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Salicornia bigelovii, a Promising Halophyte for Biosaline Agriculture: Lessons Learned from a 4-Year Field Study in United Arab Emirates

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Abstract : Salinization of natural resources constitutes a significant component of the degradation force that leads to depletion of productive lands and fresh water reserves. The global extent of salt-affected soils is approximately 7% of the earth's land surface and is expanding. The problems of excessive salt accumulation are most widespread in coastal, arid and semi-arid regions, where agricultural production is substantially hindered. The use of crops that can withstand high saline conditions is extremely interesting in such a context. Salt-loving plants or else 'halophytes' thrive when grown in hostile saline conditions, where traditional crops cannot survive. Salicornia bigelovii, a halophytic crop with multiple uses (vegetable, forage, biofuel), has demonstrated remarkable adaptability to harsh climatic conditions prevailing in dry areas with great potential for its expansion. Since 2011, the International Center for Biosaline Agriculture (ICBA) with Masdar Institute (MI) and King Abdul Aziz University of Science & Technology (KAUST) to look into the potential for growing S. bigelovii under hot and dry conditions. Through the projects undertaken, 50 different S. bigelovii genotypes were assessed under high saline conditions. The overall goal was to select the best performing S. bigelovii populations in terms of seed and biomass production for future breeding. Specific objectives included: 1) evaluation of selected S. bigelovii genotypes for various agronomic and growth parameters under field conditions, 2) seed multiplication of S. bigelovii using saline groundwater and 3) acquisition of inbred lines for further breeding. Field trials were conducted for four consecutive years at ICBA headquarters. During the first year, one Salicornia population was evaluated for seed and biomass production at different salinity levels, fertilizer treatments and planting methods. All growth parameters and biomass productivity for the salicornia population showed better performance with optimal biomass production in terms of both salinity level and fertilizer application. During the second year, 46 Salicornia populations (obtained from KAUST and Masdar Institute) were evaluated for 24 growth parameters and treated with groundwater through drip irrigation. The plant material originated from wild collections. Six populations were also assessed for their growth performance under full-strength seawater. 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 (groundwater treatment) 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. After continuous selection, the best performing salicornia will be adopted for scaling-up options. 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.

Keywords : biosaline agriculture, genotypes selection, halophytes, Salicornia bigelovii
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