BOOST FUND *AlgalFertilizer*

Algae delivering waste phosphorus to soil and crops

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BACKGROUND Phosphorus (P) is a limited major nutrient for plants, and thus an important element of modern agriculture. Nevertheless, the efficiency of P usage today hardly reaches 20% with the rest ending in waste water or carried away by run-off from fields to rivers and oceans. Here, algae gather in the nutrient rich water in huge numbers, leading to algal blooms. They take up large amount of phosphorus, storing it for later use.

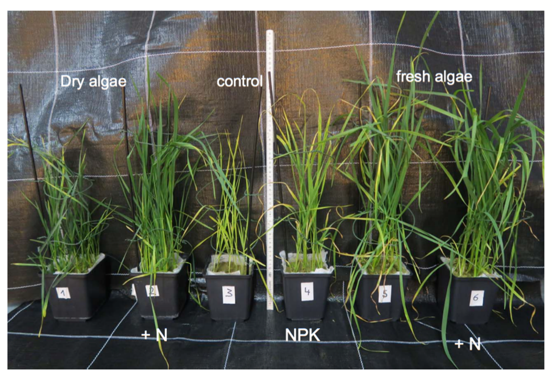
SUMMARY

- P is a limited nutrient source for plants
- 80% of fertilizer-P does not reach the plant but is washed off into rivers or waste water
- Algae accumulate P in large quantities
- Potential of algae to clean waste water from P
- Algae as P-fertilizer for crops

source: NASA

In our work, we investigate the potential of microalgae to accumulate P and use them as fertilizer for crops to close the cycle from waste water back to agriculture. The potential of algae for accumulating P will be combined with the benefit of delayed release of P from the algal biomass applied as a fertilizer to soil. Models are used to understand the underlying dynamics of the conversion of different P-pools in soil, the transport and utilization of P in the plant, and the distribution and usage of P-forms in the algal cell.

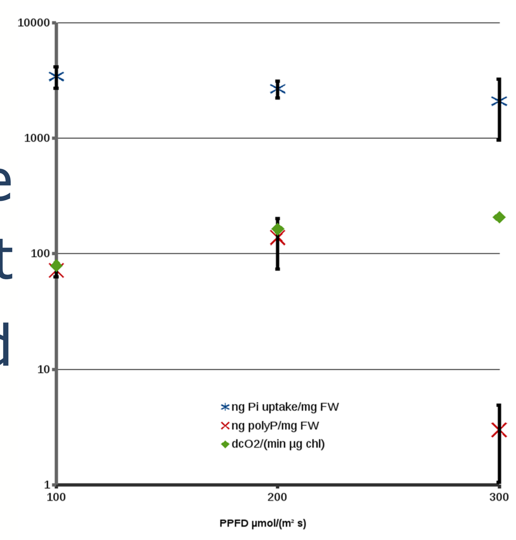
Algae as Fertilizer In a first experiment wheat seats were planted in pots containing soil mixed with C*hlorella vulgaris*. One approach used dried algal biomass, a second approach used live algae. For controls a mineral NPK-fertilizer was used. The crops grew for 40 days.
The results show that the wheat plants grew well (shoot length, and root density and length) with both algal fertilizers. A additional nitrogen source brought no further benefit. In comparison with the controls the plants fertilized with algae grew slightly better.



source: AlgalFertilizer, FZ Jülich

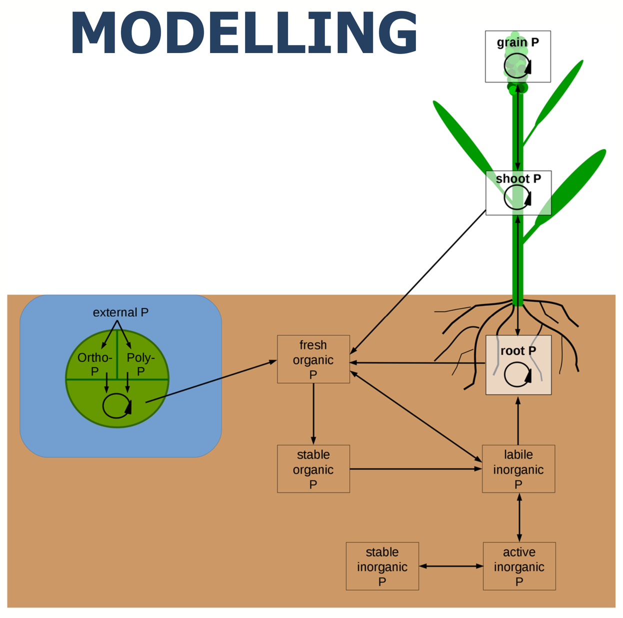
source: AlgalFertilizer, Metabolic Profiling HHU

Phosphorus Uptake C*hlorella vulgaris* were kept in a P-rich environment and then transferred into a full P medium at three different light intensities. P uptake, polyphosphates, and oxygen evolution were measured.
Polyphosphates were accumulating in increasing amounts for the lowest and middle light intensity. At a high intensity the concentration is comparatively low. A higher light intensity leads to a decreased P_i uptake. The O_2 evolution indicates an increased photosynthesis for higher light intensities.



We developed two models to simulate two aspects of our project: The Plant-Soil-Model looks at the overall picture of different P-pools in soil and at phosphorus uptake by plants and their growth in a soil fertilized with algae.
The Algae-Model concentrates on the algal cell. We examine the uptake of external phosphorus into the algal cell, and the

MODELLING



distribution into the internal orthophosphate and polyphosphate pools. We will research the effects of luxury and overshoot P-uptake. Also, the influence of different light intensities is regarded.
Simulation results will be compared to experimental data provided by our collaboration partners.

CONCLUSIONS First experiments show that it is possible to use algae not only as P but also as nitrogen source for crops. The slow release of algal nutrients might provide an advantage compared to mineral fertilizer. The uptake and distribution of P in algae is depending on external P concentrations and light intensity. For a complete understanding of the distribution of P in different soil and algal P-pools and the uptake of P in algae and plant further experiments are needed, that then can be used to develop and parameterise models.

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