Managing P Runoff with the P Index

Phosphorus (P) runoff control is essential for protection of the environment. Phosphorus is usually the limiting nutrient in fresh water ecosystems and increases in P may cause algae blooms. As algae die and decompose, the dissolved oxygen in the water decreases and this can harm fish and other aquatic organisms. This P enrichment of surface waters is known as *eutrophication*. The P concentration threshold causing eutrophication can be as low as 0.03 ppm dissolved P and 0.1 ppm total P. Runoff and the associated erosion of soil and tile flow are major pathways by which P enters surface waters. The New York P Runoff Index is a valuable tool for determining the relative risk (field by field) of generating P runoff from agricultural land.

Definitions

Surface runoff is the portion of rainwater (or irrigation water) that falls on a field but does not infiltrate into the soil, either because the soil infiltration rate or infiltration capacity (soil becomes saturated) is exceeded. The energy of raindrops and flowing water moves soil particles and manure, causing P losses from the eroded P-containing particles and the dissolved P in the runoff water. Surface runoff and leaching (base flow of excess soil water) eventually combine to produce the total runoff from an area (Figure 1).

Two Forms of P in Runoff:

Runoff contains dissolved and particulate P.

- Dissolved P is directly available for algae growth or plant uptake. Dissolved P levels can be elevated if rainwater interacts with P-rich soil, manure or fertilizer over time.
- Particulate P is attached to soil or bound in manure particles. Particulate P loss occurs as a result of erosion of soil or direct runoff of manure.

Particulate P can become dissolved P over time and vice versa. For further information on P forms and transformations, see Agronomy Fact Sheet #12: Phosphorus Basics – The Phosphorus Cycle.

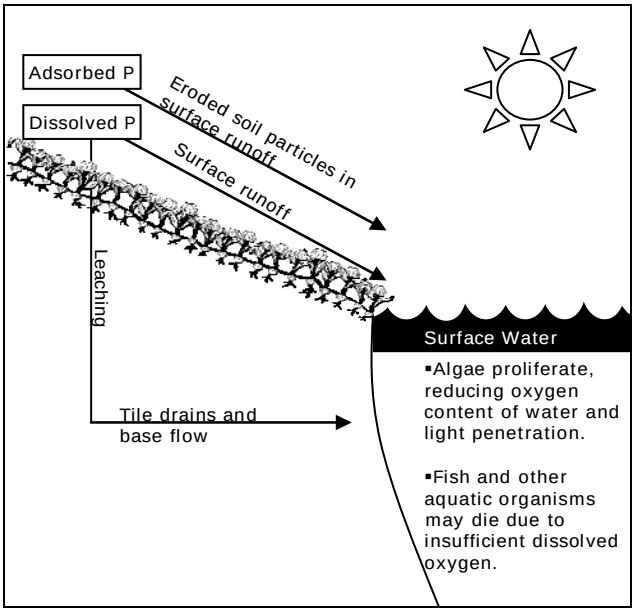

Figure 1: Phosphorus runoff process.

Two Factors Controlling P Runoff:

For P runoff to occur, there must be a P source (P-containing soil, manure or fertilizer P) and a way for this P to move to surface and/or ground water (through leaching). For this reason, the New York P Runoff Index contains a P source factor and a P transport factor.

- The P source factor is the total amount of P in the soil based on soil test information and the planned amount of manure and fertilizer application.
- The P transport factor involves water movement (for both dissolved and particulate P):
  - o Dissolved P transport is mostly controlled by drainage, flooding frequency, and flow distance.
  - o Particulate P transport is mostly controlled by flooding frequency, flow distance, soil erosion, and concentrated flow.

How to Determine Relative Risk of P Runoff:

To determine the P runoff risk for a field, the following information is needed:

- Soil and manure nutrient analyses.

- Phosphorus fertilizer application rate, timing, and method.
- Manure application rate, timing, and method.
- Erosion rate as estimated using the Revised Universal Soil Loss Equation (RUSLE).
- Drainage class and flooding frequency.
- Presence or absence of concentrated flows. "Concentrated flow" refers to surface runoff water eroding the surface of a field in a channel causing the formation of a rill or gully that cannot be smoothed out by normal tillage practices.
- The major water flow path and its distance from the field edge to a waterbody.

The P index combines this information and assigns a risk level to determine relative risk of P runoff (see Agronomy Fact Sheet #10: The New York Phosphorus Runoff Index).

Best Management Practices for Reducing P Runoff:

If the P index score is high or very high, review the variables in the P index calculation to determine which variable added significantly to the index score. Making minor management changes, implementing appropriate conservation practices, and/or altering field boundaries will often result in a lower risk score and may provide additional flexibility in nutrient applications.

If the P *source* score is high:

- Avoid further accumulation of P in soil by allocating manure and/or fertilizer P at agronomic rates to fields that need it for optimum crop production.
- Adjust manure application timing away from months during which soils tend to be saturated (February-April).
- Change manure application methods from surface application to direct incorporation (e.g. knife injection, immediate tillage, etc. – see figure 2). Surface application on frozen, snow covered or saturated ground should be avoided.

If the *dissolved* P score is high:

- Increase flow distances to streams by installing no-spreading zones. Riparian buffer strips along the banks of waterways promote the infiltration and plant uptake of nutrient-rich runoff and trap sediment.

If the *particulate* P score is high:

- Increase flow distance as described above.
- Minimize erosion by:
  - Using cover crops; cover crops may also promote infiltration and plant uptake of nutrients.
  - Implementing conservation tillage practices that retain at least 30% soil residue cover.
  - Using contour strip cropping to slow surface flow and promote plant nutrient uptake.
- Do not spread in areas where concentrated flow may occur. Install grass waterways in these areas.

Figure 2: Direct incorporation of manure can lower P runoff risk.

Additional Resources:

- Cornell University Agronomy Fact Sheet #10: The New York Phoshorus Runoff Index, and #12: Phosphorus Basics – The phosphorus Cycle: nmsp.css.cornell.edu/publications/factsheets.asp
- New York Phosphorus Runoff Index webpage: nmsp.css.cornell.edu/publications/pindex.asp.

For more information

Cornell University Cooperative Extension

Nutrient Management Spear Program
http://nmsp.css.cornell.edu

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