Department of Pesticide Regulation
Environmental Monitoring Branch
1001 I Street
Sacramento, CA 95812

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Study 231: Effects of Polyacrylamide (PAM) on the Movement of Chlorpyrifos and Soil During Irrigation

I. INTRODUCTION.

Orestimba Creek (OC) originates in the Coast Range Mountains in western Stanislaus County, passes through irrigated farmland in the San Joaquin Valley, and terminates at its confluence with the San Joaquin River (SJR). The OC watershed encompasses approximately 18,000 acres devoted to production agriculture, with alfalfa, walnuts, almonds, and dry beans the major crops. Runoff from these agricultural lands flow into OC, ultimately reaching the Bay-Delta. Irrigation tail-water and storm runoff carries pesticides, nutrients, salts and other constituents into OC and subsequently the SJR. These constituents of concern are suspected of causing harm to aquatic organisms. Detections of the organophosphate pesticides diazinon and chlorpyrifos have prompted the listing of OC on the Clean Water Act (CWA) § 303(d) list.

Extensive monitoring by various state and federal agencies during the past 10 years shows organophosphate (OP) insecticides to be a major constituent of concern in the OC watershed (Bacey et al., 2004; Starner et al., 2003; Domagalski et al., 1997; Foe, 1995). Diazinon and chlorpyrifos concentrations have exceeded water quality objectives in the San Joaquin River and its tributaries, including OC, during both the winter dormant spray period and the summer growing season when irrigation return flows occur (Foe, 1995).

One mechanism shown to be effective in reducing the movement of pesticides from the site of their application is application of polyacrylamide (PAM) (Aase et al., 1998; Bjorneberg et al., 2003; Lehrsch et al., 1996; Lentz, and Sojka; 1996; and McElhiney and Osterli, 1996). PAM is a flocculant, causing sediment particles to bind together into particles of larger sizes, which are more resistant to movement by the force of irrigation water. The net effect is a potential decrease in pesticide and soil movement from PAM treated fields (Agassi et al., 1995; Berg and Carter 1980; Singh, et. al., 1996).

This project will measure the effect of PAM in reducing chlorpyrifos movement off-site in irrigation tail-water. Specific test sites will be selected for PAM/Calcium (an improved formulation of PAM) application and monitored by staff from the California Department of Pesticide Regulation.

II. OBJECTIVE.

The objective of this monitoring study is to measure the effect of PAM, applied in irrigation water, has on the mass of pesticide moving out of a furrow-irrigated field during and immediately following irrigation. These data will provide a measure of PAM's efficacy in reducing sediment and chlorpyrifos loadings in surface water runoff in the OC watershed.

Results will be used to support this potential management practice for reducing offsite movement of pesticides to surface water.

III. PERSONNEL.

This is a cooperative study between the Department of Pesticide Regulation, the San Luis and Delta-Mendota Water Authority, and the Coalition For Urban/Rural Environmental Stewardship (**CURES)**. Funds for this project are provided by the California State Proposition 13 (2000 Water Bond) PRISM Grant Program. CURES will be responsible for several aspects of this study including field preparation, the chlorpyrifos application, the irrigation event, and the incorporation of PAM into irrigation water. DPR Environmental Monitoring Branch staff - under the general direction of Kean S. Goh, Agricultural Program Supervisor IV - is responsible for collecting and transporting samples for chemical analysis.

The roles and responsibilities of DPR personnel are identified in DPR's Standard Operating Procedure (SOP): ADMIN002.00 – Personnel Organization and Responsibilities for Studies (www.cdpr.ca.gov/docs/empm/pubs/sops/admin002.pdf).

Key Personnel are:

Project Leader:	Kevin Kelley
Field Coordinator:	Keith Starner
Senior Scientist:	Frank Spurlock
Laboratory Liaison:	Carissa Ganapathy
Chemists:	California Department of Fish and Game.
PRISM Liaison:	Parry Klassen

Questions and comments concerning this monitoring project should be directed to Kevin Kelley at 916.324.4187 or kkelley@cdpr.ca.gov.

IV. STUDY PLAN.

The goal of this study is to determine what effect polyacrylamide (PAM) added to irrigation water will have on the subsequent mass of chlorpyrifos that leaves the field in irrigation runoff. The basic unit for this study is a paired row, consisting of (side by side) a control-row (non-PAM-treated) and a PAM-treated row. Twenty paired rows will be randomly selected across the field. PAM-Calcium will be applied at the appropriate label rate for the soil type, as determined by the grower.

The plan is to simulate one irrigation event, with subsequent runoff from the field. The irrigation event will closely follow irrigation practices currently used in Western Stanislaus County. Irrigation water will come either from an irrigation canal or from a well. Samples of irrigation water will be collected at the time of irrigation (either from the irrigation canal or from irrigation pipes) and analyzed for chlorpyrifos along with the runoff samples.

A fallow field has been chosen to represent a worst-case scenario, with 100% of the applied chlorpyrifos reaching the soil surface and thereby creating the highest potential for chlorpyrifos runoff. The field will be prepared and bedded according to local farm practices for corn production. Row width will be approximately 30" furrow-to-furrow, and each row will be 50 - 100 yards in length. Chlorpyrifos will be applied, following all label directions at the maximum label rate. A broadcast application of a liquid chlorpyrifos formulation will be made either by fixed-wing aircraft or ground-based equipment as appropriate. Irrigation water will be applied twelve to twenty-four hours following application. Irrigation will cease after the appropriate amount of water (per local irrigation practices) has been applied to the field. PAM will be injected into the irrigation water at the head of each PAM-treated row at the onset of irrigation, and continue throughout the irrigation event as appropriate.

At the base of the paired rows, irrigation runoff water will collected in plastic composite buckets. Samples will be collected from composite buckets associated with each sampling unit. As water collects in composite buckets it will be pumped through volumetric flowmeters. Discharged water (from flowmeters) will be split into two components. The majority will be returned to tailwater ditches at the foot of the field. The remainder will be continuously collected in pre-labeled 1-gallon collection containers. A minimum of 40 samples will be collected (one per row). However, as the total volume of runoff cannot be estimated beforehand, a fresh sample will be collected as each previous sample container fills. Estimates for runoff per row are on the order of 50 to 500 gallons, and will vary row by row.

Prior to the onset of runoff, the reading on the flowmeter will be recorded in the field journal, and on field data sheets. As each sample container reaches capacity, the reading on the flowmeter will be notated (field data sheet) and the sample will be diverted into a second bottle. This process will continue until all runoff from the furrow has ceased. Any water remaining in the sample collection buckets will be measured and the value noted on the field data sheet. Samples will be split into 1-liter amber bottles in the field.

Samples will be transported to CDPR's warehouse and/or the Department of Fish and Game's (DFG) Analytical Laboratory according to appropriate sample transportation requirements. DFG's Analytical Laboratory will analyze samples. At sample analysis, the total volume of sample water will be measured for each sample. Samples will be analyzed per DFG Water Sample Analysis QAPP.

Concentration in each sample will represent the mean concentration in the runoff volume that flowed from the row during that sample period. Mass chlorpyrifos moving out of a row will be (for that row):

Σall samples (concentration in each sample X flow from the row during that sampling period).

Environmental parameters, such as dissolved oxygen, pH, and electrical conductivity will be recorded over the course of the study, and will be collected from both head- and tail-water.

V. CHEMICAL ANALYSIS.

Samples will be analyzed for chlorpyrifos. The California Department of Fish and Game's Chemistry Laboratory will analyze all samples. Samples will be collected and transported using the procedures outlined in DPR's SOP (QAQA004.01) for transporting, packaging, and shipping samples from the field to the warehouse. Samples will be analyzed for chlorpyrifos according to procedures outlined in the above document and according to the Determination of Organophosphorous Pesticides in Water Samples of the DFG's Fish and Wildlife Water Pollution Control Laboratory.

VI. QUALITY ASSURANCE/QUALITY CONTROL.

Quality control will be conducted in accordance with The Quality Assurance Project Plan (QAPP) for Study # 231: Water Quality Monitoring and Evaluation of PAM/Calcium Applications CURES PRISM Project, Summer 2006 (Contract # 04-108-555-0). Internal quality control (QC) is achieved by analyzing a series of duplicate, blank, spike, and spike duplicate samples to ensure that analytical results are within the specified QC objectives. The QC sample results are used to quantify precision and accuracy and identify any problem or limitation in the associated sample results. The internal QC components of a sampling and analyses program will ensure that the data of known quality are produced and documented.

VII. NUMBER OF CHEMICAL ANALYSES.

Budget: $65,000

Sample Analysis Costs: Total Sample Analysis: $61,180.

Sample Type	Number	Cost/Sample	Cost
Runoff (5/row: 40 rows)	200 Samples	$ 266.00	$ 53,200
QC (10%)	20 Samples	$ 266.00	$ 5,320
Miscellaneous Samples.	10 Samples	$ 266.00	$ 2,660

Runoff Samples:

Two hundred field-samples (five samples per row x 40 rows) are anticipated. Samples will be collected for the duration of runoff during the irrigation event that follows chlorpyrifos application. Irrigation runoff will be split with the majority returned to tailwater, and the remainder collected into one-gallon glass containers. This gallon will be split into a 1-liter primary sample, a 1-liter backup sample, a 1-liter sample for suspended sediment analysis, and a 500 ml sample for ELISA analysis.

QC Samples:

QC samples (blind spikes) will comprise approximately 10% of total number of samples. Miscellaneous samples (Equipment blanks, headwater samples) will comprise another 5 % of the total samples.

VIII. DATA ANALYSIS.

Concentrations of chlorpyrifos in water will be reported as micrograms/liter (μg/L). Analysis of variance will be used to compare differences between PAM and control treatments.

IX. REFERENCES.

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