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Enhancement of seed germination and seedling vigor of wheat (*Triticum aestivum* L.) following PGPR treatments

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Abstract: Uses of bio-fertilizers containing beneficial microorganisms instead of synthetic chemicals are known to improve plant growth through supply of plant nutrients. In order to investigated the effects of plant growth promoting rhizobacteria (PGPR) on improvement of seed germination and seedling vigor of wheat cultivars an experiment was conducted at the research laboratory of Genetics and Agricultural Biotechnology Institute of Tabarestan, Sari Agricultural Sciences and Natural Resources University (SANRU), during the 2013. In this study, a factorial experiment based a completely randomized block design with three replications was used. This experiment had two factors, the first factor with five levels of wheat cultivars (Shanghi, Zaghros, Milan and Tajan). In the second factor, four levels of rhizobacteria were treatment: single and co-inoculation *Azospirillum lipoferum*, *Azotobacter chroococcum*. Results showed that, Seed inoculation of PGPR strains significantly increased germination rate, and root length of wheat compared with the control. In addition, seedling vigor index was investigated and significantly affected by bacterial applications compared with the control. The results of this study suggest that *Azospirillum lipoferum and Azotobacter chroococcum* in combination have the potential to increase the growth and development of wheat cultivars.
Keywords: Germination, Priming, Seedling vigor, PGPR.

INTRODUCTION

The use of PGPR in agriculture for promoting the circulation of plant nutrition and reducing the need of chemical fertilizers is well recognized [1]. In addition, priming is one of the seed enhancement methods that might be resulted in increasing seed performance [2-4]. Seed priming has been successfully demonstrated to improve germination and emergence rate in seeds of many crops, particularly seeds of vegetables and small seeded grasses [5-6]. Increasing the time that seed or seedlings remain in the soil prior to emergence increases the occurrences of damage leading to death or decreased seedling growth rates [7]. Therefore, Rapid and uniform emergence is utmost important, because it is the foundation on which stand establishment is based and potential yield is determined [8]. Microbial communities in the rhizosphere contribute to plant growth by recycling nutrients and making them available [9-12].

Plant growth-promoting rhizobacteria (PGPR) are known in various cropping systems to increase plant growth and seedling vigor [13-17]. Mechanisms for PGPR mediated plant growth promotion include bacterial synthesis of the plant hormones such as cytokinin, indole-3-acetic acid, gibberellin and increased uptake availability of mineral and P in the soil [18-22]. Many researchers have been investigating the application of PGPR such as *Azospirillum* in inoculate to promote the growth of key arable crops. Furthermore, wheat transfers about 30% of carbon assimilate into the soil through the process of rhizodeposition and part of this below ground translocated C is incorporated by rhizosphere microorganisms. Therefore, bacterial abundance and turnover increase in the rhizosphere compared to the bulk soil [23].

The best known example is *Azospirillum brasilense*, which has been isolated from various plants, including wheat. Like Rhizobia, *Azospirillum* and other PGPR fix nitrogen from the air, but the plant growth promotion effect is thought to be due mainly to other factors, including excretion of plant hormones which increase the efficiency of crop root systems, and increased mobilization of soil nutrients. In addition, insufficient stand establishment of winter wheat is major problem in the low-precipitation dry land summer fallow region of the North, Iran. So, in order to increase the strength of seeds in stress conditions, examining of seed priming for accessibility to maximum germination percent and seedling establishment is necessary. Therefore, the objective of this study was to investigate the effect of PGPR priming on wheat cultivars (*Triticum aestivum* L.) by measuring the germination rate and vigor index.

MATERIALS AND METHODS

This study was carried out at the research farm of Sari Higher Education Agricultural Sciences and Natural Resources University, Iran. Wheat seeds obtained from the International Center of Agricultural Research in Sari-Iran. Three replicates of 25 seeds were germinated between double layered rolled Anchor germination papers with 10 ml of respective test solutions. Seeds were allowed to germinate at 25±1 °C in the dark for 7 days. Germination was considered to have occurred when the radicle were 2mm long. Germination was recorded every 24 h for 7 days. Fore cultivars of Wheat (Shanghi, Zaghros, Milan and Tajan) were used. The vigor index value was computed as described by Abdul-Baki and Anderson by multiplying germination of seeds in percentage and total seedling length in centimeter and expressed in whole number [24]. Root length; shoot length and seedling weights were measured after the 7th day. Root length and shoot length were measured at the time of germination count from ten normal seedlings selected at random from each replication and expressed in centimeter and those seedlings used for growth measurement were placed in a paper cover and dried in shade for 24 hrs and then they were kept in an oven maintained at 85±2°C for 48 hrs. The dried seedlings were weighed to estimate the dry matter production and the mean values were expressed in g per 10 seedlings. Data of germination percentage were transformed (arcsine) before statistical analysis in order to ensure homogeneity of variance. Data were subjected to ANOVA using the SAS statistical software package using GLM and Duncan's multiple range tests was performed to compare the treatment means.

RESULT AND DISCUSSION

Statistical differences among treatments were observed for shoot and root growth parameters of wheat cultivars. Shoot and root length varied from 5.5 to 6.9 cm and 4.6 to 5.0 cm respectively. The highest percentage of seed germination of 93.0 percent was recorded for Shanghi cultivar (Table 1). Among the wheat cultivars the highest mean value of root length was recorded in Milan (6.9 cm), whereas leased was observed in Tajan (5.5 cm). In the Zaghros cultivar germination rate was higher rather than other.

Table-1: Effect of PGPR on germination and early growth of wheat

Source of variation	Germination Percentage	Germination rate	Root length	Shoot length	Root weight	Shoot weight	Seedling weight	Seedling vigor
Wheat cultivar								
Shanghi	93.0 a	33.7 a	6.2 b	4.8 ab	125.1b	24.1 b	158.3 a	14.7 a
Zaghros	91.6 a	27.5 c	6.1 b	4.7 ab	122.7b	24.6 b	149.0 a	13.6 b
Milan	83.4 b	29.8 b	6.9 a	5.0 a	130.4a	30.0 a	159.2 a	13.3 b
Tajan	86.6 b	27.8 c	5.5 c	4.6 b	114.0c	21.1 c	134.6 b	11.6 c
Plant growth-promoting rhizobacteria (PGPR)								
Azospirillum	91.9 a	33.7 a	6.0 bc	4.7 b	122.0b	24.2 a	148.0ab	13.6ab
Azotobacter	84.4 b	27.8 c	5.6 c	4.5 b	122.1b	25.8 a	151.5ab	12.8 b
Azospirillum+ Azotobacter	91.6 a	29.8 b	6.9 a	5.1 a	129.5a	25.5 a	157.3 a	14.4 a
control	86.9 b	27.8 c	6.1 b	4.7 ab	118.6b	24.3 a	144.4b	12.56b
Significant								
Wheat cultivar (A)	231.2**	11.5 *	3.59**	0.43 *	566.0**	162.0**	1562**	19.5**
PGPR (B)	162.0**	93.0**	3.65**	0.78 *	250.0**	8.16ns	363.2ns	8.41**
A * B	3.24 ns	11.6 *	0.62*	0.24ns	24.3ns	8.61ns	97.4ns	2.05ns
Total Error	15.0	4.08	0.29	0.15	20.0	6.31	142.1	1.54
C.V	4.37	6.76	8.80	8.09	3.63	10.04	13.4	9.29

Levels of significant:* P< %5, ** P<%1, NS = not significant

Physical characteristics germination of wheat was significant effected by PGPR treatments. The shoot and root length, germination rate of wheat cultivars as influenced by inoculants treatments are presented in Table 1. In Milan and Shanghi cultivar germination rate significantly increased by *Azotobacter chroococcum* inoculation compared to control. Significant differences were observed between the control and PGPR-inoculation treatments in seedling weight trait. The percentage of germination was significantly higher in the treatments containing *Azospirillum lipoferum* inoculums and co-inoculation *Azotobacter chroococcum* and *Azotobacter chroococcum* than the untreated control and was unaffected by the single *Azotobacter chroococcum* treatment (figure 1).

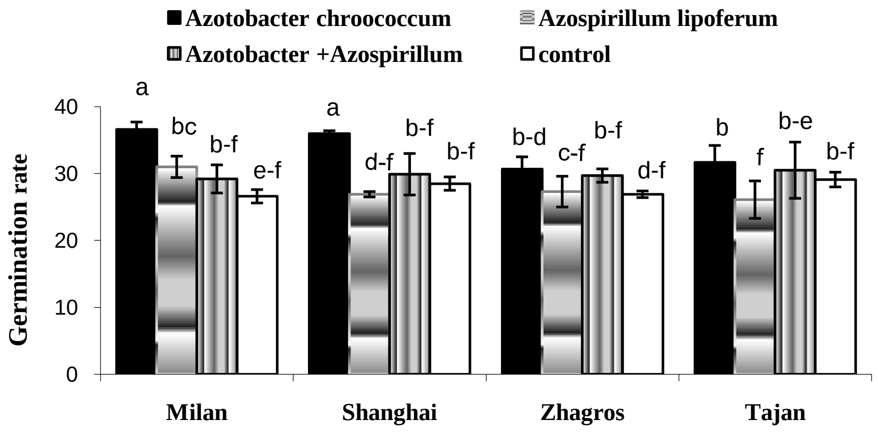

Fig-1: Effect of PGPR on germination rate of wheat cultivars

Our observation concurs with several earlier studies that have reported positive interactions between *Azotobacter chroococcum* and *Azotobacter chroococcum* [25, 12]. Saharan and Nehra reported that inoculation of crops with PGPR may result in multiple effects on early-season plant growth, as seen in the enhancement of seedling germination, stand health, plant vigor, plant height, shoot weight, nutrient content of shoot tissues, early bloom, chlorophyll content, and increased nodulation in legume [12].

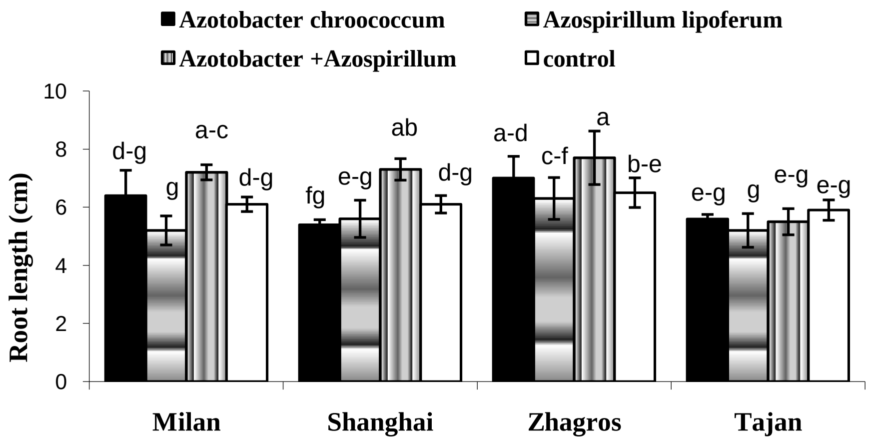

Fig-2: Effect of PGPR on root length of wheat cultivars

The seedling vigor and seedling weight was significantly higher in the treatments containing co-inoculation *Azotobacter chroococcum* and *Azotobacter chroococcum* than the untreated control and was unaffected by the single *Azotobacter chroococcum* treatment. Seedling vigor is a quantitative term encompassing the sum total of those properties of the seed, which determine the potential level of activity and performance of the seed or seed lot during germination and seedling emergence. The improvement in growth and development of plants by combined inoculation of PGPR may be because: 1. phosphate-solubilizing bacteria could alter the composition of root secretion and plasticity, which in turn may influence the colonization and development of each other; 2. mixed inoculants provided more balanced nutrition for plants, such as the added supply of N and P to the crops in addition to growth-promoting substances produced by these organisms; and 3. the interactions between PGPR and other microorganisms could cause a synergistic effect that allows for the exploitation of poorly soluble P sources.

CONCLUSION

The positive effect of PGPR inoculants on wheat growth observed in our experiments. Our results of experiment showed that priming with PGPR improves germination indices and seedling growth. The results of this study suggest that *Azospirillum lipoferum* and *Azotobacter chroococcum*, in combination have the potential to increase the growth and development of wheat cultivars.

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