

Salicornia for Biosaline Agriculture



Salicornia, a halophyte that can be irrigated with sea water, holds great potential as a biofuel for marginal environments.

Thematic Area: Aquaculture and Bioenergy

Purpose: Identify an alternative crop that is well adapted to marginal environments for biofuel production and other uses

Geographic Scope: Coastal regions and dryland areas of the Arabian Peninsula

Timeline: 2011 - 2015

Funding/Partners Agencies:

- King Abdullah University of Science and Technology, (KAUST), Saudi Arabia
- Masdar Institute of Science and Technology, Abu Dhabi, UAE

Project Lead:

- Dr. Shoaib Ismail
s.ismail@biosaline.org.ae
- Dr. Dionyssia Lyra
d.lyra@biosaline.org.ae

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www.biosaline.org

Freshwater scarcity is a global threat, especially in marginal and saline environments that struggle to produce food and animal feed to sustain an increasing population. Salinity further exacerbates the problem by depleting productive lands and freshwater reserves leading to loss of biodiversity, soil fertility and organic matter. More halophytic crops that thrive in hostile saline conditions are needed. *Salicornia (Salicornia bigelovii)* is a halophyte that can be used as a vegetable, forage, and biofuel, and holds great potential to improve the livelihood of poor rural farmers in coastal saline environments. Existing germplasm of salicornia originate from wild genetic varieties that need to be tested, developed through several generations and adapted to local conditions for large scale plantations.

Since 2011, the International Center for Biosaline Agriculture (ICBA), along with local partners are actively examining the potential for growing salicornia under the hot and dry conditions of marginal environments in the United Arab Emirates (UAE). The overall goal is to select the best performing salicornia populations in terms of seed and biomass production for future breeding and commercial scale production. This could be achieved through evaluating salicornia gene pool for various agronomic and growth parameters under field conditions. This would be followed by seed multiplication using saline groundwater and selecting the best populations each growing season for further investigation for pilot scale production systems.

Activities and Outcomes

Field trials conducted at ICBA headquarter for four consecutive years have assessed 50 different salicornia genotypes under high saline conditions. During the first year, one salicornia population was evaluated for seed and biomass production at different salinity levels, fertilizer treatments and planting methods. Optimum biomass production was achieved in the transplanted plots at 25 dS/m salinity level and at 20 kg/ha fertilization application.

During the second year, 46 salicornia populations (obtained from KAUST and Masdar Institute) were evaluated for 24 growth parameters and irrigated with groundwater through drip irrigation. Six populations were also assessed for their growth performance under full-strength seawater.



Salicornia irrigated with seawater can be used for food, feed and fuel.

Salicornia populations were highly variable for all characteristics under study for both irrigation treatments, indicating that there is a large pool of genetic information available for breeding. Irrigation with the highest level of salinity had a negative impact on the agronomic performance. The maximum seed yield obtained was 2 t/ha at 20 dS/m at 25 cm x 25 cm planting distance. The best performing salicornia populations for fresh biomass and seed yield were selected for the following season.

Goals for 2013-2014 were to assess salicornia germplasm under pilot scale production plots and look into optimization of management practices. Twelve salicornia populations were assessed for their seed potential and biomass production under two irrigation systems (bubblers and sprayers), three sowing densities (1.0, 1.5 and 2.0 g/m²) and two salinity levels (20 dS/m and 55 dS/m). Pilot trials were implemented in order to examine the large-scale production potential of salicornia cultivation. At the final vegetative stage, selected plants per population were bagged in order to isolate “seed” plants for genetic purity and forced inbreeding.

“ Initial trials are promising and indicate that cultivating the proper Salicornia varieties combined with suitable agronomic practices, could be economically viable and successful in marginal land ”

ICBA also carried chemical analyses of the salicornia seeds to examine the oil composition, protein and saponins content. Results indicated that the fatty acids profile was comparable to oil seed content of other biofuel crops. Results also indicated that the bubbler system was more efficient in enhancing the performance of salicornia plants compared to the sprinkler system.

More production scale trials are in progress during 2015. Fifteen selected salicornia genotypes are being cultivated in one sowing density (1.5 g/m²) and have been irrigated with the bubbler system. In addition, seeds from the bagged plants have been sown in small plots to ensure that the stability of the plant characteristics is maintained.

Future Directions

After continuous selection, the best performing salicornia seeds will be adopted for scaling-up in targeted marginal environments. Taking into account the results of the production field trials, salicornia expansion will be targeted in coastal areas of the Arabian Peninsula. As a crop with high biofuel and forage potential, its cultivation can improve the livelihood of local farmers. ICBA will continue testing and developing salicornia.

Subsequently, ICBA will work on developing comprehensive information packages on salicornia cultivation and best management practices. Establishment of an interactive and easily accessible website that covers all the necessary aspects for proper cultivation of salicornia is the long-term objective of ICBA.



Salicornia plants are bagged for inbreeding and genetic purity to guarantee that the seeds used for further breeding are of enhanced characteristics.