



TRI-STATE FERTILIZER RECOMMENDATIONS

for Corn, Soybean, Wheat, and Alfalfa





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FOREWORD

The *Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat and Alfalfa* (Extension Bulletin E-2567) was first published in 1995 and has served as a cornerstone in nutrient management in field crops for Indiana, Michigan, and Ohio. Field crop production practices in this region have changed over the past two and a half decades, including general reductions in tillage and crop rotations, greater plant populations and grain yields, new pests and diseases, and the emergence of precision soil sampling and fertilizer rate and placement technologies. Water and air quality issues in this region also underscore the

need to manage nutrients as judiciously and profitably as possible. In short, there is ample justification for a revision of the fertilizer recommendations and this publication represents the first step to update fertilizer recommendations in this region. The focus of this document is on managing mineral fertilizer sources in field crop systems. Animal manures and biosolids are important sources of nutrients in this region and management guidelines are provided wherever appropriate, however, proper management of these nutrient sources requires additional consideration that can lie outside the scope of this document.

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EXECUTIVE SUMMARY

The *Tri-State Field Crop Fertilizer Recommendations for Indiana, Michigan, and Ohio* have been revised and updated. Extensive research station and on-farm trials have been conducted over the past decade to validate and refine the guidelines. In general, the fertilizer recommendations originally published in 1995 provide a solid framework for managing fertilizers and soil fertility. Some changes, however, have been made to the recommendations. Here are the important points:

- Soil sampling remains a critical component of effective nutrient management.
 - ◆ Soil sample in a consistent way every 3 to 4 years at no more than 25-acre samples.
 - ◆ Adapt nutrient management based on trends over time.
- Soil pH remains one of the most important aspects of supplying adequate nutrition to crops.
 - ◆ Soil pH should be kept between 6.0 and 6.8 for field crops.
- Optimizing nitrogen management is challenging and requires careful consideration of many factors.
 - ◆ Nitrogen rate recommendations for corn are based on an economic model designed to maximize farmer profitability (maximum return to N (MRTN)) available at cnrc.agron.iastate.edu.
 - ◆ Nitrogen recommendations for wheat have been updated and are similar to the original recommendations.
- Soil test levels determine phosphorus and potassium fertilizer application rates and timing.

Soil Test Levels Classify Soils into One of Three Phases

Assessment	Rate to Apply	When to Apply
Deficient	Crop removal + fertilizer to build soil test levels	Immediately, before next crop
Optimal	Approximate crop removal	Sometime within the rotation
Sufficient	Do not fertilize	Do not fertilize

- Mehlich-3 is now the default soil extractant that has replaced Bray P1 for phosphorus and ammonium acetate for base cations. Mehlich-3 P returns approximately 35% higher soil test phosphorous (STP) values than Bray P1. Mehlich-3 K returns approximately 14% higher soil test potassium (STK) than ammonium acetate.
- **Optimal soil test levels for all crops are largely consistent with the original recommendations, except for revising the values to reflect Mehlich-3 as the soil extractant.**

New Mehlich-3 P and K Optimal Levels for Field Crops in the Tri-State Region

Crop	Phosphorus (Mehlich-3 P)	Potassium (Mehlich-3 K)	
		Sandy soils (CEC <5 meq/ 100g)	Loam and clay soils (CEC >5 meq/ 100g)
Corn, Soybean	20–40 ppm	100–130 ppm	120–170 ppm
Wheat, Alfalfa	30–50 ppm	100–130 ppm	120–170 ppm

- Crop removal rates were updated with current analyses of grain P and K concentrations.
- Nutrient removal rates per bushel of grain have decreased, especially with potassium.

Nutrients Removed in Harvested Grain		
Crop	Grain Nutrient Removal Rate	
	lb P ₂ O ₅ / bushel	lb K ₂ O/ bushel
Corn	0.35	0.20
Soybean	0.80	1.15
Wheat	0.50	0.25

Crop	Forage Nutrient Removal Rate	
	lb P ₂ O ₅ / ton	lb K ₂ O/ ton
Wheat Straw	3.7	29
Corn silage	3.1	7.3
Alfalfa	12.0	49

Source: International Plant Nutrition Institute (2014), dry matter basis: 100% for wheat straw and alfalfa; 35% for corn silage (0% moisture for wheat straw, 65% moisture for corn silage).

- Updated P and K fertilizer rates are based on expected yield goals when soil test P and K are in the maintenance range (optimal):

Crop	Yield bushel/acre	Recommended Fertilizer Rate		
		IN, MI, OH	IN & OH	MI
		lb P ₂ O ₅	lb K ₂ O/ acre	lb K ₂ O/ acre
Corn	150	55	50	30
	200	70	60	40
	250	90	70	50
	300	105	80	60
Soybean	30	25	55	35
	50	40	80	60
	70	55	100	80
	90	70	125	105
Wheat	60	30	35	15
	90	45	45	25
	120	60	50	30
	150	75	60	40

- Soils in the tri-state region typically supply adequate Ca, Mg, S and micronutrients for crop production.
- Sulfur deficiencies remain infrequent but are increasing.
- The judicious use and placement of fertilizer remains a key factor in running a profitable farming operation.
- The concept of soil fertility should be extended beyond fertilizer management to include sound agronomic practices that promote soil biology and physical structure in field crop systems.

Quick Reference Guide to Tri-State Fertilizer Recommendation Changes

What has changed?	Why the change?	Details
Soil Sampling		
Sample every 3 to 4 years in a consistent way as the foundation for an adaptive nutrient management program.	No changes	Page 11
Soil pH and Lime Recommendations		
Michigan and Indiana liming recommendations are consistent, Ohio recommendations are different.	States label and regulate liming materials differently.	Page 13
Nitrogen Fertilizer Recommendations		
Corn N recommendations are now based on economic model to maximize profitability.	Fluctuating grain and fertilizer prices necessitate a focus on economics in addition to yield.	Page 20
Wheat N recommendations have been updated.	They are calibrated with recent field trials with modern varieties.	Page 22
Phosphorus and Potassium Recommendations		
Management framework drops drawdown range, makes build-up recommended but not required.	Recommendations are simplified to provide farmers with greater flexibility to manage nutrients profitably.	Page 24
Default soil test P and K levels now based on Mehlich-3.	Make recommendations consistent with current soil laboratory practices.	Page 31
P critical level 20 ppm for corn and soybean, 30 ppm for wheat and alfalfa (Mehlich-3 P).	This update is based on extensive field trials over past decade.	Page 27
K critical levels are 100 ppm for sandy soils, 120 ppm silt and clay soils (Mehlich-3 K, all crops)	This update is based on extensive field trials over past decade.	Page 27
Grain nutrient removal rates per bushel of yield have decreased.	Crops are yielding more but grain nutrient concentrations have decreased.	Page 31
Calcium, magnesium, sulfur recommendations		
Liming supplies sufficient Ca & Mg; S deficiencies remain infrequent but are increasing.	No changes	Page 40
Micronutrients		
Most soils supply sufficient micronutrients; diagnostic tools are limited.	No changes	Page 42