Iron Accumulation and Partitioning in Hydroponically Grown Chickpeas

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BACKGROUND

► Iron deficiency is one of the most prevalent malnutrition issue world wide, affecting an estimated 6 billion people worldwide (White et al, 2009).

►Chickpea (*Cicer arietinum L.)* is a self-pollinating annual diploid that is part of the legume family and is known for its nutritional seed (Fig. 1).

►Biofortification is a common goal of plant breeding today, with the potential to breed for higher micronutrients in chickpeas, in particular iron (Diapari et al, 2014).

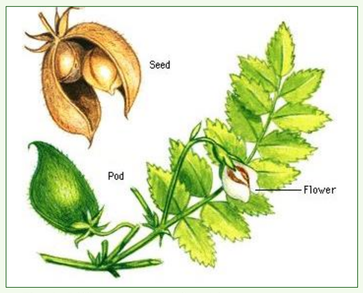


Fig. 1. Different parts of a chickpea plant

►Considerable variability present in chickpea germplasm for seed iron concentrations, which increases the potential to breed for higher iron in chickpea cultivars (Diapari et al, 2014).

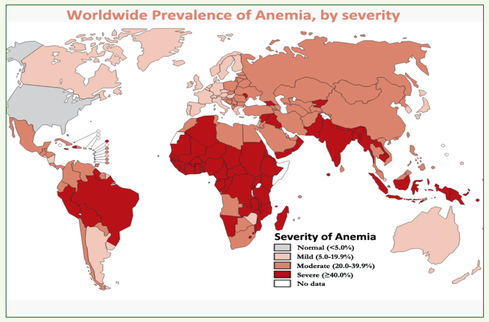


Fig. 2. Iron deficiency regions across the globe (WHO report, 2008)

OBJECTIVES

► Assess and measure the accumulation of iron in the major plant organs of a chickpea plant.

►Understand the source-sink remobilization of iron through the different growth stages (V3, V10, R2) of a chickpea plant.

►Successfully grow chickpea plants through the use of a hydroponic system.

HYDROPONICS

►The cultivation of a plant by placing the roots in liquid nutrient solutions rather than in soil.

►Better control of nutrient status and uptake by the plant compared to the soil because of the consistent input of nutrients and control of the root-zone area.

►A deep water culture system, a type of standing solution hydroponic system, was used for this experiment (Fig. 3).

Fig. 3. Deep water culture hydroponics: V3 growth stage tub (left), V10/R2 growth stage tube (center), chickpea roots (right)

MATERIALS AND METHODS

Plant Materials

CDC Verano (Low Fe) | CDC 551-1 (Low Fe) | SARIK-075 (High Fe)

Cermi-075 (High Fe) | FLIP97-677C (High Fe) | KALKA-064 (Low Fe)

Growth Stages Analyzed

V3-3rd multifoliate leaf
V10- full vegetative stage } **Veg. stages**

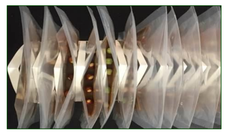
R2: Full bloom → **Rep. stage**

Samples Collected

Leaves, stem, roots, flowers

Pre-germination Techniques

D-0: Bleach seeds
D-1: Placement of seeds in germination pouch
D-4: Transfer sprouted seeds to nutrient solution



- ❖ Plants were grown in a controlled chamber with 16 h light (22°C) and 8 h dark (15°C)
- ❖ Nutrient solution changed twice a week

- ❖ The pH of the water/nutrient solution was maintained between 5.5-6.5
- ❖ 4 replications: 1 control with no iron treatment, 3 reps. with iron treatment

TISSUE ANALYSIS

► For each growth stage, 2 plants from each genotype of each replication were harvested for Fe analysis.

►**Sample Preparation**

- Plants are harvested at the required stage (V3, V10, R2) and are separated into roots, stem, and leaves, and flowers for the R2 stage.
- Plants are oven dried at 38°C for 3 days and is then ground into powder form (Fig. 4).
- Powder form of each sample is analyzed for iron content by a an atomic absorption spectrophotometer (AAS).
- Iron absorption from the medium during vegetative stages was determined by the difference in the amount of iron between treated and non-treated plants.

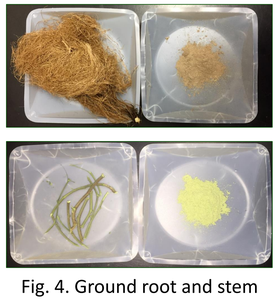


Fig. 4. Ground root and stem samples for iron analysis

RESULTS

► Iron partitioning results across all growth stages and replications show that the most iron is absorbed in the roots, followed by the leaves, then flowers, and lastly the stem (Fig.5).

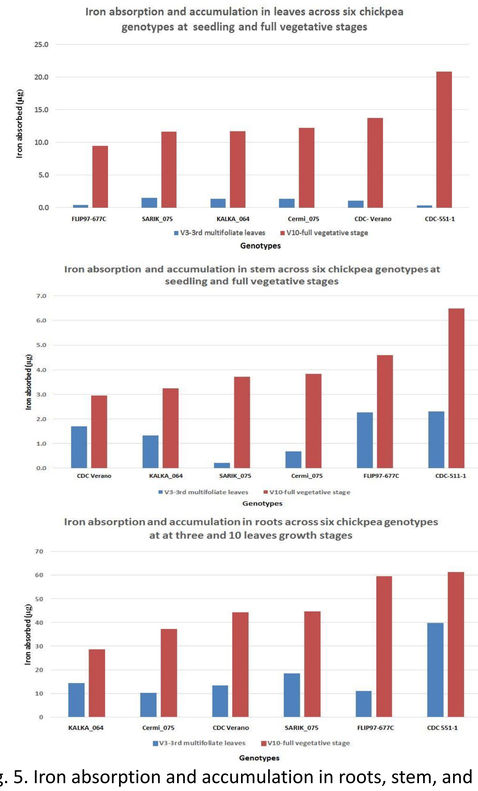


Fig. 5. Iron absorption and accumulation in roots, stem, and leaves

CONCLUSIONS

► Different genotypes absorbed and accumulated different amounts of iron in each specific plant organ.

► Growing chickpeas hydroponically is a good experimental setup to measure iron absorption and partitioning.

► Highest absorption occurred in the roots in all genotypes.

REFERENCES

►Diapari,M.,Sindhu,A., Bett, K., Deokar, A., Warkentin, T, D. and B Tar'an ,B. 2014. Genetic diversity and association mapping of iron and zinc concentrations in chickpea(Cicer arietinum L.). *Genome*. 57(8): 459-68

►White, P. J., & Broadley, M. R. (2009). Biofortification of crops with seven mineral elements often lacking in human diets–iron, zinc, copper, calcium, magnesium, selenium and iodine. *New Phytologist*, *182*(1), 49-84.

ACKNOWLEDGMENTS

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