeping lovegrass, buffalograss, caucasian bluestem, big bluestem, little bluestem, and beachgrass. If stand is well established (2-3 plants per foot of row) by mid to late August, apply 40 lb N/A in establishment year.

**Table 6. Plant Nutrient Recommendations Based on Soil Tests and Yield Goals for Maintenance of Hay, Pasture, and Silage Crops**

Crop	Nitrogen (N) pounds per acre	Recommended Nutrients Based on Soil Tests								Suggested methods of application
		Soil Phosphorus Level				Soil Potassium Level				
		Low	Mediu m	Optim um	Exces sive	Low	Mediu m	Optimu m	Exces sive	
		P <sub>2</sub> O <sub>5</sub> pounds per acre				K <sub>2</sub> O pounds per acre				
<b>MAINTENANCE</b>										
<b>Alfalfa &amp; Alfalfa-Grass Mix</b>	0*	60-100	30-60	20-30	0	190-275	140-190	90-140	90	Topdress annually
<b>Clover &amp; clover-Grass Mix</b> (more than 25% clover)										
<b>A. Yield goal 4 tons/A</b>	0*	60-100	30-60	20-30	0	190-275	140-190	90-140	90	Topdress annually
<b>B. Yield goal 8 tons/A</b>	0*	100-120	50-100	20-50	0	470-555	420-470	370-420	370	Topdress annually
<b>Birdsfoot Trefoil</b> (more than 25% trefoil)	0*	60-100	30-60	23-30	0	125-195	75-125	40-75	40	Topdress annually
<b>Bluegrass-White Clover Mix</b> (more than 25% white clover)	20-30***	50-100	25-50	25	0	50-100	25-50	25	0	Topdress annually
<b>Bluegrass Pasture</b> (little or no clover)	100-120	50-100	25-50	25	0	50-100	25-50	25	0	<b>Total</b>
	50-60***	50-100	25-50	25	0	50-100	25-50	25	0	Topdress at greenup
	25-30***	0	0	0	0	0	0	0	0	Topdress mid-late May
	25-30***	0	0	0	0	0	0	0	0	Topdress in late summer
<b>Orchardgrass And Reed Canary Grass</b> (less than 25% legumes) Yield goal: 4 tons/A	160-200	60-150	20-60	20	0	110-200	50-110	20-50	0	<b>Total</b>
	80-100***	30-80	20-60	20	0	60-100	50-60	20-50	0	Topdress at greenup
	40-50***	0	0	0	0	0	0	0	0	Topdress after first harvest
	40-50***	30-70	0	0	0	50-100	0-50	0	0	Topdress in late summer
<b>Fescue</b> (less than 25% legumes) Yield goal: 5 tons / A	220-250	60-150	20-60	20	0	110-200	50-110	20-50	0	<b>Total</b>
	100-125***	30-80	20-60	20	0	60-100	50-60	20-50	0	Topdress at greenup
	40-50***	0	0	0	0	0	0	0	0	Topdress after first harvest
	60-75***	30-70	0	0	0	50-100	0-50	0	0	Topdress in late summer
<b>Timothy, Smooth Bromegrass, Perennial Ryegrass</b> Yield goal 3 tons / A	140-180	60-150	20-60	20	0	110-200	50-110	20-50	0	<b>Total</b>
	60-80***	30-80	20-60	20	0	60-100	50-60	20-50	0	Topdress at greenup
	40-50***	0	0	0	0	0	0	0	0	Topdress after first harvest
	40-50***	30-70	0	0	0	50-100	0-50	0	0	Topdress in late summer
<b>ANNUAL RYEGRASS and/or CEREAL GRAIN FOR GRAZING</b> (established previous fall)	150	0	0	0	0	0	0	0	0	<b>Total</b>
	50***	0	0	0	0	0	0	0	0	Topdress at greenup
	50***	0	0	0	0	0	0	0	0	Topdress late April - early May
	50***	0	0	0	0	0	0	0	0	Topdress late May - early June

**Table 6. (cont'd) Plant Nutrient Recommendations Based on Soil Tests and Yield Goals for Maintenance of Hay, Pasture, and Silage Crops**

Crop	Nitrogen (N) pounds per acre	Recommended Nutrients Based on Soil Tests								Suggested methods of application
		Soil Phosphorus Level				Soil Potassium Level				
		Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive	
		P <sub>2</sub> O <sub>5</sub> pounds per acre				K <sub>2</sub> O pounds per acre				
<b>MAINTENANCE</b>										
<b>Warm Season Perennial Grasses**</b> (except Eastern Gamagrass & improved Bermudagrass) Yield goal 4 tons / A	120	60-90	20-60	0	0	90-120	30-90	20-30	90-120	<b>Total</b> Topdress at greenup Topdress after first cutting or grazing
	80***	60-90	20-60	0	0	90-120	30-90	20-30	90-120	
	40***	0	0	0	0	0	0	0	0	
<b>Eastern Gamagrass and Improved Bermudagrasses</b> Yield goal 5 tons / A	200-240	60-90	20-60	0	0	90-120	30-90	20-30	0	<b>Total</b> Topdress at greenup Topdress after first cutting or grazing Topdress after second cutting or grazing Topdress after third cutting or grazing
	50-60***	60-90	20-60	0	0	90-120	30-90	20-30	0	
	50-60***	0	0	0	0	0	0	0	0	
	50-60***	0	0	0	0	0	0	0	0	
	50-60***	0	0	0	0	0	0	0	0	

**NOTES:**

Where ranges of nutrients are indicated for phosphorus and potassium, precise amount of plant nutrient required depends upon the numerical soil test index value for that nutrient. Nutrient recommendations for most forages were developed for hay production systems. Where no grazing designation for a crop is given, pastured-based producers may modify the timing and rate of nutrient applications as long 1) the total annual application rate does not exceed the total annual recommendation for each nutrient, and 2) nutrient application timing complies with "Nutrient Application Guidelines," Section I-D, of this manual.

\*Nitrogen application is not recommended for alfalfa, alfalfa-grass, clover, clover-grass, or birdsfoot trefoil production, however, use of commercially available fertilizer formulations may result in application of up to 50 lb N / acre when fertilizer formulation and application rate is determined by crop P2O5, K2O, S, or other nutrient needs.

Organic waste nitrogen application for maintenance of alfalfa, alfalfa-grass, clover, clover-grass, or birdsfoot trefoil is not recommended because it is an agronomically inefficient use of applied nutrients. Organic waste nitrogen may be applied to alfalfa, alfalfa-grass, clover, clover-grass, or birdsfoot trefoil stands as necessary for organic waste disposal when nutrient efficient alternatives for organic waste disposal are not available, at rates up to 140 lb/A plant available N for 4 tons/A yield goal. For yield goals above 4 tons/A, increase organic waste plant available N rate 35 lb/A for each ton of expected yield above 4 tons/A. Apply half of total rate in early spring (March) and half after first cutting.

**For alfalfa & alfalfa-grass mix yield goals above 4 tons/A, adjust P2O5 as follows:**

1. If phosphorus soil test index is less than 100, Increase P2O5 by 5 lb / A for each ton of expected yield above 4 tons/A.
2. If phosphorus soil test index is greater than 100, no adjustment is necessary.

**For alfalfa & alfalfa-grass mix yield goals above 4 tons/A:** increase K2O by 70 lb/A for each ton of expected yield above 4 tons/A, regardless of potassium soil test index.

**For clover and clover-grass mixture yield goals above 4 tons / A, adjust P2O5 as follows:**

1. If phosphorus soil test index is less than 100, increase P2O5 by 5 lbs / A for each ton of expected yield above 4 tons/A.
2. If phosphorus soil test index is greater than 100, no adjustment is necessary.

**For clover and clover-grass mixture yield goals above 4 tons/A:** increase K2O by 70 lbs/A for each ton of expected yield above 4 tons / A regardless of potassium soil test index.

**For orchardgrass and reed canarygrass yield goals above 4 tons/A:** increase N application by a total of 50 lb/A for each ton of additional expected yield above 4 tons/A.

**For perennial ryegrass, smooth bromegrass and timothy yield goals above 3 tons/A:** increase N application by a total of 45 lb/A for each ton of additional expected yield above 3 tons/A.

**For tall fescue yield goals above 5 tons/A:** increase N application by a total of 50 lb/A for each ton of additional expected yield above 5 tons/A.

\*\* **For warm-season perennial grasses** including switchgrass, indiagrass, weeping lovegrass, buffalograss, caucasian bluestem, big bluestem, and little bluestem, increase N application by a total of 30 lb/A for each ton of expected hay yield above 4 tons/A.

**For eastern gamagrass and improved bermudagrasses** (high yielding warm-season grasses) yield goals above 5 tons/A hay yield, increase N application by a total of 50 lbs/A for each ton of additional expected yield above 5 tons/A.

When topdressing N, adjust rate as follows:

1. If UAN is surface broadcast, increase rate by 15-20 %;
2. If UAN is dribbled or streamed, increase rate by 5-10 %;
3. If granulated urea is broadcast, increase rate by 25%.

**Table 7. Plant Nutrient Recommendations Based on Soil Tests and Yield Goals for Sudangrass, Millet, and Forage Type Sorghum and Soybean**

Crop	Nitrogen (N) pounds per acre	Recommended Nutrients Based on Soil Tests								Suggested methods of application
		Soil Phosphorus Level				Soil Potassium Level				
		Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive	
		P <sub>2</sub> O <sub>5</sub> pounds per acre				K <sub>2</sub> O pounds per acre				
<b>Sudangrass, Millet, and Forage Type Sorghums</b>	<b>120-150*</b>	<b>45-80</b>	<b>20-45</b>	<b>0</b>	<b>80-160</b>	<b>80-160</b>	<b>40-80</b>	<b>20-40</b>	<b>0</b>	<b>Total</b> Broadcast and disked in Topdress after first harvest
(Yield goal 10-15 Ton/A)	70-100	45-80	20-45	0	80-160	80-160	40-80	20-40	0	
	50	0	0	0	0	0	0	0	0	
<b>Forage-Type Soybean</b> (Yield goal 10-15 ton / A)	<b>20</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>Broadcast and disked in</b>
<b>Summer Cover Crop &amp; Wildlife Feed Pasture</b>										
<b>A. Sudangrass and forage type sorghums</b>	<b>50</b>	<b>70-130</b>	<b>40-70</b>	<b>20-40</b>	<b>0</b>	<b>70-130</b>	<b>40-70</b>	<b>20-40</b>	<b>0</b>	<b>Broadcast before seeding</b>
<b>B. Forage type soybean and millet</b>	<b>25</b>	<b>70-130</b>	<b>40-70</b>	<b>20-40</b>	<b>0</b>	<b>70-130</b>	<b>40-70</b>	<b>20-40</b>	<b>0</b>	<b>Broadcast before seeding</b>

**NOTES:**

Where ranges of plant nutrients are indicated for phosphorus and potassium, the precise amount of plant nutrient required depends upon the numerical soil test index value for that nutrient.

\* **Sudangrass, millet, forage-type sorghum:** If a third harvest is planned, apply an additional 30-50 pounds of N after the second cutting.

**Table 8. Plant Nutrient Recommendations Based on Soil Tests and Yield Goals for Maryland-Type Tobacco**

Crop	Nitrogen (N) pounds per acre	Recommended Nutrients Based on Soil Tests								Suggested methods of application
		Soil Phosphorus Level				Soil Potassium Level				
		Low	Mediu m	Optim um	Excess ive	Low	Mediu m	Optimu m	Exces sive	
		P <sub>2</sub> O <sub>5</sub> pounds per acre				K <sub>2</sub> O pounds per acre				
Maryland-Type Tobacco	60-90	120	80	40	40	200	160	120	120	Total
	40	120	80	40	40	130	100	80	80	Broadcast
	20-50	0	0	0	0	70	60	40	40	Sidedress

**NOTES:**

Where ranges of nutrients are indicated for phosphorus and potassium, the precise amount of plant nutrient required depends upon the numerical soil test index value for that nutrient.

Potassium fertilizer should be potassium sulfate (K<sub>2</sub>SO<sub>4</sub>). Avoid fertilizers containing chloride (Cl).

**Table 9. Plant Nutrient Recommendations Based on Soil Tests for Cotton**

Crop	Nitrogen (N) pounds per acre	Recommended Nutrients Based on Soil Tests								Suggested methods of application
		Soil Phosphorus Level				Soil Potassium Level				
		Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive	
		P <sub>2</sub> O <sub>5</sub> pounds per acre				K <sub>2</sub> O pounds per acre				
Cotton	50-75	80-120	40-80	30-40	0	80-120	40-80	30-40	0	Total Broadcast pre-plant Banded with planter Sidedress
	0	50-80	10-40	0	0	50-80	10-40	0	0	
	20-25	30-40	30-40	30-40	0	30-40	30-40	30-40	0	
	30-50	0	0	0	0	0	0	0	0	

**NOTES:**

Where ranges of nutrients are indicated for phosphorus and potassium, the precise amount of plant nutrient required depends upon the numerical soil test index value for that nutrient.

**Table 10. Plant Micronutrient Recommendations Based on Soil Tests**

<b>Micronutrient</b>	<b>Crop</b>	<b>Soil Test Level (ppm in soil)</b>	<b>Recommended Nutrients Based on Soil Tests</b>
<b>Boron (B)</b>	<b>Field corn, cotton</b>	If less than 0.7 ppm B	1 pound/A boron plowed down
	<b>Alfalfa</b>	If less than 0.8 ppm B If 0.8-1.2 ppm B If greater than 1.2 ppm B	3 pounds/A boron topdressed or with fertilizer 2 pounds/A boron topdressed or with fertilizer 1 pound/A boron topdressed or with fertilizer
	<b>Red Clover, Ladino Clover</b>	If less than 0.8 ppm B	2 pounds/A boron topdressed or with fertilizer
<b>Zinc (Zn)</b>	<b>Corn</b>	If pH less than 6.8 <b>and</b> P soil test test index less than 100 <b>and</b> soil test zinc less than 0.8 ppm	4 pounds/A zinc in band <b>or</b> 10-12 pounds/A zinc broadcast
<b>Manganese (Mn)</b>	<b>Corn, Soybeans, Small Grains</b>	If less than 10 ppm Mn	6 pounds/A manganese in row <b>or</b> 0.5-1.0 pounds/A manganese, foliar spray @20 gal/A, make two foliar applications two weeks apart
<b>Sulfur (S)</b>	<b>Corn, Soybean, Small Grain, Alfalfa, Cotton</b>	<b>For sand and sandy loam soil:</b> If SO <sub>4</sub> -S less than 6 ppm in 0-8 inch depth <b>and</b> SO <sub>4</sub> -S less than 20 ppm in 16-24 inch depth	20 pounds/A SO <sub>4</sub> -S
		<b>For all other soils:</b> If less than 6 ppm SO <sub>4</sub> -S	20 pounds/A SO <sub>4</sub> -S
<b>Copper (Cu)</b>	<b>All Crops</b>	If less than 0.3 ppm Cu <b>and</b> Organic matter less than 3.8% <b>or</b> Organic matter 3.8-5.0% <b>or</b> Organic matter 5.0-10% <b>or</b> Organic matter greater than 10%	2 pounds/A copper 4 pounds/A copper 5 pounds/A copper 6 pounds/A copper