

News (News)

## The need and how of breeding alfalfa for salt tolerance

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As more salt-tolerant alfalfa varieties are developed, managing high soil salinity should become increasingly achievable for forage producers in the western U.S. Highly saline soils have been a thorn in the side of alfalfa producers in arid regions of the United States for years. Soils that are high in salt can limit alfalfa yields, and have a negative effect on plant emergence and health.

However, Forage Genetics International (FGI) and W-L Alfalfas are pioneering new ways to mitigate soil salinity by developing alfalfa varieties that are increasingly salt tolerant. These new varieties are designed to thrive in saline soils—a condition that will escalate in the future.

Saline soils develop when irrigated water that is moderately high in salt is applied to crops in arid environments. In turn, this saline water evaporates, concentrating salts near the surface. Because of inadequate rainfall, these accumulated salts are unable to leach down through the soil profile. In the Northern Plains, where soil salinity is not as pronounced as in the arid West, salts can still accumulate as a result of fluctuating water tables or saline seeps (that is, low spots on the landscape). Soil salinity is particularly prevalent in areas

of California, Texas, Nevada, Utah and Arizona.

"When you have salty soil, the salt clings to the soil particles and actually pulls moisture away," said Peter Reisen, Ph.D, director of plant breeding at FGI. "So, you can have a field that is well-irrigated, and yet the plants look like they're suffering from drought because they're not able to access that water." On saline soils, alfalfa plants must work harder and use more energy to adjust their internal cell solution to make the osmotic gradient more favorable to water absorption.

Saline soil conditions are often accompanied by two other soil problems: high sodium content (sodic soils) and high soil pH (alkaline soils). Sodic conditions negatively affect soil structure and water penetration. Alkaline soils are poor for plant growth, limiting the availability of key nutrients. The combination can compound stress on alfalfa plants, hampering crop establishment and production.

### Soil salinity and alfalfa producers

Sharon Benes, Ph.D., a professor at California State University, Fresno, has conducted research on soil salinity in California where the greater salinity problems for forage producers are found in the western San Joaquin Valley and in the Imperial Valley.

"As we have continuing irrigation water shortages in California, the higher-quality (less saline) waters will be used for the irrigation of trees and vines," said Benes. "It is pretty apparent that more saline waters will be used for forage production. With less surface water available for irrigation, many growers are using deeper groundwater for their irrigation water source. This generally means that more saline water is being applied to soils."

Other water sources are being tapped, said Benes. "If a grower is using saline well waters, or in some cases a municipal waste water with some salinity, then a soil salinity problem can develop. As is the water, so will be the soil, although water management practices such as leaching can be employed to reverse this trend."

Benes stresses the importance of soil sampling so that growers can determine the exact level of salinity, and then make better soil and crop management decisions. "It's important for growers to determine whether they have just a salinity problem or if they have saline-sodic soils, which means not only too much sodium but also not enough calcium," she said. "Sodicity can reduce the emergence of alfalfa plants, and cause poor water infiltration and drainage through the soil profile."

### Current research on salt tolerance

FGI with W-L Alfalfas began an aggressive breeding effort in 2010, evaluating and screening alfalfa plants for salt tolerance in actual field conditions. FGI uses three methods for testing new salt-tolerant alfalfa varieties:

1. **Greenhouse testing:** FGI conducts salt germination tests, which measure alfalfa seed germination under moderately high salt conditions. They also compare a new variety or breeding line to established tolerant and non-tolerant checks. A second test measures alfalfa plant growth and production potential using pure water versus using salt water.

2. **Field nurseries:** FGI tests the salt tolerance of various alfalfa varieties through six nurseries in locations from Texas to Washington that typify saline soil stresses.

"Currently, we have more than 50,000 plants we are evaluating for salt tolerance in these six environments," said Reisen. "Our program continues to expand, and the number of alfalfa seeds we plant gets larger every year."

Only the strong plants survive. If a field nursery has 5,000 alfalfa plants, after two or three years, that nursery may be down to 10 or 15 plants that are still vigorous and truly salt tolerant. "Those are the plants we would use as parents for a new variety," explained Reisen. "So once we select these plants, we're looking at another five to eight years of crossing and breeding and development before we have a variety that we can say is truly salt tolerant." FGI's data also confirms that a variety will not only perform well under salt conditions, but will also thrive where saline is not a problem, as farmers' soils are variable and not 100 percent saline.

3. **Marker-assisted selection:** Falling prices have made marker-assisted selection more appealing to alfalfa researchers. Leaf samples can be taken from plants in the greenhouse, and those genes that provide salt tolerance are then identified. FGI and its partners, including the Samuel Roberts Noble Foundation, are working with various methodologies to advance this type of genetics research. "This is a new tool in our toolbox that we think will really help speed our breeding programs and provide growers with better products faster," said Reisen.

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FGI salt-tolerant alfalfa varieties are also screened and evaluated for high resistance to all major alfalfa diseases, particularly in the areas where they will be sold.

**The outlook on soil salinity**

"Anywhere that irrigation water is becoming limited, soil salinity is going to become a bigger and bigger problem," said Reisen. "We're going to see more of it in the High Plains and Central Plains, spreading down into Kansas, Oklahoma and Texas. In the West, current water demands are great due to lack of adequate winter precipitation, which is the source of most of our irrigation water. Lack of snow and rain is impacting aquifers, which results in wells drying up. We're simply not getting the recharge that's needed."

"The development of salt-tolerant alfalfa varieties is vital for producers in our region," said Benes. "It seems that drought is in our future. We may have some wet years ahead, but we're going to continue to have very dry years. I think that the ability to grow alfalfa on more saline soils, or under irrigation with more saline water, will be critical for the future.

"The good news is that seed companies have been working on developing more salt-tolerant varieties, and they are increasing the salinity tolerance of alfalfa through these breeding efforts," said Benes.

And help is indeed on the way. "This is another area in which FGI continues to lead, as first-generation material that has gone through lab, greenhouse and extensive field evaluations could be available in as little as three years," said Jeremy Hayward, brand manager, W-L Alfalfas. "While W-L has several varieties in the lineup that meet or exceed industry checks on germination and forage salt tolerance testing, varieties that will come out of these new breeding efforts hold much promise."

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