Cultivation of *Palmaria palmata* - dealing with extreme nutrient and light regimes

*Nordic Seaweed Conference, 11th October 2018, Grenå*

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Dulse is highly valued
Recognized for different applications

@Peter Schmedes

Moroney et al, 2015
Outline of normal cultivation practice for *P. palmata*

<table>
<thead>
<tr>
<th>Land-based seedling production Oct-Feb (2-12 months)</th>
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<td>(0-2 months)</td>
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Open-sea cultivation phase (5-9 months)

Schmedes et al. Submitted for *Algal Research*  
(Werner & Dring, 2011)
Cultivate vegetative fronds?

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Photo, Lisa Westgaard “Tong og Tare”
Project Aim

Field cultivation + Laboratory growth + Depth-depended PAR

NOVANA station
Test site

Adjust normal cultivation practice?

Q1: Is high light+nutrient level always good?
Q2: Identify critical depth for optimal growth and quality?

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Cultivation

Field cultivation

NOVANA station

Test site

Water depth

Bleached tissue

2 cm

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Background

Sagert & Schubert (2000) optimal growth rate
~140-569 PAR (14 days)

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Background – seasonal growth dynamics

Deploy seedlings

Fall Winter Spring Summer

Growth rate

Tissue color

Biomass

NO₃⁻

Fall --> Winter

Werner & Dring, 2011


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Results: Field Cultivation for 8 months

Deploy seedlings

Fall | Winter | Spring

Harvest 2018 (Normal year)

- Reduced biomass harvest (0-350 g/m)
  - Early peak in quality (irradiance) (missed two month growth)
  - Uneven biomass distribution

Move cultivation lines to nutrient enriched area?
- Constant or partly nutrient enriched?
- Do we loose growth by submerging?

Mortensen (2017)

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Lab cultivation

Field cultivation + Laboratory growth

Experiment 1
PAR exposures
High N

(10 months old)

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Lab cultivation

Field cultivation + Laboratory growth

Early germination (first 12 weeks)

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(Edwards & Dring, 2011)
Lab cultivation

Field cultivation + Laboratory growth

Experiment 1
PAR exposures
High N

Experiment 2
PAR exposures
Low N | High N

Growth rate
Bleaching
Recover?

(10 months old)

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Exp.1: Spore-derived seedlings saturated at 20 PAR

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Left to grow in high nutrient regime...

...filamentous algae overgrow the seedling lines
Exp. 2. Growth of vegetative seedlings

6 PAR exposures

| Low N | High N |

Bleaching (3 weeks)

Quality recovered in 10 days

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Exp.2. N content

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Calculate PAR

**Depth-depended PAR**

(Boderskov, T. 2013)

PAR (1m)
PAR (3m)
PAR (5m)
PAR (10m)

(1994-2012)

PAR = Total irradiance * esp

\[
\text{eps} = 2.0 + 0.15 \times \cos\left(2 \times \frac{3.14159265}{12} \times (\text{month} - 8.3)\right)
\]

PAR (z) = \( I_z = I_0 \cdot e^{-Kd \cdot z} \)

Kd = 2.3*secchi depth

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Provide site-specific recommendations when to submerge or move cultivation line to secure **Quality** or optimize **Growth rate**
• The normal cultivation practice for *P. palmata* is suboptimal
  ➢ Light limits and inhibit growth and quality during season

• Elongation in seedlings (10 mth) was higher at 20-78 PAR (5-10PAR)
  ➢ Epi-foulng at constant high nutrient and highest PAR
• Biomass growth saturated at 200 PAR (vegetative seedlings)
  ➢ Irradiance below 150 PAR secured tissue quality for 3 weeks
  ➢ Tissue quality recovered by nutrient enrichment at 150-280

• Recommended adjustment of cultivation practice
  1) LOW nutrient farm site: Submerge cultivation system
    (Secure quality but loose some growth)
  2) HIGH nutrient availability: Move cultivation system when bleaching occurs
    (Quality + Accellerated growth)
Take home message

- Adjust your longline dropper system during the season
- Efficient system (net structures?)
- Consider seedling age before deployment
Thank you for listening!

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