Influence of pH Change on the Phosphorus Cycle in Aquaponics

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INTRODUCTION

In conventional fish farming, large amounts of phosphorus (P) are accumulating in the wastewater [1], which is becoming a big problem world-wide due to the potential for environmental pollution [2,3]. In aquaponics (Fig. 1), the combination of aquaculture (rearing fish) and hydroponics (the soil-less growing of plants), plants are using P for their growth but the P-cycle could be still optimized. It depends on the pH, in which form P is present in nutrient solution [4].

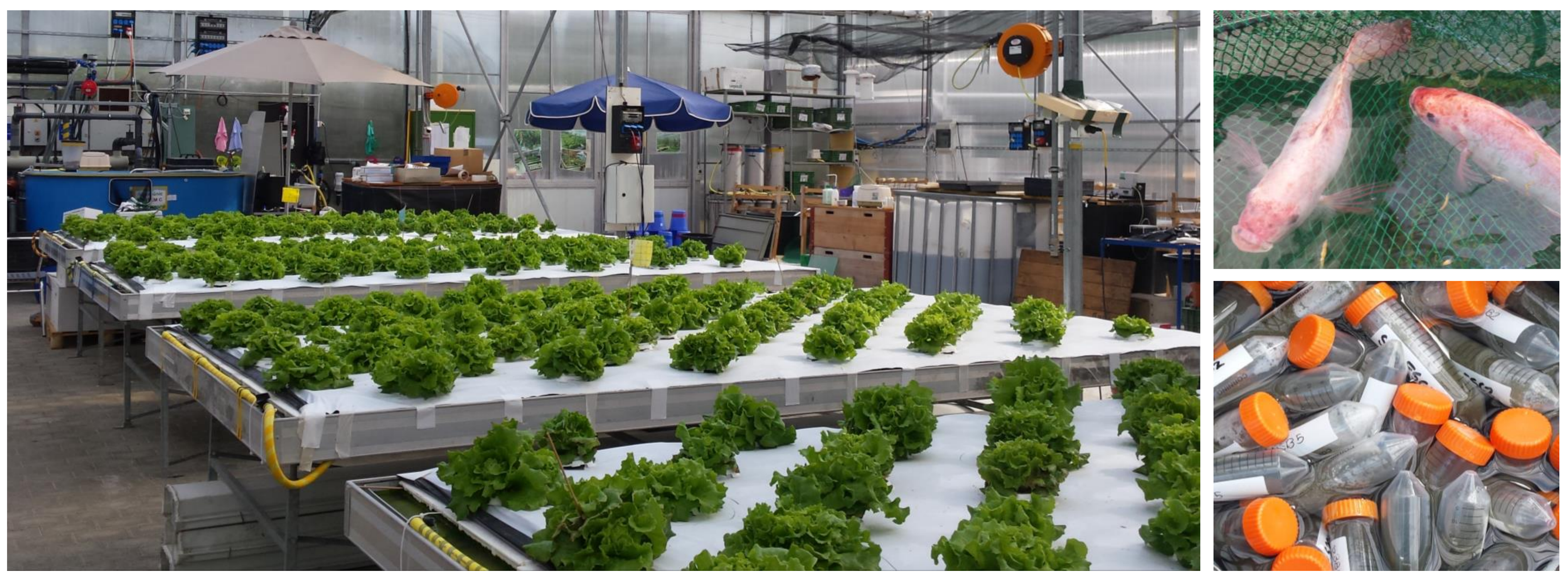

Figure 1: Picture collage of the experiment in "ZHAW Wädenswil aquaponic system, 2017"

METHODS

Three replicates of experimental aquaponic systems (4.5 m^3 each) in the foliar greenhouse at Zurich University of Applied Sciences in Wädenswil, CH, were stocked with **Nile tilapia** (*Oreochromis niloticus*), planted with **lettuce** (*Salanova®* Batavia), and monitored from 22th September to 8th November 2017 (Fig. 2).

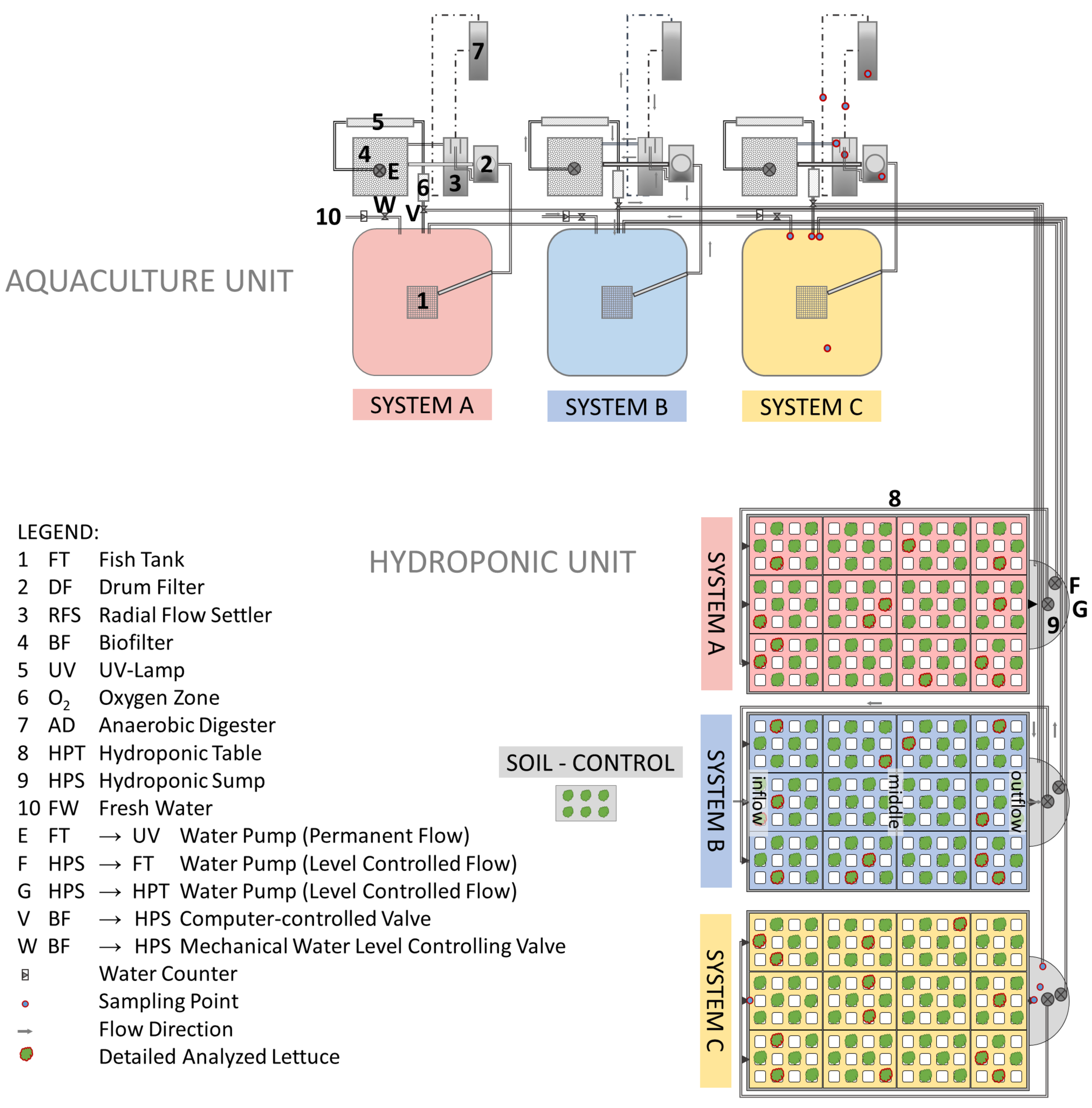

Figure 2: Detailed system set-up; "ZHAW Wädenswil aquaponic system, 2017"

In the first two weeks the pH was adjusted to 6.0 ± 0.15 by adding acid (HCl) and then for another two weeks to 7.3 ± 0.3 by adding bases (KOH and $Ca(OH)_2$). Ortho-P and total-P from 13 different sampling points in the aquaponic system (system water, sludge, and deposits) were analyzed and P mass balance calculated.

OBJECTIVES

The purpose of this thesis was to

- **calculate P mass balance** in order to optimize further P use in aquaponics and
- **examine pH manipulation effect** on P-cycle in the system (Fig. 3)

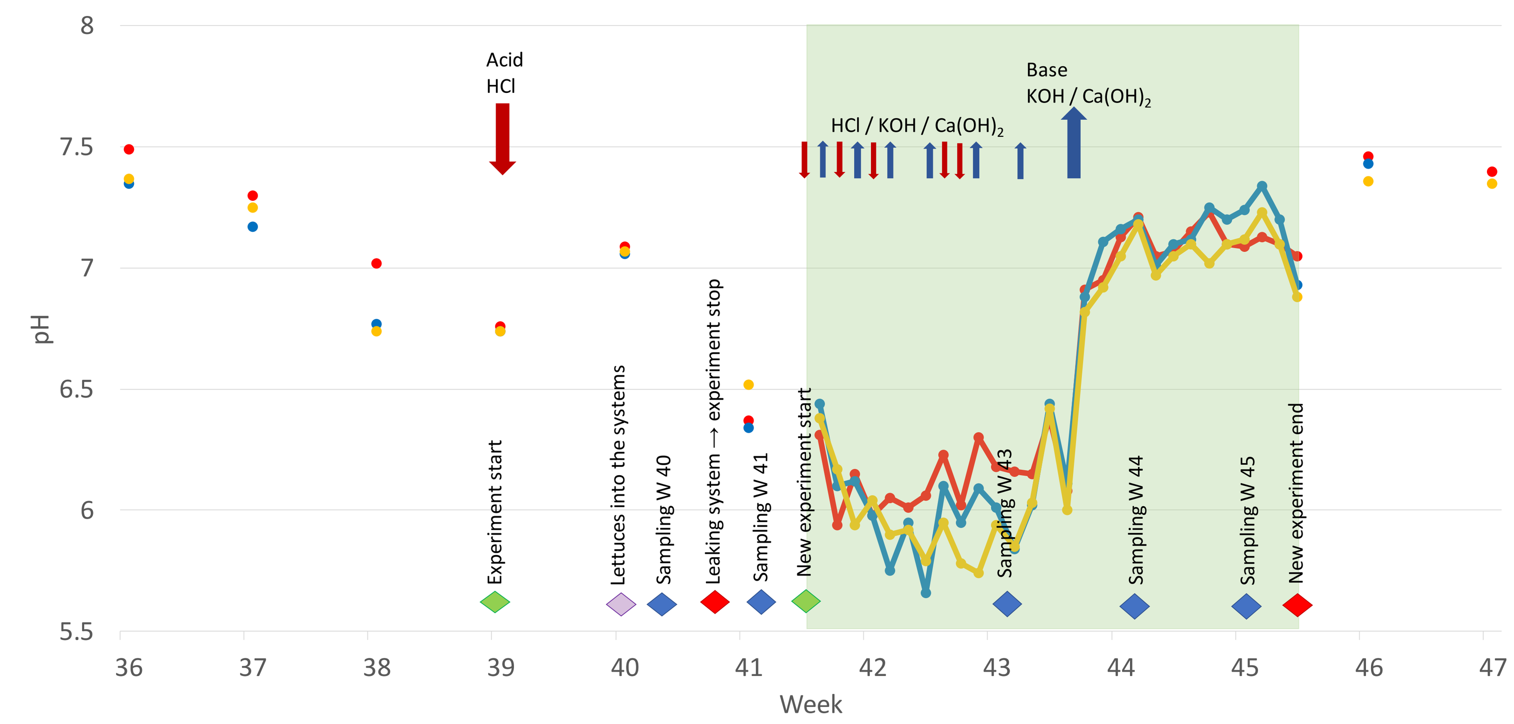

Figure 3: Timeline (week 36 - 47) with green shaded experiment period (week 41 - 45; 11th Oct - 8th Nov 2017) with marked interventions in the system and pH courses of the three replicates; system A, system B and system C in "ZHAW Wädenswil aquaponic system, 2017".

RESULTS

The P balance (Fig. 4) showed, that 41 % of the P inputs (by fish feed and tap fresh water) was absorbed by fish and 8 % by plants, the system water accumulation was 27 % and the P loss in form of deposits (biofilm on sump and fish tank surface and deposits on digester heater) in the system 24 %.

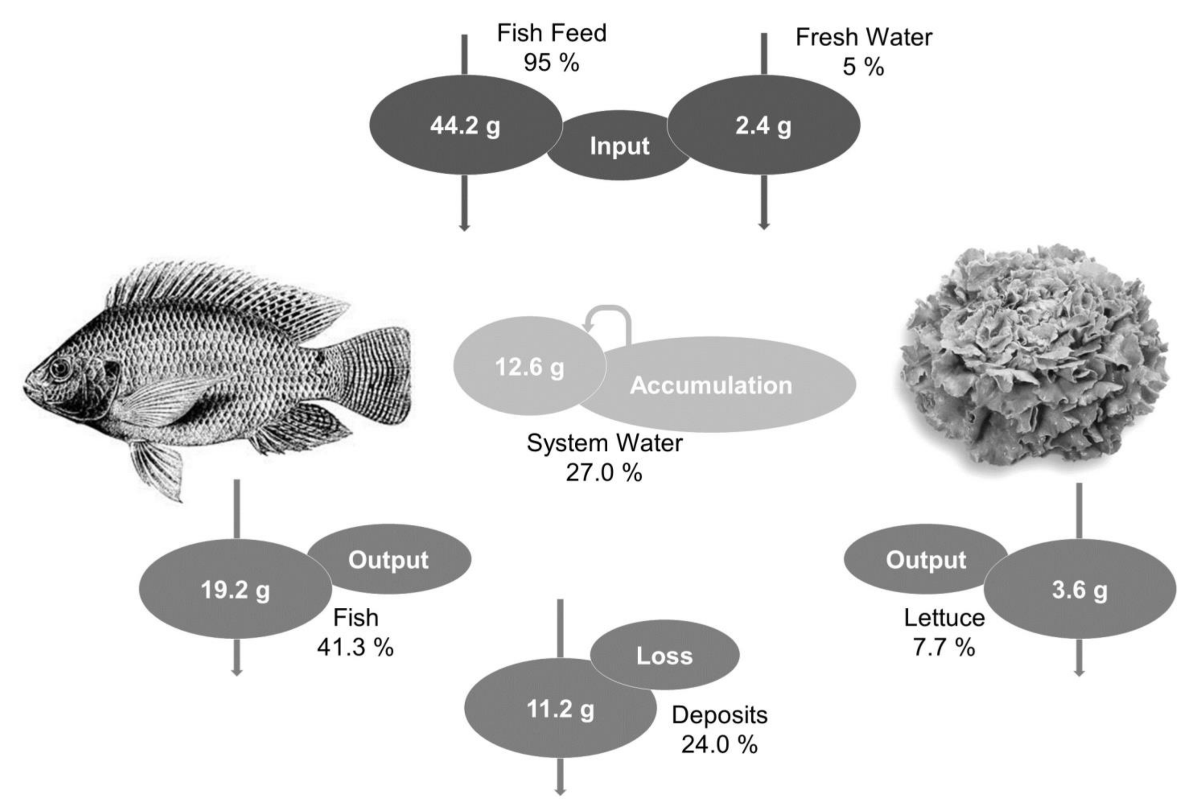

Figure 4: Phosphorus mass balance of the "ZHAW Wädenswil aquaponic system, 2017"

Around 90 % of total-P was present as ortho-P in the system water. Furthermore, the digested sludge contained more ortho-P (14 - 55 % of total-P) than fresh sludge (5 - 10 % of total-P).

DISCUSSION AND CONCLUSION

The ortho-P concentrations after the manipulations of pH in the aquaponic system water surprisingly increased with increasing pH. This is probably due to the complex dynamics between P and Ca. The established P mass balance identified and quantified several P pools, demonstrating that aquaponics systems can maximize overall P utilization if a digester is included into the loop.

LITERATURE

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