Optimising selenium fertiliser strategies for maximal wheat nutritional quality

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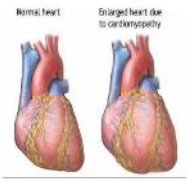
Background and significance

- Selenium (Se) is an essential micronutrient for humans and animals.
- The recommended daily intake for adults is 55 µg Se day^{-1} $person^{-1}$.
- 0.5 – 1 billion worldwide are not consuming enough Se and are at risk of deficiency diseases such as Keshan and Kashin Beck.
- The application of Se fertilisers to staple crops - **agronomic biofortification** - is an effective method to improve humans' Se dietary intake in a sustainable manner. However, the processes underlying the transfer of different applied Se fertilisers from point source to the rest of the plant over time are still poorly understood.

Objective: To **enhance** the **transfer** of applied Se fertiliser to wheat by optimising fertiliser **formulation** and **application timing.**

Kashin-Beck –disease of the bone

Keshan – disease of the heart muscle

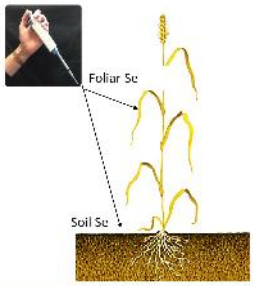


Methods

In a pot trial, spring **wheat** was grown in free-draining 2 kg pots of **sandy loam soil** (pH 7.9) under natural light conditions. Selenium was applied at a rate equivalent to **10 g ha^{-1}** in the form of **^{77}Se-enriched** sodium **selenate**.

Treatments:

- ❑ Foliar Se with 2% N in the form of urea (F.Se+N)
- ❑ Foliar Se (F.Se)
- ❑ Soil Se

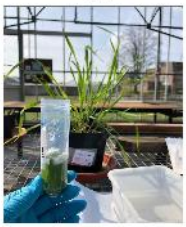


Application timing:

- ❑ At stem elongation (GS1)
- ❑ At head emergence (GS2)

Harvest:

- ❑ 3, 10 and 17 days after GS1 application
- ❑ 3, 10 and 34 days after GS2 application



Results

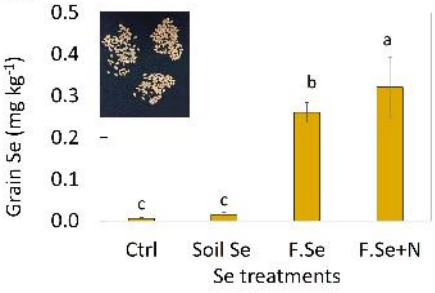


***Fig. 1:** Selenium concentrations in wheat grains*

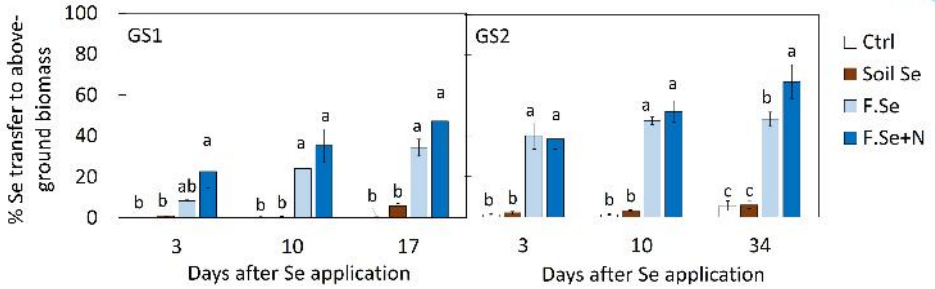


***Fig. 2:** Percentage of applied Se transferred to the above-ground biomass of plants over time when fertilised by soil Se application and foliar Se (±N) – note that the foliar Se assay excludes the leaves used for application. 'Ctrl' denotes the control treatment (no Se added).*

- **Higher** Se **uptake** was observed when fertilisers were applied at a **later** growth stage (GS2).
- Only **foliar** Se treatments were **effective** in raising plants Se above control levels, probably due to rapid **leaching** after soluble selenate was applied to the **soil**.
- With an average grain Se concentration of **0.30 ± 0.03 mg kg^{-1}**, **foliar Se** treatments effectively brought grain Se levels to the **target** level of **0.25 mg Se kg^{-1}** required for **biofortification**.
- Foliar application of Se was more effective when co-applied with N. We hypothesize that transformation of inorganic selenate to bioavailable Se-methionine was more rapid when foliar Se was co-applied with a N source, resulting in more rapid assimilation and translocation of applied Se. Ongoing chemical speciation analysis appears to confirm this hypothesis

Conclusions and applications

- Based on our results, we suggest that Se fertilisation strategies for wheat biofortification can be optimised by applying **foliar Se** with a **N** source at a rate equivalent **to 10 g ha^{-1}** when plants are at a **later developmental stage**.
- This study is novel as it uses **precise techniques** such as stable isotope labelling to trace fertiliser uptake by plants and monitor its rate of transfer to different plant parts over time.
- This study contributes to existing knowledge about fertilisation strategies to enhance micronutrient uptake in staple crops, in a bid to alleviate deficiency and tackle **Hidden Hunger**.