Development of Macronutrients in an Ugandan Inland Valley under Rice Production

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Background

Increasing population numbers in East Africa necessitate an increase in food production. This increase in the uplands is only possible with high inputs of fertilizers – which is too expensive for smallholder farmers. This forces the farmers to produce their goods in the wetland areas. These areas have a high potential for food production because of a good water availability and may become the bread basket of the region.

Goal

Along a topographical and expected hydrological gradient within one prototypical wetland in Uganda, we conducted an agricultural experiment focusing on rice production. The set up was chosen to test moderate rates of NPK inputs and look for the behavior of plants and soil – in this study focusing on soil nutrients. We wanted to figure out which position within the wetland (i) and which N-input is favorable for a sustainable production (ii).

Study Site

0°31’30“N
32°36’54“E
MAT: 28 °C
MAP: 1,200 mm
Parent Material: Alluvial Depositions
Soil Type: Gleysol

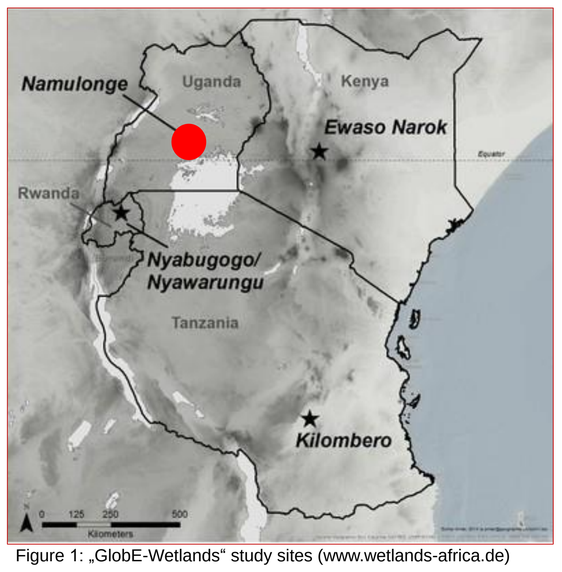


Figure 1: „GlobE-Wetlands“ study sites (www.wetlands-africa.de)

Central Field Trial

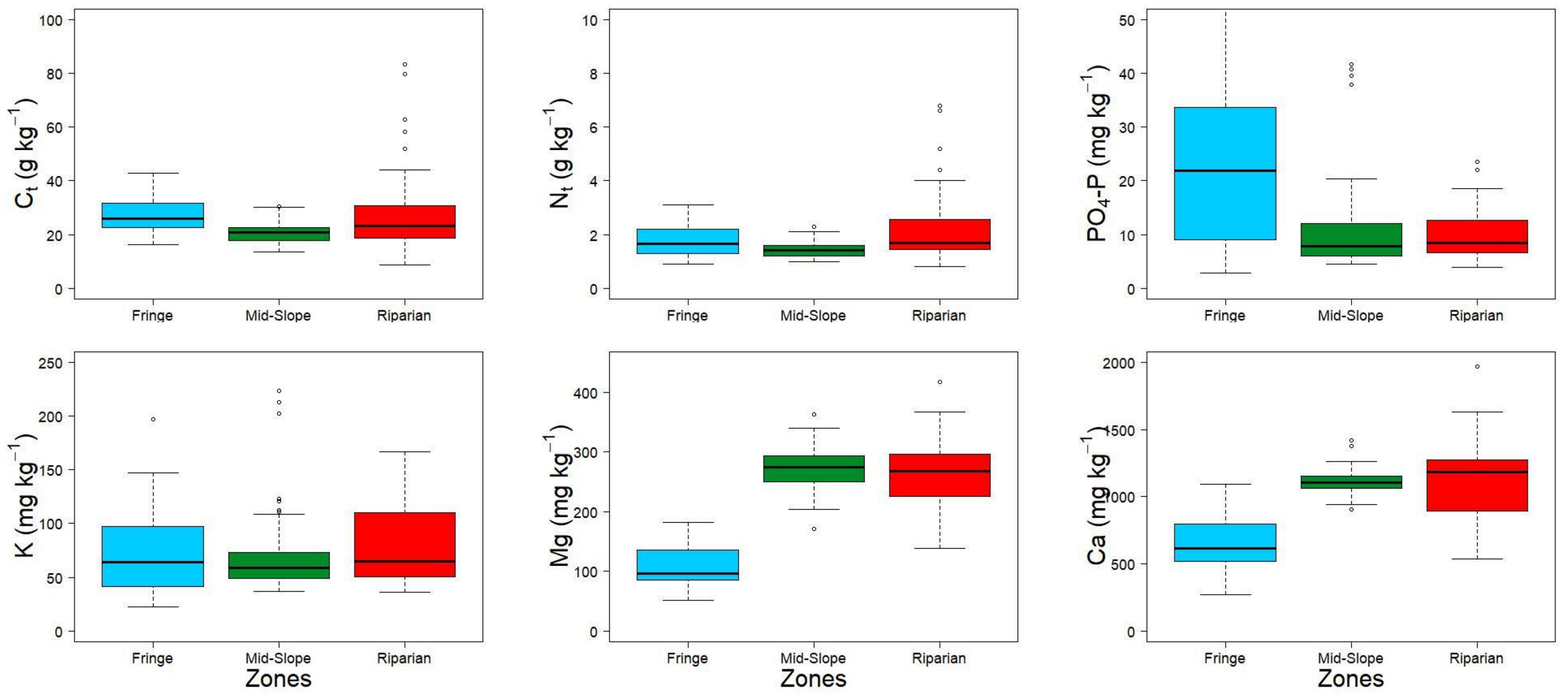
Rice Type: Saro V — Spacing: 30 cm

Positions: Fringe, Mid-Slope, Riparian — Reps: 4

Table 1: Description of Treatments within the CFT Rice in Uganda

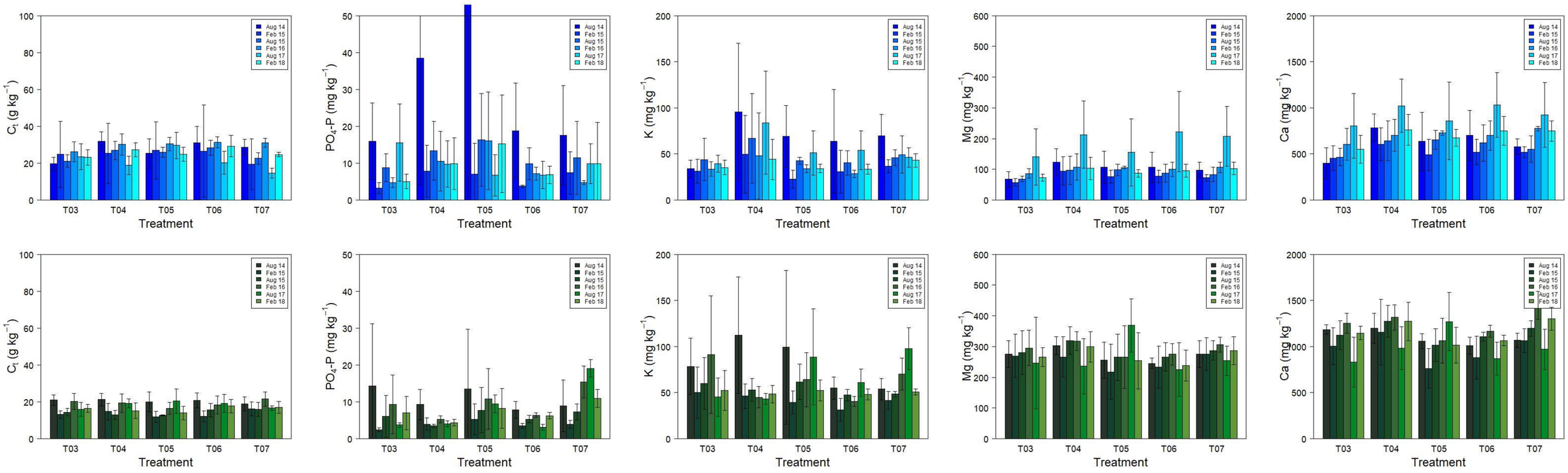
Treatment	Description
T01	Natural plant recovery
T02	No bunding, no min-N
T03	No min-N, multiple weeding
T04	60 kg ha^{-1} urea-N
T05	120 kg ha^{-1} urea-N, 60 kg ha^{-1} PK, irrig.
T06	Green-manure (60 kg-N ha^{-1})
T07	Green-manure + compost (120 kg-N ha^{-1})
T08	Double-Crop, no-N
T09	Like T05 in double crop
T10	Like T07 in double crop

Results I – Differences between the three zones



Figures 2-6: Box-Whisker-Plots of soil nutrients before the beginning of the experiment in August 2014

Results II – Development of Nutrients according to Treamtment



Figures 7-16: Bar-Charts of nutrient content according to sampling time and Treatment throughout the whole duration of the experiment (August 2014 – February 2018). Blue bars show the Fringe zone, green bars show the Mid-Slope zone.

Summary and Conclusion

There is (partly) a strong difference between the three wetland positions Fringe, Mid-Slope and Riparian. Especially the Fringe zone differs significantly in the contents of PO_4-P, Mg, and Ca from the other two zones. While PO_4-P was highly available at the beginning of the experiment in the Fringe position, after the first cropping season the content of available PO_4-P decreased strongly according to all NPK mangement options.

Looking at different NPK management options from the soil perspective, there is no option favorable. Even a high input of P does not balance the loss during the first cropping season. No matter how high the use of fertilizers is, the amount of available soil nutrients is levelling at a certain point.

Soil Analysis

Samples (0-30 cm), air-dried, ground, sieved (< 2mm), and pulverized
Extraction: Mehlich-3
Determination: ICP-OES (metal ions), and molybdenum-blue (PO_4)
Total C and N: dry combustion (950°C)

Acknowledgments

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