Synergistic Effects of Soil Amendments and Biostimulants on Enhancing Quinoa Tolerance to High Salinity Stress under Greenhouse Conditions

Bourhim Mohammad Redouane[1], Oukhey Firouze[1], Hirich Abdelaziz[2], Ghoulam Cherki[1,2]

[1] Cadi Ayyad University, FST, Center of Agrobiotechnology & Bioengineering, Marrakech, Morocco

[2] Mohammed VI Polytechnic University, ASARI, Laayoune, Morocco

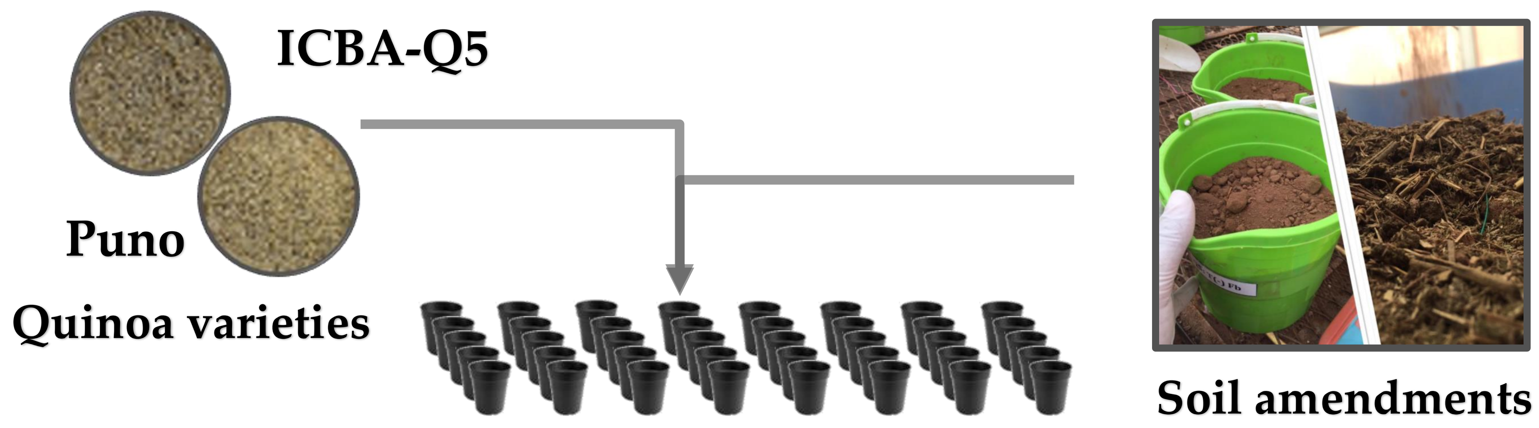
Introduction

Salinity stress poses a significant global challenge, resulting in numerous disruptions to soil and crop productivity. To address this issue, the cultivation of alternative crops capable of withstanding salinity stress, such as quinoa (*Chenopodium quinoa*), is crucial.

Therefore, this experiment was conducted to determine the effect of the biostimulation combined with soil amendment application on enhancing the quinoa (ICBA-Q5 & Puno) tolerance to high salinity level (20 dS/m) under the greenhouse conditions.

Methodology

The plant material used consisted of two quinoa varieties namely Puno and ICBA-Q5. The used agricultural soil was amended with two substances, cow manure and phosphogypsum, at respective amounts of 30 t/ha and 5 t/ha.



- ✓**Organic biostimulants:**
  - ➢Seaweed ***(Fucus spiralis)*** **"Al"** and halophyte ***(Atriplex halimus)*** **"Hp"** raw extract
  - ➢**Rosemary** hydrolat **"Rh"**
- ✓**Chemical biostimulant :**
  - ➢Zinc Sulfate '$ZnSO_4$': **(4g/L** ou **24,77mM) "Zs"**
  - ➢Sodium Métasilicate 'Na_2O_3Si': **(3mM) "Si"**

The biostimulants were applied after 40 days from sowing, by foliar spraying (20 mL per pot) each week for 4 weeks in total.

Figure 1: experimental design in the greenhouse

Figure 3: Effect of the biostimulants and soil amendments combinations on plant growth

After 80 days from sowing, the in-situ measurements of some agro-physiological parameters were done (Figure 1).

Results

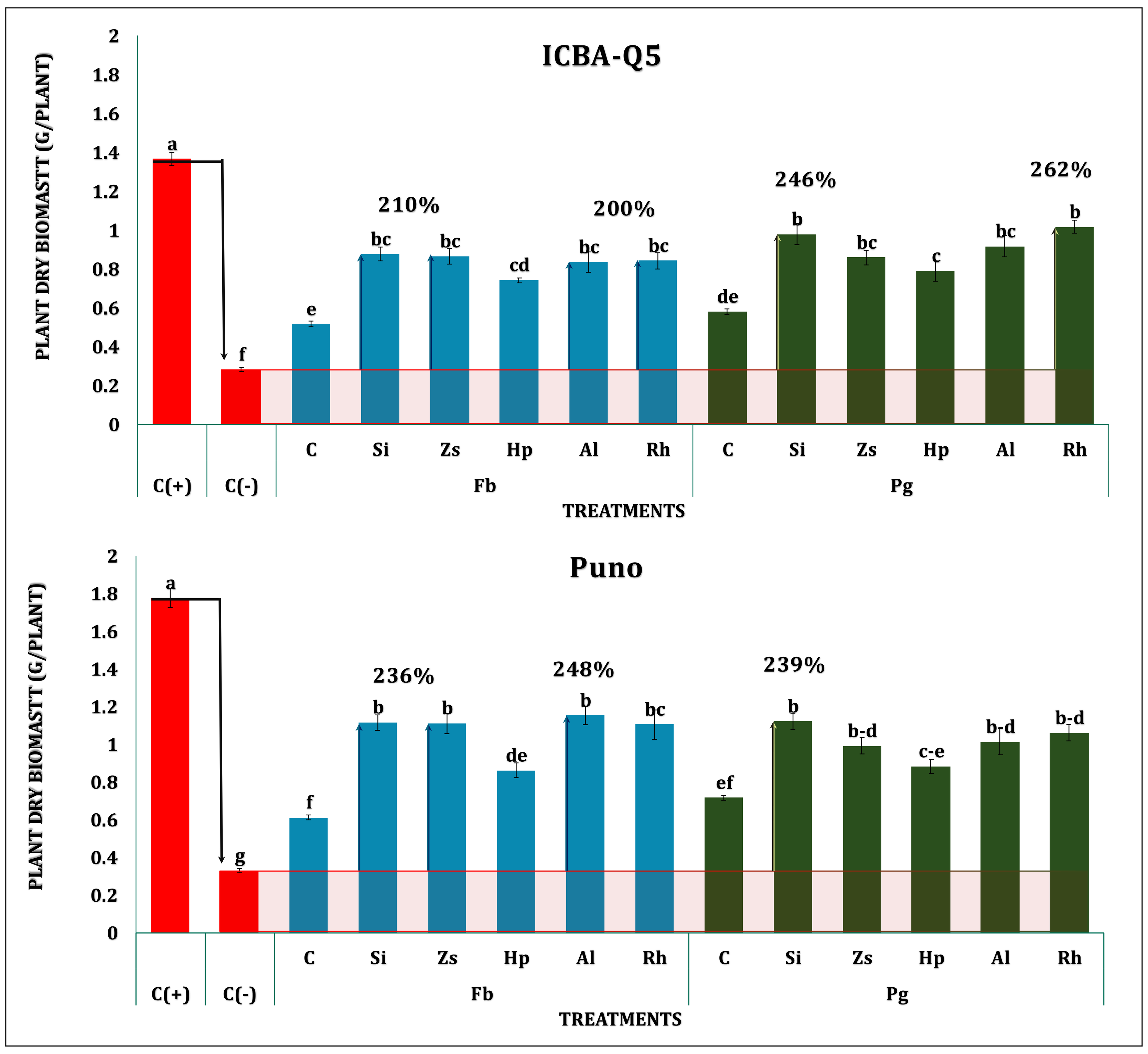


Figure 2: Combined effect of amendments and biostimulants on plant dry biomass (g/plante)

Table 1: Effect on plant mineral content (relative variation percentages compared to the negative control) highlighting the important ameliorations

Traitements		K		P		Ca		Na	
		Pn	Q5	Pn	Q5	Pn	Q5	Pn	Q5
C+		257%	284%	121%	129%	317%	319%	-64%	-75%
Fb	C	67%	89%	32%	33%	219%	177%	-30%	-45%
	Si	211%	270%	69%	35%	184%	312%	-61%	-64%
	Zs	231%	226%	71%	46%	213%	239%	-58%	-61%
	Hp	170%	171%	72%	42%	207%	239%	-52%	-57%
	Al	176%	224%	99%	54%	166%	278%	-55%	-65%
	Rh	181%	255%	79%	83%	174%	263%	-63%	-67%
Pg	C	74%	76%	55%	42%	130%	116%	-26%	-17%
	Si	285%	227%	118%	105%	255%	292%	-63%	-69%
	Zs	85%	150%	85%	68%	164%	171%	-55%	-67%
	Hp	107%	155%	89%	87%	118%	228%	-43%	-55%
	Al	124%	199%	135%	90%	161%	279%	-59%	-69%
	Rh	162%	234%	60%	115%	199%	285%	-65%	-67%

The results shown in Figures 2 & 3, revealed that in the Puno variety's growth and dry biomass was significantly increased by the biostimulation combined with soil amendment application. The combinations Rh-Pg and Si-Pg gave the best results for ICBA-Q5, and Al-Fb, Si-Pg for the Puno variety. Moreover, the combination Si-Pg registered the most important ameliorations of the plant mineral elements content compared to the negative control (Table 1).

Conclusion

The combined application of soil amendments and biostimulants enhanced quinoa tolerance to high salinity stress. Indeed, this combination improved plant growth and biomass, as well as its nutritional and water status. These treatments boosted the uptake of major nutrients and reduced the accumulation of toxic sodium in plant tissues.

This project is part of the program of the ERA-NET Cofund FOSC that has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 862555.

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