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Study 223: Protocol to determine the effect of cover crop and filter strip vegetation on reducing pesticide runoff to surface water. Phase I: pilot study and method development.

I. Introduction

Runoff is a primary mechanism of surface water contamination. A recent review (SRPW, 2001) and two Department of Pesticide Regulation (DPR) studies (Ross et al., 1997; Gill and Spurlock, 2004) indicate that cover crops and vegetative filter strips are effective in reducing runoff of organophosphate and pyrethroid pesticides commonly used in orchards during the dormant season.

The principal mechanism by which these mitigation measures work are (1) through increased water infiltration into the soil yielding reduced total runoff volume, and, to a lesser extent, (2) sediment trapping - thereby reducing off-site movement of sediment bound pesticides. Consequently a measured increase in water infiltration due to the presence of cover crops and/or filter strips (relative to bare ground) provides a direct estimate of the efficacy of these mitigation measures to reduce pesticide runoff. However, certain questions remain: (1) does the effect of cover crops/filter strips on infiltration depend on soil type - such as the variety of California soils on which orchard crops are grown - and (2) is the effect primarily on initial infiltration rates or does increased infiltration due to cover crops also manifest under steady state infiltration, such as might be observed under steady rain events in a wetted soil profile?

This study proposes to adapt a relatively easy, quick and repeatable method for measuring the effect of vegetation on initial and steady-state infiltration rates on a variety of soils on which orchards are grown. While the immediate focus is on orchard dormant spray runoff, the infiltration method has potentially far wider applicability.

II. Study Objectives

Phase I

1. Identify principal soil types where California orchard crops are grown.
2. Develop a method for measuring the effect of vegetation on initial and steady-state infiltration rates on these soils.
3. Estimate the repeatability and range of spatial variability expected in common orchard soils.

Phase II (Conducted after Phase I is completed. Will be detailed in a separate protocol)

1. Test mitigation measure (cover crop and/or filter strip) efficacy on these soils.

This project is part of DPR's Surface Water Protection Program's Operation Plan (2004-05) under Goal 1, Objective 2, Strategy 1, and Activity 2.

III. Personnel

This study will be conducted by staff from the Environmental Monitoring Branch under the general direction of Kean Goh, Ag. Program Supervisor IV. Key personnel are listed below:

Project Leader: Sheryl Gill
Field Coordinator: Roger Sava
Senior Scientist: Frank Spurlock
Potential Collaborators:

Cornell University's Precision and Computational Agriculture Program Staff
University of California Cooperative Extension Staff

Questions concerning this research project should be directed to Sheryl Gill at sgill@cdpr.ca.gov or (916) 324-5144.

IV. Study Design

Method Development

The inherently high degree of spatial, temporal, and soil management associated variability in soil infiltration rates - and the resulting difficulties involved with attempting to estimate field scale infiltration rates from point scale measurements- is well noted in literature (e.g. Viera et al., 1981; Paige and Stone, 1996). Accurately characterizing field scale infiltration rates within an acceptable confidence level may demand many replicated measurements using rapid, portable, and resource efficient methodology (Ogden, 1997).

Ring infiltrometers and rainfall simulators have been used for many years to investigate the processes of runoff and erosion (Neff, 1979). An initial literature review uncovered that much has been written about the design, construction, and operation of these devices. One device, the Cornell Micro Sprinkler, stands out as one well suited to the needs of this study. It combines the benefits of both ponding ring infiltrometers and rainfall simulators while remaining portable and water efficient enough to allow taking multiple samples at each site (Ogden, 1997; van Es, 1999). The units are inexpensive enough to allow the

purchase of several, which would make it possible to run multiple units at one site or to run simultaneous samples at different locations.

This initial pilot study will be used to familiarize staff with the new equipment and calibration procedures, and to estimate the expected range of within-field variability in infiltration rates. These data will then be used to calculate the number and spacing of samples needed to effectively characterize soil infiltration rates in Phase II of the project.

Sampling Site Selection

Soil physical properties- and as a result the potential effects of surface water runoff mitigation measures- vary greatly between soil types. GIS software and pesticide use report (PUR) and soil survey data will be used to identify the primary soil types where orchard crops are grown. Approximately five pilot study sites will be chosen representing a range of soil types. Each site will be sampled twice, once in summer/fall and once in winter (January or February) after the rainy season has begun. Studies have indicated that temporal variability in infiltration rates is significant and recommendations have been made that sampling in time may be as important as sampling in space (van Es, 1999). Sampling twice will give an indication of the degree of temporal variability that may be encountered in Phase II.

While it is anticipated that treatment effects (cover crops or filter strips) in Phase II will outweigh temporal and spatial with-in field variability, data gathered in the Phase I pilot study will indicate if this is a correct assumption.

Soil Sampling Data

Soil property measurements, including bulk density, moisture content, and textural characteristics, will be collected at each sampling site using current DPR soil sampling procedures (Garretson, 1999a-c). Selected data will be compared to soil-survey estimates of texture and bulk density.

Data Analysis

Standard geostatistical methods will be used for infiltration-rate data analysis, including calculation of the variogram and kriging. Distributional analysis may be used to aid in developing field-scale estimates of central tendency and variability of infiltration data. Nonparametric methods will be used to compare infiltration between fields and/or soil types.

V. Schedule

Analyze soil data, sample site location	8/04 to 12/04
Purchase equipment	9/04
Begin sampling	12/04
Sampling complete	6/05
Begin Phase II	6/05

VI. Budget

			Cost
Staff	Env. Scientist ($25/hr)	500 hours	$12,500
	Senior Scientist & Supervision ($32/hr)	40 hours	$1,280
	Staff Benefits (31%)		$4,300
	Student ($11/hr)	200 hours	$2,200
	Admin. for Personnel Services (31.15%)		$4,980
		Total Personnel	$25,260
Equipment	Infiltrometers	4 units @ $1000	$4,000
			$4,000
		Total	$29,260

VII. Literature Cited

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