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ORIGINAL ARTICLE

Study Effects of *Glomus mossea* and *Pseudomonas putida* inoculation on Phytic acid/ Zn ratio in Wheat seeds

Ershadi, R. [1], Alizadeh Oskuie P.[2*] and Azizi, M.A.[3]
[1]Department of Soil Science, Marand Branch, Islamic Azad University, Marand, Iran
[2]Department of Soil Science and Member of young Research Club, Marand Branch, Islamic Azad University, Marand, Iran.
[3]Department of Food Science and Technology, Faculty of Agriculture, Tarbiat Modarres University, Tehran, Iran.
*Corresponding author. E-mail: p_alizadeh@marandiau.ac.ir.

ABSTRACT
In order to study the effect of microbial inoculation on growth of wheat an experiment was carry out as factorial using completely randomized block with three replications in the research greenhouse, Islamic Azad University, branch of Marand. Wheat seeds were inoculated with Glomus mosseae and Pseudomonas putida and grown under zinc fertilized conditions andthen levels of zinc, phytic acid concentrations and P/A were determined. In the experiment, seed Zn concentrations increased with Zn fertilization in all varieties. Microbial inoculation and Zn fertilization had a negative effect on seed phytic acid (PA) concentration. Also inoculation decreased PA/Zn molar ratio.
***Key words**: Wheat, Microbial inoculation, Zinc, phytic acid*

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INTRODUCTION

Wheat (*Triticum aestivum L.*) has been cultivated in Iran, Greece, and Egypt, as early as 2500 B.C. [1]. It is the most used cereal crop making up approximately 30% of the total cereals grown [2]. Consumption of bread prepared from flours of whole wheat has been recommended because of their high content of fiber, vitamin, and minerals. Even though there is the existence of their helpful effects, these breads contain high amounts of compounds like phytic acid that have undesirable effects [3]. Phytic acid may have different effects on humans and/or animals health. Phytic acid can destroy cancer and preventive heart disease and diabetes [4]. The typical negative effect is reducing the bioavailability of cations as Mg, Ca, Zn and Fe. At high pH levels, Phytic acid is also able to reduced digestibility and bioavailability of seed proteins [5]. It has been reported that more than 2 billion people suffer from Zn deficiency worldwide [6]. Some studies have showed that Zn forms the insoluble complex with PA. A good criterion for assessment of Zn adsorption is PA/Zn molar ratio, especially in cereals and legumes [7]. According to WHO [8] 55% of Zn content of foods is absorbed if PA/Zn ratio of foods is less than 5. Arbuscular mycorrhizal fungal (AMF) inoculation increased the availability of micronutrients in the soil that make easier uptake of these nutrients as well fortifying it in the grains. In addition, the mycorrhiza may improve phytase activity in grains which inhibits the phytic acid concentrations while ameliorate the bioavailability of micronutrients in grains. The objective of the present study was increased Zn concentration to reduce the phytic acid and PA/Zn molar ratio of common wheat with inoculation of AM fungi and Pseudomonas.

MATERIALS AND METHODS

The experiment was conducted in the greenhouse of Islamic Azad University of Marand in the summer of 2014.Wheat seeds were sterilized with sodium hypochlorite 1% and was rinsed several times with distilled water. The seeds were placed in Petri Dish with moist filter paper then for a week in the refrigerator at 4°C. The seeds were planted in pots filled with sterile sand. The experiment as factorial with four factors; bacteria (*Pseudomonas putida*, no bacteria), fungi (*Glomus mosseae*, without mycorrhiza), zinc (Zinc sulfate; 0.125 and 0.25 ppm) and (zinc carbonate; 250 and 500 mg per kg), P (20 and 40 mg/l) in a randomized complete block design with three replications was conducted. Three months after planting wheat seeds in pots were taken separately. The seeds were flour. The PA content was determined by precipitation of ferric phytate and a determination of Fe remaining in the supernatant [8].The concentration of zinc in wheat, after digestion and extraction were measured by atomic absorption spectrometry [9].

RESULTS

PA/Zn

The results showed that the use of fungi, bacteria and Zn has a significant effect on the PA/Zn. Means comparison showed that fungus and bacteria are reduced PA/Zn (Table 1).Interaction effects also had a significant effect on the reduction of PA/Zn (Table 2).

Table 1. Effect of Fungus and Bacteria inoculation on Zn and Phytic acid concentration of wheat grain

Zn	PA/Zn	Phytic acid		Zn	PA/Zn	
mg/kg		g kg-1		mg/kg		
25.3b	46.58a	14232a	B0	25.9b	38.1a	G0
28.8a	23.31b	7814.7b	B1	28.3a	32.3b	G1

Table 2. Effect of Fungus and Bacteria co-inoculation on Zn and Phytic acid concentration of wheat grain

Treatment	Zn	PA/Zn	Phytic acid
	mg/kg		g/kg
G0B0	23b	52.9	14102.6
G0B1	28.7a	21.9	8388.9
G1B0	27.7a	39.9	14366.8
G1B1	28.9a	24.6	7264.4

Phytic acid concentrations

The results showed that only the effect of bacteria on the amount of phytic acid is statistically significant at 1%. Means comparison showed that plants inoculated with bacteria produced grains with significantly 50% lower phytic acid concentrations compared to control plants (Table 1).The interactions also have a significant effect on the amount of phytic acid. Mean comparison showed that concomitant use of treatments significantly reduced the amount of phytic acid (Table 2).

Zn concentrations in grains

Analysis of variance showed a significant effect of all treatments at 1% on the Zn concentration compared to control (Table 1).Mean comparison showed that with the exception of phosphorus, the use of other treatments caused a significant increase in the Zn concentration (Table 1).The interaction effects on Zn concentration were significant, except for P*B at 1%.

DISCUSSION

The data clearly indicated that the *Glomus mosseae* and *Pseudomonas putida* inoculation had consistent effects on availability of Zn and reducing PA/Zn ratio. Subramanian *et al*. [11] have shown that the mycorrhizal colonization facilitates acidification of rhizosphere, solubilization of tightly bound residual form of zinc also hyphal transport of micronutrients collectively contribute for the availability. Our study are in agreement with the observations of other reports [11,12].

Akay and Ertas [13] have reported that the chickpea genotypes rich in Zn have a negative correlation with phytic acid concentrations. Our results have clearly shown an increase in grain Zn which may have decreased the phytic acid concentrations also a negative correlation between grain Zn concentrations and phytic acid content has been found. Since mycorrhizal symbiosis alleviate accumulation of Zn concentrations in grains which may suppress the phytic acid content.

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