Influence of arbuscular mycorrhizal fungi on selenium uptake by winter wheat depends on level of selenate spiked in soil

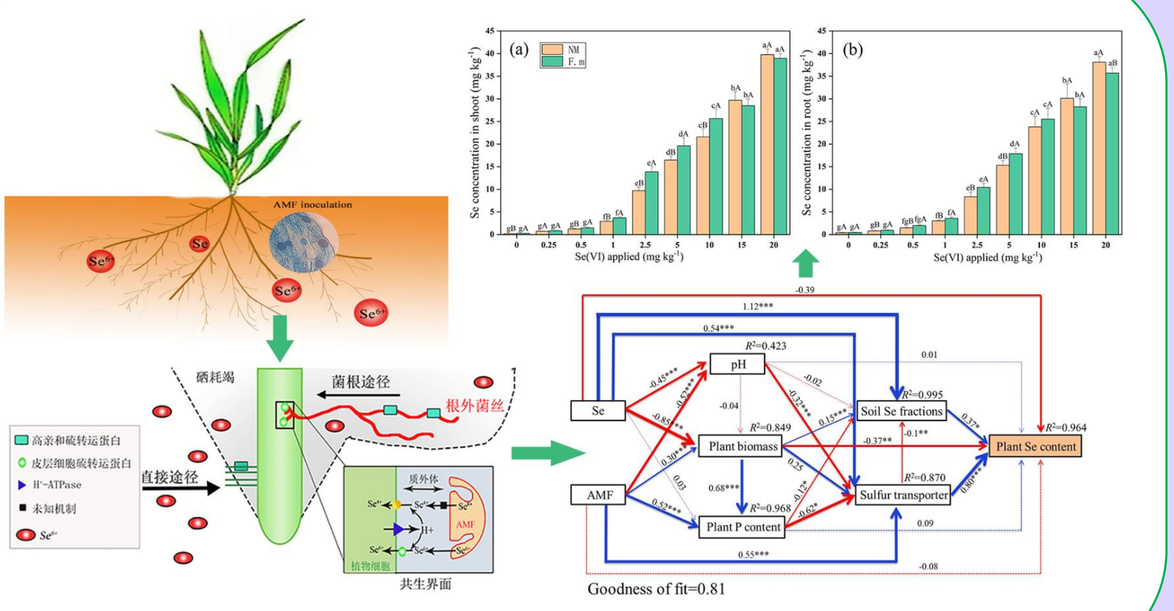
Jiao Li[1], Ruifang Liu[1], Fuyong Wu [1*]

[1] College of Natural Resources and Environment, Northwest A&F University, Yangling, China.

Presenting author E-mail: lijiao0829@126.com

***Corresponding author: Prof . Fuyong Wu, E-mail: wfy09@163.com**

1. Graphical abstract



2. Introduction

- Selenium (Se) is an indispensable microelement aspect of human and animal metabolism. However, inadequate or excessive Se intake can cause adverse health problems. Insufficient Se ingest of foods is a major reason for human Se deficiency. One strategy to solve this problem is by biofortifying wheat with Se. Therefore, it is essential to acquire a completely understand the behavior and circulation of exogenous Se in the soil-plant system.
- Se utilization efficiency in soil (< 5%) is rather low, and the residual Se in the soil might be leached and then migrated to groundwater, which were cause potentially imperil for human health as well as ecological environment. In this connection, inoculation of arbuscular mycorrhizal fungi (AMF) as a biofertilization practice may have a broad prospect of improving the efficacy of crop Se uptake from the soil. Thus, investigating the influence of AMF on plant Se uptake is necessary to understand its function in the soil-plant systems.
- In recent years, the effect of AMF on plant Se absorption and accumulation has been investigated. The varied results indicated that there must have complex mechanisms of AMF affecting Se uptake. Previous results have indicated that Se can exert favorable effects on plants at low concentrations, but it is harmful at high concentrations. Thus, we speculate that the effects of AMF on Se uptake by host plants may depend on exogenous Se addition level.

3. Objectives

The purpose of this work were to: 1) identify whether the effect of AMF on Se uptake by winter wheat varied with levels of selenate spiked in soil, and 2) reveal the influence mechanism of AMF on uptake of Se by winter wheat under different selenate levels in soil.

4. Materials and Method

- **Winter wheat:** ***Triticum aestivum*** **L. cv. Xiaoyan22**
- **AM fungal species:** ***non-mycorrhizal (NM)***

  Funneliformis mosseae **(BGC BJ05A**
- **Selenate application levels: 0, 0.25, 0.5, 1, 2.5, 5, 10, 15 and 20 mg kg^{-1}**

Table. 1. Physicochemical properties of experimental soil:

Parameters	Value
pH	8.74
TN (g kg^{-1})	1.58
TP (g kg^{-1})	1.36
AP (mg kg^{-1})	40.22
AK (mg kg^{-1})	96.84
SOM (g kg^{-1})	23.95
TSe (mg kg^{-1})	0.18

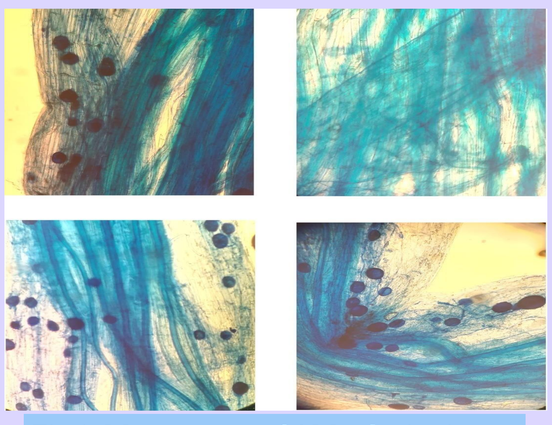


Fig.1. Measurement of AM colonization

5. Results and discussion

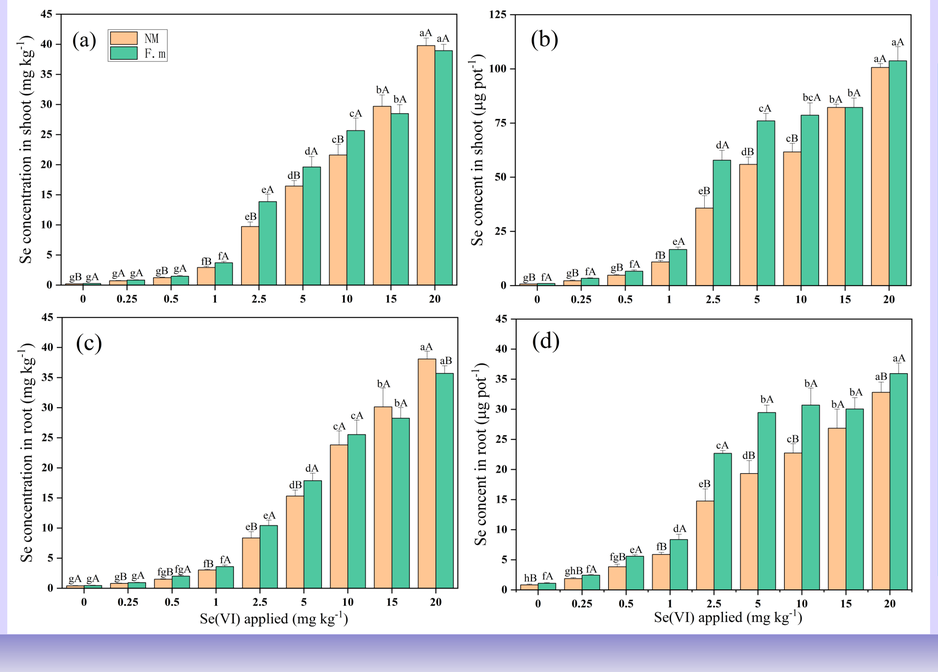


Fig.1. Se concentration (a, c) and content (b, d) in shoot and root of winter wheat grown in selenate-spiked soils uninoculated (NM) /inoculated with *Funneliformis mosseae* (*F.m*) for 10 weeks (mean ± SD, n = 4)

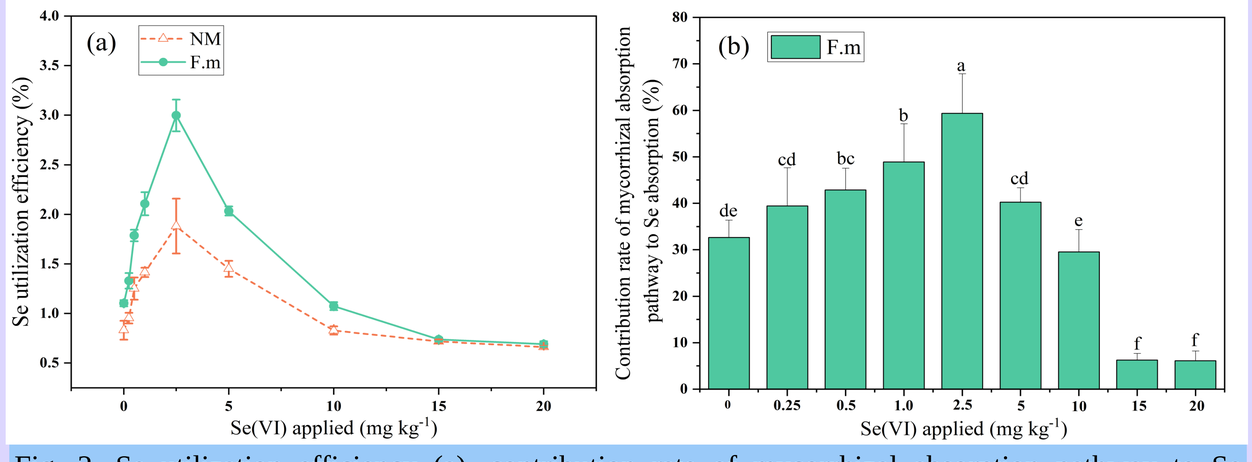


Fig. 2. Se utilization efficiency (a), contribution rate of mycorrhizal absorption pathway to Se absorption (b) in selenate-spiked soils uninoculated (NM) /inoculated with *F.m* for 10 weeks.

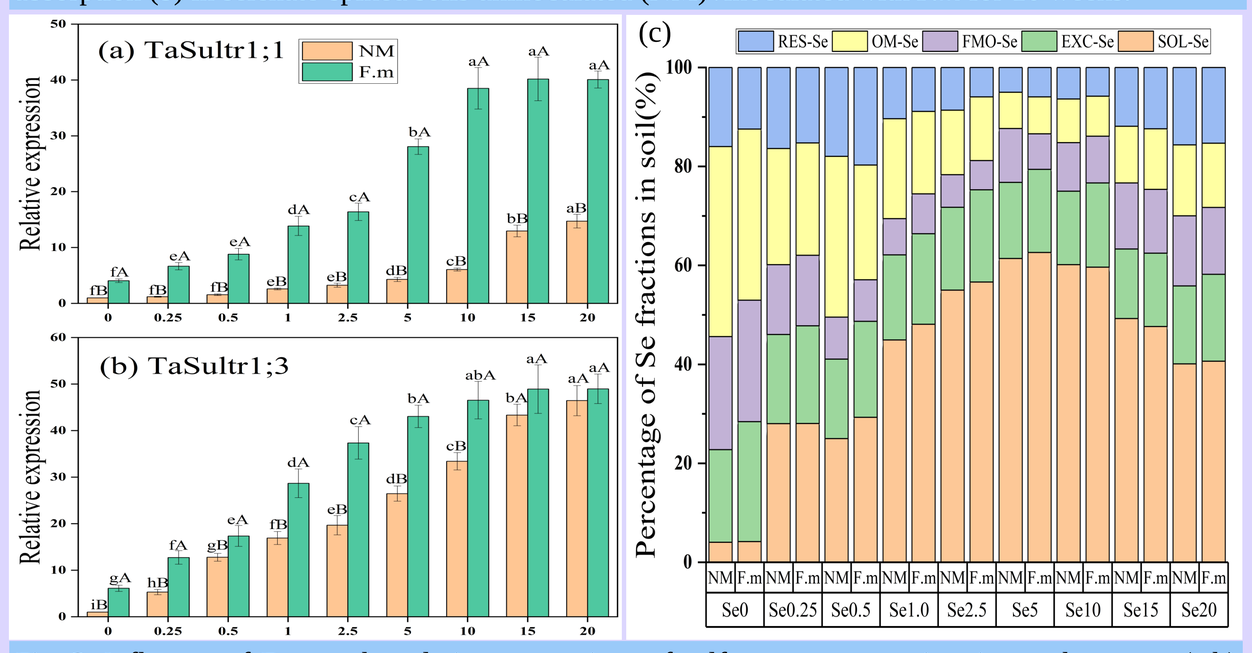


Fig. 3. Influence of F.m on the relative expressions of sulfate transporters in winter wheat roots(a,b) and proportion of different Se fractions in soils of winter wheat (c)grown in selenate-spiked soils uninoculated (NM) /inoculated with F.m for 10 weeks.

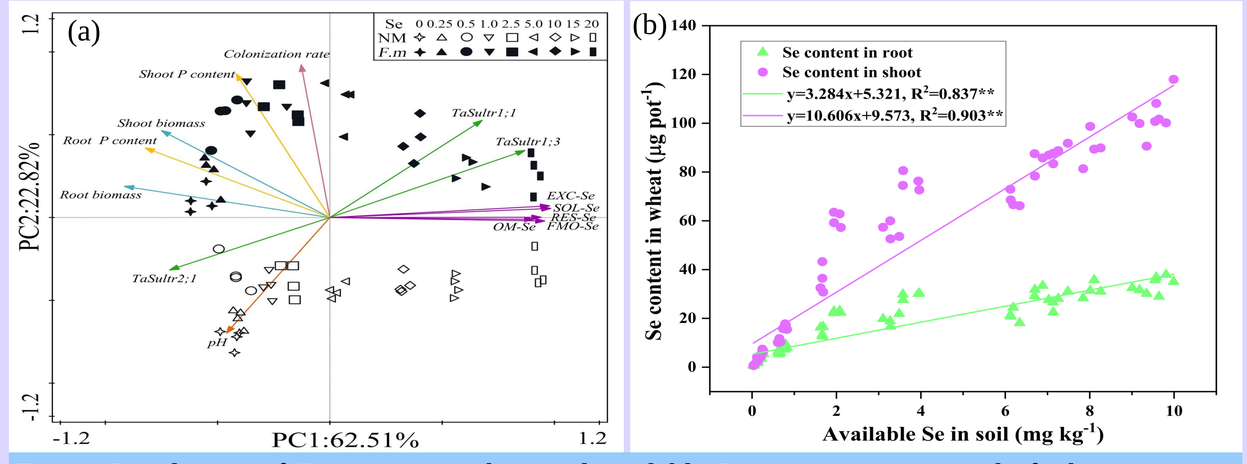


Fig. 4. Correlations of Se content in wheat and available Se concentration in soil of wheat grown in different level of selenate-spiked soils uninoculated (NM) /inoculated with *F.m* for 10 weeks.

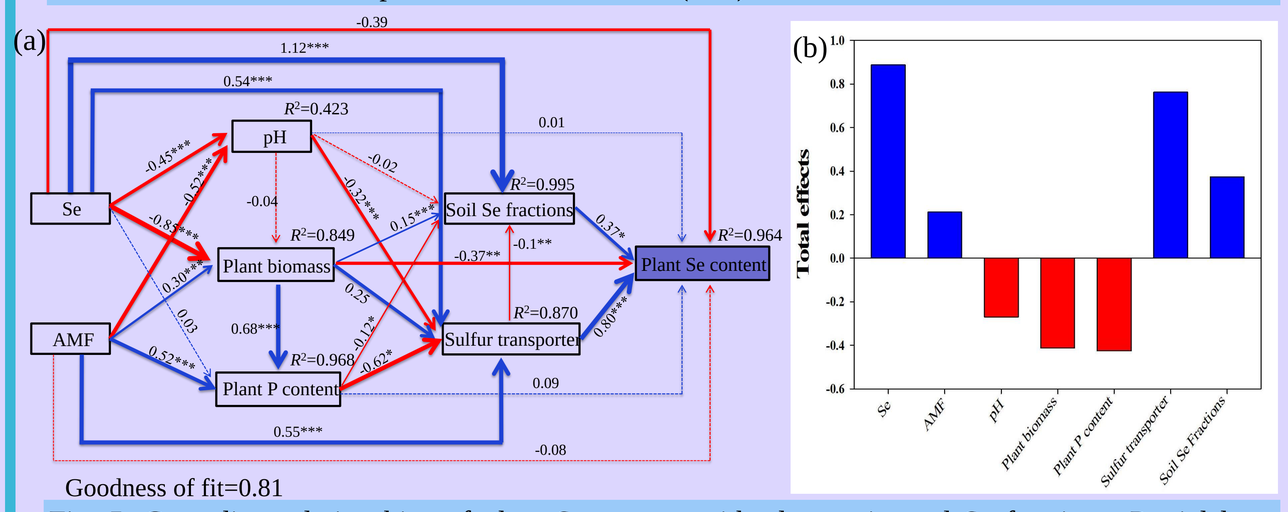


Fig. 5. Cascading relationships of plant Se content with plant traits and Se fractions. Partial least squares path modelling disentangles the major pathways of the influences of plant traits and Se fractions on plant Se content. Blue and red arrows indicate positive and negative flows of causality.

6. Conclusions

- Both AMF colonization rate and Se utilization efficiency were the highest at selenate applied level of 2.5 mg kg^{-1}.
- At low selenate concentration (≤ 5 mg kg^{-1}), AMF inoculation was contributed to promoting the uptake of Se in wheat. However, although AMF inoculation increased the bioavailability of Se at high selenate level, the expression of sulfate transporter reached saturation, which reduced the Se uptake from roots, thereby alleviating the toxicity of selenate to wheat.
- In summary, the effect of AMF inoculation on the Se behavior in the soil-plant system is closely related to selenate level in the soil.

7. Acknowledgements

The financial support from National Natural Science Foundation of China (41571456) and Natural Science Foundation of Shaanxi Province of China (2019JZ-25) is gratefully acknowledged. We want to give thanks to partners in the laboratories because of their meaningful advice and help.