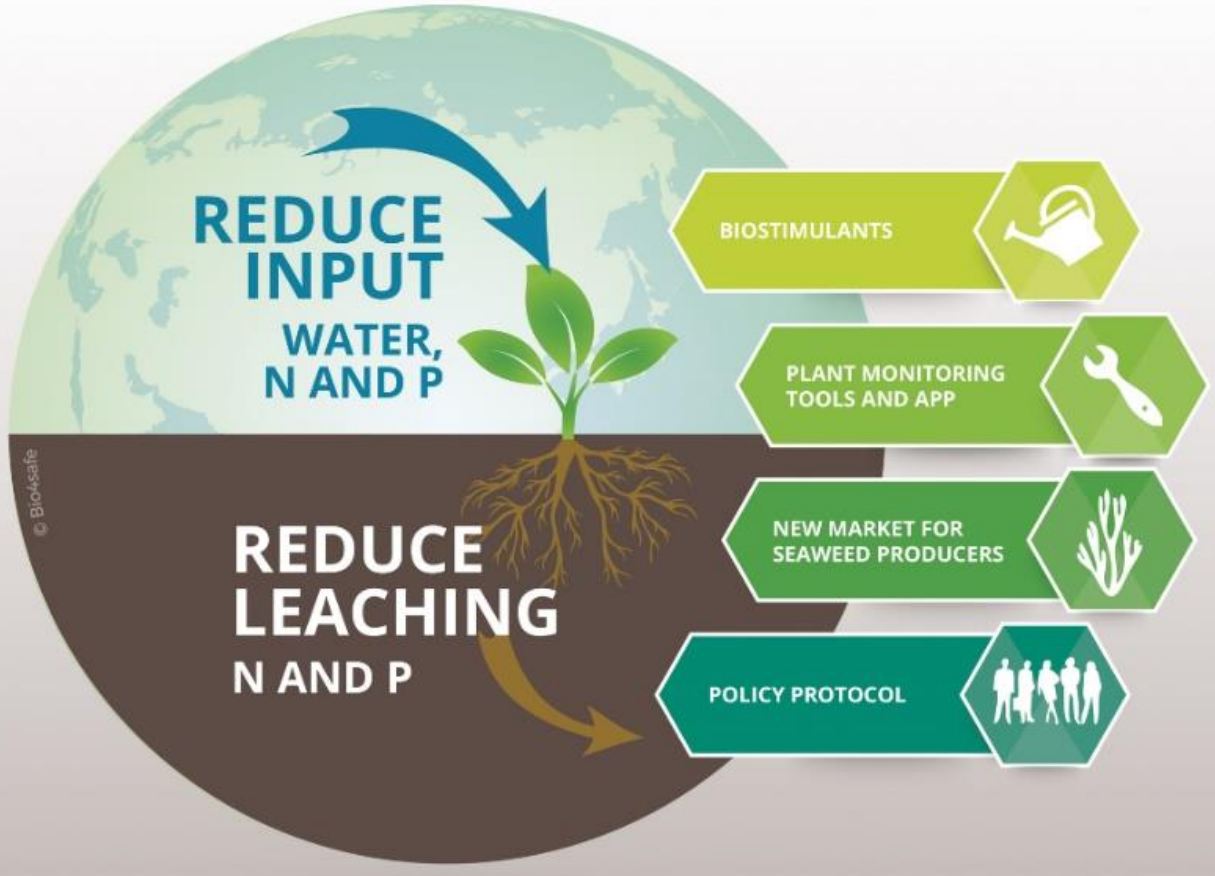
Pilot to determine the feasibility of using cultivated seaweeds for biostimulant product using press technology

Report produced by Stichting Noordzeeboerderij

As part of Deliverable 1.2.3: Roadmap and planning to achieve agreed goals: initial business cases for selected biostimulants



1 Preface

This report is part of the Interreg 2 seas project Bio4safe. The project is coordinated by PCS Ornamental Plant Research (Belgium) and includes 6 other partners including Research Station Proeftuin Zwaagdijk (NL), North Sea Farm Foundation (NL), Yncréa Hauts de France, establishment ISA Lille (France), Pôle Légumes Région North (France), NIAB (UK) and Ghent University (Belgium). The Bio4safe-project runs for a period of four years, started in 2017 and is funded by Europe via the Interreg 2 Seas Programme.

Contact information
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Project partners:

Interreg 2 Seas Mers Zeeën Bio4safe
European Regional Development Fund

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3 Pilot to determine the feasibility of using cultivated seaweeds for biostimulant product using press technology: an introduction

As part of the Interreg Bio4safe project, the feasibility of using press technology for the production of biostimulants from cultivated seaweed was examined. Multiple parties throughout the biostimulant production chain came together to observe and discuss this topic. The press technology was particularly selected because the challenge with using cultivated seaweeds is that the product degrades quickly after harvest. Therefore, a fast and offshore-suitable conservation technology is needed to retain the valuable – for biostimulant product quality - components of the seaweed directly after harvest.

The pressing of seaweed, in this case *Saccharina latissima*, aimed at the separation of liquid and dry matter. From this liquid matter, a biostimulant is be produced that subsequently will be used in the Bio4safe 2020 trials. The goal of the Bio4safe project is to reduce water and fertilizer use in horticulture (by 20 and 10%, respectively) in the 2 Seas Region with the help of biostimulants and innovative plant sensors.

The goal of the pilot was to assess the feasibility of using press technology for the production of biostimulants from cultivated brown seaweeds. This gives a first indication whether this technology can be used as processing technique for a large-scale seaweed supply chain for biostimulants.
This pilot contributes to the exploration of new processing technologies for seaweed biostimulants and thereby stimulates the supply towards production of seaweed biostimulants in the 2-seas region. Furthermore, it explores the creation of economic opportunities for local seaweed producers with new applications for cultivated seaweed.

The pilot was executed in four stages:

- The first stage concerned a pre-testing pilot with only Stichting Noordzeeboerderij and Rhinetech present to press a small amount of the frozen seaweed (approx. 270 kg).
- The second stage of the pilot was the execution of the pressing test with relevant stakeholders in the seaweed and biostimulant sector. During this phase, the remaining 600 kg was pressed.
- In the third phase of the pilot, which is currently being executed, Algaia aims produce a biostimulant from the pressed seaweed at their research facilities.
- After the successful completion of stage three, the biostimulant will be used in the field trials of the Bio4safe project, as part of the fourth stage.

3.1 Parties involved in the feasibility pilot

Ocean Rain Forest	Supply of *S. latissima* from a cultivated source
Frits van Bergen Henegouw – RhineTech	Operation of industrial press and host of the pilot
Franck Hennequart – Algaia	Production of biostimulant
Olivier Stuip – Damen Shipyards	Witness
Ruben van Maris – Maris Projects BV	Witness
Lennart Koning – Damen Shipyards	Witness
Dirk Jan Vos – Danvos	Witness
Eef Brouwers – St. Noorzeeboerderij	Organising party
Frederik Van Baelen – St. Noorzeeboerderij	Organising party
Mila Vlottes – St. Noorzeeboerderij	Organising party

4 Pre-testing: observations and analysis

4.1 Introduction

The pre-testing concerned the first stage of the pilot. Here, a small amount (approx. 270 kg) was tested in the press with only Rhinetech and St. Noordzeeboerderij present. This pre-testing was incorporated into the pilot to ensure a successful pressing test during the second stage of this pilot. In the section below, the pre-test is described as well as the preparatory actions taken prior to the pre-test.

4.2 Preparatory actions

The seaweed arrived on the 21st of February in three IBC containers of approx. 300 kg. One of these containers of approx. 270 kg was taken out of the freeze storage and placed in a refrigerated van with that was kept in temperature range of 1.9 and 5.6 degrees Celsius to regulate the defrosting of the seaweed. One important learning included that seaweed does not sufficiently defrost in these temperatures over a period of three days.

On the 24th of February the pre-test took place with 270 kg of semi-defrosted seaweed (*Saccharina latissima)* at Rhinetech Arnhem. The seaweed was pressed with a cone press.
Three variations in treatment were tested in the press:

- Semi-defrosted. Clumps of ice were still present in the seaweed.
- Soaked. The IBC container is loaded with fresh water, to a level just covering the seaweed, to help defrost the ice. The water is then removed and the seaweed (wetter than before) is again inserted into the press
- Pressed seaweed is taken through the press again.

Finally, a different type of press was tested. This press uses a wedge-wire type of mechanism that does. This press requires a lower amount of seaweed to be added in order to be functional. Therefore, it was possible to remove more clumps of ice before the seaweed was pressed.

4.3 Observations

The most important observations from this pre-test include:

- Firstly, it was noted that the seaweed started to release a viscous liquid whilst defrosting in the IBC container. This occurred whilst clumps of ice were present in the container.
- From 270 kg, approx. 40 L liquid has been pressed.
- It was observed that the press has difficulty to create friction between de pressing cone and the biomass.
- The different treatments of the seaweed created the following observations:
    - With the semi-defrosted seaweed, it was noted that most seaweed leaves were still intact. It released some liquid, but the pressed matter was not dry.
    - The soaking of the water helps to defrost the ice. It was observed that the seaweed absorbed the fresh water to a certain degree and that more liquid was released during pressing. With this treatment, the seaweed leaves were still intact as well.
    - The pressing of pressed seaweed had little effect on the pressing of the biomass. The dry matter was still intact and contained much liquid. The only difference that was observed was that a little less liquid was released.
- Using the wedge-wire press it was difficult to observe any differences in the pressing, liquid that was released and the dry matter after pressing.

4.4 Analysis of observations

- Less liquid was released during pressing than expected. Two potential explanations are suggested to explain this:
    - The pressing of the seaweed, and so the complete separation of liquid and dry matter, was potentially prevent by the clumps of ice that were present in the seaweed. It is hypothesised that the clumps of ice may prevent the compression of the seaweed and so the separation of matter.
    - The species that is used in this trial is *S. latissima*, which is known for its high concentration of alginates. It can be hypothesised that due to the high concentration of alginates in this species, it was difficult to for the press to create friction and so properly press the seaweed.
- The release of more liquid after the soaking of the seaweed may be caused the absorption of the added water in the IBC container. Therefore, it unclear whether the liquid that was released was adhesive water or internal compounds and liquid of the seaweed.



5 Pressing pilot with seaweed stakeholders: observations and analysis

5.1 Introduction

On the 27th of February, the pressing pilot with members from the Seaweed Platform and other important seaweed and biostimulants stakeholders took place at Rhinetech in Arnhem. In total, more than 600 kg of defrosted seaweed was pressed. The following parties were present during this pilot:

- Frits van Bergen Henegouw – RhineTech
- Franck Hennequart – Algaia
- Olivier Stuip – Damen Shipyards
- Ruben van Maris – Maris Projects BV
- Lennart Koning – Damen Shipyards
- Dirk Jan Vos – Danvos
- Eef Brouwers – St. Noorzeeboerderij
- Frederik Van Baelen – St. Noorzeeboerderij
- Mila Vlottes – St. Noorzeeboerderij

In the section below, the pressing test is described as well as the preparatory actions that were taken.

5.2 Preparatory actions

The seaweed was removed from freeze storage three days before the pressing test. It was again defrosted in a variation of temperature between 1.9 and 5.6 degrees Celsius. The learnings from the pre-test were taken into account as an additional measure was taken to remove clumps of ice in the seaweed. A day before the pressing pilot took place, the 600 kg were spread out on tarps to completely defrost overnight.

5.3 Observations

Together with the attendees, the following observations were described made.

- Overall, it took less than hour to press the 600 kg of seaweed.
- The pressing of 600 kg resulted in approximately 80 L of liquid.
- Spreading out the seaweed on tarps increased the defrosting of the ice clumps in the seaweed. During defrosting on the tarps, the seaweed released a significant amount liquid. It remains difficult to estimate if the liquid that was released was adhesive water that may have been added to the IBC container or internal components and liquid of the seaweed due to decomposition.
- It was difficult to observe if more liquid was released during pressing due to the lower amount of clumps present in the seaweed. It was still noted that the seaweed leaves were still intact when even after they were pressed.

5.4 Analysis of observations

- It was hypothesised by the attendees that the extraction rate may be low due to the fact that it is difficult to observe differences in the biomass before and after pressing.
- Due to the high amount of liquid that is removed during defrosting and the high salinity level in the liquid after pressing, it was theorized that there may have been seawater present in the containers with seaweed before it was frozen. This theory was checked with the producer of the seaweed. It was confirmed that no additional seawater has been added. As a consequence, it is expected that the high salinity and large liquid release during defrosting is caused by adhesive seawater on the leaves.
- Again, less liquid was released during pressing than expected. One potential explanation for this could be that due to the large amount of water that was released during defrosting on the tarps, less liquid could be released during pressing.
- It was noted by the attendees that the freezing and defrosting may lead to the release of alginates and other internal components from the seaweed. An explanation that was offered was that the freezing penetrated the cells and that as a result the sugar may leak out. As was hypothesised before, this may make it harder for the press to create friction.

6 Conclusions

To contribute to the exploration of using cultivated seaweeds as the basis for seaweed based biostimulants and thereby expand the potential market for seaweed farmers, a feasibility pilot of using press technology was performed. The pressing of seaweed, in this case *S. latissima*, aimed at the separation of liquid and dry matter for the development of a seaweed biostimulant that will be used in the field trials of the Interreg Bio4safe project.

In total, approximately 1000 kg of defrosted seaweed has been pressed. This roughly resulted in 120 L of liquid, which is less than was expected. Potential explanations that are proposed for this include that pressing of the seaweed may be inhibited by the clumps of ice that were present in the seaweed and that the viscous liquid that was released from the seaweed inhibits the creation of friction and so pressing capability and efficiency.
Additionally, the different treatments of the seaweed prior to pressing (semi-defrosted, soaked, pressed seaweed) had little effect on the pressing efficiency and the seaweed biomass. The only observable difference was that during the soaking treatment, the seaweed released a small additional amount of water. During all treatments, the seaweed leaves were still intact after pressing and this could be a sign that the cells have not released their compounds.

Overall, many valuable learnings have been gathered during this pilot that stimulate the development of a cultivated seaweed biostimulant value chain in the 2-seas region. We would like to thank everyone who contributed and attended the pilot for their efforts, contributions and feedback.

7 Attachment 1: Background information Bio4safe project

Interreg 2 Seas - BIO4SAFE

The Bio4safe project aims to significantly reduce water and fertilizer input in horticulture by making use of commercially available biostimulants and innovative plant sensors. The project, funded by the 2 Seas Interreg Programme is coordinated by the Ornamental Plant Research Centre (PCS, Belgium) and started the 1st of August 2017.

Description of the project

The 2 Seas Region (coastal region across the southern North Sea and The Canal) is known for its intensive horticulture which demands significant amounts of water and nutrients. Several EU directives aim to protect water quality by preventing N and P leaching and anticipate to water shortage. Besides these legislative environmental pressures, economic reasons force growers to reduce water and nutrient input. This project aims to improve water and fertilizer use efficiency of plants by using biostimulants (seaweed extracts and beneficial microbes. The combination of biostimulants and innovative plant sensors will result in a reduced input of water and fertilizers by 20% respectively 10%. The project includes demonstration trials on different horticultural crops (lettuce, tomato, hydrangea, strawberry, tulips, chrysanthemum, raspberry) in the four countries to promote the use of biostimulants to diverse target groups. Further, the potential of using biostimulants based on seaweeds in horticulture will be analysed, in order to create economic opportunities for seaweed producers in the 2 Seas Region.

Today, every Member State has its own regulation on commercialising biostimulants. By 2020, the EU will implement a common European legal framework for the trade of biostimulants, but it remains unclear how positive effects of biostimulants on water and nutrient use efficiency of plants should be quantified. Therefore, with this project, we aim to create a standardised protocol that can be used by accredited laboratories to objectively evaluate the impact of biostimulants on water and fertilizer use efficiency of plants.

The project is coordinated by PCS Ornamental Plant Research (Belgium) and includes 7 other partners including Research Station Proeftuin Zwaagdijk (NL), North Sea Farm Foundation (NL), Yncréa Hauts de France, establishment ISA Lille (France), Pôle Légumes Region North (France), NIAB (UK) and Dove Associates (UK) and Ghent University (Belgium). The Bio4safe-project runs for a period of four years and is funded by Europe via the Interreg 2 Seas Programme and the Province East Flanders, Belgium.

Objectives

These are the objectives of BIO4SAFE:

- To reduce water input in horticultural crops by 20%
- To reduce fertilizer input in horticultural crops by 10%
- To develop a protocol for policy makers to measure the impact of biostimulants on fertilizer and water use efficiency of plants
- To elaborate a market study to calculate the economic potential of seaweed based biostimulants for seaweed producing companies in the region

Role of the North Sea Farm Foundation

The North Sea Farm Foundation is a non-profit organisation aimed at realising a sustainable seaweed industry in the Netherlands and surrounding EU countries. The North Sea Farm Foundation is leading the market study in Bio4safe to elaborate on the economic potential of seaweed based biostimulants. To achieve this, the
existing market of biostimulants will be determined for every country of the 2 seas region (2SR), EU wide and globally. In order to show the economic potential of seaweed based biostimulants for the seaweed producing companies in the region.

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