



RESEARCH PAPER

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Plant growth promoting rhizobacteria (PGPR) alleviate toxicity of cadmium on germination and early seedling growth of fennel

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Key words: Fennel, germination components, heavy metal stress.

<http://dx.doi.org/10.12692/ijb/5.1.355-358>

Article published on July 13, 2014

Abstract

Recently, bioremediations is a developing process which applies microorganisms such as bacteria for ameliorating heavy metal toxicity. This experiment was conducted to evaluate the effect of plant growth promoting rhizobacteria (PGPR) on germination and early growth in fennel under arsenic (As) contamination. Experiment was arranged in factorial based completely randomized design with three replications. The first factor was As at four levels (consist of 0, 30, 60 and 90 mg L⁻¹) and the second factor was PGPR (with and without PGPR). Results showed that main and interaction effect of two factors revealed that inoculation of PGPR could increase vigor index, shoot and seedling length, while As significantly affected all traits. Increasing As levels significantly decreased root length, weight vigor index and seedling length up to 99, 100 and 99 percent compared to control, respectively. Meanwhile, inoculation of PGPR at 30 mg L⁻¹ As significantly improved germination rate and percent. Also, weight vigor index markedly enhanced (nearly 20%) by application of PGPR compared to control.

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Introduction

Fennel (*Foeniculum vulgare* Mill.) as a medicinal herb has utmost importance. Arsenic pollution is most stressful to environment than other heavy metal and reduces plant growth (Asgharipour and Rafiei, 2011). Heavy metals such as cadmium, copper and lead, as a result of major urban activities, industrial and agricultural production can contaminate large areas of the world (Taghavi *et al.*, 2011). Among the toxic heavy metal arsenic has no biological role in a living organism, and the easily absorbed by the root system and enter into the food chain. Toxic element for plants and other heavy metals have been reported to reduce plant growth and economic yield by 20-2 percent (Asgharipour and Armin, 2010) and causes many problems in human health and could have detrimental effect on the environment and plant and animal species (Asgharipour *et al.*, 2011; Zafar *et al.*, 2007).

Extensive studies is ongoing in order to present the application of absorbent bio-containing of fungi, bacteria, yeasts and algae to remove contaminants - such as heavy metals from the environment. Advantages of bio-adsorption process such cheap prices, rapid absorption, high performance, high capacity of absorption, causing the utility of this process is to remove heavy metals (Khorramabadi *et al.*, 2010; Vankar and Bajpay, 2008; Akhtar *et al.*, 2007).

Today, seed priming a common strategy for increasing the speed and uniformity of germination - mowing and seed germination under unfavorable environmental conditions technique is the most important quantity and quality of the product under conditions (heavy metal toxicity) using seeds pretreated with bacteria growth stimulus that can withstand adverse conditions in the plant increase (Saber *et al.*, 2010; Masoudi *et al.*, 2008). Therefore, the aim of this study was to evaluate the role of enhancing the growth of bacteria (PGPR) to improve germination fennel under arsenic infection was considered.

Materials and methods

Experimental site description

The study was conducted during 2011 in the laboratory of University of Zabol. The experimental design was completely randomized factorial with two factors with three replicates. First factor includes four levels of cadmium nitrate (zero, 30, 60 and 90 mg kg⁻¹) and the second factor comprised inoculation of the growth of bacteria (whether or not seed infection with bacteria).

Experimental layout

Growth bacteria used in this research are: *Azotobacter* spp, *Azospirillum* spp, *Bacillus subtilis* and *Pseudomonas* spp. The Seeds of this plant after sterilization and pre-treatment of seeds of 30 seeds each petri (diameter 9 cm and height 5.1 cm) Whatman paper 42 which contains a set number of each Petri as a replication of treatments were considered. Then 10 ml of arsenic nitrate concentrations specified for each treatment in each Petri Dish poured distilled water was used for control treatment. Then Petri incubated at a constant temperature of 25 ° C for 9 days. After planting seeds germinated seeds per day to the ninth day were counted.

Based on data obtained from counting the percentage of seed germination, germination rate, seedling length, vigor index was calculated as weight for length and vigor index (Asgharipour *et al.*, 2011).

Statistical analysis

Standard analysis of variance Using SAS Software compare the characters with the least significant difference test with (LSD) was performed.

Results and discussion

Germination characteristics

The results of comparison and interaction effects associated with growth traits in basil and cadmium-treated bacteria showed that the presence of bacteria increased vigor index, stem length, wheat and length of shoot and root, while cadmium nitrate had significant effect on all studied traits (Table 1 and

Figure 1). Between cadmium nitrate and bacteria in terms of increasing length percentage and germination percentage of fennel, and vigor

longitudinal interactions significant there were significant (Tables 2 and 3).

Table 1. The effects of cadmium pollution and application of bacteria on root length, seedling length and seedling vigor index of fennel.

| Treatment | Root length | Seedling length | Seedling vigor index |
|-------------------------------|-------------|-----------------|----------------------|
| Bacteria | | | |
| Non-inoculated | 11.2 a | 40.24 a | 1.106 b |
| Inoculated | 09.2 a | 23.21 b | 2.127 a |
| Cadmium (mg g ⁻¹) | | | |
| 0 | 63.22 a | 88.51 a | 225 a |
| 30 | 18.2 b | 18.26 b | 2.172 b |
| 60 | 00.1 b | 03.13 c | 4.69 c |
| 90 | 167.0 b | 17.0 d | 00.0 d |
| CV (%) | 7.16 | 14 | 3.19 |

* The numbers of each column having a common letter are not significantly different the test was based on LSD at the 5% level, respectively.

Seedling vigour

Resellers, system builders fennel highest vigor index weight in the presence of bacteria (19% increase compared to control) was observed (data not shown), but the seedlings in the presence of bacteria had decreased by 12 percent compared to the presence of bacteria. Increasing cadmium nitrate, increased root length, weight and length of root and shoot and plant vigor by 99, 100 and 99%, respectively, compared to control.

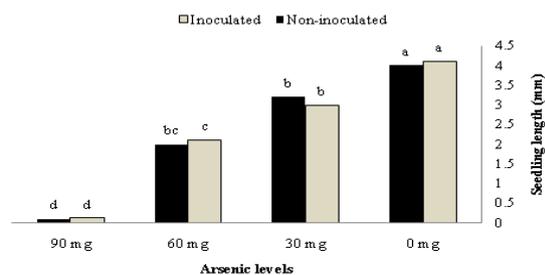


Fig. 1. The effects of Arsenic toxicity on seedling length of fennel.

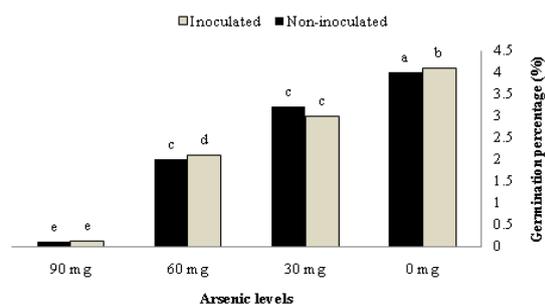


Fig. 2. The effects of Arsenic toxicity on germination percentage of fennel.

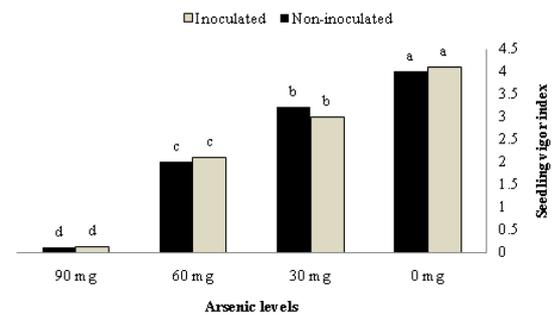


Fig. 3. The effects of Arsenic toxicity on seedling vigor index of fennel.

The maximum length what percentage of germination Woman, germination rate Portrait of a woman and vigor in the absence of bacterial contamination of cadmium was observed and no statistically significant differences in the presence of bacteria in the environment. But did increase the level of contamination compared to the amount of bacteria present in 100, 85, 85 and 99 percent declined.

Conclusion

In general different levels of arsenic in the lower reaches of bacteria can be improved by increasing the growth of some components germination is basil. Although further studies on other types of microorganisms and how they act are essential Appears.

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