METER
ENVIRONMENT

DEGRADATION OF SOIL-APPLIED HERBICIDES UNDER LIMITED IRRIGATION

Soil-applied herbicides are important for controlling weeds in many crops because they offer a broadened control spectrum and chemical diversity. But if soil-applied herbicides persist in the soil too long, there is risk for damage to susceptible rotational crops in succeeding years. Since herbicide degradation in the soil is highly dependent on water, imminent needs to reduce agricultural water use in the future could lead to limited herbicide degradation and a greater risk for carryover.

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Recently Daniel Adamson and a research team at the University of Wyoming, under the guidance of Dr. Gustavo Sbatella, investigated the effects of soil-applied herbicides under limited irrigation conditions. They wanted to understand how

limited irrigation affects the efficacy and carryover of soil-applied herbicides in Wyoming's irrigated crop rotations. A two-part field study was undertaken by applying four soil-applied herbicides to dry beans and four soil-applied herbicides to corn.

SOIL MICROBE ACTIVITY MATTERS

Describing his research site, Adamson says, "Wyoming is not a huge farming state but there's a pocket of farm ground near the Powell/Cody area with a unique rotation. The main crop is sugar beets, and they also grow dry, edible beans, sunflowers and malt barley. Some of these crops don't have a wide variety of post-emergent herbicide options, so growers are dependent on soil-applied herbicides for weed control. However, they need to balance weed control with timely dissipation so sensitive rotational crops won't be injured.

Adamson says that soil-applied herbicides tend to be fairly long-lived in the soil, which is advantageous for weed control. Importantly, the herbicides dissipate through degradation by soil microbes, and soil microbes are highly influenced by how much water is in soil. When the soil is moist and warm, microbes are more active, and they degrade the herbicides faster. Thus, his team hypothesized that if future climate change effects led to limited availability of surface water for irrigation, these herbicides may not degrade as quickly and possibly injure crops planted successionally.

ASSESSING HERBICIDE DAMAGE

During the first year, the research team applied three irrigation treatments to each crop: 100%, 85%, and 70% of crop evapotranspiration. Both crops and soil moisture were monitored using METER data loggers and soil moisture sensors. Adamson recalls, "The sensors were our means of tracking what was happening in the soil in terms of volumetric water content. Some of the areas were chronically dry, so the sensors enabled us to confirm that the treatments were applied correctly and should theoretically affect how the herbicides were performing. The volumetric soil water content of the three irrigation treatments averaged 24%, 18%, and 16% throughout the growing season, and crop yield decreased as irrigation was reduced."

Over the course of the second year, the team collected soil samples at regular intervals following herbicide application. They analyzed the samples for herbicide level and used them to perform a greenhouse bioassay to determine crop response to residual herbicide. Also during the second year, crop response was evaluated in the field when sugar beet, sunflower, and dry bean or corn was planted over the original plots and assessed for herbicide damage.

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HURDLES AND CHALLENGES

Adamson said timing was the major difficulty in terms of applying irrigation treatments. He said, “There were no differences in irrigation timing for the various treatments. The way we irrigated was not representative of a typical deficit irrigation strategy because we were tied to a sprinkler with other projects on it. So we irrigated based on when the full water treatment would normally be irrigated. Other treatments had smaller nozzles so the amount of water was physically reduced.”

Adamson said they also weren’t prepared to track how some of the herbicides would behave in the soil. “Some of the herbicides degrade into metabolites that are phytotoxic in the soil, and it was hard to analyze for all molecules that were plant active. So that was challenging.”

SURPRISING RESULTS

Adamson said the results of the experiment were surprising. He says, “It was a good result for growers because we found there were no differences in the fields, statistically or visually, between how the herbicides carried over in the really dry soil versus the normally irrigated soil. So that was surprising, but from a practical standpoint for farmers, it was important information. They now know if they do have to start applying less water, it isn’t something to be overly concerned about.”

MORE RESEARCH IS NEEDED

Adamson says more work is needed in this area of research. He adds, “There’s a tremendous amount of information within the weed science community about what herbicides do in the soil and things that influence that. But relatively few studies look at changing irrigation rates in a practical sense. A lot of the current studies are done in rain-fed systems where the amount of rain changes (i.e., a normal year vs. a drought year). In irrigated systems, you might reduce the amount of water, but it’s not a drastic reduction like a rain-fed system might experience. There’s not a huge amount of research looking at how different irrigation rates affect herbicide management, so I do think it would be worth exploring in the future.”

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