



# Information

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## Soil Fertility Management

SFM-1

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

The Maryland Cooperative Extension Soil Testing Laboratory has been analyzing soil samples and generating plant nutrient application recommendations since 1954. 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 “balance” 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 goals, also have 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 employs 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

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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 generates 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 are 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 “Interconverting Among Soil Test Analyses Frequently Used in Maryland”, SFM-4, which is available from your Maryland Cooperative Extension county office, or on-line at [www.agnr.umd.edu/MCE/Publications](http://www.agnr.umd.edu/MCE/Publications).

### **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.

*Prepared by:*

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Soil Fertility / Nutrient Management Specialist

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

Crop	Total Amount of Nutrients Recommended and Suggested Method of Application	Nitrogen (N)	Nitrogen if no P & K recommended	Recommended Nutrients Based on Soil Tests									
				Soil Test Phosphorus Category				Soil Test Potassium Category					
				Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive		
		lbs N / A		lbs P <sub>2</sub> O <sub>5</sub> / A					lbs K <sub>2</sub> O / A				
<b>FIELD CORN FOR GRAIN</b>													
(140 bu / A yield goal)													
1. Conventional-tillage *	Total Recommended	140	140	65-135	30-65	20-30	0	110-180	60-110	20-60	0		
	Broadcast	30	30	35-95	0-25	0	0	80-140	30-70	0-30	0		
	Banded with planter	30	0	30-40	30-40	20-30	0	30-40	30-40	20-30	0		
	Sidedress	80	110	0	0	0	0	0	0	0	0		
2. No-tillage *	Total Recommended	140	140	65-135	30-65	20-30	0	110-180	60-110	20-60	0		
A. Alternating No-tillage/Conventional tillage	Broadcast	30	30	35-95	0-25	0	0	80-140	30-70	0-30	0		
	Banded with planter	30	0	30-40	30-40	20-30	0	30-40	30-40	20-30	0		
	Sidedress	80	110	0	0	0	0	0	0	0	0		
B. Continuous No-tillage **	Total Recommended	140	140	75-180	30-75	20-30	0	110-180	50-110	20-50	0		
	Broadcast	30	30	45-140	0-35	0	0	80-140	30-80	0-20	0		
	Banded with planter	30	0	30-40	30-40	20-30	0	30-40	20-30	20-30	0		
	Sidedress	80	110	0	0	0	0	0	0	0	0		
<b>GRAIN SORGHUM</b>													
(100 bu/A yield goal)													
	Total Recommended	75	75	65-135	30-65	20-30	0	80-150	30-80	20-30	0		
	Broadcast	45	75	35-95	0-25	0	0	50-110	0-40	0	0		
	Banded with planter	30	0	30-40	30-40	20-30	0	30-40	30-40	20-30	0		

Notes for Table 1 on following page.

**Table 1 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  $P_2O_5$  &  $K_2O$  is recommended by soil test. A starter fertilizer 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,  $P_2O_5$ , and  $K_2O$ .

**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).

For conventional-tillage or no-tillage corn:

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

For corn yield goals above 140 bu / A, adjust  $P_2O_5$  as follows:

- 1) If phosphorus soil test index is less than 51, increase  $P_2O_5$  0.6 lb / A for each bushel of expected yield above 140 bushels.
- 2) If phosphorus soil test index is between 51 and 100 lb / A, increase  $P_2O_5$  0.3 lb / A for each bushel of expected yield above 140 bushels.
- 3) If phosphorus soil test index is greater than 100, no adjustment is necessary.

For corn yield goals above 140 bu / A, adjust  $K_2O$  as follows:

- 1) If potassium soil test index is less than 51, increase  $K_2O$  0.8 lb / A for each bushel of expected yield above 140 bu / A.
- 2) If potassium soil test index is between 51 and 100 lb / A, increase  $K_2O$  0.4 lb / A for each bushel of expected yield above 140 bu / A.
- 3) 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:

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

For grain sorghum yield goals above 100 bu / A, adjust  $P_2O_5$  as follows:

- 1) If phosphorus soil test index is less than 51, increase  $P_2O_5$  by 0.4 lb / A for every bushel of expected yield over 100 bu/A.
- 2) If phosphorus soil test index is between 51 and 100, increase  $P_2O_5$  by 0.2 lb / A for every bushel of expected yield over 100 bu/A.
- 3) If phosphorus soil test index is greater than 100, no adjustment is necessary.

For grain sorghum yield goals above 100 bu / A, adjust  $K_2O$  as follows:

- 1) If potassium soil test index is less than 51, increase  $K_2O$  by 0.6 lb / A for every bushel of expected yield over 100 bu/A.
- 2) If potassium soil test index is between 51 and 100, increase  $K_2O$  by 0.3 lb / A for every bushel of expected yield over 100 bu/A.
- 3) 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	Total Amount of Nutrients Recommended and Suggested Method of Application	Nitrogen (N)	Nitrogen if no P & K recommended	Recommended Nutrients Based on Soil Tests							
				Soil Test Phosphorus Category				Soil Test Potassium Category			
				Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive
<b>CORN SILAGE (20 ton / A yield goal)</b>		lbs N / A		lbs P <sub>2</sub> O <sub>5</sub> / A				lbs K <sub>2</sub> O / A			
1. Conventional-tillage *	Total Recommended	120	120	55-125	35-55	0-35	0	150-250	80-150	20-80	0
	Broadcast	30	30	30-85	0	0	0	120-210	60-120	0-50	0
	Banded with planter	20	0	25-40	35-55	0-35	0	30-40	20-30	20-30	0
	Sidedress	70	90	0	0	0	0	0	0	0	0
2. No-tillage **											
A. Alternating No-tillage/ Conventional-tillage	Total Recommended	120	120	55-125	35-55	0-35	0	150-250	80-150	20-80	0
	Broadcast	30	30	30-85	0	0	0	120-210	60-120	0-50	0
	Banded with planter	20	0	25-40	35-55	0-35	0	30-40	20-30	20-30	0
	Sidedress	70	90	0	0	0	0	0	0	0	0
B. Continuous No-tillage	Total Recommended	120	120	95-165	35-95	0-35	0	150-250	80-150	20-80	0
	Broadcast	30	30	55-125	0-55	0	0	120-210	60-120	0-50	0
	Banded with planter	20	0	40	35-40	0-35	0	30-40	20-30	20-30	0
	Sidedress	70	90	0	0	0	0	0	0	0	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 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 good 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 application (sidedress or fertigation).

For conventional-tillage or no-tillage corn silage:

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

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

- 1) Increase nitrogen rate by 7 lb / ton for each ton of expected yield between 20 and 40 tons / A.
- 2) 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:

- 1) 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.
- 2) 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.
- 3) 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:

- 1) 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.
- 2) 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	Total Amount of Nutrients Recommended and Suggested Method of Application	Nitrogen (N)	Recommended Nutrients Based on Soil Tests							
			Soil Test Phosphorus Category				Soil Test Potassium Category			
			Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive
		lbs N / A	lbs P205 / A				lbs K20 / A			
<b>1. WHEAT, BARLEY, RYE, OATS *</b>										
A. Lodging not expected	Total Recommended	70-100	60-100	40-60	20-40	0	60-100	40-60	20-40	0
	Broadcast and disk in or drill with seed.	20-40	60-100	40-60	20-40	0	60-100	40-60	20-40	0
	Topdress.	50-60	0	0	0	0	0	0	0	0
B. Lodging expected	Total Recommended	50-80	60-100	40-60	20-40	0	60-100	40-60	20-40	0
	Broadcast and disk in or drill with seed.	0-20	60-100	40-60	20-40	0	60-100	40-60	20-40	0
	Topdress.	50-60	0	0	0	0	0	0	0	0
<b>2. SPRING OATS</b> (60-65 bu / A yield goal)	Broadcast and disk in or drill with seed.	30-60	60-100	40-60	20-40	0	60-100	40-60	20-40	0
<b>3. SMALL GRAIN - DOUBLE-CROP SOYBEAN</b> (Double-crop recommendation)										
A. Lodging not expected	Total recommended	70-100	140-265	85-140	20-85	0	145-255	75-145	20-75	0
	Broadcast or drill in fall	20-40	70-165	45-100	20-85	0	75-155	35-105	20-75	0
	Topdress.	50-60	70-100	40	0	0	70-100	40	0	0
B. Lodging expected	Total	50-80	140-265	85-140	20-85	0	145-255	75-145	20-75	0
	Broadcast or drill in fall	0-20	70-165	45-100	20-85	0	75-155	35-105	20-75	0
	Topdress	50-60	70-100	40	0	0	70-100	40	0	0
<b>4. SMALL GRAIN - LEGUME INTERSEEDED</b>	Total recommended	20-40	75-125	50-75	20-50	0	75-120	45-75	20-45	0
	Broadcast or drill in fall	0-20	75-125	50-75	20-50	0	75-120	45-75	20-45	0
	Topdress.	0-20	0	0	0	0	0	0	0	0
<b>5. ICM WHEAT **</b> (Intensive Crop Management) (100 bu / A yield goal)	Total	100-120	100-140	80-100	20-80	0	100-140	80-100	20-80	0
	Broadcast at planting	20-40	100-140	80-100	20-80	0	100-140	80-100	20-80	0
	Topdress **	80-100**	0	0	0	0	0	0	0	0
<b>6. ICM WHEAT ** - DOUBLE-CROP SOYBEAN</b> (Intensive Crop Management) (100 bu / A wheat yield goal)	Total	100-120	140-265	85-140	20-85	0	145-255	85-145	20-85	0
	Broadcast at planting	20-40	70-165	45-100	20-85	0	75-155	35-95	20-85	0
	Topdress **	80-100**	70-100	40	0	0	70-100	50	0	0

Notes for Table 3 on following page

**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):

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

For ICM wheat yield goals above 100 bu / A, adjust  $P_2O_5$  as follows:

- 1) If phosphorus soil test index is less than 51, increase  $P_2O_5$  by 1 lb / A for each bushel of expected yield above 100 bu / A.
- 2) If phosphorus soil test index is between 51 and 100, increase  $P_2O_5$  by 0.5 lb / A for each bushel of expected yield above 100 bu / A.
- 3) If phosphorus soil test index is greater than 100, no adjustment is necessary.

For ICM wheat yield goals above 100 bu / A, adjust  $K_2O$  as follows:

- 1) If potassium soil test index is less than 51, increase  $K_2O$  by 1 lb / A for each bushel of expected yield above 100 bu / A.
- 2) If potassium soil test index is between 51 and 100, increase  $K_2O$  by 0.5 lb / A for each bushel of expected yield above 100 bu / A.
- 3) 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  $P_2O_5$  as follows:

- 1) If phosphorus soil test index is less than 51, increase  $P_2O_5$  by 1.5 lb / A for every bushel of expected double-crop soybean yield over 40 bu / A.
- 2) If phosphorus soil test index is between 51 and 100, increase  $P_2O_5$  by 0.75 lb / A for every bushel of expected double-crop soybean yield over 40 bu / A.
- 3) 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  $K_2O$  as follows:

- 1) If potassium soil test index is less than 51, add 3 lb / A  $K_2O$  for every bushel of expected double-crop soybean yield over 40 bu / A.
- 2) If potassium soil test index is between 51 and 100, add 1.5 lb / A  $K_2O$  for every bushel of expected double-crop soybean yield over 40 bu / A.
- 3) 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	Total Amount of Nutrients Recommended and Suggested Method of Application	Nitrogen (N)  lbs N / A	Recommended Nutrients Based on Soil Tests							
			Soil Test Phosphorus Category				Soil Test Potassium Category			
			Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive
<b>SOYBEAN (full season)</b> (40 bu / A yield goal)	Broadcast or banded at planting	0 *	80 - 120	45 - 80	20 - 45	0	80 - 125	40 - 80	20 - 40	0
<b>CANOLA</b>										
A. Lodging not expected	Total	120-150	60 - 80	40 - 60	20 - 40	0	60 - 80	40 - 60	20 - 40	0
	Broadcast	20-40	60 - 80	40 - 60	20 - 40	0	60 - 80	40 - 60	20 - 40	0
	Topdress	100-110	0	0	0	0	0	0	0	0
B. Lodging expected	Total	70-100	60 - 80	40 - 60	20 - 40	0	60 - 80	40 - 60	20 - 40	0
	Broadcast	20 - 40	60 - 80	40 - 60	20 - 40	0	60 - 80	40 - 60	20 - 40	0
	Topdress	50-60	0	0	0	0	0	0	0	0
<b>SUNFLOWER</b> (0.5 ton seed / A yield goal)	Total	50	30	20	0	0	30	20	0	0
	Broadcast at planting	50	30	20	0	0	30	20	0	0

**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 P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O, 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 P<sub>2</sub>O<sub>5</sub> as follows:

- 1) If phosphorus soil test index is less than 51, increase P<sub>2</sub>O<sub>5</sub> by 1.5 lb/acre for each additional bushel of expected yield over 40 bu / A.
- 2) If phosphorus soil test index is between 51 and 100, increase P<sub>2</sub>O<sub>5</sub> by 0.75 lb / A for each additional bushel of expected yield over 40 bu / A.
- 3) If phosphorus soil test index is greater than 100, no adjustment is necessary.

For full-season soybean yield goals above 40 bu / A, adjust K<sub>2</sub>O as follows:

- 1) If potassium soil test index is less than 51, increase K<sub>2</sub>O by 3 lb / A for each bushel of expected yield over 40 bu / A.
- 2) If potassium soil test index is between 51 and 100, increase K<sub>2</sub>O by 1.5 lb / A for each bushel of expected yield over 40 bu / A.
- 3) 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 P<sub>2</sub>O<sub>5</sub> as follows:

- 1) If phosphorus soil test index is less than 51, increase P<sub>2</sub>O<sub>5</sub> by 1.5 lb / A for every bushel of expected double-crop soybean yield over 40 bu / A.
- 2) If phosphorus soil test index is between 51 and 100, increase P<sub>2</sub>O<sub>5</sub> by 0.75 lb / A for every bushel of expected double-crop soybean yield over 40 bu / A.
- 3) 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 K<sub>2</sub>O as follows:

- 1) If potassium soil test index is less than 51, add 3 lb / A K<sub>2</sub>O for every bushel of expected double-crop soybean yield over 40 bu / A.
- 2) If potassium soil test index is between 51 and 100, add 1.5 lb/ A K<sub>2</sub>O for every bushel of expected double-crop soybean yield over 40 bu / A.
- 3) 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:

- 1) Add 25 lb N / A for each 0.25 tons / A of expected yield above 0.5 tons / A.
- 2) Add 5 lb P<sub>2</sub>O<sub>5</sub> / A for each 0.25 tons / A of expected yield above 0.5 tons / A.
- 3) Add 10 lb K<sub>2</sub>O / A for each 0.25 tons / A of expected yield above 0.5 tons / A.
- 4) 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	Total Amount of Nutrients Recommended and Suggested Method of Application	Nitrogen (N)	Recommended Nutrients Based on Soil Tests							
			Soil Test Phosphorus Category				Soil Test Potassium Category			
			Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive
		lbs N / A	lbs P205 / A				lbs K20 / A			
<b>ALFALFA &amp; ALFALFA-GRASS MIX</b>										
A. Spring seeded	Broadcast and disked in	15-30 *	110-205	70-110	20-70	0	185-295	115-185	20-115	0
B. Fall seeded	Total recommended	15-30 *	155-280	100-155	60-100	0	205-300	140-205	80-140	0
	Broadcast and disk in	15-30 *	60	60	60	0	60	60	60	0
	Topdress after first cutting	0	95-220	40-95	20-40	0	145-240	80-145	20-80	0
<b>CLOVER, CLOVER-GRASS MIX, BIRDSFOOT TREFOIL</b>	Broadcast and disk in	15-30	60-100	40-60	20-40	0	60-100	40-60	20-40	0
<b>LESPEDEZA, LESPEDEZA-GRASS MIX</b>	Broadcast and disk in	15-20	35-60	20-35	20	0	40-65	25-40	25	0
<b>COOL-SEASON PERENNIAL GRASSES **</b>	Broadcast and disk in	40-60	60-100	40-60	20-40	0	60-100	40-60	20-40	0
<b>WARM-SEASON PERENNIAL GRASSES ***</b>	Broadcast and disk in	0	40-60	20-40	0	0	60-90	20-60	0	0
<b>BUCKWHEAT</b>	Broadcast and disk in	15-20	30-50	20-30	20	0	30-50	20-30	20	0

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.

\* 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.

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

Crop	Total Amount of Nutrients Recommended and Suggested Method of Application	Nitrogen (N)	Recommended Nutrients Based on Soil Tests								
			Soil Test Phosphorus Category				Soil Test Potassium Category				
			Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive	
		lbs N / A	lbs P205 / A				lbs K20 / A				
<b>ALFALFA &amp; ALFALFA-GRASS MIX</b> (more than 25% alfalfa)											
A. Yield goal: 4 tons / A	Topdress annually	0 *	60-100	30-60	20-30	0	190-275	140-190	90-140	90	
B. Yield goal: 8 tons / A	Topdress annually	0 *	100-120	50-100	20-50	0	470-555	420-470	370-420	370	
<b>CLOVER &amp; CLOVER-GRASS MIX</b> (more than 25% clover)											
A. Yield goal: 4 tons / A	Topdress annually	0 *	60-100	30-60	20-30	0	190-275	140-190	90-140	90	
B. Yield goal: 8 tons / A	Topdress annually	0 *	100-120	50-100	20-50	0	470-555	420-470	370-420	370	
<b>BIIRDSFOOT TREFOIL</b> (more than 25% trefoil)	Topdress annually	0 *	60-100	30-60	20-30	0	125-195	75-125	40-75	40	
<b>BLUEGRASS-WHITE CLOVER MIX</b> (more than 25% white clover)	Topdress annually	20-30	50-100	25-50	25	0	50-100	25-50	25	0	
<b>BLUEGRASS PASTURE</b> (with little or no clover)	Topdress annually	100-120	50-100	25-50	25	0	50-100	25-50	25	0	
<b>COOL-SEASON PERENNIAL GRASSES **</b> (less than 25% legumes). Yield goal: 4 tons / A	Total recommended Topdress in February-March Topdress after first harvest Topdress in August	150-160 50-60 50 50	60-150 30-80 0 30-70	20-60 20-30 0 20-30	20 20 0 0	0 0 0 0	110-200 60-100 0 50-100	50-110 50-60 0 0-50	20-50 20-50 0 0	0 0 0 0	
<b>TIMOTHY</b>	Total recommended Topdress in February-March Topdress in August	80-120 60-80 20-40	60-150 30-80 30-70	20-60 20-30 0-30	20 20 0	0 0 0	110-200 60-100 50-100	50-110 50-60 0-50	20-50 20-50 0	0 0 0	
<b>ANNUAL RYEGRASS</b>	Total recommended Topdress in February-March Topdress in May	100 50 50	60-150 60-150 0	20-60 20-60 0	20 20 0	0 0 0	110-200 110-200 0	50-110 50-110 0	20-50 20-50 0	0 0 0	
<b>WARM SEASON PERENNIAL GRASSES ***</b> Yield goal: 4 tons / A	Total recommended Topdress in May	75 75	60-90 60-90	20-60 20-60	0 0	0 0	90-120 90-120	30-90 30-90	20-30 20-30	0 0	
<b>EASTERN GAMAGRASS</b> Yield goal: 4 tons / A	Total recommended Topdress in mid-April to early 1 Topdress after 1st harvest Topdress after 2nd harvest	240-300 80-100 80-100 80-100	60-90 60-90 0 0	20-60 20-60 0 0	0 0 0 0	0 0 0 0	90-120 90-120 0 0	30-90 30-90 0 0	20-30 20-30 0 0	0 0 0 0	
<b>CEREAL GRAIN FOR GRAZING</b>	Total recommended Broadcast before seeding Topdress in February-March	100 50 50	50-100 50 20-50	25-50 25-50 0	25 25 0	0 0 0	50-100 50 20-50	25-50 25-50 0	25 25 0	0 0 0	

Notes for Table 6 on following page

**Table 6 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.

\* 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 upto 50 lb N / acre when fertilizer formulation and application rate is determined by crop  $P_2O_5$ ,  $K_2O$ , 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  $P_2O_5$  as follows:

- 1) If phosphorus soil test index is less than 100, Increase  $P_2O_5$  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, adjust  $K_2O$  as follows:

- 1) Increase  $K_2O$  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  $P_2O_5$  as follows:

- 1) If phosphorus soil test index is less than 100, increase  $P_2O_5$  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, adjust  $K_2O$  as follows:

- 1) Increase  $K_2O$  by 70 lb / A for each ton of expected yield above 4 tons / A regardless of potassium soil test index.

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

Cool-season perennial grass (including timothy and annual ryegrass) N rate assumes 4 tons / A hay yield. For cool-season grass hay yield above 4 tons / A, increase N application by a total of 45 lb / A. for each ton of additional expected hay yield above 4 tons / A.

\*\*\* Warm-Season Perennial Grasses: bermudagrass, switchgrass, indiagrass, weeping lovegrass, buffalograss, caucasian bluestem, big bluestem, little bluestem.

Warm-season perennial grass (including eastern gamagrass) N rate assumes 4 tons / A hay yield. For warm-season grass hay yield above 4 tons / A, increase N application by a total of 40 lb / A. for each ton of additional expected hay yield above 4 tons / A.

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

Crop	Total Amount of Nutrients Recommended and Suggested Method of Application	Nitrogen (N)  lbs N / A	Recommended Nutrients Based on Soil Tests							
			Soil Test Phosphorus Category				Soil Test Potassium Category			
			Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive
			lbs P205 / A				lbs K20 / A			
<b>SUDANGRASS, MILLET, and FORAGE-TYPE SORGHUMS</b> (10-15 ton / A yield goal)	Total recommended	120-150 *	80-160	45-80	20-45	0	80-160	40-80	20-40	0
	Broadcast and disked in	70-100	80-160	45-80	20-45	0	80-160	40-80	20-40	0
	Topdress after first harvest	50	0	0	0	0	0	0	0	0
<b>FORAGE-TYPE SOYBEAN</b> (10-15 ton / A yield goal)	Broadcast and disked in	20	80-160	45-80	20-45	0	80-160	45-80	20-45	0
<b>SUMMER COVER CROP &amp; WILDLIFE FEED PASTURE</b>										
A. Sudangrass and forage-type sorghums	Total recommended	100	70-130	40-70	20-40	0	70-130	40-70	20-40	0
	Broadcast before seeding	50	20-80	20-50	20-40	0	20-80	20-50	20-40	0
	Topdress after first harvest	50	50	20	0	0	50	20	0	0
B. Forage-type soybean and mi	Broadcast before seeding	25	70-130	40-70	20-40	0	70-130	40-70	20-40	0

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 for Maryland-type Tobacco**

Crop	Total Amount of Nutrients Recommended and Suggested Method of Application	Nitrogen (N)  lbs N / A	Recommended Nutrients Based on Soil Tests							
			Soil Test Phosphorus Category				Soil Test Potassium Category			
			Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive
			lbs P205 / A				lbs K20 / A			
<b>MARYLAND-TYPE TOBACCO</b>	Total	60-90	120	80	40	40	200	160	120	120
	Broadcast	40	120	80	40	40	130	100	80	80
	Sidedress	20-50	0	0	0	0	70	60	40	40

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	Total Amount of Nutrients Recommended and Suggested Method of Application	Nitrogen (N)	Recommended Nutrients Based on Soil Tests							
			Soil Test Phosphorus Category				Soil Test Potassium Category			
			Low	Medium	Optimum	Excessive	Low	Medium	Optimum	Excessive
		lbs N / A	lbs P205 / A				lbs K20 / A			
<b>COTTON</b>	Total	50-75	80-120	40-80	30-40	0	80-120	40-80	30-40	0
	Broadcast pre-plant	0	50-80	10-40	0	0	50-80	10-40	0	0
	Banded with planter	20-25	30-40	30-40	30-40	0	30-40	30-40	30-40	0
	Sidedress	30-50	0	0	0	0	0	0	0	0

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>	less than 0.7 ppm B	1 lb / A boron plowed down
	<b>ALFALFA</b>	less than 0.8 ppm B	3 lb / A boron topdressed or with fertilizer
		0.8 to 1.2 ppm B greater than 1.2 ppm B	2 lb / A boron topdressed or with fertilizer 1 lb / A boron topdressed or with fertilizer
	<b>RED CLOVER, LADINO CLOVER</b>	less than 0.8 ppm B	2 lb / A boron topdressed or with fertilizer
<b>ZINC ( Zn )</b>	<b>CORN</b>	If pH < 6.8 and P soil test index < 100 and soil test Zn < 0.8 ppm Zn	4 lb / A zinc in band or 10-12 lb / A zinc broadcast
		If pH > 6.8 or P soil test index > 100 and soil test Zn < 1.0 ppm Zn	4 lb / A zinc in band or 10-12 lb / A zinc broadcast
<b>MANGANESE ( Mn )</b>	<b>CORN, SOYBEAN, SMALL GRAINS</b>	less than 10 ppm Mn	6 lb / A manganese in row, or 0.5 - 1.0 lb / A manganese, foliar spray @ 20 gal / A, apply two foliar applications, two weeks apart.
<b>SULFUR ( S )</b>	<b>CORN, SOYBEAN, SMALL GRAIN, ALFALFA, COTTON</b>	For sands and sandy loam soil: If SO <sub>4</sub> -S < 6 ppm in 0-8 inch depth <b>AND</b> SO <sub>4</sub> -S < 20 ppm in 16-24 inch depth	20 lb / A SO <sub>4</sub> -S
		For all other soils: If SO <sub>4</sub> -S < 6 ppm SO <sub>4</sub> -S	20 lb / A SO <sub>4</sub> -S
<b>COPPER ( Cu )</b>	<b>ALL CROPS</b>	less than 0.3 ppm Cu	2 lb / A copper if organic matter < 3.8 % 4 lb / A copper if organic matter 3.8 - 5.0 % 5 lb / A copper if organic matter 5.0 - 10 % 6 lb / A copper if organic matter > 10 %