Long term irrigation with saline water - the Israeli perspective

An interview with a local researcher

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Dr. Eran Rave, head of Gilat Research Center, ARO.

We are pleased to host Dr. Eran Rave for a discussion on the past, current and future use of saline water in Israel. Dr. Rave is a whole-plant physiologist, specializing in the effects of environmental conditions on plant development, photosynthesis and assimilate transport, and CAM photosynthetic plants. Dr. Rave also works closely with citrus growers in Israel dealing with treated wastewater irrigation. Today, Dr. Rave is the head of Gilat Research Center which is a part of the Agriculture Research Organization (ARO) of Israel.

What is your perspective on the use of saline water in Israel along the years?

Since its establishment, two major problems have arisen in the water sector in Israel - a decrease in the amount of water suitable for drinking, and a constant deterioration in its quality. The level of salinity in the Sea of Galilee, Israel's main freshwater source, and in the aquifers rose constantly and decreased the quality of the water.

Until 1990, the water used for agriculture was drinking water. Only from the 1990s did the process of water recycling and the use of effluent water begin. About 70 percent of the sewage water in Israel is purified and used for irrigation purposes. In the nineties the quality of recycled water was not as high as it is today and it was more saline.

Also, over-pumping of water from aquifers in the Negev desert increased salinity until it became undrinkable and unsuitable even for agriculture.

It took time to understand that there is a problem with the use of saline water for irrigation. During the first years, between 1992-1997, no effects were observed, and only after 5-10 years of saline water irrigation, some indicators of negative effects were observed. There were no immediate yield losses at first. The water used for irrigation had 230-250 mg/l of Cl,- which is not very high, but over the years, and with very little leaching, the effect of long-term salinity build-up was observed in both soils and plants.

Does the purpose justify the risk?

The use of saline water came from pure necessity of water for irrigation. The main water source for irrigation back then was from the largest treated wastewater facility in the Dan region (central Israel), that was used for irrigation in the south of Israel. Looking back, the use of that water saved the Israeli agriculture, since no other water source was available. The use of saline water for irrigation in Israel was drastically reduced following the acknowledgment of its negative effects. There are still some places that use saline water for irrigation but it's not as common as before. Since then, the quality of the treated wastewater has improved, and the salinity levels were decreased, mainly by using sea water from the desalination project. Also, many farms have their own desalination systems.

How does water salinity affect the plants' ability to take up nutrients from the soil?

High soil salinity has a secondary effect on nutrient uptake by plants. High salinity reduces the plants' water consumption and consequently the water flow from the soil and through the plant is reduced. Since most of the nutrients are taken up and flow in the plant with the water flow, any reduction in water flow leads to reduction in nutrient uptake.

Primarily referring to nitrogen uptake, which can be reduced x4 under saline water irrigation. As for other nutrients, there is a competition for uptake between cationic nutrients and high concentrations of sodium.

Is the damage to the soil following the long-term saline water irrigation irreversible?

There is no conclusive answer for that. The soil SAR was increased but the soil EC was reduced after moving to low salinity water irrigation and natural leaching by rains. The soil SAR can be recovered with the right treatment.

Is there any direct correlation between soil/water salinity and increasing salt content in the plants and edible parts?

Salts accumulate in all plant organs, from roots to leaves and fruits. In most cases, the roots accumulate most of the salts, and in some crops, like carrots, that's the edible part. Salts can also accumulate in edible leaves like lettuce, or in fruits, such as in citrus. High irrigation water salinity will eventually lead to salt accumulation in all plant tissues.

In addition to the damage to plants, is there any hazard for human consumption of high salt content of fruits and vegetables?

In root vegetables we have reached near risky levels, but there was never any risk for the public. The salinity level in carrots, for example, can reach 80 mg\l following saline water irrigation. In citrus, the salt levels reached levels which are toxic to the tree itself, but the salt concentration in the fruit remained lower and it was nontoxic for human consumption.

Is the salt accumulation in plants reversible?

In vegetables and rotational crops, it's not an issue since they are harvested at the end of the season. Soils with high salt content can be leached to reduce salt levels and sail SAR can be treated by Ca amendment. In tree crops it takes more time. Leaves of trees are replaced every year or two, so they will become clean eventually. There is some salt accumulation in the roots and trunk that will be flushed by water flow over time when irrigating with fresh water.

Is there any practice you can recommend for reducing or monitoring the salinity level in soils and crops?

Keep your finger on the pulse! Don't wait for a scheduled lab analysis at the end of the season or a visit from the extension service. Do frequent soil salinity analysis - at least once a month - by simple means of sampling small amounts of soil (such as a laundry detergent spoon), 1:1 dilution with water and measuring with an EC meter;

Occasionally flush soil salts by non-saline irrigation and monitoring;

Soil mulching to reduce evaporation and salt accumulation in the topsoil layer;

Reduce pulse irrigation and maintain long, deep irrigation to expand the moisture bulb around the dripper as much as possible and drive the salts away from the root zone.

Does the future depend on genetically modified salinity resistant plants?

When no other option exists, we must irrigate with saline water. But eventually even desert plants that are salt tolerant, will die as a result of high salinity. A genetic solution is too farfetched since it takes 10-20 years of research, so it won't be relevant enough. The salts need to be removed one way or another. It's better to treat the water beforehand, than to treat the soil later, but it's not always possible. On the other hand, irrigation with desalinated sea water also poses a few problems. The lack of crucial ions in the water can also do damage to plants.

Based on the Israeli experience and your personal experience, what can you recommend when dealing with saline water?

There is no global silver bullet. Every region needs its own solution according to the local conditions, available water sources, and resources for addressing the problem.

The basics would be to constantly monitor the salinity built-up in the soil by simple means. Conduct soil flushing occasionally. Use salt resistant rootstocks if available.

The red line is irreversible damage from long term irrigation with salty water. Usually, it will be soil damage, as plants can be easily replaced. Soil remediation might take time, good quality ware and resources. The bottom line is the economic cost-effective solution per local conditions.

Considering the above perspective by Dr. Rave, we can conclude that irrigation with saline water sources is not recommended, since it might cause long-term damage to soil and plants. When no other water is available and it's the only option, caution needs to be taken. Monitoring the salinity levels and correct salt management can sustain growth under saline conditions.

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