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Environmental Monitoring Branch
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STUDY #291: EVALUATING S-METOLACHLOR MOVEMENT IN COARSE- AND MEDIUM-TEXTURED CALIFORNIA SOILS

I. INTRODUCTION

Metolachlor, a pre-emergent herbicide primarily used on beans, corn, cotton, and processing tomatoes, has been detected in ground water in several states including Georgia, Iowa, Minnesota, Nebraska, and Wisconsin (Pittman and Berndt, 2003; Kalkoff et al., 1998; MDA, 2010; Spalding et al., 2003; Rheineck and Postle, 2001). The California Department of Pesticide Regulation (DPR) has conducted three ground water monitoring studies in areas with high metolachlor use to determine if the pesticide is reaching ground water in California from agricultural use (Troiano and Sitts, 1990; Weaver and Nordmark, 2002; Bergin and Nordmark, 2012). Metolachlor was not detected in any of the studies despite being detected in other states. Two of these studies also analyzed for and detected the degradates of metolachlor—metolachlor ethanesulfonic acid (ESA) and metolachlor oxanilic acid (OXA) (Weaver and Nordmark, 2002; Bergin and Nordmark, 2012).

DPR has used zero-tension column lysimeters in previous field studies to better understand the persistence and mobility of pesticides and their degradates (Clayton and Aggarwal, 2012; Aggarwal and Clayton, 2013). For this study, DPR will make a combined application of s-metolachlor; simazine, a known ground water contaminant; and potassium bromide, a tracer for the movement of water, to each of three zero-tension column lysimeters. The data collected will help to characterize the fate and movement of s-metolachlor relative to its degradates and to simazine and its degrades. Each lysimeter will contain a different soil type and weekly irrigations will be tailored to achieve similar amounts of leachate from each lysimeter. The leachate will be periodically extracted from the lysimeters and analyzed for bromide and pesticide residues, including degradates. Once the pesticide residues are no longer detected in the leachate, the soil in the lysimeters will be cored and analyzed for pesticide residues.

II. STUDY OBJECTIVE

This study is intended to better understand the fate and movement of s-metolachlor, metolachlor ESA, and metolachlor OXA in various soil types and under irrigated agricultural conditions in California. The s-metolachlor residues and degradates analyzed from the leachate and soil will be compared to the movement of potassium bromide and to simazine and its degradates, deethylsimazine (ACET) and didealkylated triazine (DACT).

III. PERSONNEL

Study personnel from the Environmental Monitoring Branch of DPR include:

Project Leader:	Joy Dias
Field Coordinator:	Alfredo DaSilva
Senior Scientist:	Murray Clayton
Laboratory Liaison:	Sue Peoples for analysis conducted by CDFA
Cooperators:	University of California Kearney Agricultural and Extension Center
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IV. STUDY PLAN

This study will be conducted at the University of California Kearney Agricultural Research and Extension Center. Three zero-tension column lysimeters are installed at this location. Each lysimeter contains an undisturbed sample of a different soil type: Delhi sand, Hanford sandy loam, and Panoche loam. Each lysimeter will receive an application of 14.5 mg each of s-metolachlor and simazine. 1000 mg of potassium bromide will be applied to each lysimeter as a tracer for water movement. Irrigation water will be applied to the lysimeters at 7-day intervals for the duration of the study. The amount of water added to the lysimeters will be calculated based on 160% of cumulative evaporative demand which will be based on reference evapotranspiration (ETo) from a nearby CIMIS weather station for the previous week. Water applications will be tailored to produce approximately 24 mm depth of drainage water weekly from each lysimeter. This depth of drainage water approximates the average weekly depth of drainage predicted by DPR's LEACHM model during a 6 month irrigation season when simulating irrigation efficiencies at 160% of plant demand (Troiano and Clayton, 2009). Collection of daily weather station data will include ETo; mean, maximum, and minimum air temperature; and rainfall.

The leachate will be extracted from the lysimeter reservoirs at 7-day intervals just prior to the weekly water applications. The leachate will be measured for total volume and analyzed for bromide and pesticide residues, including degradates. The sampling will continue weekly until residues are no longer detected in the leachate samples.

Once pesticide residues are no longer detected in the leachate, the lysimeters will be cored to collect soil samples. The cores will be analyzed for bromide and pesticide residues, including degradates.

V. SAMPLING METHODS

Sampling from the lysimeter reservoirs will consist of extracting all of the leachate from each lysimeter using a self-priming, peristaltic pump. Each extraction will be measured for total volume and then partitioned into vessels for bromide, s-metolachlor, and simazine analysis. The samples will then be placed on ice and transferred to refrigerated storage until the

chemical analysis. Between each leachate extraction, the pump's tubing will be flushed with cleansing liquids identical to those used for soil sampling equipment in protocol FSSO002.00 (Garretson, 1999).

Soil to be analyzed for pesticide and bromide residues will be sampled following the general methodology in soil sampling protocol FSSO002.0 (Garretson, 1999). These cores will be sampled to the full lysimeter depth of 3 feet at 6-inch increments. Each 6-inch sub-core will be extracted using post-hole diggers and trowels. The soil extraction equipment will be sanitized consistent with those methods used for bucket augers as stated in sampling protocol FSSO002.00 (Garretson, 1999). Soil from each 6-inch sub-core will be thoroughly mixed inside a plastic bag and two subsamples of approximately 500 g each will be transferred to sealed jars on dry ice and maintained in frozen storage until the chemical analysis. An additional subsample will be transferred to a plastic bag, sealed, and placed in cold storage prior to its analysis for bromide residues using protocol METH007.00 (Pinera-Pasquino, 2008).

VI. CHEMICAL ANALYSIS AND QUALITY CONTROL

The CDFA Center for Analytical Chemistry will conduct the pesticide analysis. Analytical methods are current for water solubilized s-metolachlor, metolachlor ESA, and metolachlor OXA and for water solubilized and soil-bound simazine, ACET, DACT. An analytical method for soil-bound s-metolachlor, metolachlor ESA, and metolachlor OXA will need to be developed. Analytical quality control procedures for these chemicals will follow recommendations from the chemistry laboratory quality control protocol QAQC001.00 (Segawa, 1995). Quality control procedures for the analysis of bromide in water will follow those recommended in protocol METH007.00 (Pinera-Pasquino, 2008).

VII. DATA ANALYSIS

A mass balance analysis will be performed for bromide and the pesticides using residues quantified from the leachate extracted from the lysimeter reservoirs and from the soil cores. Data analysis will include comparing bromide and pesticide movement in the different soil types. These analyses will help to further characterize the movement and fate of s-metolachlor and its degradates and their potential threat to ground water relative to that of simazine under California irrigated agricultural conditions.

This study will provide a dataset on the leaching behavior of s-metolachlor and its degradates that can be used for further development of DPRs ground water model. For modeling purposes, the soil in each lysimeter has been characterized for various hydrogeological properties: hydraulic conductivity, soil water retention parameters, textural composition, total organic carbon content, and bulk density.

VIII. TIMETABLE OF ACTIVITIES

September 2014

- Finalization of study protocol

May – September 2014

- Background leachate extraction from lysimeters

September 2014

- S-metolachlor, simazine, and bromide solution application to lysimeters

September 2014 – February 2015

- Weekly leachate extraction from lysimeters and weekly irrigation
- Biweekly transfer of samples to CDFA laboratory for chemical analysis

March – June 2015

- Weekly irrigation
- Monthly leachate extraction from lysimeters

June 2015

- Soil sampling within lysimeters for chemical and bromide residues.

July – December 2015

- Data analysis

January – June 2016

- Preparation of scientific report

IX. BUDGET

Budget component	Units	Expense/unit($)	Total expense($)
Pesticide analysis of lysimeter reservoir leachate	215	864	185,760
QA/QC for pesticide analysis of lysimeter reservoir leachate	22	864	19,008
Pesticide soil analysis	108	864	93,312
QA/QC for pesticide soil analysis	11	864	9,504
Equipment & supplies	1	1,000	1,000
Travel (days)	40	135	5,400
PY	0.25	100,000	25,000
Total			338,984

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