

AGROCHEMICALS AND WATER QUALITY: AN OVERVIEW OF CURRENT STUDIES AT NHRI

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Introduction

In the semi-arid ecosystem program at the National Hydrology Research Institute (NHRI), one area of research is sustainable development on the prairies. As part of this research, our group is investigating the impact of agriculture on water quality and quantity on the prairies. Agricultural management practices; including tillage, fertilization, pest control and irrigation, are being evaluated in this program. Three studies have been partially funded under the Canada Saskatchewan Agriculture Green Plan Agreement;

- i) Management systems to minimize herbicide and nutrient leaching under irrigation,
- ii) Quality of drainage from the Outlook Irrigation District in relation to irrigation management, and
- iii) Herbicides and nutrients in surface runoff from different tillage systems.

All three studies are being conducted in partnership with Agriculture and Agri-Food Canada through Allan Cessna who provides environmental chemistry and herbicide residue analysis expertise. The Saskatchewan Centre for Soil Research is a partner in the surface runoff study and the Saskatchewan Irrigation Development Centre (SIDC) is a partner in the leaching study. Other co-operators involved in the studies include; Saskatchewan Soil Conservation Association (Conservation Learning Centre), Saskatchewan Research Council and PFRA (Surface Water Quality Study), Saskatchewan Water Corporation and producers.

Herbicide and Nutrient Leaching Under Irrigation

In the past four years, on a tile-drained site at SIDC, we have monitored herbicide leaching under the worst case scenario of the fall irrigation for salt removal. Relative leaching rates have been obtained for a number of commonly-used herbicides (2,4-D, dicamba, MCPA, trifluralin, triallate, bromoxynil, diclofop, mecoprop and clopyralid) and the existence of preferential flowpaths has been established. The objective of the current study is to identify management practices which will prevent or reduce herbicide leaching and preferential flow.

Green Plan funds have been used to establish a "field laboratory" at SIDC. The field laboratory is a tile-drained field irrigated by a centre pivot. The tile drains were installed in the spring of 1994 and are arranged so that effluent from the four quadrants of the field can be monitored separately. Four automated samplers were purchased to collect water samples from the tile drains and to measure flow rates. In most cases the samplers will be programmed to take hourly samples and composite them over a day but the programming can be altered to meet the needs of a particular study. Suction lysimeters have been installed to remove water samples from the soil matrix at 30, 60, 90 and 120 cm depths at two locations in all four quadrants. Two zero tension lysimeters have been installed in each quadrant to capture water moving through preferential flowpaths and time domain reflectometry (TDR) waveguides have been installed to monitor soil water content.

At present we are monitoring the equilibration of the field laboratory. There is still considerable slumping above the drains and infiltration rates and density measurements will be used to test for physical equilibration when the field is visually uniform. During the 1994 fall leaching, water samples taken from the lysimeters and tile drains were analyzed for nutrients and major ions to test for chemical equilibration. These data are still under review.

Management studies will begin when the field laboratory is judged to have equilibrated. Studies being considered include;

- 1) Timing of irrigation in relation to herbicide application. This study will determine a recommended waiting period for irrigation after a herbicide has been sprayed.
- ii) Irrigation application. This study will evaluate the effect of irrigation volume on leaching and water-use efficiency. For example we may compare three applications of 15 mm with one application of 45 mm.
- iii) Fertilizer application method. We will study how leaching is affected by method of fertilizer placement. Fertigation may also be compared to conventional methods.
- iv) Effect of tillage practice. Shallow tillage has been shown to break up pores which allow preferential transport of herbicides and nutrients. Trash cover on zero-till fields may prevent herbicide applications from entering the soil.
- v) Innovative management techniques. We will assess the effect of a light sprinkle irrigation immediately after herbicide application. It is anticipated that this irrigation will enhance herbicide breakdown and hence reduce leaching when the field is irrigated normally.

We do not expect to start management studies until the fall of 1995 at the earliest.

Irrigation Drainage

The objective of this study is to measure quantities of herbicides and nutrients in the drainage water from the Outlook Irrigation District and relate the findings to management practices in the drainage area. Two of the drainage ditches which drained a major portion of the surface-irrigated acres in the district to the South Saskatchewan river are being monitored for flow rate, major nutrients (nitrate, ammonia, total P and ortho P), and a suite of herbicides (2,4-D, dicamba, MCPA, trifluralin, triallate, bromoxynil, diclofop, mecoprop and clopyralid). The results will be related to management data for the drainage areas which are obtained by conducting a survey of the producers each year.

The North (1 C) drain monitored drains approximately 20,000 acres of which about 5,000 are surface irrigated. Since the drain flows through a natural wetland, three samplers were installed to see if passage through the wetland improved the quality of the drainage water. One sampler was installed at the exit from the irrigated area, a second sampler was installed before the drainage water passed into the wetland and the third was on the other side of the wetland just before the outlet to the river. The sampler on the South (9A) drain was installed at a control structure just upstream of the outlet to the river. About 6,500 acres are drained by the South drain but only about 1,600 acres are surface irrigated.

Samplers were installed on the drains from June to October of 1994. Hourly subsamples were taken and composited daily. All samples were analyzed in June and July but then the number was reduced to 3 per week. Herbicide analyses are not yet complete but the nutrient data are available. Nitrate levels were very low in all samples. The maximum concentration observed was less than 1 mg L^{-1} (the Canadian Water Quality Guideline for nitrate is 10 mg L^{-1}). Phosphorus levels in approximately 25 % of samples exceeded the water quality guideline for phosphorus in flowing water of 0.1 mg L^{-1} .

Surface Runoff From Different Tillage Systems

Conservation tillage practices have been designed to sustain soil quality but there is concern that the practices may have adverse affects on water quality as a result of changes in the water balance and generally greater use of agrochemicals. This study was initiated to assess the effects of tillage practice on the quality and quantity of surface runoff water into small reservoirs or natural water bodies.

Study sites have been selected in all major soil zones of Saskatchewan. There are intensively studied sites near Biggar in the Dark Brown Soil Zone and at the Conservation Learning Centre (CLC) near Prince Albert in the Black Soil Zone. In conjunction with our study, Brian McConkey of Agriculture and Agri-Food Canada, Swift Current Research Centre is monitoring water quality in runoff from three different tillage systems in the Brown Soil Zone.

The Biggar site covers an area of approximately 1 square mile and includes four different management systems; long-term zero-tillage (>10 yrs), short term zero-tillage, conventional tillage with high inputs, and conventional tillage with minimal inputs. The site is dissected by natural drainage channels and all water drains on the site to a farm reservoir (stocked with fish). The runoff from each tillage system can be isolated by sampling at strategic points in the drainage network.

At the CLC we have two on-farm sites under zero-tillage management and a site at a neighbouring farm which is conventionally managed. At all three sites, the water body is a small natural wetland in a closed basin. The two basins on the CLC are in a 4-year rotation (peas, barley, canola, wheat) and one basin will be cropped to a broadleaf and the other to a cereal in each year of the study. Peas and Wheat were grown on the basin in 1994. The conventionally farmed basin is in a 3-year rotation (canola, wheat, summerfallow) and was cropped to canola in 1994.

Other study sites, involving farm dugouts, are located at Tisdale (Grey Soil Zone), Craik (Dark Brown Soil Zone) and Lucky Lake (Brown Soil Zone). All farm dugouts in closed basins and the land surrounding them is farmed using management systems typical of the areas. At Craik and Tisdale the water from the dugouts is for domestic use and we are sharing the sites with a SRC/PFRA study on water treatment.

In the fall of 1994 all of the sites were characterised by soil survey and sampling, elevation survey (for basin delineation and landscape classification) and water sampling. Snow surveys were conducted in January and will be repeated if significant additional snowfall is received. Snowmelt runoff will be measured and sampled this spring and we will also monitor runoff-producing rains. The water quality parameters for this study as the same as in the irrigation drainage study.

Discussion

This overview describes studies that were initiated in 1994/95 and will continue until 1997/98. A lot of time has been spent in site selection and characterization and we feel that we have obtained a good group of study sites across the province. The methodology for the studies is in place but there is still time to make changes to accommodate additional measurements or analyses. We hope that others who are interested in these studies will come forward and make comments or suggest possible points for collaboration.

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