Water Watch

A newsletter for the Maquoketa River Watershed

Soluble phosphorus from tile drainage – a potential issue

by John Rodecap, Iowa State University Extension project coordinator

Seasonally depleted oxygen levels (hypoxia) have been observed in the Gulf of Mexico. A peak in the hypoxia zone was observed after the floods of 1993 and remained nearly constant through 1997. The hypoxia zone declined only to increase to new record levels in 2001 following the Upper Mississippi River basin's extended spring thaw and wet spring.

The cause of the hypoxia zone and eutrophication problems in Iowa lakes have been linked to over-enrichment from nutrient sources, primarily nitrogen (N) and phosphorus (P).

Like corn and soybeans grown on Midwest soils, plants in water including algae grow best in a nutrient-rich (soluble N and P) environment.

The algae can grow so dense that sunlight no longer reaches some desirable plants in water. When the algae die the decomposition consumes oxygen, often depleting oxygen concentrations below two parts per million (ppm), impacting aquatic species including fish.

Phosphorus was once thought to move into surface water only attached to sediment in surface runoff. Recent statewide ambient water monitoring by the Iowa Department of Natural Resources (IDNR) and Iowa State University (ISU)-IDNR monitoring in the Maquoketa Headwaters watershed indicate P can also be delivered from subsurface (tile) drainage systems. Figure 1 shows P concentrations in stream flows, which at times can be dominated by tile flows.

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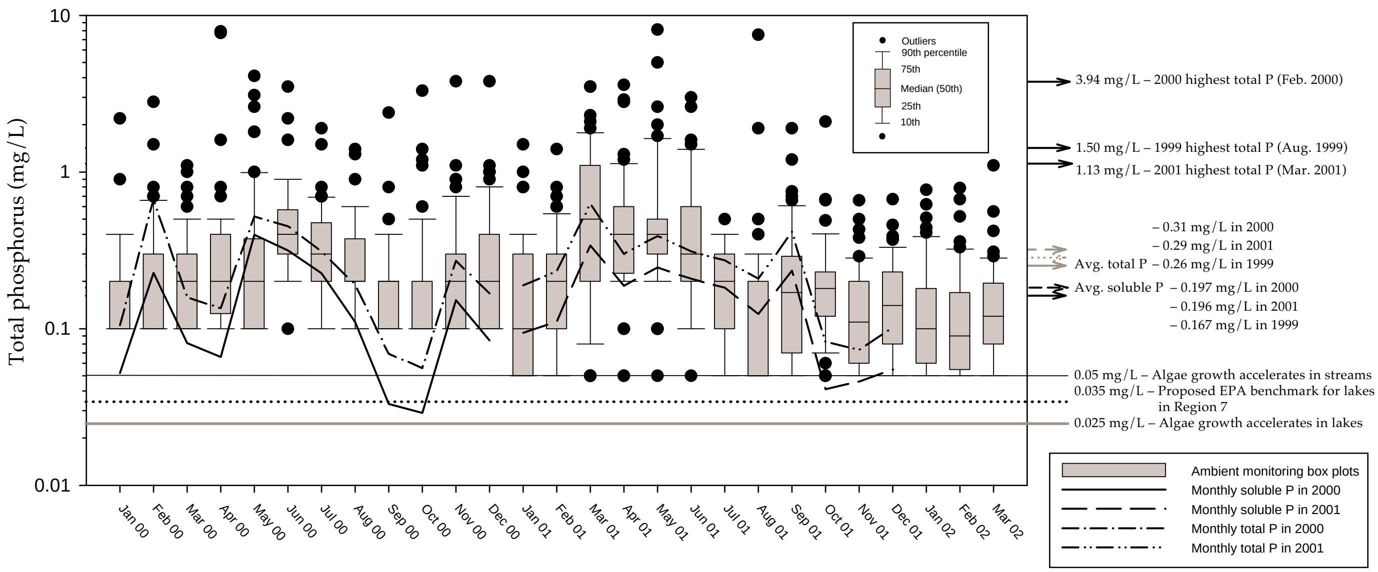

Figure 1. Total phosphorus for ambient non-city sites, IDNR-Geological Survey Bureau ambient monitoring, Jan. 2000-Mar. 2002 (1,539 samples at 57 sites statewide). ISU-IDNR monthly average total and soluble P analyses for 2000-01 at Backbone Park are plotted within the figure (see legends). Annual average analyses of 250-plus samples (1999-2001) from the Maquoketa Headwaters are presented along the right side of this figure.

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Soluble P, cont.

Non-agriculture P sources include point sources such as rural and urban wastewater, construction runoff and atmospheric deposition.

Within agriculture, Iowa agriculture statistics for 2000 indicate commercial P_2O_5 fertilizer applications on corn and soybeans totaled 613,000,000 pounds. At a cost of $0.23 per pound that totals $140,990,000. Most of these dollars are exported from Iowa.

Crop removal by 1.74 billion bushels of corn at 0.375 pound of P_2O_5 per bushel and 459 million bushels of soybeans at 0.80 pound of P_2O_5 per bushel totals 1.02 billion pounds. A considerable portion of Iowa grain production is fed in Iowa and the P cycles back through livestock.

Estimates of cattle, hog and poultry numbers in 2000 indicate approximately 546 million pounds of P_2O_5 was excreted in the manure. Imported P in mineral supplements is fed to the cattle, hog and poultry population. Estimates, depending on feeding strategies and additives like phytase, suggest that nearly 50 percent of the ration-balancing P additions are excreted by livestock and poultry.

The total commercial fertilizer P_2O_5, 613 million pounds, plus manure, 546 million pounds, is approximately 1.16 billion pounds of P_2O_5 versus 1.02 billion in the corn and soybeans produced, a net surplus of 140,000,000 pounds. This does not take into account P made available from soil development and mineralization. Some P leaves Iowa in corn and soybean exports.

Because of continuing importation of fertilizer and ration-balancing P, both soil test levels and acreage of soils testing high or very high for P continue to increase. Iowa State University soil test recommendations differentiate soils on their sub-soil P test. Soils with inherent high subsoil P are in the high soil test range when testing 16 ppm or higher and soils with inherent low subsoil P are in the high soil test range when analyzed at 20 ppm or higher.

Some producers have adopted Global Information System soil testing procedures and variable rate fertilizer application believing they have adopted environmentally friendly technology. The problem is that some fertilizer recommendations continue to call for crop removal rates of P and adding or fertilizing to 20 ppm on high subsoil soils or 25 ppm on low sub-soil soils. A general rule of thumb is an extra 20 pounds of P_2O_5 is required to raise the soil test by one point. As the excessive P level increases, the potential for P movement to streams and rivers increases. For example, Illinois research has shown that soils testing 20 ppm deliver P in runoff and drainage at twice the 0.035 ppm proposed benchmark level for lakes in EPA Region 7, regardless of what tillage system is used.

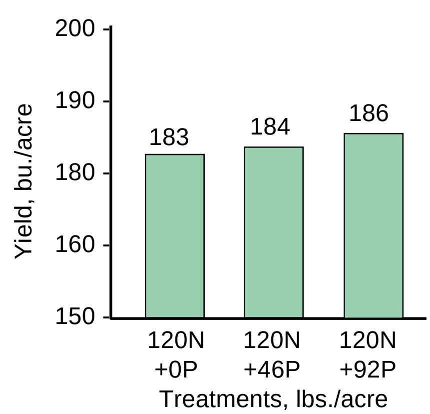

Figure 2. Two-year average corn yields, corn-following-soybean phosphorus demonstrations, 2000-2001.

The ISU-IDNR water monitoring implemented in the Maquoketa Headwaters in 1999, 2000 and 2001 shows annual average total P concentrations in surface water of 0.26, 0.31 and 0.29 ppm respectively, about eight to nine times greater than the 0.035 ppm EPA proposed benchmark concentrations (see figure 1). Starmont High School student monitoring of 89 tile lines on 37 farms in 2001 shows P concentrations of 0.27 ppm in April, 0.24 in May and 0.21 ppm in July, about 7 times the EPA proposed benchmark for P in EPA Region VII lakes.

The good news is the positive impact refined/reduced P use can have on net farm income. This cost avoidance can be viewed as value-added agriculture or economic development in the agriculture sector.

On-farm field demonstrations hosted by nine farmers in the Maquoketa Watershed using various P rates provide clear evidence that addition of P on high-testing soils (average of 52 ppm) is not profitable as shown in figures 2 and 3. Nutrient management workshops with eight to 12 producers in group sessions have

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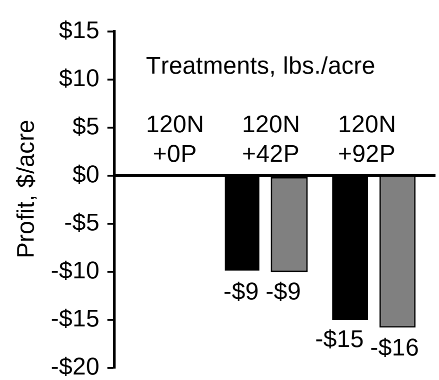

Figure 3. Corn value response to commercial P (P_2O_5 at $0.23 per pound, corn at $2.00 and $2.40 a bushel), 2000-2001.

Field scale GPS-GIS N study among 2002 watershed demos

by Chad Ingels, nutrient and manure management specialist, Maquoketa Watershed Project

Ten Maquoketa Watershed area corn growers have planted 50-acre nitrogen (N) management demonstrations to identify the most efficient and cost-effective N source, rate and application timing based on soil type, plant population, hybrid and tillage and planting system.

These cooperators join 40 southern Minnesota growers in the Center for Agricultural Partnerships' Midwestern Water Quality Project study. The large-scale field trials are designed to collect statistically valid information on individual farms, then pool the data and evaluate it against other related N management research.

The 50-acre large-block study includes N rates of zero, 60, 90, 120 and 150 pounds of N per acre on corn following soybean with the 120 application rate replicated three times across the field. The location of the various nitrogen rates is identified using the Global Positioning System (GPS) that will also be used on the yield-monitor-equipped combine to gather yield data.

Soil type information in the Global Information System (GIS) will be layered over the nitrogen rates and yield information to identify boundaries, yield response and economically-optimum N rates based on soil type.

A test of the N study on eight Minnesota farms in 2001 showed yield variation from 118 to 162 bushels per acre across soil types and an economic optimum N rate of 113 pounds N per acre.

The ten Iowa farms in 2002 have 28 different soil types with corn suitability ratings ranging from 5 to 89.

Nitrogen sources include spring-applied anhydrous ammonia, liquid 32 percent N and 28 percent N applied preplant, with the planter and sidedressed.

Two farms planted their corn no-till in soybean stubble while the remaining were planted using conservation tillage practices.

The University of Minnesota Precision Ag Center is managing the data and calculating the economic optimum N rate for the various management practices.

Cooperators are reimbursed for yield loss with funding from the National Fish and Wildlife Foundation, Shell Oil Co. Marine Habitat Program, U.S. Environmental Protection Agency, McKnight Foundation and the managing partner, the Center for Agriculture Partnerships (CAP), based in North Carolina. The regional partner is Blue Earth Consulting, Lake Crystal, Minn.

"Farmers are willing to do their part to reduce nutrient runoff and improve water quality," says Larry Elworth, executive director for CAP. "But they need proven information on nitrogen use and yield response before they risk an entire year's crop with reduced rates."

Cooperators in the N study are Gary Soules, Nolan Knight, Tim and Jim Recker, Loran Steinlage, Collin Jensen, Verle Jones, Tim and Jim Burrack, C&J Farms, Rodney and Randy Hamlett and Richard Cole.

The Clinton Soil and Water Conservation District, through a grant from the Integrated Farm/Livestock Management Program, has teamed with the Maquoketa Watershed Project to developed a series of manure, phosphorus (P) and N management field demonstrations in the Elk River, Deep Creek and Mineral Creek watersheds.

Brian Feddersen, Clinton, is working with ten cooperating producers in Elk River and Deep Creek watersheds, while project staff are assisting nine producers in Mineral Creek and the Headwaters watersheds during the 2002 crop season.

The field demonstrations will focus on determining the value of livestock manure for use as a crop nutrient source and refining P and N management strategies by comparing different rates of nutrient use.

Data collected from the field demonstrations will be added to information collected in Mineral Creek and the Maquoketa Headwaters watersheds during the 2000 and 2001 seasons and published in *Water Watch* next fall.

Producers hosting field demonstration sites in the four watersheds are: Pat Hartung, Mark Bormann, Gene Grant, Warren Moeller, David Greve, Ron Gray, Dennis Eggers, Ryan Jargo, Steve Eickert, Rich Feddersen, Bruce Reade, Alan Jacobs and Pauline Antons, Russell, Mike and Steve Streeper, Steve Streets and Jerard Gnade, Nick Hayes, Bill Dallenbach, Don Thole, Tom Hayes and Larry Hiemes.

Project staff are providing assistance to Brian Lang, Iowa State University Extension crop production specialist, with research on soybean aphid management.

Mineral Creek demonstration cooperators

Pauline Antons, right, and Alan Jacobs are second-year cooperators in Mineral Creek watershed demonstrations. They are shown at the 2001 nitrogen and phosphorus on corn following beans demonstration site on Antons' farm near Center Junction; this year they are hosting a manure demonstration site on the same farm.

Soluble P, cont.

been very successful in helping producers understand their soil resource, proper soil sampling procedures and how to read important P analysis data on the soil test report. These workshop sessions provide producers with the knowledge and skills to formulate their own recommendations and P management programs for their farms. The workshops also include manure application calibration and as a result, refined use of the P-rich manure resource.

Nutrient management plans become most effective with producer involvement in plan development. Producers, if given the right information as they develop nutrient plans for their farms with mentoring from a crop production specialist, will become consumers of environmentally friendly rates of nutrients used in crop production.

Most people will do what is right if it is good for their net income and the environment.

Phosphorus has been imported for many years; it will take many years to solve the P problem.

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