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# Effects of Arbuscular Mycorrhizal Fungal Inoculation and Phosphorous Addition on Maize Photosynthesis and Growth in A Reclaimed Soil of the Mining Areas

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## Introduction

- Phytoremediation of soils in the reclaimed mining-disturbed areas has been challenged by the low bioavailability of indigenous phosphorus (P) and the low use efficiency of fertilizer P applied.
- Arbuscular mycorrhizal fungi (AMF) inoculation in combination with fertilizer P addition can improve P bioavailability.
- However, effectiveness of AMF inoculation can be influenced by soil type, soil P status and AMF species. In addition, adaptations of AMF to abiotic factors can strongly influence the effect of AMF symbiosis on plant growth.
- The objectives of this study were to i) evaluate the effects of AMF inoculation on maize photosynthesis characteristics and growth at different P levels in soils of a mining-disturbed area; and ii) identify the P levels that support optimal AMF association.

## Materials and Methods

- The soil samples were collected from a reclaimed land of the mining-disturbed area located in Wangqiao Town, Xiangyuan County, Changzhi City, Shannxi Province, China. The mining land began to collapse in 1970s and stabilized around 2000. The field was then mixed with a loader machine in 2010 before sampling.
- A 70-day pot study was conducted in a greenhouse of Shanxi Agriculture University, China.
- Treatments were factorial combinations of two factors, including i) mycorrhizal inoculation (non-mycorrhizal control - NAMF vs. *G. mosseae* as a mycorrhizal inoculum - AMF) and ii) fertilizer P (four levels of 0, 25, 50 and 100 mg P $kg^{-1}$).
- Determinations: AMF colonization rate; maize growth parameters (i.e. partitioned biomass), photosynthetic characteristics (net photosynthetic rate $P_n$, transpiration rate $T_r$, stomatal conductance $G_s$ and intercellular $CO_2$ concentration $C_i$), and P utilization.

Fig.1 The terrain in mixing pushed engineering reclamation after subsidence (left) and phytoremediation with maize (right) in the area

## Results and Discussion

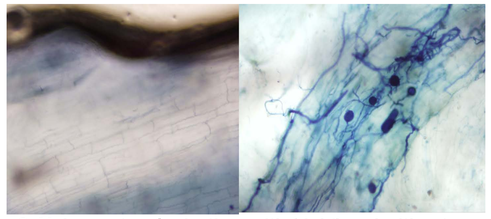

Fig. 2. Maize root colonization with (right) and without (left) AMF inoculation.

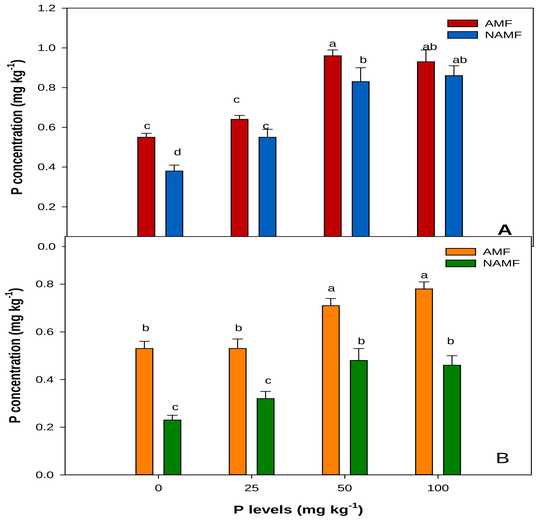


Fig.3 Phosphorus concentration of shoot (A) and root (B) of AMF and NAMF treatments

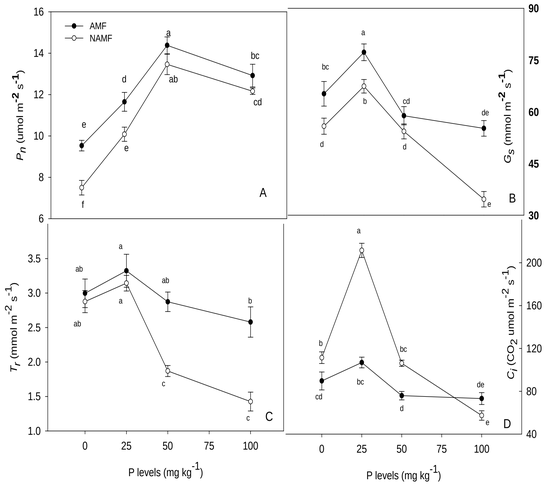


Fig. 4 Relationships between the addition of P and (A) net photosynthetic rate ($P_n$ ), (B) stomatal conductance ($G_s$), (C) Transpiration rate ($T_r$) , and (D) Intercellular $CO_2$ concentration ($C_i$) of AMF and NAMF treatments

## Results and Discussion

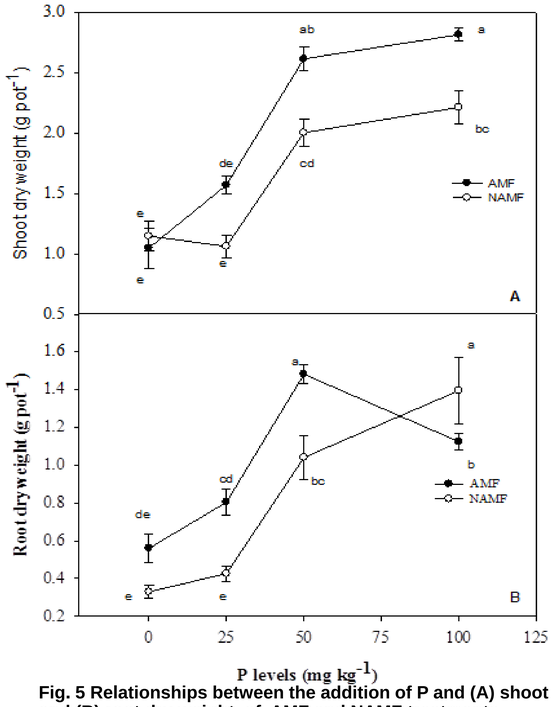


Fig. 5 Relationships between the addition of P and (A) shoot and (B) root dry weight of AMF and NAMF treatments

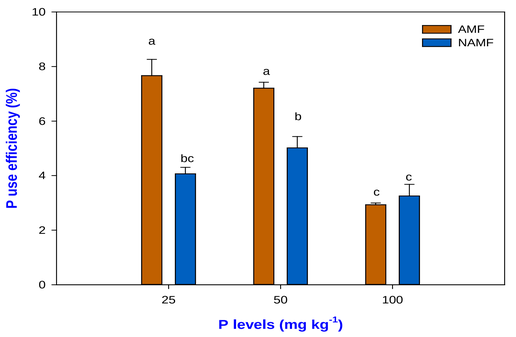


Fig. 6 Relationship between P addition and P use efficiency of AMF and NAMF treatments

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## Results and Discussion

### Root colonization and P concentration in shoot and root (Fig. 2 and 3):

- ✓Root colonization reached 78-94% with AMF, while with NAMF no root colonization was observed.
- ✓With AMF, root colonization increased with increases in P rate.
- ✓Compared with NAMF plants, maize shoot and root P concentration was improved by 15.5% and 47.8%, respectively, at the 50 mg P $kg^{-1}$ rate.

### Photosynthetic characteristics (Fig. 4):

- ✓AMF increased *Pn*, *Tr* and *Gs*, but decreased *Ci*.
- ✓With increasing P levels, photosynthetic parameters of maize leaves in both AMF and NAMF treatments showed an initial increasing and then a decreasing trend after a peek. The highest levels of net photosynthetic rate were obtained at 50 mg P $kg^{-1}$, regardless AMF inoculation.

### Maize Growth (Fig. 5):

- ✓ With increasing P rates, the growth of both AMF and NAMF maize plants increased.
- ✓ Maize plant leaf area and stem diameter of AMF increased by 21.9 and 13%, respectively, relative to NAMF. Compared to NAMF, shoot and root dry weight with AMF increased by 25%.
- ✓ The treatment combination of AMF with 50 mg $kg^{-1}$ P was considered the optimum for maximum plant growth.

### Phosphorus efficiency (Fig. 6):

- ✓Phosphorus use efficiency was higher in the AMF treatment than the NAMF treatment, and decreased as P level increased.
- ✓At 25 and 50 mg P $kg^{-1}$ levels, the P use efficiency of AMF plants increased by 88.5% and 43.5% compared to NAMF treatments.

## Conclusions

- ✓Significant differences were observed between the treatments with and without AMF in plant P concentration, photosynthetic characters and growth parameters in rehabilitated mining-disturbed soils.
- ✓It appeared that fertilizer P at 50 mg P $kg^{-1}$ in combination with AMF inoculation given the optimal association for maize growth in the rehabilitated soils of mining-disturbed area.



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