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Quality Water for Idaho

Best Management Practices for Phosphorus Management to Protect Surface Water

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Water is the lifeblood of Idaho. More than 22 billion gallons of water are used in the state each day. More than 97 percent of this water irrigates 4.1 million acres of farmland. Eighty percent of this water comes from surface sources (rivers and reservoirs); the other 20 percent is groundwater. Currently, the quality of water used in Idaho is very good compared with water in other areas of the United States and the world.

Because water is so vital to Idahoans, agricultural best management practices (BMPs) to protect water from phosphorus pollution are becoming more important. Phosphorus is a common water pollutant in Idaho's lakes and rivers. Phosphorus originates from many sources, including agriculture.

Phosphorus is essential to all forms of terrestrial life. It is widely distributed over the surface of the earth in biologically available forms, cycling within plants, animals, soil, and water in the phosphorus cycle. A simplified phosphorus cycle is shown in figure 1. In commercial agriculture, fertilizer is the major phosphorus addition to this cycle.

Water quality problems associated with phosphorus are generally confined to surface waters. Phosphorus in soil is tightly held to soil particles, is immobile, and does not leach. Consequently, contamination of groundwater is rarely a problem. This publication discusses phosphorus as a surface water quality concern.

Many human activities contribute phosphorus to surface waters. Agricultural land enriched with phosphorus by fertilization or manure can contribute substantial amounts of phosphorus to surface waters as the result of runoff and/or erosional processes. Activities associated with modern agriculture often significantly increase soil erosion and water runoff from land and transport sediment into surface waters.

Surface water pollution with phosphorus is controllable — by reducing soil erosion and keeping soil out of creeks, streams, rivers, and lakes.

Specific BMPs for phosphorus fertilizer and manure management that should be employed to protect surface water quality in many areas of Idaho include:

1. Soil erosion control
2. Fertilizer recommendations based on research and soil sampling
3. Correct phosphorus fertilizer placement
4. Variable fertilizer management
5. Efficient manure management
6. Barnyard and/or feedlot runoff control
7. Conservation tillage and residue management
8. Buffer (filter) strips

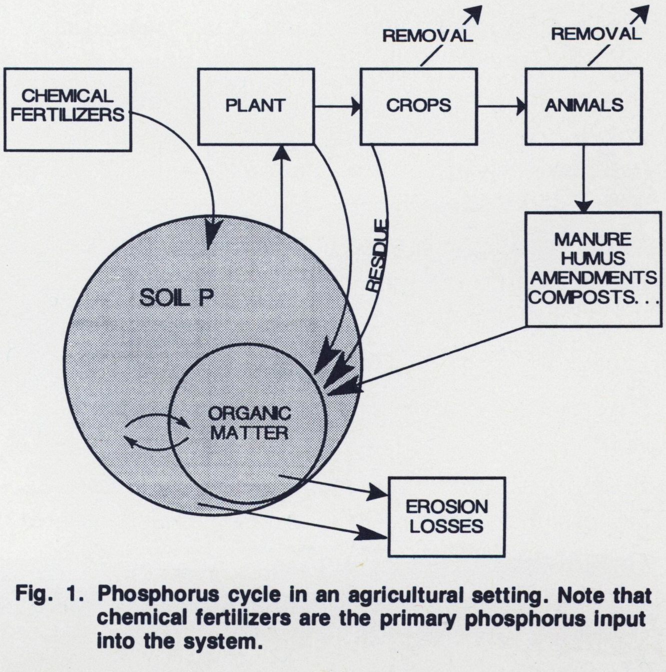

Fig. 1. Phosphorus cycle in an agricultural setting. Note that chemical fertilizers are the primary phosphorus input into the system.

Soil erosion control

Runoff and soil erosion from agricultural lands are major causes of phosphorus pollution of surface waters. In addition to reduced cropland productivity through removal of fertile topsoil, the consequences of soil erosion include accelerated eutrophication (increase in mineral and organic nutrients combined with a decrease in dissolved oxygen — an environment favoring plants over fish) and sedimentation of surface waters, destruction of fish and wildlife habitat, and decreased recreational and aesthetic values of surface waters. Sediment is a prime carrier of phosphorus.

Numerous BMPs for the control of runoff and soil erosion are available. These practices reduce contaminant transport to surface waters. Practices for runoff and soil erosion control include both management practices and physical structures.

Management practices designed to control runoff and soil erosion are:

- **Permanent vegetative cover** — establishment and maintenance of perennial vegetative cover to protect soil and water resources on land retired from agricultural production
- **Conservation cropping sequence (rotation)** — a sequence of crops to provide organic residue for erosion reduction
- **Conservation tillage and residue management** — tillage practices that leave residues from the previous crop on the soil surface
- **Contour farming** — tillage, planting, and cultivation on sloping land performed on the contour of the landscape perpendicular to the slope
- **Strip cropping** — farming operations with alternating strips of row crops, hay, or small grain
- **Cover crops** — ground-hugging crops planted after row crop removal to prevent soil erosion
- **Buffer (filter) strips** — strips or areas of close-growing vegetation (usually grass) for removing sediment, organic matter, and other pollutants from runoff and wastewater
- **Mulching** — use of residue from an off-site source for erosion prevention

Structures designed to control runoff and soil erosion include:

- **Diversions** — channeled ridges perpendicular to slopes
- **Fences** — barriers that enclose or divide land areas and prohibit stock access to critical streambank areas
- **Grade stabilization structures** — structures to stabilize slope gradients, control erosion, and prevent the formation of gullies
- **Grass waterways** — graded, vegetated channels for water runoff
- **Ponds/sediment basins** — structures to trap water and sediments
- **Terraces** — earthen embankments of channels and ridges, perpendicular to the slope, designed to intercept and transport runoff at nonerosive velocities.

Fertilizer recommendations based on research and soil sampling

Phosphorus application rates for Idaho crops should be based on scientific information. Reliable fertilizer recommendations are developed by calibrating and correlating laboratory soil test values with results of plot research on crop response to fertilizer applications rates.

The University of Idaho has developed more than 30 fertilizer guides for Idaho crops. The data base used to develop these fertilizer guides is extensive and has been collected for more than 30 years. Fertilizer guides are based on years of field research and take into account the amount of residual phosphorus in the surface foot of the soil profile.

Soil sampling is a very important BMP that considers the amount of plant-available phosphorus already in the soil profile. Soil sampling should be done 3 to 4 weeks before planting a crop. The soil samples should be representative of the field. Normal sampling depth for phosphorus analysis is 12 inches.

Soil samples for phosphorus should be taken at least once during each crop rotation cycle. Maintain a record of soil test results on each field to evaluate long-term trends of nutrient levels.

Correct phosphorus fertilizer placement

Placement of fertilizers is an integral part of efficient crop management. Correct placement of fertilizers in the plant rooting zone often improves the efficiency by which plants take up nutrients and consequently encourages maximum yields of intensively managed agronomic crops (fig. 2). Correct fertilizer placement is more critical for maximum crop yields under reduced tillage than under conventional tillage.

Phosphorus should never be placed on the soil surface without incorporation. Banded applications below seeding depth, placement with the seed (pop-up), and/or broadcast-incorporated applications are superior to surface broadcast treatments because they minimize erosional losses of phosphorus. Banding of phosphorus below or with the seed is the best BMP (fig. 2) because no phosphorus is left on the soil surface for erosional loss. A broadcast-incorporated application leaves a portion of the phosphorus fertilizer on or near the soil.

Variable fertilizer management

Variable fertility management within a single field has the potential to improve nutrient use efficiency, improve economic crop return, and reduce environmental pollution. A variable fertilizer management strategy can be easily tailored for any field. Knowledge of how yield varies across a field is the primary information a grower needs to implement this BMP.

To use a variable management strategy, follow these steps: (1) divide the field into different management units based on yield potential, (2) take separate soil samples from each management unit in the field, (3) use fertilizer guides to apply nitrogen based on yield potential for each management unit, and (4) apply phosphorus, potassium, and sulfur based on soil sampling and analysis from each management unit.

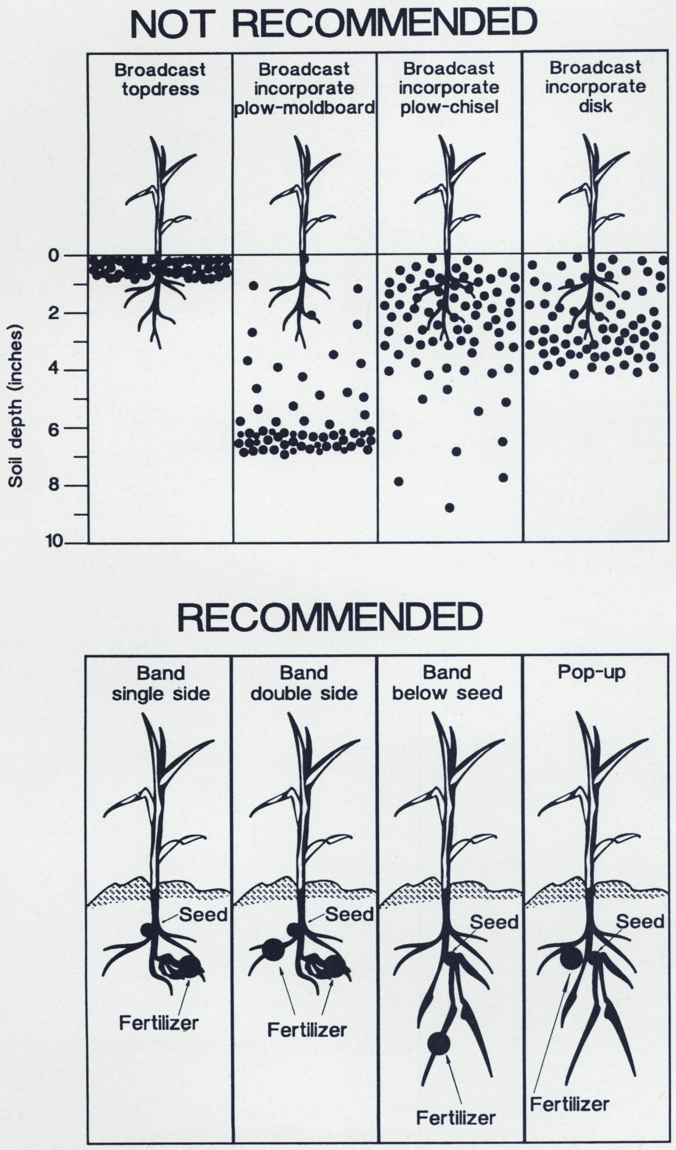

Fig. 2. Methods of applying phosphorus fertilizers on agricultural fields. Broadcast applications (top) leave a portion of the fertilizer near the surface and thus are not recommended for the protection of surface water quality. Banding and pop-up placement of phosphorus (bottom) are BMPs.

Efficient manure management

Runoff from manured fields carries both soluble and sediment-associated contaminants to surface waters. The high soluble phosphorus content of manure can have immediate adverse effects on surface water quality. Manure management strategies should take into account application methods, application rates, application timing, a site evaluation, and manure storage.

As with commercial phosphorus fertilizers, threats to surface water from manure will be minimized if applications are incorporated or injected beneath the soil surface. Manure should be tested for phosphorus content, and a soil test should be taken to help determine the amount to apply to meet crop demand. The amount of phosphorus in the manure can be used as a fertilizer phosphorus credit. The period of major concern for application of manure from a surface water quality standpoint is the winter and early spring months when manure is difficult to incorporate and runoff is most likely.

Site considerations include land slope and proximity to surface waters. When suitable sites for land application of manure are not available, the use of manure storage facilities is recommended. Manure management BMPs are not only environmentally sound but also are very often cost effective.

Barnyard and/or feedlot runoff control

Runoff from barnyards, feedlots, or both contributes significant amounts of nutrients, including phosphorus, to nearby surface waters. Water quality impacts increase with decreased distance between a barnyard and a water body. BMPs to protect water quality can be grouped into clean water diversions and runoff treatment practices. Runoff treatment practices include yard shaping, settling basins, outlet boxes, and filter strips.

Conservation tillage and residue management

Conservation tillage and residue management is any tillage system that leaves plant residue on the soil surface. Conservation tillage systems are BMPs because they reduce both runoff and erosion when they maintain adequate amounts of residue on the soil surface.

Buffer (filter) strips

Buffer strips of vegetation around water bodies reduce the sediment and nutrient contents of runoff. The velocity of runoff passing through a buffer strip is reduced as is its capacity for transporting sediments and nutrients. Sediment is deposited, and runoff infiltrates the soil or passes through the buffer strip with a substantially reduced contaminant load.

Summary of Best Management Practices for phosphorus

- Use soil erosion control practices to minimize runoff and soil loss.
- Test soil and apply phosphorus at recommended rates for crop production in Idaho.
- Credit phosphorus contributions from manure and other organic wastes.
- Band phosphorus below the soil surface or broadcast and incorporate it.
- Limit manure applications on untilled lands.
- Avoid manure applications to sloping, frozen, saturated, or eroding soils.
- Control runoff from barnyards and feedlots.
- Install buffer (filter) strips adjacent to surface waters receiving runoff from croplands.

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