

**Phosphorus (P) and Potassium (K) Recommendations:**

Response of crops to additions of P and K is a continuous function. When inadequate amounts are present in the soil, crops respond to P and K additions with increases in biomass and/or grain production according to the general response curve shown in Figures 1 and 3. Recommendations given in this bulletin follow the **buildup**, **maintenance** and **drawdown** philosophy presented in “[Tri-State Fertilizer Recommendations](#)” bulletin E-2567. Figure 3 illustrates this philosophy in combination with a typical response curve. These recommendations provide for **buildup** of available P and K levels when the soil test level is below the critical soil test level (CL) (Figure 3). At the critical soil test level (CL), crop yield will be near 95 to 97 percent of maximum. The **buildup zone** is also the **zone of response** where the amount of P or K applied to the soil will greatly affect crop growth and yield. When soil test levels are in this zone the probability of economic benefit from applied P or K fertilizer is very good.

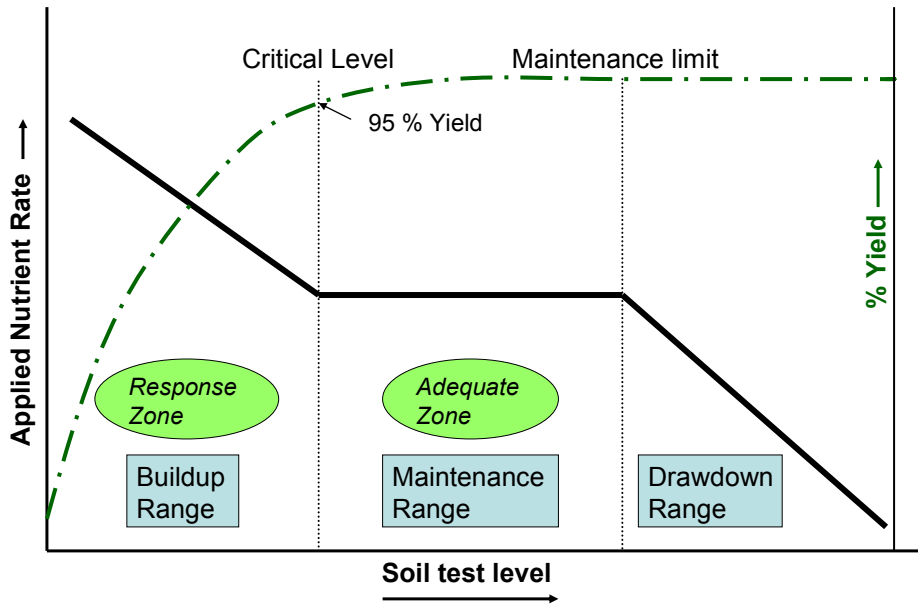


Figure 3. Nutrient recommendation scheme for phosphorus and potassium.

**Maintenance** recommendations (amount equal to crop removal) are given to keep the available soil P and K levels in the “**Adequate Zone**” or “**Maintenance Range**” (CL to ML). This provides insurance against variations due to field variability and those caused by sampling variability, and provides long term economic benefit. It is possible to get some current season economic benefit from applied P or K fertilizer when soil test values are in the lower end of the maintenance range, but the probability is low. When soil test values are near the critical level, economic benefit is more likely to occur from band applied P and/or K than from broadcast application. Applying amounts of P and K equal to crop removal will maintain the current soil test levels.



Soil test levels in the “**Draw Down**” range (soil test >ML) are more than adequate for top crop production. No additional P or K is needed and no response to applied P or K should be expected. However, some is recommended to slow the rate of draw down and allows for field variation. The recommendation goes to zero when the soil test value for P is 10 ppm > ML and for K is 20 ppm > ML for most field crops.

Crop yield plays an important role in these recommendations. In the buildup zone, the amount of P or K recommended is a combination of the amount required to build up the level in the soil toward the optimum range (CL) plus the amount that will be removed in the harvested portion of the crop. It is very important to provide realistic yield goals to the MSU Soil and Plant Nutrient Lab so that you receive nutrient recommendations that are economically and environmentally sound. Table 3 provides a guide for average amounts of nitrogen (N), phosphate (P<sub>2</sub>O<sub>5</sub>) and potassium (K<sub>2</sub>O) removed in the harvested portion of major agronomic crops grown in Michigan. The exact amounts may vary with stage of maturity, environmental conditions, and crop type or variety.

### **Nutrient Use Options:**

Having available soil P and K levels in the adequate zone (Figure 3) provides the opportunity for excellent yields when growing conditions are favorable. As described previously, applying sufficient P or K to build toward and/or maintain a soil nutrient level in the adequate zone is a preferred management option. However, there are other nutrient management options that can result in top yields and better short term economics of crop production.

**Soil Test is in the Responsive Zone or Build Up Range.** Applying only maintenance amounts of P<sub>2</sub>O<sub>5</sub> or K<sub>2</sub>O in most situations will provide adequate nutrients for near optimum economical crop production at less cost than following the buildup + maintenance recommendation. This approach will maintain the current soil test level, no build up or draw down should occur. As the price of P or K increases relative to the value of the crop produced, the amount of nutrient to produce the most economical return will decrease. (See Figure 4.) Application of phosphate in a band placed 2 inches to the side and 2 inches below the seed at planting improves the efficiency of use in comparison to broadcast application, and reduces the amount of phosphate needed in a given year. Applying some potash in the 2 x 2 placed fertilizer band can also contribute to a reduction in the amount of supplemental K<sub>2</sub>O needed in a given year. However, at some point in time more than maintenance amounts of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O will need to be applied to replace those used from the soil.

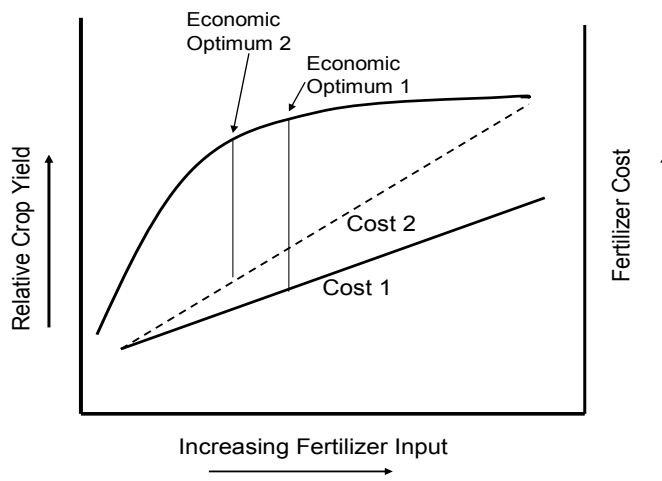


Figure 4. Illustrates change in economic fertilizer rate as the cost of fertilizer changes.

**Soil Test is in the Adequate Zone or Maintenance Range.** Soil nutrient levels in this range provide flexibility in nutrient management. Long-term it is good to maintain available nutrients in this range, but there may be situations where financial resources may be limited. Applying less than maintenance amounts of  $P_2O_5$  or  $K_2O$  will result in some decrease in available P or K levels in the soil. For many soils applying 50 percent of maintenance will result in the soil test value decreasing 2 to 4 ppm P and 5 to 10 ppm K per year depending on the crop and soil texture. Available nutrient levels will change more quickly in sandy soils than in clayey soils. Depending on the actual soil test level it may be possible to apply less than a maintenance amount for 4 to 5 years without having an impact of crop productivity.

**Soil Test is greater than adequate.** There is no yield benefit to applying P and K when the available soil level is greater than adequate. In the draw down range (10 ppm P and 20 ppm K beyond adequate) some P and K is recommended to slow the rate of draw down in the soil test value. Also, putting a small amount of  $P_2O_5$  or  $K_2O$  in the starter fertilizer band may help stimulate early growth. However, it is perfectly acceptable to apply no P or K and take advantage of the nutrients stored in the soil “bank” through previous applications of fertilizer, manures or other materials.

As indicated, **phosphorus recommendations** take into consideration the soil test level and the crop yield. The buildup portion of the recommendation is based on building the soil up to the critical value or level (CL) where yield is 95 to 97 percent of maximum. Buildup assumes that, on average, it takes 20 pounds of  $P_2O_5$  to increase the soil test 1 ppm P or 5 lb/A/yr over a 4-year period. The P buildup recommendations are given in Table 7. The critical level varies with the crop and its response to phosphorus (Table 8). The maintenance plateau for most field crops is 15 ppm on mineral soils. Maintaining the soil test P value in this maintenance zone helps insure that P will not limit crop yield.

When the soil test P value is above the maintenance zone the soil P level should be drawn down so the recommendation is less than crop removal. The phosphorus critical levels (CL), maintenance plateau length (PL) and drawdown length (DDL) are given in Table 7 for field crops grown on mineral and organic soils. The maximum annual phosphorus recommendation is 200 lb P<sub>2</sub>O<sub>5</sub>/A.

**Equations used to calculate the recommended amount of P<sub>2</sub>O<sub>5</sub>, in pounds per acre, when the soil test is in each zone.**

**Mineral soils:**

Buildup zone:  $\text{lb P}_2\text{O}_5 / \text{A} = ((\text{CL} - \text{ST}) * 5) + (\text{YP} * \text{CR})$   
*when ST is < CL*

Maintenance zone:  $\text{lb P}_2\text{O}_5 / \text{A} = (\text{YP} * \text{CR})$   
*when ST is  $\geq$  CL and  $\leq$  ML*

Drawdown zone:  $\text{lb P}_2\text{O}_5 / \text{A} = \{\text{YG} \times \text{CR}\} \times \{[(\text{CL} + \text{PL} + \text{DL}) - \text{ST}] \div \text{DDL}\}$   
*when ST > ML*

**Organic soils:**

Buildup zone:  $\text{lb P}_2\text{O}_5 / \text{A} = ((\text{CL} - \text{ST}) * 2) + (\text{YP} * \text{CR})$   
*when ST is < CL*

Maintenance zone:  $\text{lb P}_2\text{O}_5 / \text{A} = (\text{YP} * \text{CR})$   
*when ST is  $\geq$  CL and  $\leq$  ML*

Drawdown zone:  $\text{lb P}_2\text{O}_5 / \text{A} = \{\text{YG} \times \text{CR}\} \times \{[(\text{CL} + \text{PL} + \text{DL}) - \text{ST}] \div \text{DDL}\}$   
*when ST > ML*

*where:* CL = critical soil test value (ppm)  
 ML = maintenance limit  
 ST = soil test value (ppm)  
 YP = yield potential or goal  
 CR = nutrient removal in harvest portion of crop (lb/unit of yield)  
 PL = maintenance plateau length  
 DDL = drawdown length; recommendation is phased to zero

Table 7. Phosphorus buildup recommendations, mineral soils.

P Soil Test	CL	15	20	25	30
	<b>Buildup Recommendation</b>				
ppm	lb P <sub>2</sub> O <sub>5</sub> /A				
5	50	75	100	125	
10	25	50	75	100	
15	0	25	50	75	
20	0	0	25	50	
25	0	0	0	25	
30	0	0	0	0	

CL = critical soil test value

Table 8. Values for key factors used in calculating the phosphorus recommendations for field crops grown on mineral and organic soils.

Crop	Mineral soil			Organic soil		
	CL <sup>1</sup>	PL <sup>2</sup>	DDL <sup>3</sup>	CL <sup>1</sup>	PL <sup>2</sup>	DDL <sup>3</sup>
	-	-	ppm	-	-	ppm
Alfalfa seeding	25	15	10	30	15	10
Alfalfa topdress	25	15	10	30	15	10
Barley	15	15	10	40	15	10
Barley/legume seeding	25	15	10	40	15	10
Beans, dry edible	15	25	30	40	15	10
Brassica forage	15	15	10	40	15	10
Bromegrass hay	15	15	10	40	15	10
Buckwheat	15	15	10	40	15	10
Canola	25	20	10	55	15	10
Clover seeding	20	15	10	30	15	10
Clover topdress	20	15	10	30	15	10
Clover-Grass hay	20	15	10	30	15	10
Corn grain	15	15	10	55	15	10
Corn silage	15	15	10	55	15	10
Corn, seed	20	20	10	--	--	-- <sup>4</sup>
Grass, warm-season	10	15	10	20	15	10
Grass, cool-season	10	15	10	20	15	10
Millet	15	15	10	40	15	10
Oats	15	15	10	30	15	10
Oats for cover	25	15	10	30	15	10
Orchardgrass hay	15	15	10	30	15	10
Pasture, intensive grazing	20	15	10	30	15	10
Pasture,extensive grazing	15	15	10	30	15	10
Peppermint	40	30	10	70	15	15
Potato	75	75	25	120	50	20
Rye grain	15	15	10	40	15	10
Rye silage	15	15	10	40	15	10
Sorghum	15	15	10	40	15	10
Sorghum-Sudangrass hay	15	15	10	30	15	10
- haylage	15	15	10	30	15	10
Soybean	15	15	10	35	15	10
Spearmint	40	30	10	70	15	15
Spelts	15	15	10	40	15	10
Sugar beet	15	15	10	--	--	-- <sup>4</sup>
Sunflower	15	15	10	40	15	10
Timothy hay	15	15	10	--	--	-- <sup>4</sup>
Trefoil hay	20	20	10	40	15	10
Trefoil seed production	20	20	10	--	--	-- <sup>4</sup>
Wheat grain	25	15	10	55	15	10
Wheat/legume seeding	25	15	10	55	15	10

<sup>1</sup>CL = critical P soil test value

<sup>2</sup>PL = maintenance plateau length

<sup>3</sup>DDL= drawdown length

<sup>4</sup>Not recommended on organic soils.