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Agronomy Technical Note

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Phosphorus Management Best Accepted Technology

Recommendations to Address Phosphorus Water Quality Concerns

Phosphorus (P) is an essential element for both plants and animals. It is a component of proteins and nucleic acids and plays an important role in energy transfer. While P concentrates in seeds, it is removed in both grain and forage when crops are harvested.

Phosphorus is applied to crop fields as commercial fertilizers, manures and/or biosolids. Phosphorus present in the soil and applied as a crop nutrient can be lost to surface and ground water by erosion, runoff and leaching. If too much P enters surface water it can cause algal blooms, accelerate eutrophication and increase the cost of treating drinking water.

Agriculture's charge is to manage P judiciously as a crop nutrient and minimize losses to surface and ground water resources.

Overall Management Strategies

Any cropping system that optimizes fertilizer rate, timing and placement and minimizes soil erosion and runoff will effectively manage soil and P losses from fields. The following list of specific management practices can be used to increase farm profitability and minimize soil and P losses.

- Minimize/prevent **all** forms of erosion (sheet and rill, wind, ephemeral and classic gullies, irrigation induced) to decrease P delivered to surface waters. Any soil lost to tile inlets, ditches, streams, rivers, ponds or lakes can negatively impact water quality.
- Reduce runoff by increasing infiltration to decrease dissolved P transport. Runoff can best be decreased by adopting a system that includes long-term, continuous no-till, cover crops, and the treatment and prevention of compaction and surface crusting.
- Improve soil health to increase water infiltration, aggregate stability, functional mycorrhizal communities and improve P availability to crops.
- Utilize flotation equipment and/or controlled traffic cropping systems to decrease the total amount of the field trafficked. This will reduce soil compaction, increase water infiltration and reduce surface runoff.
- Establish setbacks and avoid applications near environmentally sensitive areas (e.g. watercourses, surface tile inlets, tile blow outs, flood plains, steep slopes, poorly drained soils). These practices will reduce P movement to environmentally sensitive areas.
- Limit the number of tile risers in fields. Blind inlets can be used in place of tile risers to filter excess water and P loss to tile drains.
- Repair old, broken tile systems and tile blow outs. This will minimize soil and P loss to ditches and streams via the tile drainage system.

- Eliminate P applications to high testing soils. Well-managed silage, hay and biomass crops will generally remove more P from the field than grain crops and can further help to reduce excessive soil test P levels.
- Minimize the loss of crop residues from fields. Establishing a cover crop, leaving higher stubble heights and avoiding excessive chopping and sizing of crop residues can all reduce residue losses from the field via both wind and water.
- Utilize emerging technologies such as drainage water management, water control structures and constructed wetlands to capture storm runoff and reduce soil and P loss to water.
- Plant cover crops to reduce erosion, increase infiltration, trap and hold crop residues and improve nutrient cycling.

Soil Testing

Fertilizer recommendations are based on the nutrient needs of the crop to be grown and the quantity of those nutrients available in the soil as measured by a soil test.

- Sample and analyze soils every 4 years or less.
- A composite soil sample should consist of a minimum of 12-15 individual soil cores regardless of the soil sampling method (grid, soil type, management zone) used.
- A composite soil sample should not represent more than 20 acres.
- Collect a 0-8 inch soil sample for nutrient recommendations for all agronomic cropping systems. For no till systems, collect an additional 0-4 inch soil sample for pH and lime recommendations only. A 0-4 inch soil sample also can be used to assess the degree of soil nutrient stratification. (continued)

However, the 0-4 inch soil sample should not be used for nutrient recommendations.

- Avoid adding excessive P to soils that do not need P. Agronomically, there is very little likelihood of crop yield response if soil test P is greater than 30 ppm (60 lbs/acre) for corn and soybeans. Applying maintenance rates of P (the P removed in the harvested portion of the crop) will ensure continued high yields. Soil test P levels greater than 50 ppm (100 lbs/acre) increase soluble P and increase dissolved P losses in runoff. Adding P to fields with soil test P levels greater than 50 ppm will almost never result in greater crop yield.
- Optimize soil pH. Liming soils with a pH less than 6.0 will increase the availability of soil P to plants.

Time of Application

- Do not surface apply P (organic or inorganic) to frozen and/or snow covered ground.
- Do not apply P ahead of predicted heavy rainfall or when fields are saturated.
- Only make surface applications of P under ideal (not saturated, not crusted, not compacted or bare) soil conditions. Apply P ahead of planting a cover crop, cash crop or into a growing cover crop whenever possible.
- If a fall or early winter surface application of P and tillage is planned, time the fertilizer application before tillage to ensure P incorporation and reduce the potential for surface P runoff. Seeding a cover crop with this operation also will help minimize P runoff.

Method of Application

Place P below the soil surface (injection or incorporation) to decrease the potential for P runoff.

- When applying maintenance rates (or less) of P, apply the P in a 2 x 2 band placement at planting.
- Use variable rate application methods to apply P only where needed (soil management zones or grid) as indicated by a soil test.
- Do not surface apply P on soils with high runoff potential, especially during late fall, winter and early spring.
- Consider using shallow vertical tillage (may not be no-till) to incorporate P, if applying high rates of P.
- Incorporate P within 24 hours or prior to a predicted rainfall event capable of producing runoff.

Rate

- Minimize soil erosion and runoff to decreases P losses that later will have to be made up with additional applications of P.
- Avoid first, but incorporate biennial applications (one application for two crops).
- Agronomically, there is very little likelihood of crop yield response if soil test P is greater than 30 ppm (60 lbs/acre) for corn and soybeans. Applying P to fields with soil test P levels greater than 50 ppm will almost never result in greater crop yield.
- If soil test P is greater than 200 ppm (400 lbs/acre) stop all P (fertilizer, manure/biosolids) applications.
- For P deficient soils (<15 ppm or 30 lbs/acre), recommended rates of fertilizer should be applied annually. Also, apply 25 to 50 percent of the recommended fertilizer in a band or strip below the surface.
- For biennial applications (one application for two crops), crop response is more likely when the P application is made before the corn crop in a corn-soybean rotation.
- If applying manure and/or biosolids at rates to meet the nitrogen needs of the next crop remember that the amount of P applied is likely enough to satisfy the P recommendations for multiple future crops. Injection and/or incorporation application methods should be used and erosion and runoff should be controlled.

Regular soil testing, scouting for crop nutrient deficiencies, monitoring soil compaction, improving soil health and tissue sampling are all tools that should be part of a nutrient management plan for all cropping systems.

References

Tri-State Fertilizer Recommendations for Corn, Soybean, Wheat & Alfalfa (E-267), 1996.

Indiana Field Office Technical Guide (FOTG) Standard (590) Nutrient Management.

A BMP Toolbox for Reducing Dissolved Phosphorus Runoff to Lake Erie - Draft Working Document, 2011.

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