

## Exploring the synergistic effects of seaweed active ingredients

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## Context & Objectives

Climate change has amplified abiotic stresses and particularly drought, which is increasing in frequency and severity. Drought affects plant growth and development (Bray et al., 2000; IPCC, 2021) with an impact on grassland sustainability and crop yield. A novel approach to reduce stress-induced limitations is the use of biostimulants. Indeed, some algal extracts have been shown to improve plant resistance to drought (Goñi et al., 2018; Dalal et al., 2019). Using a bioassay carried out under controlled conditions, we have previously shown that a whole extract of Laminaria digitata improved the drought resistance of perennial ryegrass (Lolium perenne). To better understand the mode of action of this biostimulant, we explored the effects of purified fractions containing different proportions of alginates and fucoidans, two polysaccharides present in cell wall of brown algae known for their numerous potential applications (Fernando et al., 2019).



Extern

Externa

Unstable membrane

14-days drought period follow by a 10-days recovery period.

Two fractions containing high proportions of alginates or fucoidans were prepared from the whole algal extract. They were mixed to obtain 4 levels of one ingredient while the other one was at the same concentration. Whole algal extract as well as the mixtures containing different proportions of alginates and fucoidans were sprayed on leaves after the cut.



The shoot 0-3cm (called stubble) were cut in 5-mm length pieces and incubated in pure water for 24h. The cell membrane stability was estimated by measuring the conductivity of the solution after a 24h incubation at room temperature to challenge the stability of membrane and after boiling treatment to know the total conductivity after rupture of membranes (adaptation from Volaire, 2002).

A stable membrane will prevent electrolyte leakage, leading to a low C1 and CMS close to 100. On the contrary, an unstable membrane will allow electrolyte leakage, leading to a high C1 and a low CMS. Thus, the CMS is used as a proxy of cell membrane stability.



1 day after re-irrigation

Low

CMS







During recovery, the early regrowth was faster for plants sprayed with the whole algal extract, and with the mixture corresponding to a spraying of 8 g.ha<sup>-1</sup> alginates and 4 g.ha<sup>-1</sup> fucoidans, or 5 g.ha<sup>-1</sup> alginates and 0.2 g.ha<sup>-1</sup> fucoidans than for the control dried plants.





The decline in cell membrane stability (CMS) during drought was less pronounced in plants sprayed with the whole algal extract (corresponding to 29 g.ha<sup>-1</sup> alginates and 4 g.ha<sup>-1</sup> fucoidans) than in the dried control plants. The mixture of 8 g.ha<sup>-1</sup> alginates and 4 g.ha<sup>-1</sup> fucoidans gave the same result, as well as those corresponding 8 g.ha<sup>-1</sup> alginates and fucoidans at either 0.2 or 11 g.ha<sup>-1</sup>. The optimal mixture resulting in the least decline of CMS contained alginates at 5 g.ha<sup>-1</sup> and fucoidans at 3 g.ha<sup>-1</sup>.

Plants sprayed with the whole algal extract retained more water in their shoot (0-3cm) than the dried control plants. The mixture of 5 g.ha<sup>-1</sup> alginates and fucoidans at 3 and 11 g.ha<sup>-1</sup> had the best effects.

## Conclusion & Perspectives

The best effects on drought resistance, as monitored by early regrowth, Cell Membrane Stability and water content, were obtained with the mixtures containing alginates at 5 to 8 g.ha<sup>-1</sup> and fucoidans at 0.2 to 3 g.ha<sup>-1</sup>. Fucoidans are active at lower contents than alginates, suggesting different underlying mechanisms. The mixture leading to a spraying of similar amounts of alginates/fucoidans (30/4 g.ha<sup>-1</sup>) as the whole algal extract (29/4 g.ha<sup>-1</sup>), showed no effect on drought resistance unlike the whole algal extract. This indicates that other ingredients of the algal extract are involved in the improvement of the drought resistance of perennial ryegrass. Currently, the effects of laminarans and mannitol, are being studied.

Understanding the underlying mechanisms by which algal extract and its ingredients trigger drought resistance in perennial ryegrass will be investigated using transcriptomic approaches.

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