Effects of soils and droughts on yield, water use efficiency and thiamine of leafy vegetables

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Introduction

- Green leafy vegetables, vital for food and nutrition security and human health, have been neglected than the staple and cash crops
- In a time when intensive agriculture is degrading soils, and climate is changing, this lack of knowledge can be harmful
- In Uganda and Kenya, similar vegetables are cultivated, however, due to the high variance in soil type, production both of quantity and quality differ
- The main aim of this research was to evaluate the effects of (i) soil fertility and (ii) different drought intensities on yield, water use efficiency and thiamine content of green leafy vegetables

Figure 1. A picture of experimental 144 pots in the greenhouse trial

Sukuma wiki (SW) (collards)

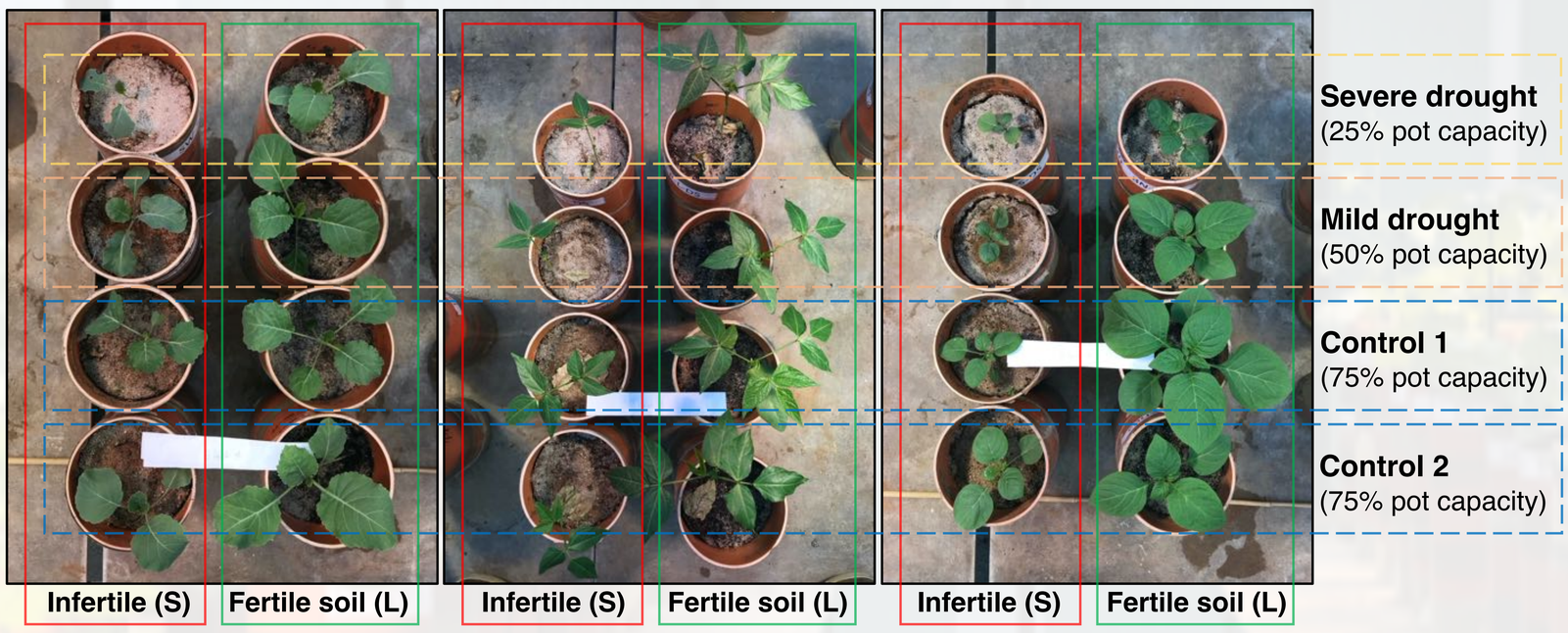
Rich in antioxidant vitamins

Cowpea (CP)

Rich in vitamins (A, B_1, B_2 and C)

Black nightshade (BN)

Rich in vitamins (A, B_1, B_9 and C)



Methods

- A greenhouse trial 17th Sept. – 7th Nov. 2019 (51 days)
- Seeds from Uganda and Kenya
- Soil samples from Tauchenweiler (endostagnic alisol; infertile soil) and Höwenegg (endoleptic cambisol; fertile soil) (Germany)
- Watering regimes of 25 (severe drought), 50 (mild drought) and 75 (control) % pot capacity (PC)
- Six replicates of each treatment
- Randomized complete block design (RCBD)
- Total yield
- Water use efficiency (yield/ total water consumption)
- Thiamine (vitamin B_1) analysis using a high-performance liquid chromatography (HPLC)

Figure 2. A set of three East African green leafy vegetables sukuma wiki (Brassica oleracea var. viridis), cowpea (Vigna unguiculata) and black nightshade (Solanum nigrum) with drought (control, severe and mild) and soil fertility (low and high) treatments in a greenhouse trial. This is a reorganized set to take a picture from an experimental position at 31 days after sowing.

Results

Yield (Fig. 3A)

- Yield decreased in all vegetables with decreasing water availability
- Soil fertility did not affect the yield of sukuma wiki (collards) with enough water condition, however, sukuma wiki was the most drought-sensitive among three vegetables
- Cowpea and black nightshade were more dependent on soil fertility than sukuma wiki

Water use efficiency of yield (WUE_Y) (Fig. 3B)

- Fertile soil had a higher WUE_Y than infertile soil
- The severe drought resulted in the highest WUE_Y in fertile soil
- Sukuma wiki had the highest WUE_Y in all treatments

Thiamine (Vitamin B_1)

- Thiamine of cowpea and sukuma wiki was increased significantly under the severe drought (25% pot capacity) in infertile soil (Fig. 3C)
- The absolute thiamine amount was, however, decreased due to the decreased yield (Fig. 3A)
- Thiamine content of black nightshade was not affected by the treatments (Fig. 3C)

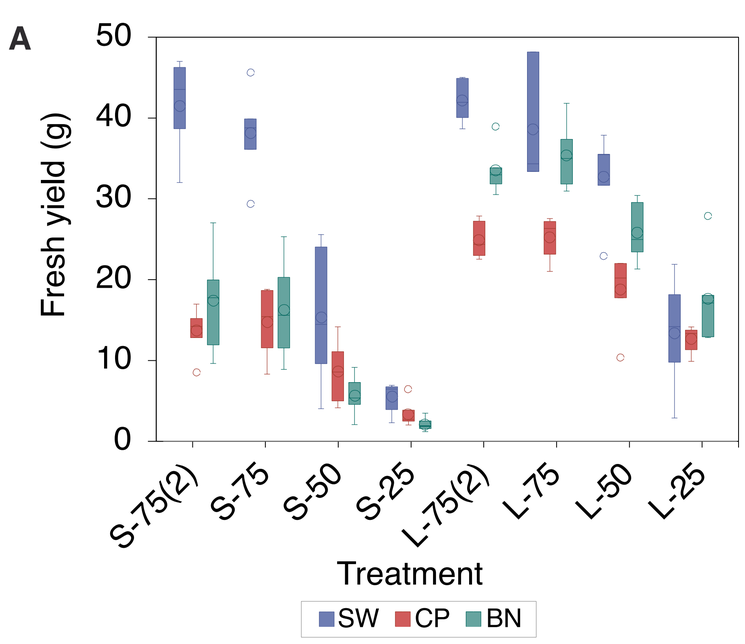


Figure 3. Leaf yield (A), water use efficiency of yield (WUE_Y) (B) and thiamine content in mg per 100g of fresh weight (C) in three green leafy vegetables, sukuma wiki (SW), cowpea (CP), and black nightshade (BN), under soil and drought treatments. Treatment: S (infertile soil), L (fertile soil), 75 (75% pot capacity), 50 (50% pot capacity) and 25 (25% pot capacity).

Conclusions

- Soil fertility and drought affected the yield and thiamine (vitamin B_1) content of vegetables in different ways
- Severe drought increased the water use efficiency and thiamine content, however, the yield and absolute thiamine was decreased
- The results can be used to suggest better-quality and -quantity diets in rural areas and understand the effects of drought and soil fertility on food and nutrition security

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