Research on Phosphorus Losses From Cropland

Recent studies conducted at Kansas State University's East Central Kansas Experiment Field have indicated that phosphorus best management practices are very effective at reducing phosphorus runoff from crop fields.

No-till farming methods reduced soil erosion by 75 percent compared to a conventional (chisel-disk) tillage system. Total phosphorus losses under no-till were reduced by approximately 40 percent compared to conventional tillage. Total phosphorus consists primarily of insoluble phosphorus attached to soil particles or as freestanding inorganic compounds.

Researchers also found no-till actually had higher losses of soluble phosphorus in runoff water than did the conventional system. Soluble phosphorus is more readily utilized by algae than is insoluble phosphorus attached to soil particles, and it may be a better indicator of pollution problems than amounts of total phosphorus in surface water.

To reduce losses of soluble phosphorus under no-till systems, the researchers found phosphorus fertilizers should be deep banded or placed near the seed. Deep banding phosphorus fertilizers reduced phosphorus runoff losses by 50 percent compared to broadcast fertilizer applications. The combination of reduced-tillage and phosphorus placement below the soil surface will be effective in reducing phosphorus losses into surface waters.

Daniel L. Devlin
Department of Agronomy

Kent McVay
Department of Agronomy

Gary M. Pierzynski
Department of Agronomy

Keith Janssen
East Central Experiment Field

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Kansas State University
Agricultural Experiment Station
and Cooperative Extension Service

MF-2321 August 2002

WATER QUALITY

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Best Management Practices for *Phosphorus*

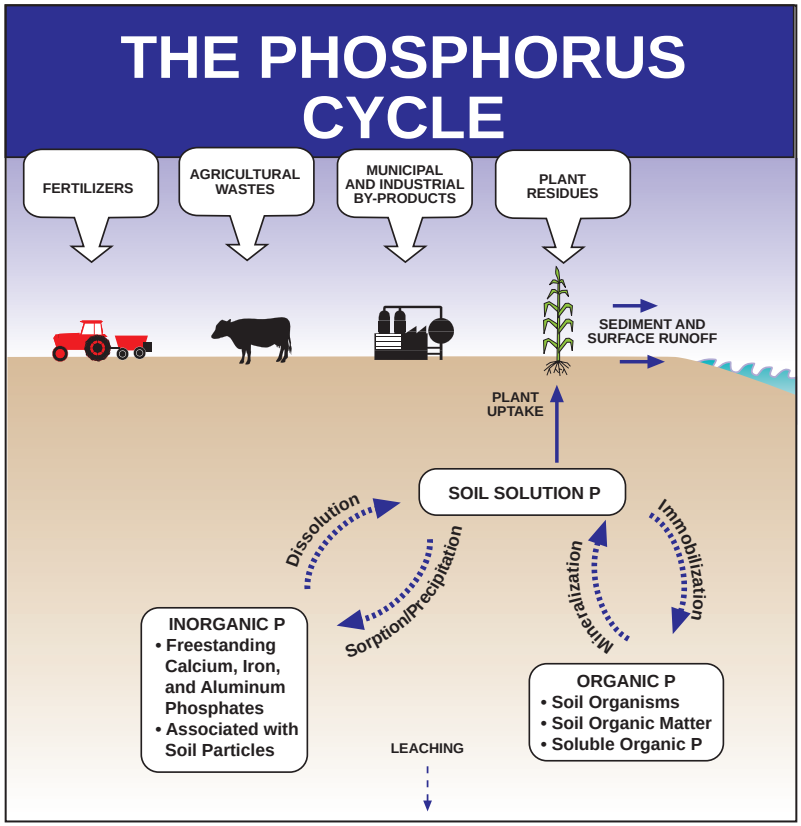
Kansas State University
Agricultural Experiment Station
and Cooperative Extension Service

Phosphorus (P) is essential for crop growth and economically viable yields. In some cases, however, phosphorus can move into surface waters and cause impairments of normal uses. Water-quality problems associated with phosphorus are generally confined to surface waters.

In most soils, phosphorus exists in one of four forms: (1) associated with soil particles; (2) in mineral form as aluminum, iron, or calcium compounds; (3) soluble compounds dissolved in soil water; or (4) incorporated in organic matter.

Most phosphorus exists in the soil as inorganic minerals. Inorganic phosphorus generally does not leach into groundwater. Inorganic phosphorus can move into surface waters associated with soil particles during erosion, especially where the land has been recently manured or fertilized with phosphorus and not incorporated.

Soluble phosphorus can move off-site with runoff water during heavy rainfall or irrigation.



Concerns About Phosphorus in Water

◆ When excessive amounts of phosphorus enter lakes and streams, it enhances the growth of undesirable algae and other aquatic weeds. This results in eutrophication, which eventually chokes out other life forms, depletes oxygen supplies, and creates foul odors and unpleasant tastes.

Phosphorus fertilizer applications on agricultural lands have been identified as a source of phosphorus in surface water.

Runoff from livestock confinement areas and from livestock waste applications to cropland and grazinglands can contribute to phosphorus contamination of surface water.

Supplying phosphorus fertilizer at rates higher than necessary for crop production is unwise from both environmental and economic viewpoints. Phosphorus-application rates should be dictated by soil-test results.

◆ Best Management Practices for phosphorus fall into two categories:

1) Phosphorus-use practices. Producers can help reduce the potential for phosphorus movement into water by applying phosphorus fertilizer only where needed and incorporated or applied below the soil surface. Manure applications should either be incorporated with light tillage or injected below the soil surface. These BMPs are broadly effective at reducing movement of phosphorus into surface water.

2) Erosion control. Most phosphorus under field conditions is strongly attached to soil particles. Erosion not only moves soil, but also moves absorbed phosphorus into surface water. Once submerged, chemical equilibrium reactions can cause a certain amount of absorbed phosphorus to be released into the water as soluble phosphorus. BMPs that reduce soil erosion play an indirect, major role in reducing the potential for phosphorus movement.

Using the most appropriate combination of BMPs can greatly reduce phosphorus movement into surface water from agricultural fields.

EROSION AND RUNOFF-CONTROL BEST MANAGEMENT PRACTICES FOR PHOSPHORUS

Practice	Description	Benefit
1. **Conservation tillage**	Cropping system that maintains at least 30 percent of the soil surface covered with residues after planting.	Helps reduce erosion. Most effective as a BMP when used along with phosphorus-placement methods such as deep banding, incorporation, or seed placement.
2. **Contour farming**	Planting crops in rows that follow the contours of the land, perpendicular to the slope of the land.	Crop furrows are positioned to block downhill water flow, reducing sheet and rill erosion.
3. **Gradient terraces**	A terrace designed to divert runoff to a suitable outlet, such as a grass waterway.	Reduces speed of runoff, and hence, the amount of soil that is eroded from the field during an intense storm.
4. **Level terraces**	A terrace designed to store water until it can be passed through an underground outlet or seep into the soil.	Breaks slopes into segments to stop water movement and allow eroding soil particles to settle out rather than leaving the field.
5. **Grass waterways**	Sodded channel that provides an outlet for runoff.	Serves as a controlled outlet for field runoff water and sediment movement, reducing the potential for gully erosion.
6. **Contour strip cropping**	Alternating strips of close-growing, erosion-resistant crops and erosion-susceptible row crops, planted on the contour.	Eroding sediments from the row crop strips are trapped and deposited in the strips of solid-seeded, erosion-resistant crops.
7. **Vegetative filter strips**	Strips of permanent vegetation on the downhill perimeter of erosive-crop fields or between the field and water bodies.	Catches and filters sediments from surface runoff.
8. **Constructed wetland**	Artificial wetland created downhill from crop fields.	Sediments and runoff are collected, and soluble nutrients are assimilated by growing vegetation.
9. **Sediment-control basin**	A short earth embankment constructed across the slope to form a sediment basin.	Traps runoff water and allows sediments to settle out.
10. **Critical-area planting**	Planting permanent vegetative cover on highly erodible lands that cannot be stabilized by ordinary conservation practices.	Takes erodible land out of production, reducing or eliminating need for phosphorus application on the area.
11. **No tillage**	Direct seeding of the crop into previous residue without tillage.	Greatly reduces soil erosion and increases infiltration rates on most soils.

EIGHT PHOSPHORUS BEST MANAGEMENT PRACTICES

Practice	Description	Benefit
1. Soil testing and sound fertilizer recommendations	Sample the upper 6 inches of soil to analyze for available phosphorus. Fertilize soils with medium or lower phosphorus soil-test values using environmentally and economically sound agronomic guidelines. Soils testing high should not receive phosphorus fertilizer unless as a low rate of banded starter.	Helps determine accurate fertilizer recommendations and reduce potential for excessive phosphorus applications.
2. Determine available phosphorus credits	Credit all available phosphorus from manure and other organic sources.	Results in more accurate phosphorus recommendations.
3. Site-specific management	Rather than applying a single phosphorus rate over the entire field, phosphorus-application rates are varied on-the-go with a variable-rate applicator.	Helps ensure no area of a field receives less or more phosphorus than necessary.
4. Phosphorus placement	Phosphorus fertilizer should be incorporated, deep banded, or banded near the seed at planting on soils with runoff potential.	Reduces potential for runoff of soluble phosphorus.
5. Manure collection, storage, and handling	Sample manure to determine its nutrient content, then calibrate the manure spreader and apply no more than needed to meet the phosphorus requirement of the crop. Incorporate after application. Do not apply manure to frozen soil.	Helps avoid runoff problems and the application of excessive levels of nutrients.
6. Irrigation management	Manage irrigation to prevent overapplication.	Helps prevent phosphorus runoff and leaching.
7. Setback zones	Do not apply phosphorus fertilizers or manure within 100 feet of surface waters or in areas subject to flooding.	Helps prevent direct movement of applied phosphorus into surface waters.
8. Erosion- and runoff-control measures	(see chart on opposite side)	Phosphorus is often tightly attached to soil particles. Reducing soil erosion helps reduce phosphorus losses if phosphorus has been applied to the field surface.