used as fertilizer for crops in Pima and Pinal counties since 1983. Prior to 1983, the sludge was deposited in county landfills. (*See related story.*)

The water hyacinths at the research facility are growing in 3 feet of water contained in six ponds, or raceways. Five of the raceways are 30 feet wide and 200 feet long. The sixth raceway is 39 feet wide and 212 feet long.

"We have been taking water just prior to chlorination, which is the very last step before being discharged in the Santa Cruz River," Karpiscak says. After treatment by the hyacinths, the water is sent back to Roger Road for treatment. This provides the closed-loop, research facility with complete freedom to stress the system until it fails.

Three of the six raceways are equipped with different frost protection systems—a green house, a fog system and a sprinkler system that uses recycled effluent. Three of the cells have no frost protection system.

"This winter, we had plants survive in all the raceways," Karpiscak says. "We're still evaluating the data, but what we know for sure is that we got the plants through the winter and that we are able to treat secondary water to tertiary standards."

The facility has been successfully treating secondary water from the Roger Road facility since research began in late 1988. In August, the hyacinth system began accepting primary water from Roger Road to treat to secondary, and possibly even tertiary, standards. Future research also will focus on the amount of water lost to evapotranspiration.

The water hyacinth project cur-

THE CASE OF THE

MOVING FINGERS

BY LORRAINE B. KINGDON

CHARLIE RODGERS

UA scientists use blue dye to follow herbicide and water movement through soil. The "black dots" show where soil samples have been taken from the test plot.

rently treats about 200,000 gallons of waste water a day, a small percentage of the 55 million gallons of sewage received at the Roger Road and Ina Road facilities each day. Projections for the year 2020 estimate a county output of 110 million gallons a day.

"The reason we looked into the hyacinth program was to see if we could find cost-effective methods we could use in our outlying facilities," says Philip Patterson, the Pima County project manager. "The water hyacinth treatment system is meant for smaller operations, it won't replace large facilities because of the land cost involved." Some studies have estimated a water hyacinth treatment system is 50 percent cheaper to build and 33 percent cheaper to operate than conventional treatment facilities.

Patterson says the results of Karpiscak's research will determine whether the county will implement a full-fledged water hyacinth treatment system in the future.

Although there is little doubt about water hyacinths' ability to treat sewage, the system is unable to handle materials such as toxic chemicals.

"Nothing is designed to deal with that, whether it's a biological system or a traditional sewer treatment facility," Karpiscak says. "People don't realize their garages, kitchens and pantries are filled with all kinds of potent chemicals. If chemicals get thrown down the drain, they end up in millions of gallons of water. The only way to stop that is at the source."

Contact Karpiscak at the UA Office of Arid Lands Studies, 845 N. Park Ave., Tucson, Ariz., 85721, (602) 621-1955.

The mystery isn't solved, but at least Jack Watson knows there is a mystery.

Chemicals in the soil—specifically herbicides and fungicides—aren't acting the way scientists expected them to, says Watson, a University of Arizona Cooperative Extension water quality specialist. Scientific theories currently are based on traditional models developed from laboratory studies. But three years of field observations show chemicals moving more deeply through soil than scientists expected.

The rate at which chemicals move has little bearing on the effectiveness of herbicides or fungicides, so the information might be only of theoretical interest except for concerns about ground water contamination. Suddenly, the mystery assumes critical importance.

"The question haunting us is whether we can use traditional models to predict the flow of chemicals. If not, we're back to square one," Watson said.

Watson and Jon Chernicky, a UA weed scientist, are checking herbicide and water movement through the soil in a particularly colorful way —using blue dye.

At the Maricopa Agricultural Center in Maricopa, Ariz., they tested three different herbicide application methods, using blue dye, herbicide, water and potassium bromide. The potassium bromide, a harmless chemical, was used as a tracer for the water.

As a control, Watson and Chernicky sprayed the broad-leaf herbicide, prometryn, the dye and potassium bromide on the soil surface, and mixed it with the top 2 to 3 inches of the soil before adding 4 inches of irrigation water. This represents the conventional way farmers apply herbicide.

In a second treatment, Watson and Chernicky mixed the herbicide, dye and potassium bromide with the irrigation water before application.

The final treatment involved prewetting the soil. As soon as the water soaked into the soil, the dye, herbicide and potassium bromide were applied immediately in a follow-up irrigation.

The scientists took a total of 1,200 samples of soil to test in the laboratory. Even without waiting for final test results, they have reached some tentative conclusions based on dye patterns in the soil. Some of the dye was absorbed into the soil particles and some into organic matter. The highly visible result was long, blue "fingers," reaching into the soil profile. Generally, the dye stayed close to the top of the soil, but intermittent "fingers" indicated a deeper than average movement.

Watson and Chernicky are trying to discover whether the herbicide moves along the same or similar flow paths as indicated by the fingers, or if it moves uniformly down through the soil.

Watson said they can tell the dye moves much less through wet soil than it does through dry soil.

That knowledge may not seem particularly practical, but the implications are clear for water quality regulations and laws. If pesticides are transported through soils to any great extent, normal agricultural practices may, indeed, impact ground water, even when the water is deep underground.

If the reverse is true—then localized "point sources" more likely cause reported pesticide contamination. In that case, less stringent regulation of pesticide use is probable.

One thing is certain. Scientists will have to re-examine the methods they use to predict chemical movement through the soil.

Contact Watson and Chernicky at the Maricopa Agricultural Center, 37860 W. Smith-Enke Rd., Maricopa, Ariz., 85239, (602) 568-2273.