Effects of gypsum on degraded alkaline soils and plant growth in urban agriculture of Ouagadougou, Burkina Faso

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Introduction

To meet fresh food requirements of rapidly increasing population of cities in the semi-arid tropics, low quality irrigation water in urban gardens is used. In Ouagadougou farmers irrigate their intensively managed fields with alkaline industrial wastewater which leads to sodification.

Firstly, we assessed the effect of sodium- (Na) and bicarbonate- (HCO_3^-) loaded industrial wastewater on soil properties and plant development.

Secondly, we tested gypsum ($CaSO_4$) as a soil amendment to ameliorate the quality of affected soils and improve growing conditions for spinach plants.

Highlights

- Gypsum and clean water treatment reduced soil pH and SAR, whereas aggregate stability was increased
- Gypsum incorporation reduced significantly sodium uptake by spinach plants

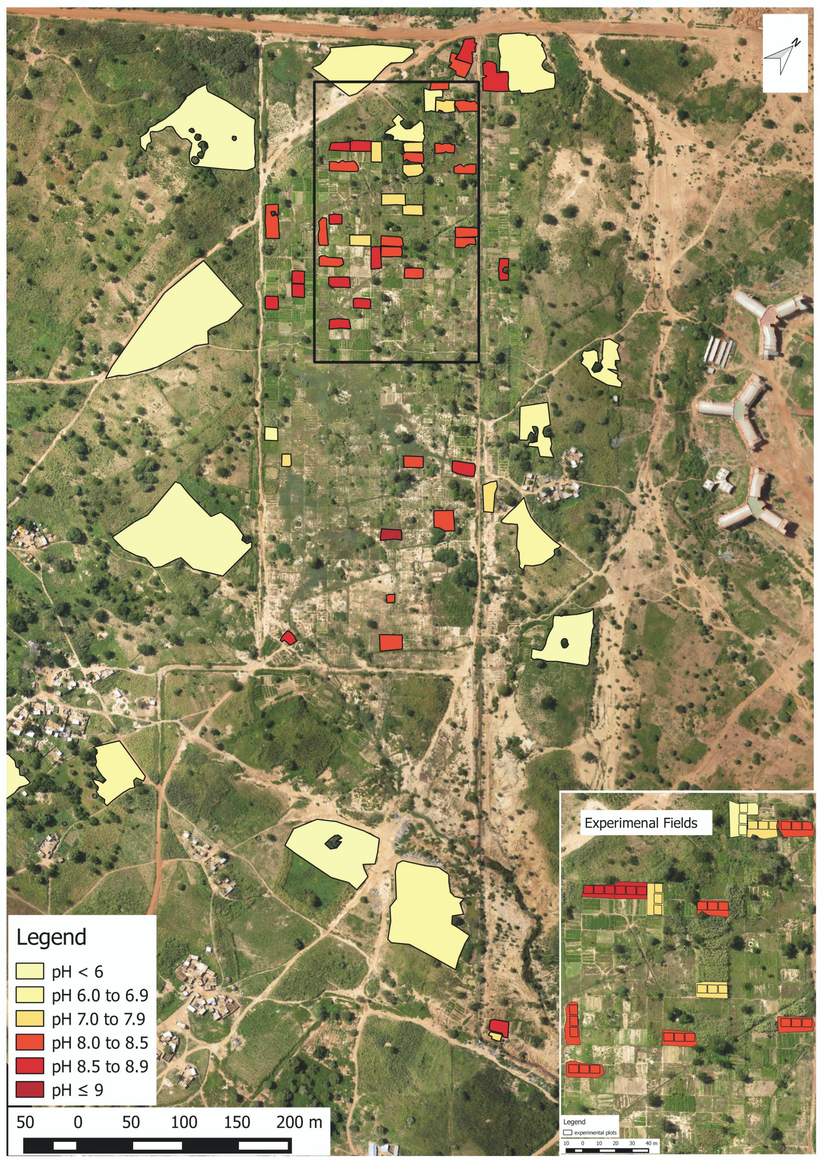

Figure 1. Map of degraded fields in industrial area of Ouagadougou and on-farm experimental sites with different soil pH.

Methods

- Experimental setup was based on the establishment of 12 fields with soils that differ in their degradation level (SDL): low, moderate or high
  - Gypsum incorporation to the topsoil (0 - 20 cm) of 6.8 (moderate SDL) and 10 t ha^{-1} (high SDL)
  - Spinach cultivation under clean and wastewater irrigation
- Soils were analysed for chemical and physical parameters (pH, exchangeable cations, aggregate stability)
- Spinach plants were analysed for yield and nutrient contents

Results

Gypsum application to soil led to:

- a reduction of soil pH (< 8), ESP (< 18%) and sodium absorption rate (SAR) from 14.0 to 7.9 $(mmol\ l^{-1})^{0.5}$
- an increase in aggregate stability from 44.2% to 51.2%

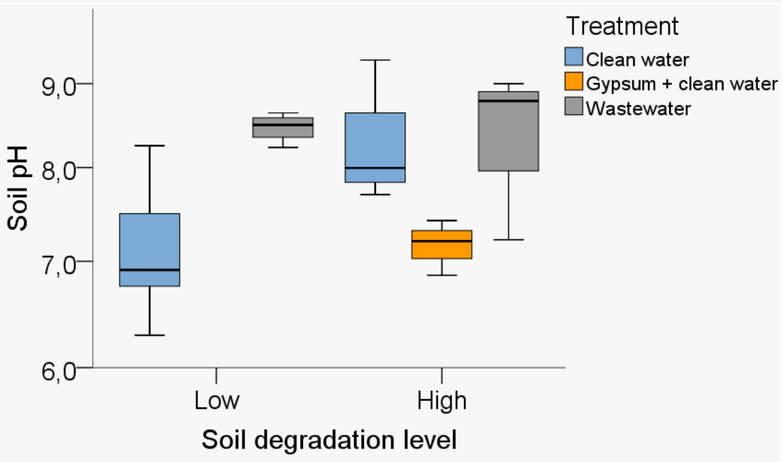

Figure 2: Soil pH in different treatments and soil degradation level.

- a slight increase in spinach yield

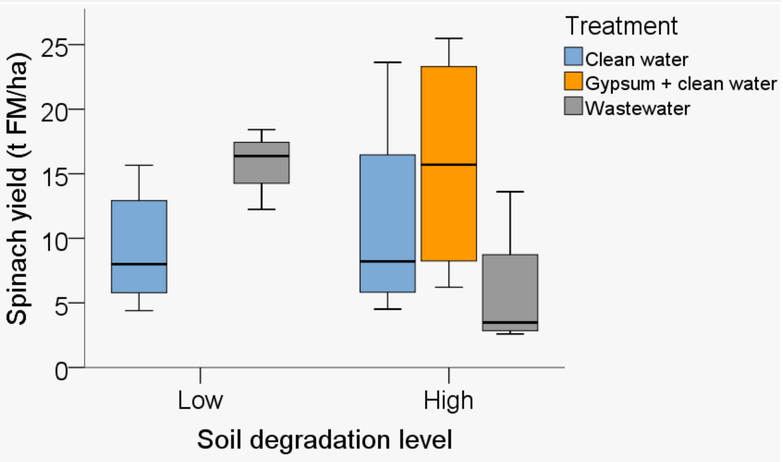

Figure 3: Effect of gypsum application on spinach yield under clean and wastewater irrigation cultivated on highly degraded soils.

- a decline of Na content in plant tissues up to 80%

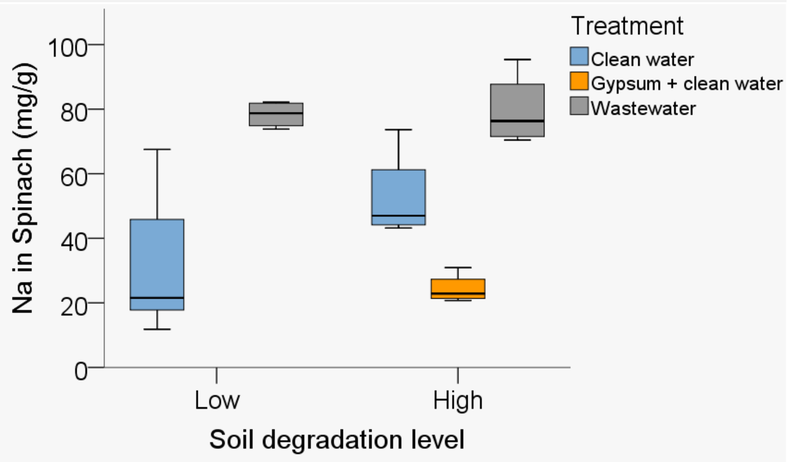

Figure 4: Effect of gypsum application on sodium content in spinach under different treatments and soil degradation level.

- an increased Ca:Mg ratio in soils from 3.5 to 7.8 and influenced the complex cation interactions and with positive effect on the cation uptake by spinach roots

Figure 5: Farmers practice of irrigating spinach (a) with alkaline sodic water from wastewater channel (b); Gypsum incorporation (c), maize plot (d) and irrigation of spinach plot (e); Farmer group of on-farm experiment (f).

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