Kansas Water Resources Research Institute

Annual Technical Report

FY 1998

Introduction

Research Program

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Phosphorus in Surface Runoff: Best Management Practices and Soil Dynamics
Project Number	C-02
Start Date	09/01/1997
End Date	08/31/1999
Research Category	Water Quality
Focus Category #1	Surface Water
Focus Category #2	Nutrients
Focus Category #3	Non Point Pollution
Lead Institution	Kansas State University

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Gary M. Pierzynski	Associate Professor	Kansas State University	01
Keith A. Janssen	Associate Professor	Kansas State University	02
Dan L. Devlin	Associate Professor	Kansas State University	03

Problem and Research Objectives

Total, soluble, and bioavailable P losses in runoff are influenced by a variety of factors. The purpose of this project is to quantify the impact of best management practices on P losses in runoff. The specific objectives are: 1.) To determine the effects of tillage and P rate/placement in a sorghum/soybean crop rotation on sediment, total P, soluble P, total bioavailable P, bioavailable particulate P, and soluble organic P concentrations in surface runoff. 2.) To determine the effects of tillage and P rate/placement

in a sorghum/soybean crop rotation on the distribution of total, Bray-1 extractable, organic, microbial biomass, and bioavailable P concentrations in soil. 3.) To determine the effects of tillage and P placement on P release characteristics of soil. 4.) To related changes in the distribution and forms of soil P to surface runoff characteristics.

Methodology

A field study was established in 1994 near Ottawa in east central Kansas on a Woodson silt loam soil (1-2% slope). The study is a randomized complete block split-plot design with three replications. A sorghum/soybean crop rotation is in place with two sets of plots used such that both crops are grown each year. Tillage systems are the main plots and include conventional (chisel in fall, disk in the early spring, and field cultivation immediately prior to planting), ridge-till, and no-till. Superimposed over the tillage systems are three P fertilizer treatments: a check (no P applied), 25 kg P/ha surface broadcast, and 25 kg P/ha knifed 10 cm below the soil surface. All of the P is applied prior to planting the sorghum; no P is applied the year that soybeans are grown. Plots are 3 by 15 m in size. Runoff is collected by delimiting a 4.65 m2 area in each plot with a metal frame pushed 5 cm into the soil. Runoff is directed to a sump and then pumped through a series of splitters to reduce the overall amount of runoff volume, and to obtain a composite sample of the whole runoff event. The metal frames are put into place early in the spring and left in place until harvest. Water samples are analyzed for sediment, total P, soluble P, and bioavailable P concentrations. Soil samples were collected monthly from each plot to try and establish a relationship between extractable P in soil and P in runoff. These samples were collected to a depth of 5 cm.

Principal Findings and Significance

Previous reports on this project have focused on the runoff results from the sorghum component of the crop rotation. Results from the sorghum plots in 1998 were similar to previous years. Soluble and bioavailable P losses were generally higher for broadcast P compared to knifed P or the no P controls. No-till and ridge-till produced higher soluble and bioavailable P losses compared to conventional tillage. Total P losses were highest for ridge-till compared to either no-till or conventional tillage. Runoff was collected for the first time from the soybean component of the rotation in 1998. Generally, the highest soluble and bioavailable P losses were 5 times lower than the highest such losses from the sorghum. Total P losses were 2 times lower for the same comparison. Results from previous years on the sorghum plots has suggested that soluble and total P losses drop off within the first two or three runoff events following P applications. Therefore, it was expected that these losses would be substantially less for runoff collected from the soybeans compared to the sorghum. Treatment effects on soluble and bioavailable P losses were similar to those found from the sorghum plots while treatment effects on total P were variable. Soil samples (0-5 cm) were collected from both the soybean and sorghum plots shortly after the P treatments were applied, and extracted with the Bray-1 extractant. These results were regressed against soluble and bioavailable P concentrations in water samples from the first runoff event following the treatment applications (recall that treatments were applied to only the sorghum plots). Significant relationships were found for both components of the crop rotation, as shown in Table 1. The interesting aspect of this exercise was that the range of Bray-1 extractable P was similar for both sets of soil samples, yet the soluble and bioavailable P concentrations for the water samples collected from the soybean plots were much lower. Other researchers have shown similar relationships between soil properties and runoff characteristics but our data suggests that the length of time since P was applied is also quite important. Table 1. Linear regression results for Bray-1 extractable P versus soluble (SP) or bioavailable P (BP) concentrations in runoff. Soil samples were collected on July 15, 1998 and the runoff event occurred on July 26, 1998. crop P fraction r2 equation sorghum soluble 0.34 SP = -0.43 +

0.0245(Bray-1) sorghum bioavailable 0.37 BP = -0.46 + 0.0255(Bray-1) soybean soluble 0.25 SP = -0.02 + 0.0017(Bray-1) soybean bioavailable 0.22 BP = -0.008 + 0.002(Bray-1)

Descriptors

Phosphorus, soil-water relationships, water quality, best management practices

Articles in Refereed Scientific Journals

None at this time

Book Chapters

None at this time

Dissertations

None at this time

Water Resources Research Institute Reports

Kansas Water Resources Research Institute, 1998 Annual Report

Conference Proceedings

None at this time

Other Publications

None at this time

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Sources and Control of Geosmin in Midwestern Water Supply Reservoirs
Project Number	B-02
Start Date	09/01/1998
End Date	08/30/2000
Research Category	Water Quality
Focus Category #1	Water Supply
Focus Category #2	Water Quality
Focus Category #3	Treatment
Lead Institution	University of Kansas

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Stephen J. Randtke	Professor	University of Kansas	01
David W. Graham	Professor	University of Kansas	02
Frank deNoyelles	Professor	University of Kansas	03

Problem and Research Objectives

Seasonal taste and odor problems are perhaps the single greatest public relations issue many water utilities face because consumers generally rely on the taste of their water as the primary indicator of its safety. In recent years, Midwestern water utilities have been facing increasing taste and odor problems, some of which have been quite severe. A number of utilities have found it necessary to spend large sums of money for taste and odor control; and their efforts have not always been successful. In the majority of cases, geosmin has been found to be, or is suspected of being, the primary culprit; but information regarding the sources of geosmin in Midwestern reservoirs, and the factors influencing its production, release, and decay, are lacking. There is also a lack information regarding the effectiveness of in-lake management techniques for controlling geosmin in Midwestern reservoirs, as well as the effectiveness of drinking water treatment processes when extremely high levels of geosmin (e.g., 200 to 500 ng/L) are encountered. The goal of this project is to help managers of water supply reservoirs, treatment plant superintendents, and others to control geosmin and related compounds in Midwestern drinking water supplies. Specific objectives include: 1) establishing the relative importance of various sources of geosmin production in typical Midwestern reservoirs; 2) developing a fuller understanding of the physical, chemical, and biological factors influencing geosmin production, release, and decay in Midwestern reservoirs; 3) assessing the ability of both traditional and novel in-lake management techniques to reduce or minimize geosmin production, and to prevent severe episodes; and 4) identifying and developing drinking water treatment processes able to control geosmin during severe episodes when routine methods (e.g., adsorption on PAC, as typically practiced) are inadequate.

Methodology

To accomplish the stated objectives, field sampling is being combined with mesocosm and laboratory experiments. Pilot-scale experiments are planned for the second year of the project to examine selected in-lake management and in-plant treatment techniques. Since geosmin production and decay involve complex phenomena, an integrated approach is required to address the problem in a comprehensive manner. Several reservoirs with a history of taste and odor problems, as well as water treatment facilities drawing water from these reservoirs, are being routinely monitored for geosmin in an effort to detect the onset of geosmin episodes and to examine the effectiveness of current treatment practices for removing geosmin. To identify and characterize potentially significant sources of geosmin, judiciously selected microenvironments in each reservoir will be sampled when episodes occur. This typically happens in the fall or early winter, but may also happen at other times during the year. Microenvironment sampling will involve collecting samples in algal mats, weed beds, brush piles, areas of standing timber, deep and shallow waters, aerobic and anaerobic sediments, mud flats, and influent streams. When high geosmin levels occur, reservoirs will also be intensively sampled to examine the spatial variability of the geosmin. Samples will be collected throughout the reservoirs at various depths and analyzed for geosmin and related water quality parameters. Mesocosms, model ecosystems that can be manipulated to simulate a range of physical, chemical, and biological conditions, are being used to examine geosmin production, release, and decay under more controlled conditions and to examine the

effective of selected in-lake management techniques for geosmin control. Laboratory experiments are being conducted: 1) to obtain a deeper (i.e., mechanistic) understanding of phenomena observed in the field and in mesocosm experiments; and 2) to examine potentially useful treatment techniques on a small scale, especially techniques that are potentially applicable to severe episodes.

Principal Findings and Significance

The following paragraphs describe: the tasks that have been accomplished since the project began in September, 1998; the principal findings to date, and their significance; and future plans. Samples for geosmin analysis have been (and are being) collected from five lakes (including four major federal reservoirs in three different states, as well as a small experimental lake), three tributaries to one lake, and three drinking water treatment plants able to partially remove geosmin. Although detectable levels of geosmin have been found in most samples, no severe episodes have occurred and no microenvironmental samplings have been conducted. Despite the lack of severe episodes, the data are nevertheless quite useful. Samples collected from different depths at two lakes clearly show that the geosmin levels are not always uniformly distributed, yielding important clues as to the sources and behavior of the geosmin. In combination with previously acquired geosmin data and various historical records, these data are expected to prove quite useful in understanding the conditions leading to geosmin production and, ultimately, the causes of severe geosmin episodes. The possibility of adding five additional lakes to the study is being actively explored. For one of these lakes, located in Kansas, the investigators have proposed to jointly conduct an intensive study in cooperation with other investigators at the University of Kansas and the Kansas Biological Survey. In May, 1999, two of the principal investigators made a two-day trip to visit three other lakes (in Oklahoma) that are used as sources of drinking water by a utility experiencing severe periodic taste and odor problems. The investigators met with the water plant superintendents, the lake managers, and other personnel to discuss their experiences in depth and to explore the possibility of participating in a joint project. A mesocosm study involving 32 large (10 m3) tanks was conducted last fall to examine the impact of various loadings of nitrogen and phosphorus on geosmin production. Geosmin production was negligible in all of the tanks, clearly indicating that geosmin production is not simply the result of nutrient enrichment or of a particular nitrogen to phosphorus ratio. Additional experiments are being planned for this fall, but the specifics will depend on the outcome of various laboratory tests being conducted this summer. A large quantity of naturally occurring geosmin was extracted for use in laboratory studies. Some laboratory studies have been completed and others are on-going or in the planning stages. Laboratory-scale tests conducted to date have examined the rate of degradation of dissolved and intracellular geosmin under aerobic and anaerobic conditions and in both light and dark conditions. Dissolved geosmin was found to degrade relatively rapidly (in several days), whereas the degradation rate of intracellular geosmin was substantially slower. Another experiment examined the effect of temperature on the rate of degradation of geosmin, but the samples have not yet been analyzed. Plans for several laboratory experiments involving algae, alone and in combination with bacteria, are presently being refined by the investigators and will be initiated later this month. The results will be used to guide the design of the next set of mesocosm experiments as well as follow-on laboratory studies. Jar tests were conducted to examine the rate and extent of geosmin removal by seven different types of powdered activated carbon (PAC). Additional tests examined the effect of adding various chemicals (potassium permanganate, lime, polymers, chlorine, and chlorine dioxide) before or after the PAC was added. There were significant differences among the types of PAC in both the rate and extent of geosmin adsorption; and all of the chemicals except lime significantly interfered with geosmin removal, whether they were added before or after the PAC. Another experiment examined the use of split dosing of PAC, i.e., dividing the dosage in half and treating the water twice, a practice that is often possible in a water treatment plant and that has been used at times by one of the treatment plants participating in

the study. The results were disappointing, in that split dosing did not appear to offer much of an advantage over the use of a single dosage; but the investigators plan to conduct additional experiments along these and related lines, since substantial benefits are predicted on a theoretical basis. Water utilities faced with severe taste and odor problems often consider using granular activated carbon (GAC) to address the problem. However, as demonstrated by the results of this and other studies, the GAC filters typically used in water treatment plants have a relatively short detention time and are able to remove only a fraction (usually less than half) of the geosmin present in the water being treated. Therefore, GAC must be combined with other processes (e.g., PAC or oxidative processes) to adequately control the problem. To more thoroughly investigate the use of GAC, the investigators collaborated with a local water utility to design and build four pilot columns suitable for studying GAC adsorption. These will be used to conduct pilot studies during the next taste and odor episode this utility experiences. Plans are presently being made to study a number of other treatment technologies, including novel technologies, some suitable for use in treatment facilities and some for use in lakes and reservoirs. The investigators are carefully reviewing the relevant literature before conducting these studies in order to maximize the amount and quality of information obtained.

Descriptors

Geosmin, taste and odor, algae, cyanobacteria, actinomycetes, reservoir management, water quality control, water treatment

Articles in Refereed Scientific Journals

None at this time

Book Chapters

None at this time

Dissertations

None at this time

Water Resources Research Institute Reports

Kansas Water Resources Research Institute, 1998 Annual Report

Conference Proceedings

None at this time

Other Publications

None at this time

Basic Project Information

Basic Project Information	
Category	**Data**
Title	The Relationship Between Soil Test Phosphorus Levels and Phosphorus in Surface Runoff in Manure Amended Soils: A Rainfall Simulator Study.
Project Number	D-01
Start Date	03/01/1999
End Date	02/28/2001
Research Category	Water Quality
Focus Category #1	Surface Water
Focus Category #2	Nutrients
Focus Category #3	Non Point Pollution
Lead Institution	Kansas State University

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Gary M. Pierzynski	Associate Professor	Kansas State University	01
Gary Clark	Professor	Kansas State University	02

Problem and Research Objectives

Our primary objective is to determine the relationship between soil test P levels and total, dissolved, and bioavailable P in surface runoff from manure amended soils.

Methodology

A rainfall simulator will be constructed according to standard plans. Briefly, this consists of an aluminum frame to hold spray nozzles, associated water piping, pressure gauges, and electrical wiring that will provide uniform simulated rainfall to a plot 1 by 2 meters in size. The simulator will be used on plots that will be established in the fall of 1999. Six soil test P levels will be established in separate, duplicated, plots by applying varying amount of cattle manure. The target range of soil test values will be from the initial value plus 250 mg/kg in 50 mg/kg increments. Once established, the rainfall simulator will be used to collect runoff from the plots. The rainfall simulations will be repeated four times over the course of one year. Vegetation and erosion will be controlled on the plots with a heavy application of mulch. Water samples will be analyzed for total, soluble, and bioavailable P concentrations.

Principal Findings and Significance

This is the first report on this project, which was started just 3 months ago. The framing for the rainfall simulator has been constructed and the associated plumbing is being installed. The simulator will be completed by the end of the summer. A graduate student has been hired and will begin fall semester 1999. The student will work on calibrating the simulator, establishing the plots, and collecting the first runoff samples.

Descriptors

Phosphorus, soil-water relationships, water quality, best management practices

Articles in Refereed Scientific Journals

None at this time

Book Chapters

None at this time

Dissertations

None at this time

Water Resources Research Institute Reports

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Conference Proceedings

None at this time

Other Publications

None at this time

Basic Project Information

Basic Project Information	
Category	**Data**
Title	The Kansas Water Institute:colon;colon; An Integrated Electronic Community of Knowledge
Project Number	E-01
Start Date	03/01/1999
End Date	02/28/2000
Research Category	Water Quality

Category	
Focus Category #1	Education
Focus Category #2	None
Focus Category #3	None
Lead Institution	University of Kansas

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Robert Worth Buddemeier	Professional Staff	University of Kansas	01
James K Koelliker	Professor	Kansas State University	02
Edward A. Martinko	Professional Staff	University of Kansas	03
William L. Hargrove	Professional Staff	Kansas State University	04
Gary Clark	Professor	Kansas State University	05

Problem and Research Objectives

The problem to be addressed is that of communication barriers and less than optimal cooperation among the various water research professionals that are capable of contributing to holistic solutions to the problems of water resource use and management in the state of Kansas. The approach to be taken in addressing this is development of effective electronic (WWW) systems and links in the form of a "Virtual Water Institute". This cooperative endeavor will (1)Link, cross-reference and integrate existing electronic resources of relevant agencies and the institutions; (2)Develop specific listings of research needs, issues, and expertise/information throughout the state; and (3) provide mechanisms for exchange and sharing of both information and ideas, and for electronic collaboration.

Methodology

The techniques to be used will be establishment and coordination of multiple websites using the latest in information display and download technology, search engines, and interactive communication links. Contents, format and design will be overseen by a committee of interrelated parties for the participating institutions, with actual development coordinated through the project and institutional webmasters.

Principal Findings and Significance

In as much as funding is not yet in place, no actual results have been obtained. However, initial coordination meetings between KU and KSU personnel have been held, a number of sample/example websites have been identified as possible partial "role models," and extensive preliminary discussions have taken place between scientists, administrators and webmasters at the lead institutions.

Descriptors

Water Resources, Information systems, World Wide Web, Collaboration

Articles in Refereed Scientific Journals

None at this time

Book Chapters

None at this time

Dissertations

None at this time

Water Resources Research Institute Reports

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Conference Proceedings

None at this time

Other Publications

None at this time

Information Transfer Program

The most significant information transfer activity sponsored by KWRRI was the Water and the Future of Kansas Conference. This conference is a statewide conference held to present current information and to discuss current issues in water resources in our state. In March, 1998, approximately 150 people attended representing a crossection of regulatory agency, university, private consulting engineers, and agribusiness personnel.

USGS Internship Program

Internship Evaluation

Additional remarks

Not applicable

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	0	4	0	0	4
Masters	0	1	0	0	1
Ph.D.	0	1	0	0	1
Post-Doc.	0	0	0	0	0
Total	0	6	0	0	6

Awards & Achievements

None at this time

Publications from Prior Projects

Articles in Refereed Scientific Journals

None

Book Chapters

None

Dissertations

None

Water Resources Research Institute Reports

None

Conference Proceedings

None

Other Publications

None