High Salt, Low Water Barleys

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One recently developed type of barley can produce half a ton of grain per acre using seawater as its sole irrigation. Another type, even newer, can yield two tons per acre without any watering after it is planted. It grows to maturity using a single 6-to-8-inch irrigation given before planting, plus two to six inches of rain.

University of Arizona plant breeder Dr. R. Thomas Ramage and his co-workers developed both of these barleys.

The latter type has two roles cut out for it: as a January-to-April crop in rotation with cotton on irrigated Southwestern farmland, and as a quick, after-rainstorm crop in unirrigated deserts like North Africa's. Genetically uniform lines of barley suited to specific growing conditions are now being selected from the variable population developed for single-irrigation use.

For the type of barley that grows with just seawater, the half-ton yield is too low to be economically practical now, compared with the 3- to-4-ton yields of conventionally grown barleys. However, it offers some security for a time when fresh water becomes too scarce or expensive. Also, another line from Ramage's salt-tolerant population yields up to two tons of grain using water about half as salty as the sea. Water of this high salinity (1.5 to 2% salt, compared with 3% for seawater) is available but unused in several areas of the West.

Photograph: Barley from a one-irrigation test plot in Tucson.

Genetic Plasticity

Besides allowing specific benefits from either the one-irrigation or the salt-tolerant barley populations, the breeding work behind them has demonstrated that a crop grown by farmers for thousands of years can still be rapidly adapted to new growing requirements.

One key growing requirement for crop plants in Arizona from now on will be efficient use of water. The state uses up about 2.2 million acre-feet more groundwater each year than is replenished naturally, and nine-tenths of the state's total water depletion is by irrigated agriculture. Other dry regions in the Southwest and worldwide also need crop plants that use water at peak efficiency.

"Domestic crops have enough genetic plasticity for us to make them much more efficient users of what water we have available," Ramage said recently. ". . .We have been pleasantly surprised at how quickly we have moved barley to this situation" (single-irrigation growth with good yields).

This barley research is one example of work to improve traditional crops' ability to use low levels or low quality of water. Such efforts are a promising counterpart to more widely known work in adapting wild desert or seaside plants into marketable crops.

Ramage started breeding barley for salt tolerance in 1959. He was testing a breeding method for pushing a selected plant characteristic to an extreme while maintaining a genetically diversified population. From that population, individual plants can be isolated and inbred to give genetically uniform lines adapted to specific growing requirements. Many varieties that share the same desired trait (salt tolerance, for example), but differ in other characteristics, can all be developed this way from the same population.

Salt Tolerance

For refining this breeding method, Ramage chose salt tolerance in barley as the trait to push. Barley is more salt-tolerant than other cereal grains, but varieties available when he started this work could not give economic yields with water saltier than 0.75%. Ramage developed his original salt-tolerant barley population at Safford on salty soil using salty irrigation water.

By 1970, selected lines from this population had been grown with seawater in California by Dr. Emanuel Epstein. The half-ton yields are not enough to satisfy Ramage.

He said, "You could grow thousands of acres of barley on sand dunes with seawater and lose money on every acre of it. . . . Still, it's good to know that if we did have to depend on seawater sometime in the future, we could take these domesticated crops and have a usable production from them."

Salt-tolerant barley has some potential uses that look more immediately practical than seawater farming. Arizona has large supplies of water that is too salty for many uses, but not as salty as the sea. Dr. Edward P. Glenn and Barney P. Popkin described these supplies at the 1981 meeting of the Arizona-Nevada Academy of Science. Salty groundwater is easily accessible near the heavy soils of the Safford area, near the loams of the Gila River Indian Reservation and near the sandy soils of the Wellton-Mohawk Irrigation District. There is more in northeast Arizona, near Buckeye and south of Tucson. Also, water that has been used for some industrial or urban purposes is available but salty.

In recent years, Ramage has tested varieties from his salt-tolerant population that yield up to two tons when irrigated with 2% salt water in a greenhouse. Standard varieties in the same conditions yield almost nothing. Another test line yields 2.5 tons per acre with 3% salt water if it has first been sprouted with 1% salt water. Such varieties may allow productive use of the low-quality water available in this state and elsewhere.

Single-Irrigation Barley

Uses for Ramage's single-irrigation population may be even more widespread. He started developing this population about eight years ago in cooperation with a U.S. Agency for International Development project in North Africa. Some areas there with less than a foot of rainfall a year get most of that rain in a few sporadic storms. A grain that could be grown to maturity on one initial watering would allow desert dwellers there to plant their fields after a heavy storm and expect some harvest whether or not other rain came.

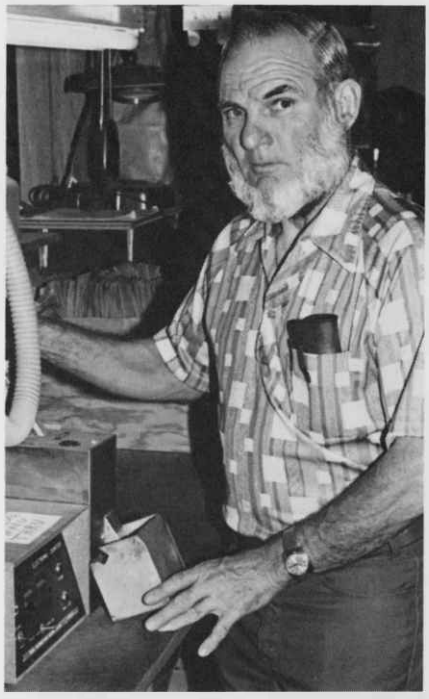
"This happens to be the exact type of barley that our cotton farmers need here," said Ramage. They can schedule their irrigation, instead of waiting for the rain. By irrigating, then planting barley after harvesting cotton, they can make full-season use of their farmland with minimal extra use of water. The barley can be harvested in time for May 1 cotton planting.

Ramage and his co-workers have produced a population of barley that suits these needs. In tests this year at Tucson and Mesa, selected lines from that population yielded 1.5 to 2 tons of grain per acre with a single pre-planting irrigation of six to eight inches and negligible subsequent rainfall.

Ramage and Rex Thompson, who conducted the Mesa test, officially released the single-irrigation population this summer on behalf of the UA Agricultural Experiment Staion and the U.S. Department of Agriculture. The population is called Composite Cross XXXIX. The release makes it available to other public or private plant breeders. They can select from the population specific lines that perform well in various local conditions. Some lines are now being tested in North Africa. Ramage expects commercial seed companies to find lines they will inbreed for uniformity, then market for U.S. growers.

The best-yielding test lines from Composite Cross XXXIX reach maturity about a week earlier than standard barley varieties in some tests. That is probably one factor in their ability to get by on less watering. Another may be a deep root system; the initial irrigation moistens the soil to a depth of five to six feet. Ramage pointed out that further research to pinpoint the ways in which some varieties use soil moisture more efficiently than others could make the plant breeder's job easier.

He said, "There is no reason to expect that water efficiency of other traditional crops can't be improved the way we have improved barley's."



Dr. R. Thomas Ramage with grain-counting machine for analyzing barley harvest. (Photo by Ted Bundy.)