

## Inoculation Effects of Endophytic Fungus *Piriformospora indica* and *Pseudomonas putida* Bacteria on Growth and Nutrient Uptake of Wheat Plants Under Zinc Deficiency Condition

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(Received: Nov. 27-2013 ; Accepted : June 23-2014)

### Abstract

Zinc deficiency is the most widespread micronutrient disorder in the production of wheat (*Triticum aestivum* L.) and other cereal crops. An experiment was conducted in greenhouse, in 2013, using the sterile sand-perlite (2:1 v/v), to study the effects of two beneficial microorganisms on growth and nutritional status of wheat (Nicknejad cultivar). The study was arranged as factorial in a completely randomized design with three replications. The experimental factors consisted of *Piriformospora indica* ( $E_0$ : Uninoculated;  $E_1$ : Inoculated), *Pseudomonas putida* ( $E_0$ : Uninoculated;  $E_1$ : Inoculated) and Zinc ( $Zn_0$ : 0;  $Zn_1$ : 2 $\mu$ M  $ZnSO_4$ ). The results showed that inoculation by *P. putida* increased shoot dry weight at both levels of zinc, but this increase was observed for root dry weight only without zinc application. The iron concentration of shoot was decreased as a result of inoculation by *P. putida* at both levels of zinc. However, *P. indica* inoculation increased iron concentration in zinc application, but had no significant effect without zinc application. At both levels of zinc, the highest P, Zn, chlorophyll a and b concentrations were achieved by inoculation with *P. indica*. Inoculation by *P. putida* reduced P concentration at both levels of zinc but it reduced Zn, chlorophyll a and b concentrations only with zinc application. The results of this research showed that despite negative effect of *P. putida* on nutrient uptake, inoculation by *P. putida* and/or *P. indica* plays an important role in the promotion of wheat growth in zinc deficiency conditions.

**Keywords:** Wheat, Zinc deficiency, Chlorophyll, Nutrient, Microorganisms.

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