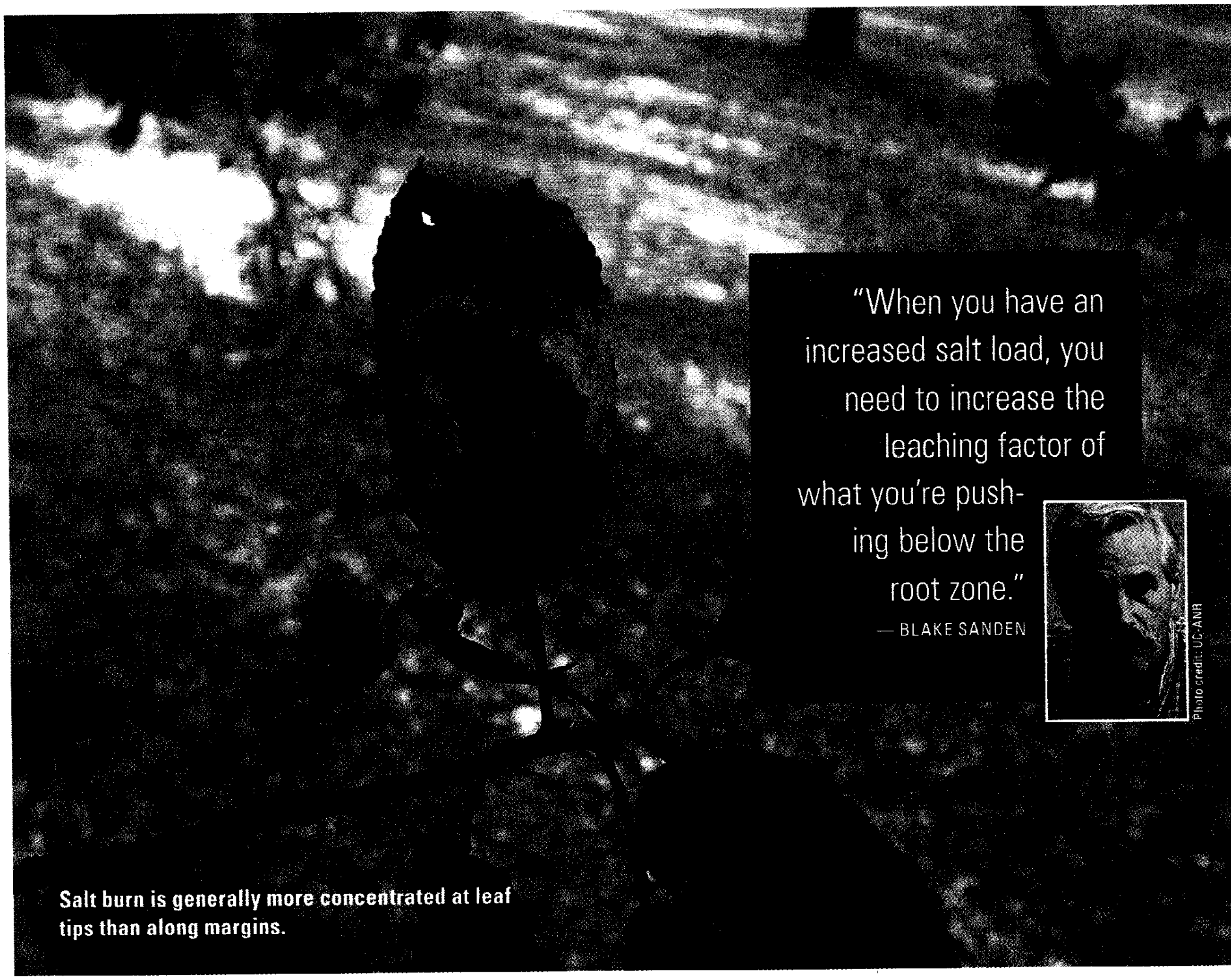
GROUNDWATER SALINITY TORCHING CALIFORNIA ALMONDS

After four years of drought, burned leaves and defoliation are a common sight in almond trees irrigated with salty groundwater.



> "When you have an increased salt load, you need to increase the leaching factor of what you're pushing below the root zone."
> — BLAKE SANDEN

Photo credit: UC-ANR

Salt burn is generally more concentrated at leaf tips than along margins.

Photo credit: Brent Holtz

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MILLIONS OF YEARS ago, the Central Valley was an inland sea, and sharks were swimming through Bakersfield.

Eventually, that inland sea receded and fresh water from snowpack, floodwaters and estuaries began displacing the salty water in the area's aquifer, pushing it out toward the west, explains Blake Sanden, farm advisor with the Kern County Cooperative Extension.

Now almond growers — particularly those on the west side of the Valley, who are relying more heavily on groundwater irrigation — are dealing with the ramifications of saline water. "The initial disposition of why the west side is salty in the unconfined aquifer on top, and why the east side is not, is just the whole nature of ancient geology," Sanden says.

But we've actually made it worse through the drilling of wells and our ability to import water from the California aqueduct 450 miles to the north.

"Now what you're doing is creating a net import of salts into the south Valley for which previously, the only recharge into that unconfined groundwater pumping aquifer was the snowmelt runoff and rain," Sanden explains. "This is more than an additional million tons of extra salt a year being imported by that aqueduct water down to the different water districts that are using that aqueduct water."

THE IMPACT OF SALINITY ON ALMONDS

Crops such as cotton, alfalfa, and even pistachios can handle some salinity, but almonds tend to suffer, because they don't have the ability to generate a high level sugar and electrolyte concentration in the roots, Sanden explains.

"As the salt concentration in soil goes up, the osmotic resistance to water movement into the roots increases," he says. "The plants can't pump water into the roots."

In addition to total salinity, Sanden says almonds growers have to be concerned about specific ion toxicity, which comes from sodium chloride and boron.

"If you have high boron and you're growing almonds, you have big problems," he says. "As little as five pounds of soluble boron per every acre-foot (of water) can cause trouble in almonds."

Sanden says there are some engineering outfits trying to develop inexpensive ion exchange scrubbers to pull the boron out,

RESEARCHERS STUDY ALMOND ROOTSTOCK SALT TOLERANCE

Some newer rootstocks are showing promising tolerance to salinity.

The continued drought means more growers are relying on groundwater, which, depending on location, can be quite saline. Consequences of salty water on almonds include leaf burn and defoliation. But, some rootstocks might be more tolerant of salt.

Patrick Brown, professor of plant sciences at the University of California-Davis, has been working with colleagues to test the salt-tolerance of various rootstocks to determine which, if any, can withstand increased water salinity. They're also studying ways growers can manage water such that the salinity effects are minimized on the trees.

"It's very clear that there is a tremendous variety of response to salinity in Californian rootstock material," Brown says. "The traditional material that's most widely planted is Nemaguard, and actually, among the common rootstocks, that's probably the poorest in terms of tolerance to salinity."

Brown says to date, the best materials they've tested include Viking and Empyrean. "Their level of tolerance to salt and chloride is really remarkably better than Nemaguard," he says.

"We're also working on screening methods, so that new rootstocks, as they come along, can be screened for their potential tolerance to salt so that growers, when they make an investment in an orchard and plant the orchard, they can be assured that they're planting the best possible rootstock for the challenges they have," he adds.

Irrigation Management

As almond planting continues to increase and water becomes more scarce, Brown and his colleagues determined it was also important to study irrigation management and how certain practices might minimize the impact of saline water. They're currently in the process of determining when to use poor-quality water versus good-quality water, and how using the right water at the right time could mitigate the effects of salt.

Brown adds that salinity and nitrogen management are very closely tied together.

"When you have access to adequate or greater than adequate levels of water, such as during the winter, the standard strategy (for managing salinity) would be to apply large volumes of water and wash the salt out of the soil," he says.

However, that approach can put at risk the leftover nitrogen in the root zone, which could leach into the groundwater supply.

"It's pretty clear that growers are going to have to think of managing salinity and preventing the loss of nitrogen through the bottom of the profile at the same time," Brown says. "And that's a new context that most growers will not have thought about, and it's going to take some clever strategies and some good education to make sure we can manage both those things at the same time."

WHAT'S THE PROBLEM WITH SALINITY?

Besides testing various rootstocks, researchers have been working to identify what it is about salinity that damages trees, says UC-Davis' Patrick Brown.

"It's well known that salinity can be a problem because it induces water stress, but salinity can also be a problem because the plants are sensitive to high levels of sodium and chloride," Brown, says. "In the studies that we've been doing to date, it appears that the most important factor, first and foremost, is the chloride, and then the sodium. The salt-induced water stress from excess salinity, while it is important, is not as important as the toxicity caused by those ions."

The researchers are also working on gaining a better understanding of the biology of salt and how it moves around the plant.

"That will also help us understand better how to manage and mitigate the problem," Brown says.

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Photo credit: UC-Davis

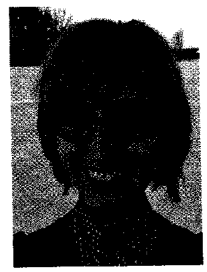
but an economical way to do it has not yet been discovered. Others have been toying with using reverse osmosis for salt mitigation, but so far, no one has developed an economically practical system for agricultural irrigation purposes.

WHAT GROWERS CAN DO

There are some things growers can do, though, to mitigate the risk of adverse effects from saline water. Soluble calcium helps displace soluble sodium, for example, so gypsum can be applied to reduce the amount of soluble sodium present. Gypsum also improves the soil structure to help with leaching.

"When you have an increased salt load, you need to increase the leaching factor of what you're pushing below the root zone," Sanden says. "If we have drought conditions, where we only get a couple or three inches of rain, and it's not enough with just the rainfall to push salts out of the root zone, then you, as a grower, have to apply extra water to accomplish leaching."

In addition, Sanden says there are some wetting agents that can be used to help water move through the soil more easily. In the meantime, "pray for rain," he says. ●



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