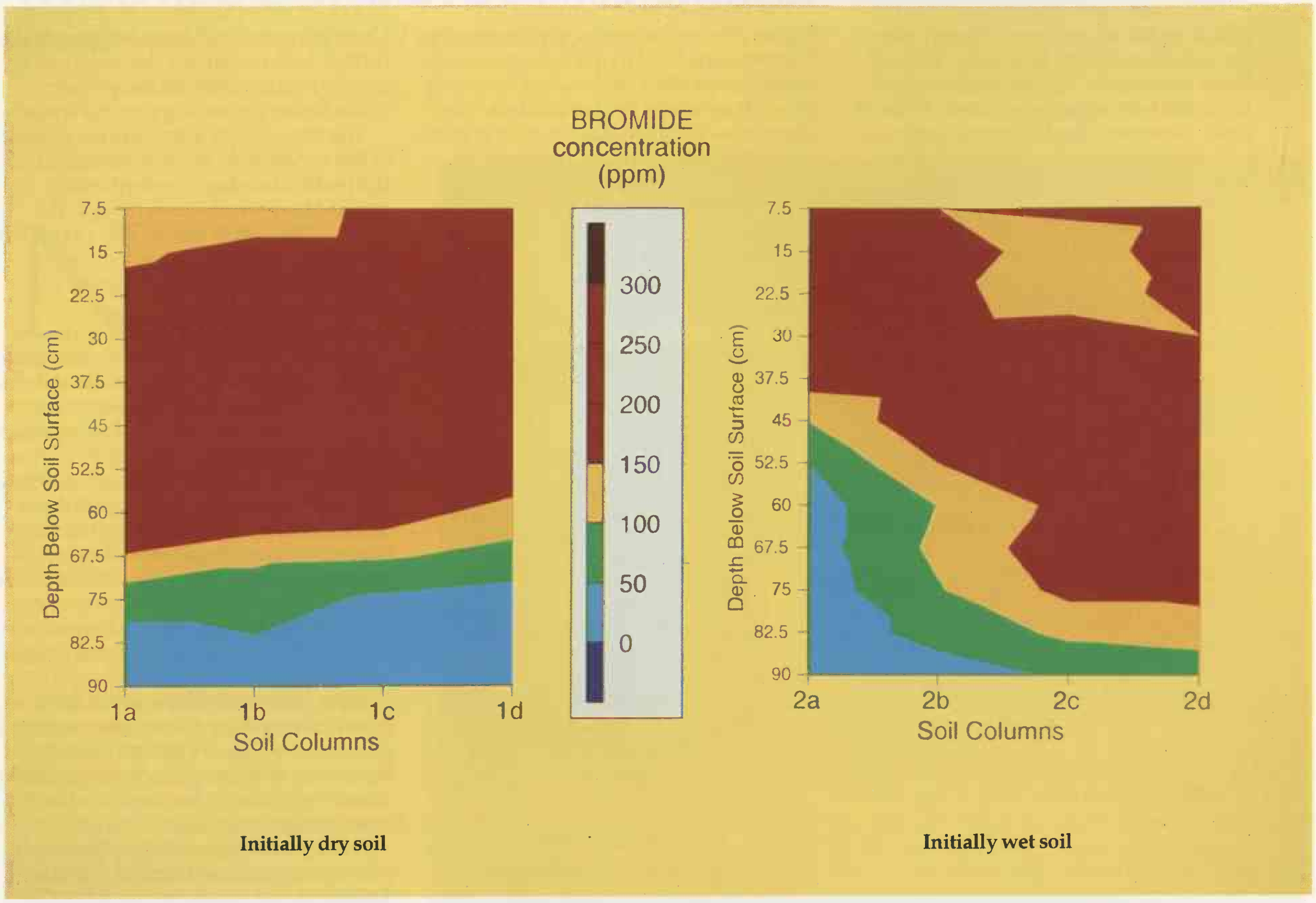

Example of two sites of measured chemical penetration demonstrates patterns of herbicide leaching through wet and dry soils. (Computer artwork by Jon Chernicky)

Some Surprising Movements

By Maggy Zanger

A team of University of Arizona scientists were surprised. Chemicals applied to crops move in soil further than they originally expected; the possibility of contaminated underground water sources could be greater than they had believed. Since farmers still need to apply herbicides and fungicides to grow crops, another look at the way they manage those applications is vital.

Jack Watson, a Cooperative Extension water quality specialist, Art Warrick, a soil physicist, and Jon Chernicky, a weed scientist, recently completed research on the problem at the UA Maricopa Agricultural Center. Their work focused on one question: Can growers manage their crops so as to reduce the likelihood of chemicals moving out of the plant's root zone?

"If we can do that, we will have gone a long way towards solving the problem of ground water contamination by herbicides," Watson says.

To their surprise, the scientists found that when the herbicide they tested is applied to wet soil, it sometimes traveled deeper that when it was applied to dry soil. And, when the chemical is applied to dry soil in irrigation water, higher concentrations of the herbicide remained in the root zone.

Farmers want herbicides to stay in the root zone so they will be more effective. At the same time, herbicides that remain near the surface are obviously less of a threat to an underground water source. Herbicides degrade with time, so the more slowly they travel down from the root zone, the safer they are presumed to be.

The UA researchers speculated the timing of irrigation and the way herbicide was applied might have something to do with the distance into the soil the chemical would travel. So they traced the distance water and an herbicide soaked into soil under three different herbicide application methods. They used the popular herbicide prometryn, blue dye to track its flow in the soil, and potassium bromide, a harmless chemical that moved with the water.

These three chemicals were applied in three different ways.

1. The herbicide, dye and potassium bromide were mixed into the irrigation and applied onto dry soil with a four-inch irrigation.

2. The soil was first irrigated with four inches of water, followed by four more inches of water containing the three chemicals were applied.

3. Using the conventional method of herbicide application, the prometryn, was sprayed onto a dry soil, roto-tilled into the soil and then irrigated with four inches of water containing the dye and bromide.

With each type of treatment, the irrigation water moved more deeply into the soil than did the herbicide. With all three treatments, the herbicide stayed up in the root zone a good deal, Watson says. However, the treatment onto wet soil ended up sending the potassium and the herbicide deeper in some instances.

"We had expected that having the soil initially wet would give us better control of the chemical. It turned out that was not always the case," Watson says. But, if the soil is initially dry when the herbicide is applied through irrigation, the chemical remains nearer the surface.

When applied with irrigation onto dry soil, the prometryn traveled from six to nine inches deep. When applied by irrigation onto wet soil, the prometryn traveled as little as six inches, but as far as 14 inches. Applied conventionally on dry soil, it traveled an average of 12 inches. What do these facts mean to growers, and the way they manage their crops?

"If you go to chemigation, you have to be careful about the soil conditions," Watson says. "You could be worse off than you would be otherwise. It can go as much as 50 percent deeper if the soil is initially wet. But if the soil is initially dry, it appears that using chemigation you can do at least as good a job, or better job, of controlling the depth of movement." Mixing chemicals into the irrigation water saves time and energy and prevents soil compaction because a tractor is not driven over the field another time.

The water-applied herbicide left higher concentrations of the chemical in the root zone than in the conventionally applied roto-tilled herbicide, Chernicky says. He assumes the herbicide is more effective — because it appears in greater concentrations — when applied with water. The experiment, however, did not include weed studies to determine if this greater concentration resulted in more effective use of the herbicide. Perhaps the application rate of chemical herbicides can be cut back by as much as a third with the same effectiveness. Chernicky plans to study this possibility further because such a decrease could greatly reduce costs for the grower while better protecting ground water.

Allan Fertig

Jack Watson

"For whatever reason, the water moved more deeply in some areas than others."

The researchers also were surprised at the variation in the concentration of the herbicide when conventionally applied to dry soil. Even though the sprayer they used was highly calibrated to apply the chemical evenly, the concentration of the chemical varied considerably.

"For whatever reason, the water moved more deeply in some areas than others," Watson says. Since the soil was tested in three inch-wide vertical columns, he did not expect to find so much variation in such a short distance. This uneven flow is called a preferential flow event. The team will next concentrate on researching how and why this uneven dispersion happens. Does it happen consistently throughout the season or is it a one-time event? If it is consistent through the season, is it a random event or does it happen in some type of predictable manner?

If the preferential flow is not random, then perhaps there is an element causing it that scientists have not yet considered. If random, then it raises other questions about how it might be controlled with management practices.

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Charlie Rodgers

UA scientists followed herbicide and water movement through soil. The black circles show where soil samples were taken.