PULSE

Priming Using Seaweed Extracts

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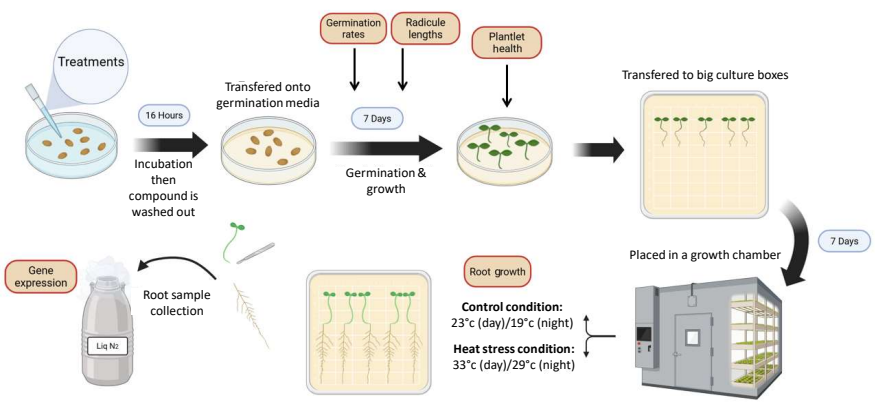
Introduction

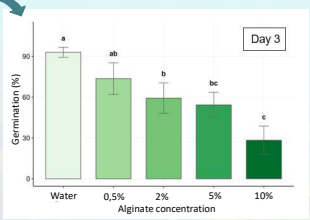
Biostimulants are increasingly used in agriculture to improve plant growth and stress tolerance. However, their efficacy often remains inconsistent because their effects depend on environmental, physiological, and genetic factors. This variability is particularly important for seaweed extract based biostimulants, whose compositions can vary according to algal species, harvesting and process conditions. Our previous studies in tomato showed that certain seaweed derived biostimulants are mainly effective under abiotic stress conditions, such as heat stress. Gene expression analyses suggested that these products induce a priming effect, where plants activate stress response mechanisms before stress exposure, potentially improving their tolerance to subsequent stress. However, the mechanisms by which the biostimulant activates the priming effect and the biostimulant compounds that are responsible of the priming induction are still unknown.

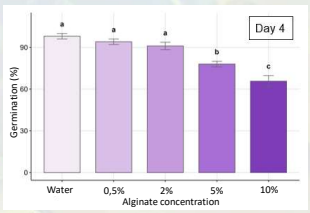
The objective of this project is to better understand the establishment of this priming effect induced by seaweed extract derived subfractions during tomato germination and early development. In this study, the effects of seaweed extract subfractions were evaluated through germination assays, root growth analyses under control and heat stress conditions, and expression analyses of heat stress and growth related marker genes.

Evaluation of seaweed extract subfractions

Seaweed sub-fractions were made from Algaia's complex seaweed extracts. These were tested on commercial cherry tomato seeds exhibiting high germination rate (~ 95%).







Pretreatment by Alginate enriched subfraction affects seed germination

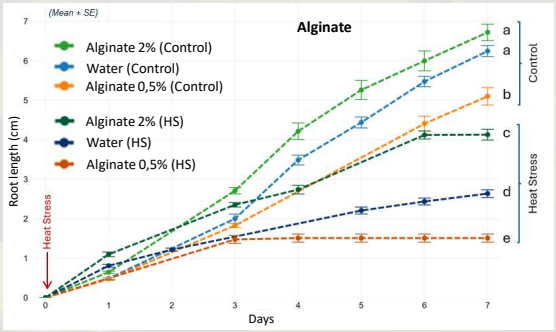
→ Alginate sub fraction decreased germination rates

→ 0,5% and 2% reached the same germination rates as control condition on day 4

Delayed rather than inhibitory germination response for lower concentrations

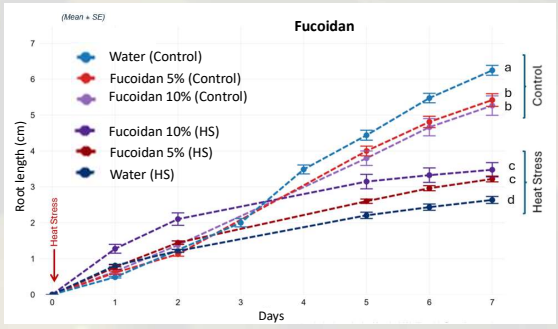
Do these fractions improve tolerance to heat stress ?

Root growth response to two algae sub-fractions reveals potential priming effect(s)



→ Decrease in root length at 0.5% in both conditions
→ Increase in root length (60 %) at 2% in HS condition

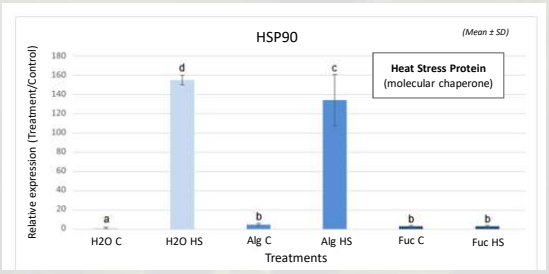
Germination and root growth results show potential pattern of hormetic priming

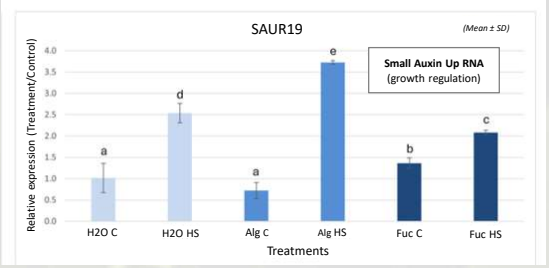


→ Decrease in root length in control condition for all tested concentrations
→ Increase in root length under HS condition for higher concentrations

Positive effect on root growth through priming with the fucoidan sub-fraction only shown under heat stress

How do these fractions influence molecular stress and growth responses ?





Pretreatments with alginate or fucoidan sub-fractions affect heat stress and growth related marker genes expressions

→ Upregulation of *HSP90* in HS vs Control (H_2O and Alginates)

→ No induction for fucoidan HS (suppressed *HSP90* activation)

→ Alginate: Strongest relative expression of *SAUR19* in HS compared to H_2O and Fucoidan

The different expression patterns suggest the induction of two different heat stress response mechanisms

Conclusion

These results highlight the potential of seaweed extract derived sub-fractions as priming agents to improve heat stress tolerance in tomato seedlings. In particular, alginate enriched fractions showed promising protective effects under heat stress. Interestingly, gene expression analyses suggest that different fractions may activate distinct stress response pathways. However, the fractions tested were not fully purified, meaning the observed effects cannot yet be directly attributed to specific compounds. A PhD project initiated in January 2026 will therefore focus on improving fraction purification and further characterising the molecular mechanisms underlying seaweed extract induced priming using OMICs approaches.

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(J. RETTENMAIER & SÖHNE GMBH)