Salicornia bigelovii: a promising halophytic species for a salinized world

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Introduction

Salinization of natural resources constitutes a significant component of the degradation force that leads to depletion of productive lands and fresh water reserves. 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. Salicornia research at ICBA started in 2011 in collaboration with several research Institutions (Photos 1, 2 & 3).

Photo 1. Salicornia plant at flowering stage. Photo 2 & 3. Salicornia plots at ICBA experimental station.

Objectives

- (2011-2012): One *S. bigelovii* population was evaluated for seed and biomass production at different salinity levels, fertilizer treatments and planting methods (the project was implemented in collaboration with Masdar Institute)
- (2012-2013): Evaluation of 37 *S. bigelovii* wild populations irrigated with brackish groundwater (salinity≈20 dS/m) (the project was implemented in collaboration with Masdar Institute and KAUST)
- (2013-2014): Pilot scale production trials of the best screened *S. bigelovii* populations for pure line selection, under two salinity treatments (brackish and seawater) and three sowing densities (1.0, 1.5 and 2 g/m^2) (the project was implemented in collaboration with KAUST)
- (2014-2015): Pilot scale production trials of the best screened *S. bigelovii* populations for pure line selection (Photo 4), cultivated in one sowing density (1.5 g/m^2), irrigated with bubbler irrigation system under brackish and seawater treatment
- (2015-2016): Evaluation of the best screened *S. bigelovii* germplasm under pilot scale production plots and optimization of management practices of Salicornia production for various uses

Photo 4. Bagged Salicornia plants to force inbreeding.

Key Results and Discussion

- Establishment and growth of *Salicornia bigelovii* was affected by the growing season. Optimum sowing date 1st -15th of October led to higher biomass
- Optimum productivity was increased when 15 and 20 kg N/ha (provided through NPK fertilization)
- Good and economical yield was obtained at 30-35 ppt salinity (on loose textured soil)

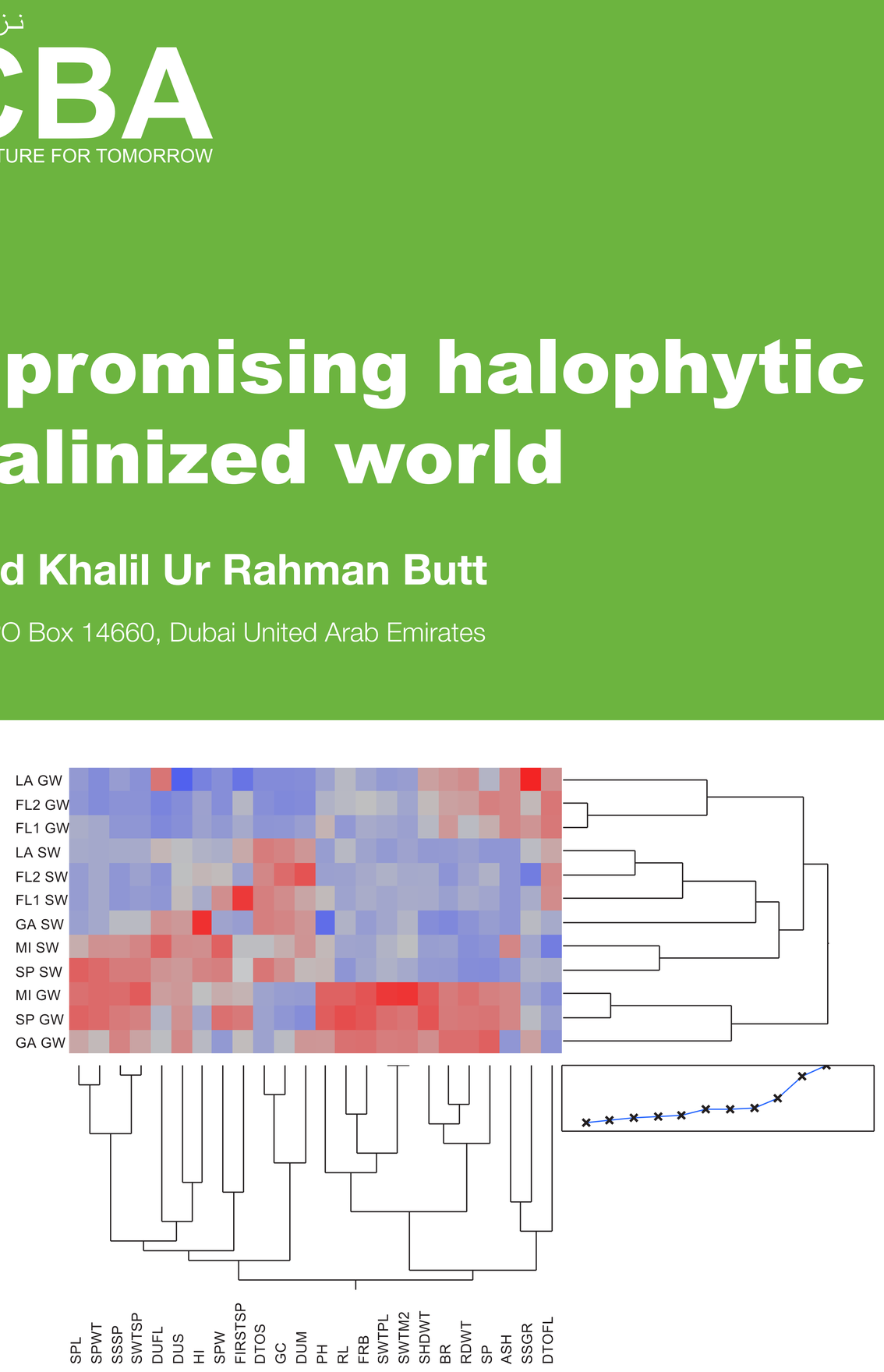

Figure 1: Six S. bigelovii populations are differentiated based on irrigated with ground (GW) (16.000 ppm) and seawater (SW) (30.000 ppm) for several growth parameters studied. Red boxes indicate higher levels of correlation and blue boxes indicate lower levels of correlation.

- *S. bigelovii* populations were highly variable for all characteristics under study for both irrigation treatments probably because of the out-crossing nature of the breeding system
- Irrigation with ground and sea water clearly affected the agronomic performance of *S. bigelovii* populations. Sea water prolonged the duration of growth cycle for all Salicornia populations compared to ground water irrigation (Figure 1, Photo 5)
- The maximum seed yield was 2 t/ha, treated with brackish water at a planting density 16 seedlings/m^2
- Maximum values for fresh biomass yield/m^2 achieved after irrigation with brackish water. Potential green biomass values could range from 120-140 t/ha
- The oil content ranged from 12% to 30%, protein content varied between 27.2% and 31.3% and saponins content ranged from 0.4% to 4.7%.

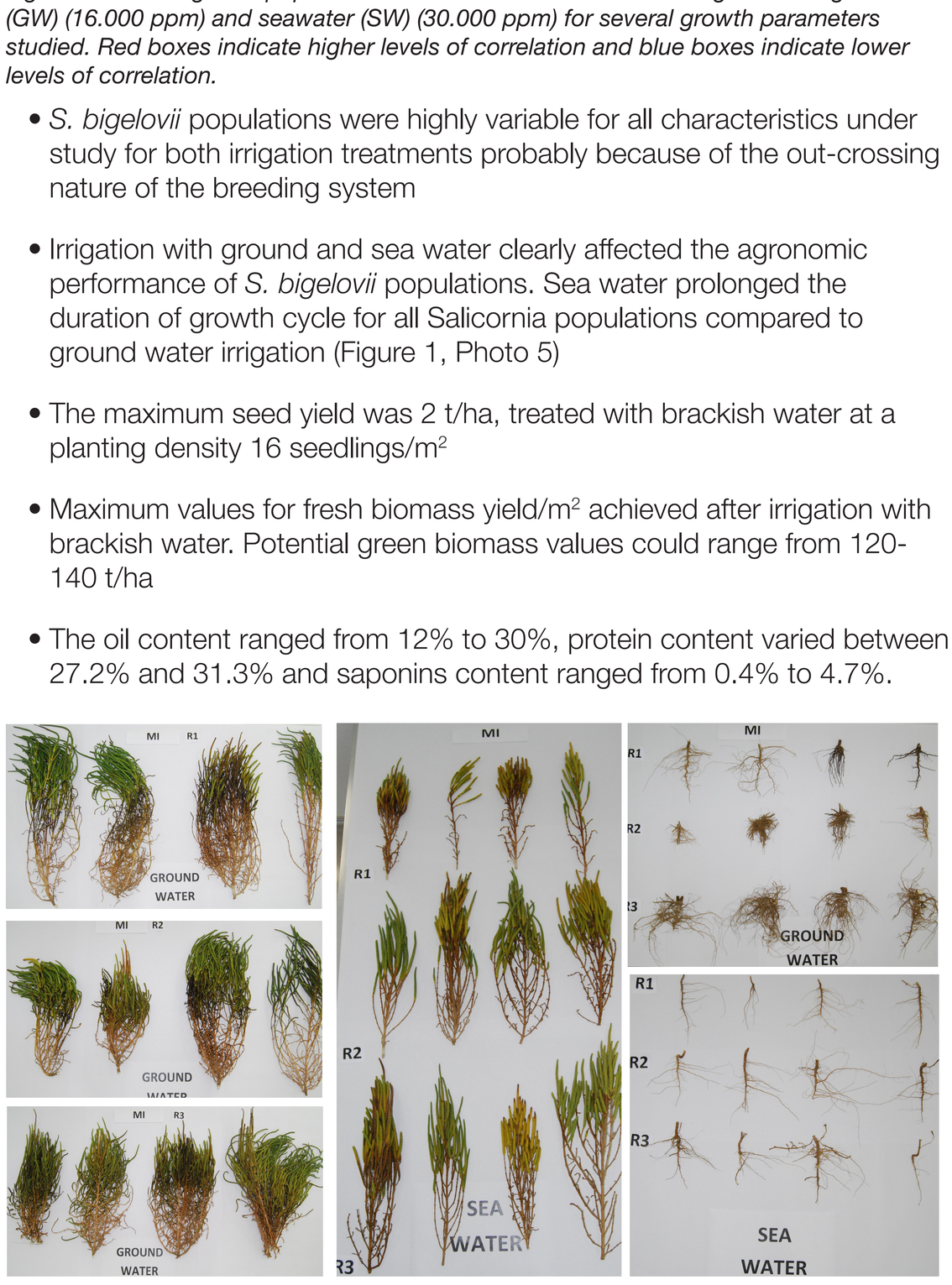

Photo 5: Differentiation in Salicornia bigelovii plant growth (shoots and roots) under groundwater and seawater irrigation treatment

Conclusions

After continuous selection, the best performing *S. bigelovii* would be adopted for scaling-up options. Taking into account the results of the production field trials, *S. bigelovii* expansion would be targeted in coastal areas. Finally, a knowledge hub providing comprehensive information on *S. bigelovii* cultivation and optimization of its management practices is under preparation, aspiring to cover all the necessary aspects for proper implementation.

Key references

1. Brown J.J., Glenn E.P. and Smith S.E. (2014). Feasibility of Halophyte Domestication for High-Salinity Agriculture. In Sabkha Ecosystems: Volume IV: Cash Crop Halophyte and Biodiversity Conservation, pp. 73-80. Springer, The Netherlands.
2. Glenn E.P., O'Leary J.W., Watson M.C., Thompson T.L. and Kuehl R.O. (1991). *Salicornia bigelovii* Torr.: an oilseed halophyte for seawater irrigation. *Science* 251(4997):1065–1067.
3. Panta S., Flowers T., Lane P. , Doyle R., Haros G. and Shabala S. (2014). Halophyte agriculture: success stories. *Environmental and Experimental Botany* 107:71-83.