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Seaweed residuals as fertilisers in agriculture

Ishita Ahuja and Anne-Kristin Løes

SIG Seaweed 5 Conference

Trondheim 27. november, 2019

Organic Materials Review Institute (OMRI) approved seaweed products

OMRI Products List: About 140 products available as seaweed extracts/fertilisers in categories: Seaweed and Seaweed products/Fish products, liquid, stabilised, as per search on OMRI website, 25.11.2019.

- ASCO-SLE Liquid Seaweed Extract 0-0-6
  - RULING BODY: NOP
  - STATUS: Allowed
  - PRODUCT CODE: aqu-2831
  - CLASSIFICATION: Crop Fertilizers and Soil Amendments
  - CATEGORY: Aquatic Plant Products, synthetically extracted
  - COMPANY: OrganicOcean, Inc.
  - DATE LISTED: 20-Dec-2011
  - EXPIRATION: 01-Sep-2020
- Acadian Organic Liquid Seaweed Concentrate 0.1-0.0-5.0
- Actagro Elyxir Concentrated Foliar Solution 0-0-4
- Activ Liquid Seaweed Extract 0-0-5
- AgroKelp Fertilizante Orgánico Líquido Concentrado de Algas Marinas
- AgVerra AV Seaweed Extract
- Alga-Fusion Bioestimulante
- algabiol plant biostimulant fertilizante orgánico
- Algas Pacific NPKelp Seaweed Extract Liquid Organic Fertilizer
- Algas Pacific NPKelp Seaweed Extract Liquid Organic Fertilizer

OMRI determines which input products are allowed for use in organic production and processing, USDA and Canada - programs.

- Available as powder, cream, extracts or liquid fertilisers- classified as Crop fertilisers and Soil Amendments.
- Most of them are from seaweeds only but some are blended with fish.
- Companies based in US, Canada, Mexico, China---and also Norway.

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Some of the OMRI approved seaweed products

BWF Banducci Inc.: Super 6-1-1 Plus Kelp is a blended pelagic fish and seaweed high-nitrogen product.

GS Plant Foods: Liquid Kelp is derived from *Ascophyllum nodosum*.

Trade Corporation International S.A.U. : Phylgreen® Ascophyllum Nodosum Algae Pure Cold Extract Liquid Organic Fertilizer

CATAWBA Enterprises:

Fish Seaweed blend: *A. nodosum* and the Humic & Fulvic Acids in Catawba Seaweed Blend

Seaweed powder: *A. nodosum, Humic & Humic acids*

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Seaweeds as fodder and fertiliser

Seaweeds - exploited through ages for fodder and fertiliser along Norwegian coast but lost value through modernisation of agriculture and production of mineral fertilisers.

NOEN GJØDSLINGSFORSØK MED TANG OG TARE

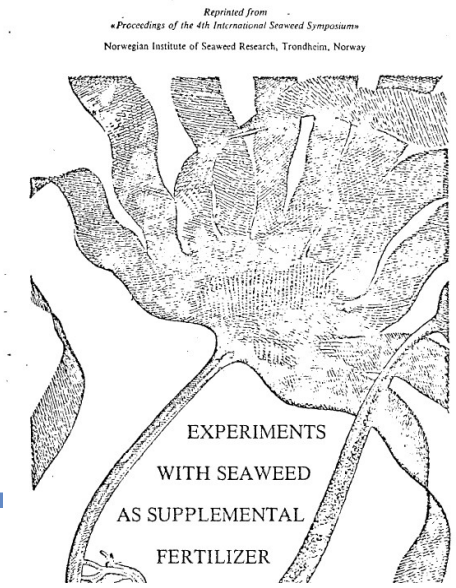
av

Sverre Myklestad

GJÖDSLINGSFORSÖK MED TAREGJÖDSEL 1959

av

Sverre Myklestad



In Norway: Products from Knotted Wrack

ALGEA The Arctic Company Kristiansund

Knotted wrack (*Ascophyllum nodosum*), collected along the coast of Norway, dried, grounded and extracted by acid/alkali to produce extracts - agriculture and animal feed.

- AlgeaFert Solid G
- AlgeaFert Liquid
- AlgeaFert Liquid K +
- AlgeaFert Meal

▼ Algea® Fert Solid G

RULING BODY: NOP
STATUS: Allowed
PRODUCT CODE: ale-2739
CLASSIFICATION: Crop Fertilizers and Soil Amendments
CATEGORY: Aquatic Plant Products, synthetically extracted
COMPANY: Algea AS
DATE LISTED: 30-Jan-2012
EXPIRATION: 01-Mar-2020

ALGEA FERT SOLID G

CF certificate

This gives waste – we call it algae fibre - still has lot of nutrients.

SIG Seaweed 5 Conference

Focus: *How do we create a market for seaweed products and biomass to develop the seaweed industry?*

So what's our aim: NORSØK studies-

Marine rest raw materials for fertilisers to organic agriculture **(RESTOR)**

- We initiated our work by getting Algae fibre from Algea AS.

Algae fibre: nutritional parameters and heavy metals/trace elements

% DM	~22.5 - 30 %
Organic C (% of DM)	31 - 32
Total N (% of DM)	1.2 - 1.5
P-Olsen (mg/100 g)	> 25.0
Total P (g/kg DM)	2.3 – 3.6
Ca (g/kg DM)	48 - 68
K (g/kg DM)	74 - 130
Mg (g/kg DM)	11 - 25
S (g/kg DM)	11 - 15
pH	8.6 - 10

Cu	4 - 9.4
Zn (mg/kg DM)	82 - 110
Ni (mg/kg DM)	< 1.5 - 4
Cd (mg/kg DM)	0.9 - 1.1
Pb (mg/kg DM)	< 0.30
Hg (mg/kg DM)	0.08 - 0.3
Cr (mg/kg DM)	3.8 - 7
As (mg/kg DM)	27 - 33

Algae fibre as fertiliser

Pot experiment with Ryegrass

Field-pot experiment with Leek

Field-plot experiment with Oats

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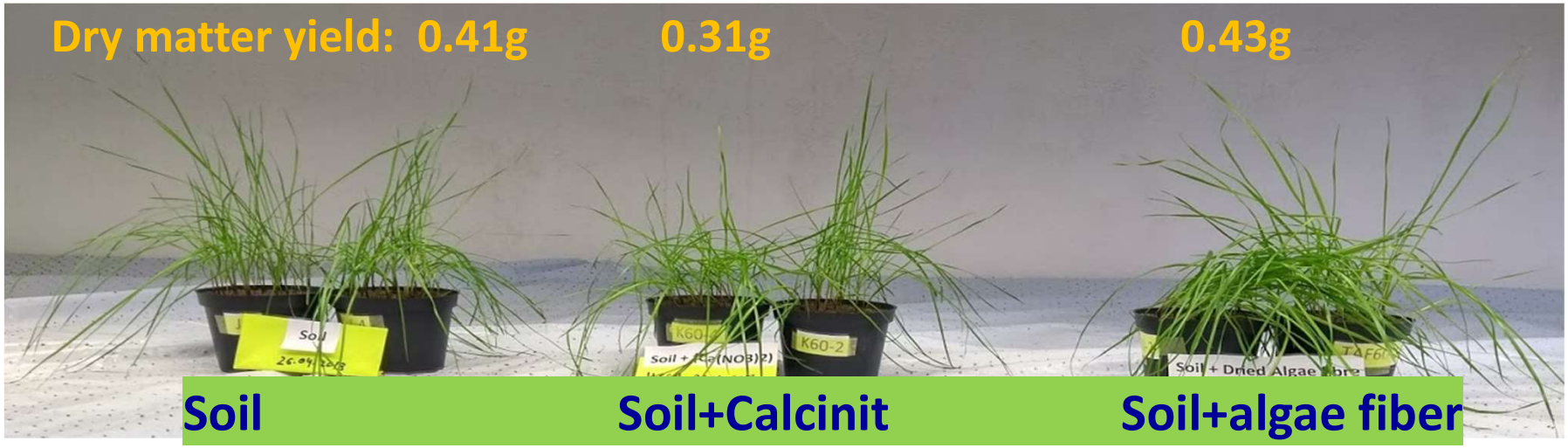
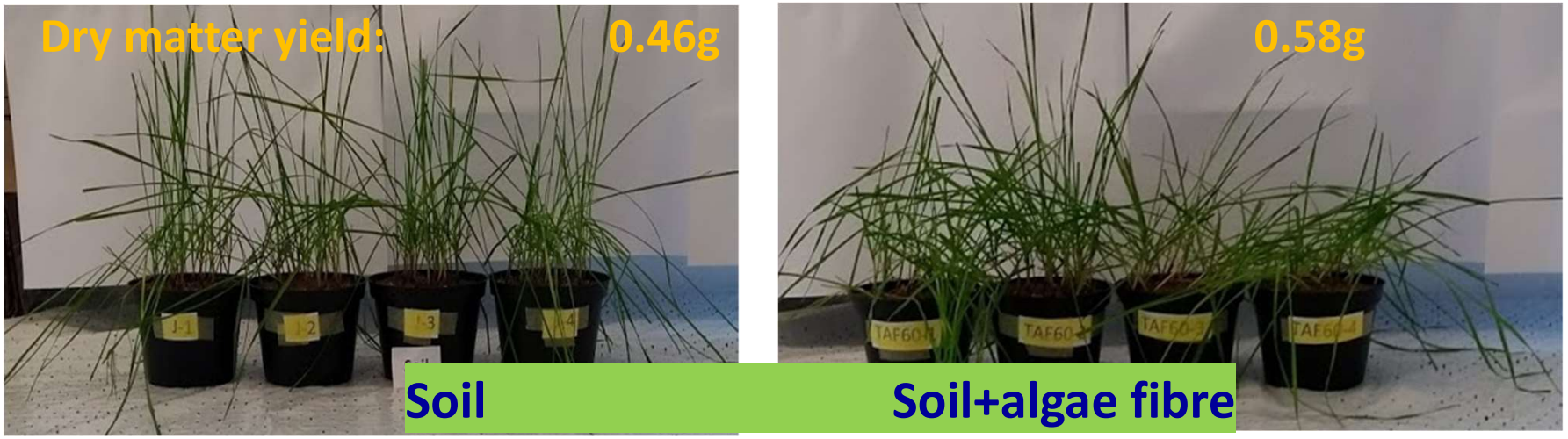
Pot experiment with ryegrass in 2018

First harvest



Second harvest



Pot experiment with ryegrass (*Lolium westerwoldicum*): some of the main conclusions

- High pH in algae fibre, increased soil pH from 5.3 to 6.8, may be beneficial in acidic soil but may affect the uptake of plant nutrients where the uptake is affected by soil pH.
- Concentrations of As in the algae fibre was high. Despite this, concentrations of As in ryegrass plants were below the limit of detection.
- Algae fibre is high in K, which in combination with fish bones can give a more balanced NPK fertiliser, as fish bones have high N and P.
- High K in algae fibre, may lead to luxury uptake, decreasing uptake of Ca and Mg with potentially negative health effects in animals, of particular concern especially in forage crops for dairy cows.

NORSØK
Norwegian Centre for Organic Agriculture

Effect of fish bones and algae fibre as fertilisers for ryegrass

Fiskebein og algefiber som gjødsel til raigras

NORSØK REPORT | VOL. 4 | NR. 7 | 2019

Ishita Ahuja og Anne-Kristin Løes, NORSØK

Organic eprints

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Effect of fish bones and algae fibre as fertilisers for ryegrass

Ahuja, Ishita and Løes, Anne-Kristin (2019) Effect of fish bones and algae fibre as fertilisers for ryegrass. NORSØK report, no. Vol. 4 No. 7 2019. Norwegian Centre for Organic Agriculture (NORSØK), Tingvoll, Norway.

PDF - English
1MB

Summary

In organic growing, both in Norway and elsewhere in Europe, significant amounts of fertiliser products not derived from certified organic farming are used, such as dried poultry manure or other types of fertilisers derived from conventional farms such as animal by-products. Organic agriculture aims to be independent of conventional agriculture, and fertilisers derived from harvesting of natural materials may be a relevant alternative. Catching of wild fish, and collection or cultivation of seaweeds, result in residual products which contain essential plant nutrients. Sediments of fish bones, which are residues from hydrolysis of fish remains used to produce fish oil and soluble proteins, are rich in nitrogen and phosphorus. Residues from seaweeds (algae fibre), after extraction of soluble nutrients sold as a liquid fertiliser, are rich in potassium and sulphur. However, we do not know much about how such residues affect plant growth. This topic was studied in a pot experiment with annual (Westerwold) ryegrass, which was harvested five times during the experimental period, April-August 2018. We had four replicates per treatment, and fish bones and algae fibre were applied either as fresh material or after drying at 105 °C. The control treatment was an experimental soil without any fertiliser, and we also had a treatment with calcium nitrate (Calcinit). The three types of fertilisers were applied in low and high amounts, where we aimed at a fertilisation level corresponding to 300 or 600 kg nitrogen (N) per ha (corresponding to 30 or 60 kg per daa). However, the actual amounts of N applied in fish bones, and algae fibre were somewhat lower than this. The total number of treatments was 11.

Application of fish bones gave a significant increase in the production of ryegrass. In total, across two N levels, and the drying status of materials, the accumulated above-ground yield over five harvests (stubble included) was 3.3 g DM per pot for fish bones, as compared with 2.2 g DM per pot in the control treatment. Fertilisation of ryegrass with algae fibre and Calcinit both gave an average yield of 2.6 g DM per pot. Converting these numbers to kg DM per ha, the accumulated yields were 7 166 kg/ha without any fertiliser, 8 541 kg/ha with algae fibre, 8 616 kg/ha with Calcinit and 10 916 kg/ha with fish bones. The average yield increase in % of the control yield was 19% with algae fibre, 20% with Calcinit and 52% for fish bones.

Nitrogen was the nutrient which was supposed to give the most significant effect on the production of plant dry matter. Somewhat more N was applied with Calcinit than with fish bones, but the yields were still considerably higher with fish bones. This was likely explained by the phosphorus (P) content of the fish bones (no P is present in Calcinit). Drying at 105 °C did not reduce the positive growth effect since slightly higher yields were observed with dried than with fresh materials. Fertilisation with algae fibre led to luxury uptake of potassium (K) in above-ground material of ryegrass while causing low uptake of calcium (Ca) and magnesium (Mg). In spite of high concentrations of arsenic (As) (33 mg/kg DM) in algae fibre, the concentrations of As in ryegrass plants amended with this material were below the limit of detection.

Both fish bones and algae fibre contain valuable plant nutrients and organic matter, which may have a positive effect as fertilisers and soil amendments. However, they are not well balanced as compared with the requirements of agricultural crop plants. Hence, unless special nutrients are requested, they need to be combined or mixed with other sources of nutrients and organic matter, to produce a valuable fertiliser which will also be easy to use in practice. Several further studies are required to possibly develop commercial fertiliser products for organic growing from marine-derived residual materials such as fish bones and algae fibre.

https://orgprints.org/36439/

Field experiment with oats 2019: Application of algae fibre to soil

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Field experiments: Experimental Design

Crops: Oats (160 kg N/haa) and leek (320 kg N/ha)

Treatments:

Control – No Nitrogen (N)

Mineral fertiliser: Calcinit (CaNO3)

«Grønn Øko» Green Organic (poultry manure) 8 % N

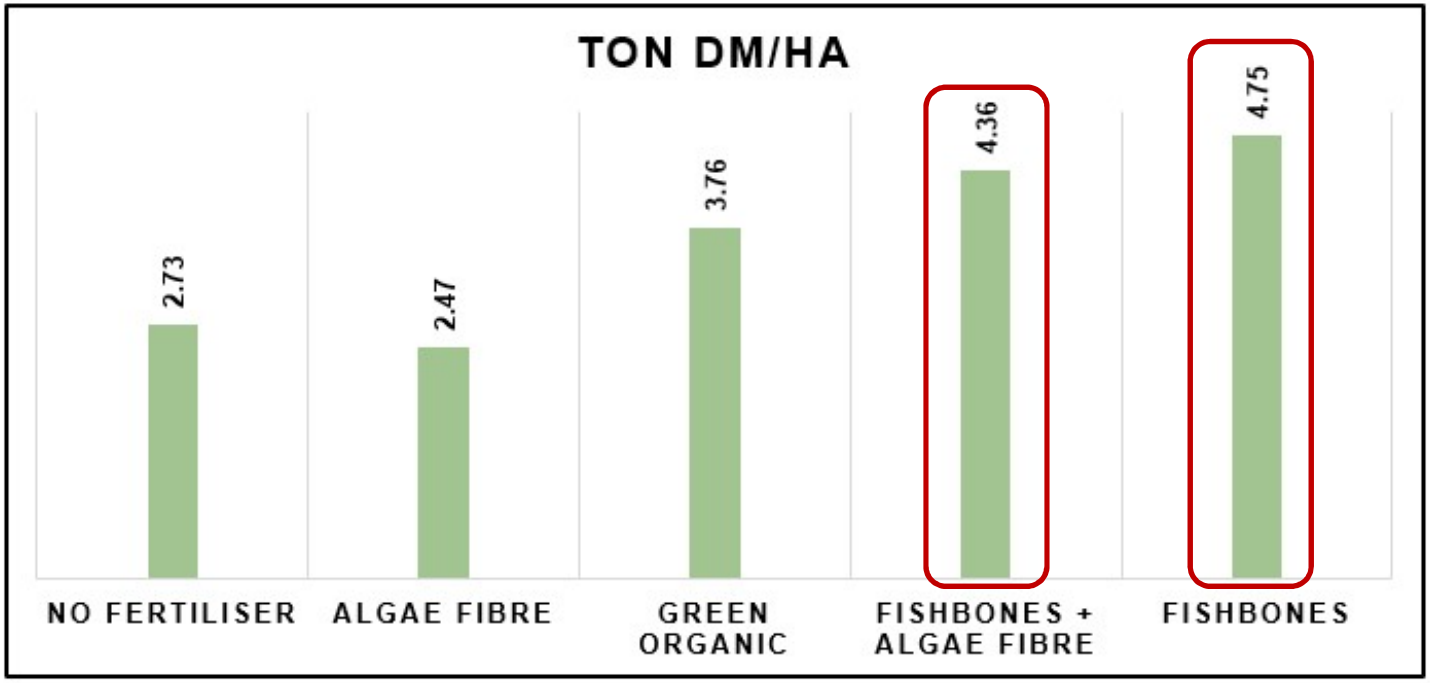
Fish bones 6 % N

Algae fibre 0.4 % N

Fish bone (70% N) + algae fibre (30% N)

People in action during harvesting of oats on 31st July

Field-plot experiment with oats: Main conclusions so far-----



- Algae fibre in combination with fish bones resulted in high yield.

- Algae fibre is high in K, which in combination with fish bones can give a more balanced NPK fertiliser, as fish bones have high N and P.

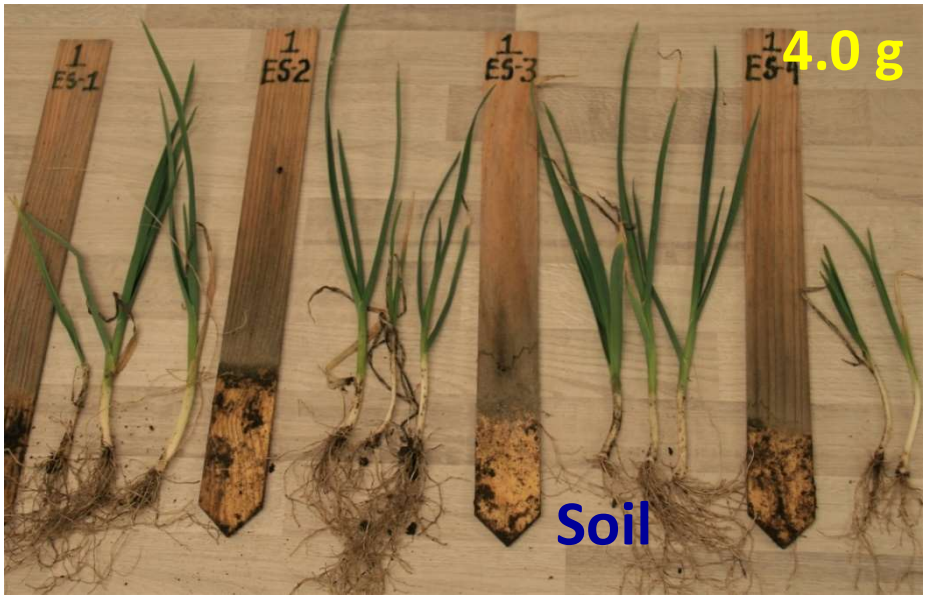
Field-pot experiment with leek (*Allium porrum*) plants

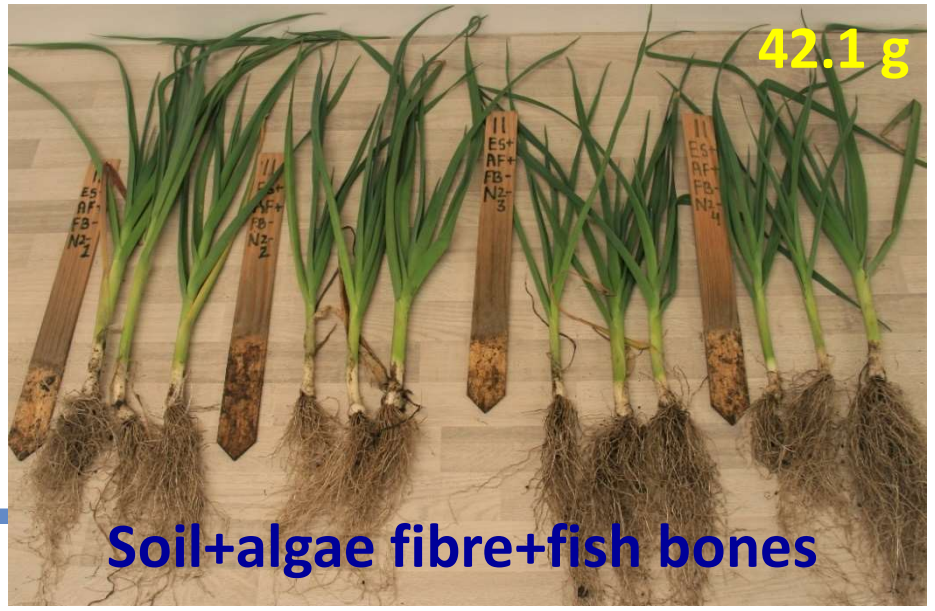
Leek plants on 27th May

Leek plants on 3rd September

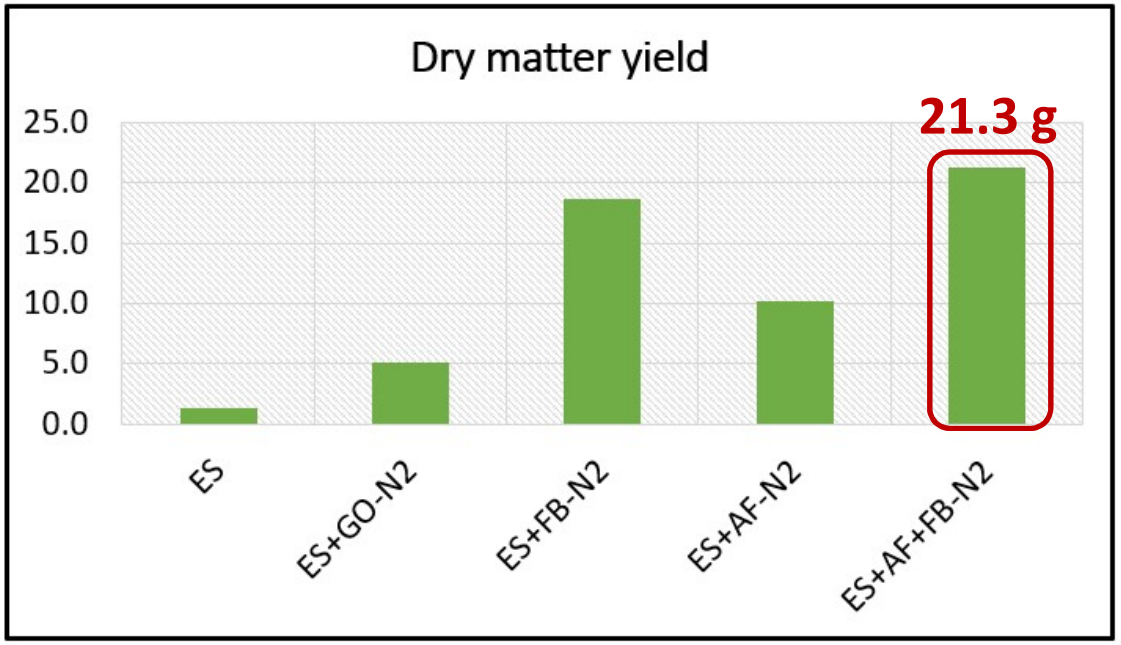
Leek plants on 3rd September

Fresh yield per plant





Field-pot experiment with leek : Main conclusions so far-----



- Algae fibre showed better effect on leek plants due to long growth period.

- Algae fibre is high in K, which in combination with fish bones can give a more balanced NPK fertiliser, as fish bones have high N and P.

Acknowledgements

Marine rest raw materials for fertilisers to organic agriculture **(RESTOR)**

Møre og Romsdal fylkeskommune

ORGANIC PLUS

Pathways to phase-out contentious inputs from organic agriculture in Europe

Funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No [774340 — Organic-PLUS]).

Anne de Boer Hanne Dahlen Marius Bless Morten Rørdam Peggy Haugnes Tatiana Rittl

Why not work together and generate a new fertiliser product from the seaweed processing waste?

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Seaweeds as fertilizer: Some bits from the Norwegian history

Myklebust (Sunnmøre): "Tang og tare er ansett som en meget god gjødning til eng, og hovedmassen blir brukt slik, men den blir også mye brukt til havre og bygg".

- Sverre Myklestad, in a report entitled Noen Gjødslingsforsøk med Tang og Tare, *Norsk Institutt for Tang- og Tareforskning, writes that in a book* "Norges Naturlige Historie" from 1752, bishop Pontoppidan described use of seaweed as fertiliser.
- Results from the studies using seaweed as fertiliser for potato, conduced by Dr. E. Solberg, Statens Landbrukskjemikse Kontrollstasjon i Trondheim (1901-1904), are discussed.
- Myklestad 1963, Experiments with seaweed as supplemental fertiliser, Norwegian Institute for Seaweed Research, Trondheim. Field experiments were carried out on turnips, odder beets and cauliflower in 1958-1960.

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Algae fibre: What about arsenic?

Cu	4 - 9.4
Zn (mg/kg DM)	82 - 110
Ni (mg/kg DM)	< 1.5 - 4
Cd (mg/kg DM)	0.9 - 1.1
Pb (mg/kg DM)	< 0.30
Hg (mg/kg DM)	0.08 - 0.3
Cr (mg/kg DM)	3.8 - 7
As (mg/kg DM)	27 - 33

QUALITY CLASSES:	0	I	II	III
Cd	0.4	0.8	2	5
Pb	40	60	80	200
Hg	0.2	0.6	3	5
Ni	20	30	50	80
Zn	150	400	800	1500
Cu	50	150	650	1000
Cr	50	60	100	150
As	5	8	16	32

As *Arsenic,* ***B*** *Boron,* ***Cd*** *Cadmium,* ***Co*** *Cobalt,* ***Cr*** *Chromium,* ***Cu*** *Copper,* ***Fe*** *Iron,* ***Hg*** *Mercury, Ni Nickel, Pb Lead, Mn Manganese, Mo Molybdenum, Zn Zinc.*

Soil conditioners in

class 0: may be applied according to crop demands on all types of land.

class I: may be used in amounts up to 40 tons of DW/ha of agricultural land over a period of 10 years, or applied as a top layer up to 5 cm on land not used for growing of food or feed crops.

class II: may be used in amounts up to 20 tons of DW/ha of agricultural land over a period of 10 years or applied as a top layer as described for class I products.

class III: may be used as a top layer as described for class I and II or used as a top layer up to 15 cm to cover waste deposits.

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