

Plant Genetic Resources for Marginal Environments: Identification, Multiplication & Dissemination



Amaranth is a highly nutritious multi-purpose crop being tested for its ability to grow and produce yields in highly saline and marginal environments.



There is a continuous need to search and identify high value food and bioenergy crops such as mustard, which has many uses, to provide farmers with options for crop diversification in marginal and saline environments.

Thematic Area: Crop Productivity and Diversification

Purpose: Identify and isolate genes contributing significantly to salinity tolerance

Geographic Scope: Global

Timeline: 2013 - 2015

Partners:

- Consultative Group for International Agricultural Research (CGIAR)
- United States Department of Agriculture (USDA)
- World Vegetable Center (AVRDC)
- National Agricultural Research System (NARS)

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Salinization poses a serious threat, particularly to countries with arid and semi-arid climates like those of the Middle East and North Africa (MENA) region. More than 1.5 million hectares of agricultural land is lost every year to salinity and it is estimated that as much as 20% of the world's arable land is saline. The end result? Crop yield decline, major constraints for agriculture production and increased global threat to food security. It is clear that we are at a crossroads where innovative methods are needed to sustain agricultural production.

The plant genetic resources program at the International Center for Biosaline Agriculture (ICBA) is studying a wide range of salt-tolerant and water-use efficient crops, to assess their ability to grow and produce economic yields under marginal conditions. The main objectives of the "Plant Genetic Resources for Marginal Environments: Identification, Multiplication and Dissemination" project launched by ICBA include:

- > Acquisition of crop/plant species germplasm with potential tolerance to salinity and heat stress;
- > Identification of new crop/plant species genotypes with local adaptation, high yield potential and salinity tolerance though preliminary evaluation;
- > Seed multiplication and dissemination of stress-tolerant germplasm for conservation and further utilization.

ICBA is operating a Genebank to acquire, conserve and distribute germplasm of food, forage and bioenergy crops. So far, some 12,600 accessions of 230 proven to be or potentially salt-tolerant species originating from 134 countries have been assembled from various sources and conserved in the ICBA Genebank under a controlled environment (35°C and 30-40% RH). ICBA's Genebank plays a major role in conserving plant genetic materials that can have a vital role in coping with the challenges to agricultural productivity resulting from climate change and environmental degradation.

Activities and Outcomes

With the initial focus on forage production, several crops such as sorghum, pearl millet, triticale, and buffel grass were screened for tolerance at various levels of salinity. Crops with multiple uses (forage, food and industrial) such as safflower, cowpea, guar and quinoa were identified as promising alternatives for diversifying production.



Sesbania, a multi-purpose salt tolerant leguminous forage crop can provide farmers with options for crop diversification.

Recent germplasm acquisition included the barley core collection consisting of 2,750 accessions, 52 salt-tolerant wheat accessions from Mexico, six quinoa accessions from Peru and a wild cowpea variety (*Vigna marina*) native to the Hawaiian Islands that grows naturally on sandy beaches and frontal dunes near the seashore and has presumed value as salt-tolerant forage. In addition, samples of *Citrullus colocynthis* were collected from the northern areas of the United Arab Emirates (UAE). *Citrullus* has good potential as biodiesel feedstock crop for marginal areas as the seeds contain 30-40% oil.

Field trials were conducted from 2012-2014 to evaluate the effect of salinity on growth and yield potential of amaranth, mustard, oat and sesbania. Amaranth is an annual leafy vegetable with edible leaves and stems. It is also known for being gluten-free seeds and high in lysine, fiber and protein which are important nutrients. Mustard is cultivated for its tender green leaves used as vegetable while the seeds are a source of edible oil and

also used as a condiment. Oat is a cool season cereal. Its grain is used widely for human consumption especially as a breakfast cereal but also topically in health and beauty products for the skin. Additionally the green plant makes good forage, hay and silage, while the grain is also an important as livestock feed. Sesbania is a short-lived perennial, cultivated primarily as a green manure and source of forage for small ruminants.

Results from field trials show that amaranth has good adaptation to the UAE environment and produces high biomass and seed yields with non-saline water. Oat, mustard and sesbania were moderately tolerant as increase in salinity from 0.2 (control) to 5 dS/m had only marginal effect on yields. In mustard, the study has also enabled the identification of three accessions with a high degree of salinity tolerance.

Seeds of salt-tolerant accessions of crops such as barley, triticale, sorghum, pearl millet, cowpea and quinoa were multiplied in large quantities using spacial isolation at ICBA headquarters for conservation and dissemination. Recently, seed multiplication was conducted on approximately 150 salt-tolerant germplasm accessions samples for dissemination to researchers/partners in 12 countries.

Future Directions

There is a continuous need to search and identify more stress-tolerant crops, especially high value food and bioenergy crops to provide farmers with a wide range of options for crop diversification in marginal and saline environments. The project at ICBA will continue its pursuit in identifying and providing access to new germplasm in order to help researchers find solutions to sustain agricultural productivity in marginal and saline environments worldwide. Furthermore a systematic collection, evaluation and multiplication of economically important indigenous plants will be undertaken.



Cowpea is a multi-purpose heat tolerant legume known for its value as a food and forage crop which can thrive in marginal environments.