Lost water of the Napa Valley vineyards

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Getting the most out of every drop of water is a high priority for grape growers in the southern Napa Valley, where summers are hot and dry and vines have to be irrigated to make it through the growing season. But Stanford researchers have found that a significant portion of the water applied to the vines zips right by the plants, hardly even pausing.

"We found that about 10 percent of the water that is applied is lost below the vine rooting zone and does not have contact with the soil and vine roots," said Eve Hinckley, who worked on the project for her PhD thesis in the department of geological and environmental sciences at Stanford. "This is a conservative estimate."

The problem lies in deep cracks that are a chronic feature in the clay-rich soils of the areaDue to the physical and chemical properties of these soils, they naturally swell when wet and shrink as they dry, producing cracks. Hinckley says that tendency is exacerbated by the weekly cycle of irrigating during the growing season, when vines are typically watered for 4 hours a week. Under a regular regimen of swelling and shrinking, the cracks become more pronounced and water speeds through them without interacting with the soil.

Hinckley is presenting her results at the fall meeting of the American Geophysical Union on Wednesday, Dec. 16.

She gathered her data by burying devices called lysimeters about 16 inches down in the soil - just below the root zone of the vines. That is also the depth to which many of the deep cracks penetrate in the

vineyard where she did her study. The lysimeters captured water flowing through the soil, giving her data on the volume, chemical composition, and residence time of water in the soil.

The speedy passage of so much water through the cracks in the soil affects more than just the job of getting enough water to the vines. There are significant consequences on either end of that rapid flow. Upstream, it means that more water has to be stockpiled each winter than the vines are actually using.

All the water needed to sustain the vines through the summer has to be captured for each vineyard by the grower during the preceding winter. Most of that water is diverted from rivers and streams that are temporarily swollen - in a good year - by the winter rains. A lesser portion comes from rain falling directly into the reservoirs and runoff from adjacent slopes.

"You will often see a string of reservoirs coming off of a stream," Hinckley said. "The lowest one has the first water rights. When it's full, the grower closes it off and then the next grower up the slope is allowed to fill." In a winter with low rainfall, sometimes the higher reservoirs in the string never fill completely.

"Diversions are a pretty big deal up in the (river) system," Hinckley said. "And that is what has been a concern to the public, because it is siphoning water from the supply that would be going to groundwater recharge or to streams, where fish may be spawning." Chinook salmon and steelhead trout both spawn in the Napa River and its tributaries.

Hinckley said growers can take several approaches to reducing their water loss. Most vineyards have irrigation drip lines about a foot to 18 inches above the ground surface. Lowering those lines onto the ground - or even burying them - would reduce the speed and force with which

irrigation water hits the ground, slowing its pace through the soil. But lowered or buried the lines are at risk of breakage during tilling operations and buried lines can get plugged.

Another possibility is slowing the rate at which water is delivered from the drip emitter, Hinckley said. "They could irrigate earlier in the day when evaporation rates are lower, and could irrigate for a bit longer, but still deliver less water to the vine and there would be more time for the water to soak into the soil."

Hinckley said some growers have systems that send small pipes down into the root zone of each vine, putting water directly where it is needed. "That is very labor intensive," she said, which makes it expensive to install. "But we are living in a world where water is a precious resource, so many growers are taking those measures."

Slower delivery could also help mitigate the problem of animal burrows, mainly ground squirrels, which are usually just below and parallel to the ground surface. Like the cracks, burrows offer water an easier path than slowly percolating through the soil and thus contribute to routing water away from the vines. Hinckley's lysimeters did not intercept water flowing through these burrows, which is one reason why she says the 10 percent estimate of water loss is a minimum. She said she's been out in the vineyards during big rainstorms and seen the burrow's effect.

"It basically looks like an artesian well," she said. "Water is flowing up, just spurting out from the subsurface."

The winter storms also revealed another cause for concern.

To determine the residency time of irrigation water in the soil, Hinckley analyzed the sulfur in the irrigation water she captured. Growers typically apply sulfur to their vines weekly throughout the growing

season to combat mildew. The form of sulfur they use is chemically distinguishable from the sulfur found in the soil naturally, so by determining the quantity and type of sulfur in the water, she could tell whether the water had lingered in the soil long enough to react with it.

In addition to enabling her to calculate that at least 10 percent of the irrigation water was zipping past the root zone without reacting, she discovered that during the winter rainstorms, all the sulfur applied to the vines during the previous growing season was getting washed below the rooting zone of the vines, and potentially out of the vineyard. That could have significant consequences for areas downstream, she said.

"The growers absolutely bathe the landscape in sulfur," Hinckley said. "They are broadcast spraying it across the whole vineyard."

"The next stage of work is to look at what the implications of that sulfur input are for aquatic systems downgradient of the vineyards," she said. "There, sulfur may interact with other elements, such as heavy metals, which could have ecological consequences."

Provided by Stanford University

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