TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE   RENO, NEVADA   SOIL CONSERVATION SERVICE

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AGRONOMY TECHNICAL NOTE NO. NV-60

SUBJECT: CPA - PHOSPHORUS AND WATER QUALITY

The attached Idaho Technical Note Agronomy No. 36 can be useful in discussions with individuals planning to apply phophorus. With the emphasis on water quality, this type of knowledge will be needed.

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for

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U.S. DEPARTMENT OF AGRICULTURE BOISE, IDAHO SOIL CONSERVATION SERVICE

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PHOSPHORUS AND WATER QUALITY

Water quality is one of the important issues facing Idaho agriculture. Agricultural chemicals from non point sources are becoming pollutants in the states rivers, lakes and streams. The purpose of this technical note is to review the role phosphorus plays in water quality and management needed to protect Idaho waters from phosphorus pollution.

PLANT REQUIREMENTS

All plants require phosphorus in their growth processes. They obtain phosphorus from the water solutions within the soil. Plant roots absorb phosphorus from this solution principally as the orthophosphate ion H2PO4-, and to a lesser amount, the secondary orthophosphate H2PO4- ion. Rapidly growing plants must have phosphorus readily available to the roots at all times during the growth period.

PHOSPHORUS IN SOILS

Loam soils typically contain about 3000 pounds of P205 in an acre-furrow slice (top 6 inches) of soil. Only a very small amount of phosphorus in the soil is available to plants. This is because only a small fraction of phosphorus is in solution in the proper ionic form or in contact with the plant roots. Generally, only soils with high phosphorus levels have sufficient phosphorus available to readily meet plant growth requirements. Because of this, farmers must add supplemental phosphorus if quality yields are to be maintained. University of Idaho crop fertilizer guides recommend maintaining available phosphorus in the soil from 4 ppm to as high as 20 ppm, depending upon the crop grown.

PHOSPHORUS MOVEMENT IN THE SOIL

Phosphorus is very reactive in the soil and readily becomes a component of over 30 different chemical compounds. It also ties up (fixes) readily with the clay particles on the soil colloids and becomes immobile. When the soil pH is basic, phosphorus ties up with various calcium and magnesium compounds and has low availability to plants unless there is an

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abundance of phosphorus in the soil. When the soil pH is acid, phosphorus ties up with iron and aluminum to form highly insoluble compounds. Phosphorus has the highest solubility at pH's from 5.5 to 7.0. Even at the most desirable pH level, only a small fraction of the phosphorus in the soil is available in solution at one time.

Soils with higher clay content tie up the phosphate ion more readily and tighter than soils with low clay content. The Phosphate ion stays fixed to the clay colloid or in one of the compounds until acids in the soil break the ionic bonds and change it into the H2PO4- ion. Phosphorus movement is very slow in soils with high clay content. Since phosphorus moves very little in the soil it is not available to all roots. Plant roots are only able to adsorb phosphorus with which they have direct contact. Phosphorus located an inch or two from the root will not be available to the plant. From a crop production standpoint, it is important to keep the phosphorus content of the soil high enough that adequate phosphorus is readily available to the plants' roots.

PHOSPHORUS MOVEMENT IN WATER

Since phosphorus movement is very limited within the soil, there is generally very little or no movement of phosphorus into ground water. Only in extremely coarse soils, where there is little clay and few chemicals to tie up the phosphorus ion, is there a possibility phosphorus might leach below the plant root zone. In many cases soils will absorb phosphorus carried by water. Studies by Carter, etal., at Kimberly, Idaho, show irrigation water coming into a large irrigation tract. About 30 percent more phosphorus came into the tract than left the tract in the runoff and drainage. This shows phosphorus in the water was absorbed as it flowed over and through irrigated soils.

The primary movement of phosphorus is in surface water where phosphorus moves as sediment attached to eroding soil particles. Very little phosphorus will be in a soluble form in surface water. Soluble phosphorus that does get into surface water readily fixes into one of the various phosphate compounds or to colloidial soil particles in the water. Phosphorus also bonds to organic matter and moves in surface water attached to the organic particle. Filters are used to collect phosphate samples in water. Estimates of the amount of phosphorus contained in animal manures can be made by using Table 4-1 of the Agriculture Waste Management Field Manual.

PHOSPHORUS IN SEDIMENT

Studies by the Agricultural Research Service at Kimberley show phosphorus averaged 0.14% of the total sediment loss from irrigated cropland. This is equal to 2.8 pounds per ton of sediment. These studies also show phosphorus concentrations were higher on smaller sediment particles (colloidal clays) than on the larger sediment particles. Under high phosphorus soil conditions, the amount of phosphorus in a ton of sediment would be greater than this amount. Under low fertility conditions it would be less. Generally there are about 3 pounds of phosphorus per ton of soil. Total phosphorus in a ton of soil can be calculated when the approximate amount of phosphorus in the furrow slice is known by using the following formula:

Phosphorus in soil = Total phosphorus in the furrow slice divided by 6 inches divided by 160 tons per acre inch.

Where the soil contains 3000 pounds of phosphorus in the furrow slice, there would be 500 pounds of phosphorus per acre inch. Since an acre inch contains approximately 160 tons of soil we would end up with 3 pounds of phosphorus per ton of soil.

When the amount of phosphorus in the soil in parts per million is known, we can calculate the pounds of phosphorus per ton of soil with the following formula:

Total p per ton = 2000 lbs x ppm

Where the soil contains 2500 parts per million we would have 2000 pound per ton x 2500 ppm, or 5 pounds of phosphorus per ton of soil.

IMPACTS OF PHOSPHORUS IN RUNOFF WATER

Research has not shown a strong impact from phosphorus on running water in streams and rivers. Most stream damage is from attached sediment covering up the spawning beds and aquatic food supplies.

When phosphorus gets into still water ponds, lakes or reservoirs, it helps stimulate aquatic plant growth. Excessive aquatic plant growth reduces the quality of fisheries and recreation areas. In still water management, the object is to control aquatic plant growth by limiting essential nutrients. Phosphorus coming into a pond can be reduced by reducing soil erosion and limiting the amount of sediment with its attached phosphorus entering the pond. When phosphorus becomes the limiting element in the plant food supply, plant growth is reduced and water quality improved. It is often difficult to reduce phosphate levels in ponds and lakes enough to reduce aquatic growth.

WATER OUALITY CONSERVATION PRACTICES FOR PHOSPHORUS

Since phosphorus moves primarily attached to soil particles, the best way to reduce phosphorus movement into surface water is to reduce soil erosion and sediment moving into the water. Erosion control practices that keep the soil from moving are best. Vegetative cover, growing crops or residue that cover the soil and conservation tillage practices are the most effective at stopping soil erosion on cropland fields. Mulching and cover crops can be used to cover the soil when crop residues are not adequate. Banding phosphorus below the soil surface will reduce the accessibility of phosphorus to soil erosion.

Once soil erosion has occurred, sediment basins and filter strips will reduce the amount of eroded soil moving in runoff. Vegetative filter strips can be constructed along the downhill end of the field to trap eroding sediments. Filter strips will trap about 50 percent of the sediment from the field. Ponds can be constructed in drainageways to settle out sediment that has gotten into the stream. Ponds near Kimberly trapped 65 to 76% of the sediment and 25 to 33% of the total phosphorus entering the pond.

In flatter stream areas, shallow paddies can be developed to trap sediment and produce harvestable vegetation. As the vegetation is harvested and removed from the site, phosphorous in the vegetation will also be removed. This will reduce the amount of phosphorus available in the stream system that could move into the still water pond or reservoir.