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Influence of variety, *Azotobacter* and *Azospirillum* on some characteristic of corn

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ABSTRACT: Corn is the most powerful cultivation plant and the greatest attraction and storage of free energy in the earth and in terms of energy, it is a good food for livestock and it is full of energy and it is the main food of a great number of people as directly or indirectly via livestock and vegetable products and it has the highest position in comparison with other cereals. Due to this, it is called the lord of cereals. Biological products and especially the use of *Aszosprilium* spp appeared among the new the technologies for optimizing plant implantation, *Aszosprilium* is growth promoting Rhizobacteria (PGPR) capable of colonizing the root and stimulating root growth thus enhancing mineral and water uptake plants. Treatments included variety of corn (700, 703, 704 and 647) and (control, *Azospirillum*, *Azotobacter, Azospirillum* + *Azotobacter*). Analysis of variance showed that the effect of variety and bacteria on all characteristic was significant.

Key words: Leaf dry weight, Stem diameter, Stem height, Number of leaf per plant

INTRODUCTION

Maize (*Zea mays* L.) is the world's most widely grown cereal, and it is ranked third among major cereal crops (Ayisi and Poswell, 1997). Corn is the most powerful cultivation plant and the greatest attraction and storage of free energy in the earth and in terms of energy, it is a good food for livestock and it is full of energy and it is the main food of a great number of people as directly or indirectly via livestock and vegetable products and it has the highest position in comparison with other cereals. Due to this, it is called the lord of cereals (Nourmohammadiand Kashani, 1998). In developed countries maize is mainly grown for animal feed, industrial products such asglucose, dextrose, and starch and specialized foods (Malvar *et al.*, 2008). Maize is produced on nearly 100 million hectares in developing countries, with almost 70 % of the total maize production in the developing world coming from low and lower middle income countries (FAOSTAT, 2010). By 2050 demand for maize will double in the developing world, and maize is predicted to become the crop with the greatest production globally, and in the developing world by 2025 (Rosegrant *et al*., 2008). In Africa maize is the most dominant food crop of rural diets, mainly in the Eastern and Southern regions. The increase in consumption of maize is also due to the renewed interest in traditional dishes and diversified maize products. Maize can be grown for biomass production, that can be used for livestock feed or industrial energy. Maize is grown almost everywhere in the world because it is adapted to a wide range of environmental conditions. Maize production can be variable depending on the regions of the world. For example, in Eastern and Southern Africa, annual maize production averaged 16.2 million tons over the past twenty years, barely resulting in food self-sufficiency (Banziger *et al*., 2000). During the same period, production levels fluctuated between 7.3 and 22.4 million tons in the same region indicating how variable and uncertain maize production can be (Banziger *et al*., 2000). Maize yields variations between regions or agro-ecological zones can be attributed to various factors of which some are agronomic like plant density, planting dates, and soil fertility. Azospirillum spp. is a free-living plant-growth-promoting bacterium capable of affecting growth and yield of numerous plant species, many of them of agronomic and ecological significance (Bashan *et al*. 2004). In general, a successful colonization either of the rhizosphere, the surface and/or the interior of the root is determinant to enhance plant growth and crop yield in rhizobacteria-based biotechnologies (Arunakumari *et al*. 1992; Okon and Itzigsohn 1995). However, most of the works published in relation to plant growth promotion by Azospirillum only mention inoculum size and not the effective root colonization reached. Beneficial rhizobacteria have tremendous potential to facilitate plant growth and productivity, in a number of ways. Another remarkable eminence on the credit of these marvelous creatures is their capability to support plants under stressed environments. When established in soils exposed to abiotic stresses, the populations of rhizobacteria become adapted to such stressed conditions thereby developing tolerance and further they can be isolated to be used as inoculum to support crops grown in correspondingly stressed environments (Sandhya *et al*., 2010, Khan *et al*., 2012).

They can protect plants against deleterious effects of different environmental stresses to which crop plants are intermittently exposed, like heavy metals, flooding, salt and drought (Mayak *et al*., 2004). Biological products and especially the use of Aszosprilium spp appeared among the new the technologies for optimizing plant implantation, Aszosprilium is growth promoting Rhizobacteria (PGPR) capable of colonizing the root and stimulating root growth thus enhancing mineral and water uptake plants (Puente, 2009). (Zahir *et al*., 2004) reported that the seed yield of corn increased 8.19% due to use combined bacteria Pseudomonas and *Azospirillum*. Mahfouz and Sharaf-Eldin, (2007) reported that the application of bio-fertilizer: *Azotobacter*, *Azospirillum* and Bacillus increased seed yield and essence content in Fennel plant. In another study on Fleawort medicinal plant cleared that the use of bio-fertilizer *Azospirillum* increased the quality and quantity yield, significantly (Khalil, 2006). (Soleimani Fard *et al*., 2012) studied the effect of growth stimulating bacteria on phenology, yield and yield components of maize hybrids. The recent years is done many efforts to improve conditions for germination and vigor of seeds and seedlings, one of these efforts is seed priming, that can increase the germination and growth of seeds (Foti *et al*., 2002). Growth parameters such as speed and uniformity of emergence are very important factors for achieving to high quantity and quality yield especially in annuals. Use of hormones and growth regulators in agricultural practices are the modern and customary methods in order to increase the yield of crops. Plant growth regulators, chemical compounds that are used in small rate, cause that the plant growth and development be better (Muniralzaman, 2000). Plant microbe interactions intercede to the plant fitness in a variety of ways (Mascher, 2007). Beneficial, symbiotic interactions of plants with microbes can shield plants from biotic and abiotic stresses (Mascher, 2007). Microorganisms have the potential to alter the plant health status and productivity and can elevate crop yield to a remarkable level. The soil microbial communities have definite interactions with plants and can play remarkably important roles in plant growth and development. Microbial strains, isolated from arid or semi-arid soils have not been only well adapted to such environments, but also can abet plant mitigate the effects of restricted water availability by improving the plant water status through amplified osmolytes production, when used as inoculants. *Azospirillum* is one such competent genus of rhizobacteria that can bring about incredible outcomes in context of plant growth promotion and augmenting the drought stress tolerance, when segregated from soils with low water content. The genus consists of free-living plant growth promoting bacteria (PGPR), capable of affecting growth and yield of copious plant species, many of agronomic and ecological significance (Bashan, *et al*., 2004). Rai and Gaur (1988), reported a synergistic effect of *Azospirillum* and *Azotobacter* on the yield of wheat, corn and sorghum. Inoculation by *Azospirillum* increased total dry matter and seed yield in sorghum up to 10-30 percentage compared with control (Kapulnic *et al*., 1981). Effect of different N fertilizer levels and biofertilizers on forage sorghum indicated that using of 75 kg/ha N (urea), 25 kg/ha N (castor residuum) and inoculation by *Azospirillum* increased the raw protein and quality of forage (Yadav *et al*., 2007). In this sense, when *Azospirillum* is inoculated using seed inoculation, it increases the productivity of wheat (Piccinin *et al*., 2011). Biological fertilizers contain one or several specific micro-organisms causing more and better development of root systems and components for better absorption (Egamberdiyeva, 2007). Mycorrhizal fungi most important action is crop yield increment, especially in soils with low fertility. Such performance due to absorption increment through the roots, penetrate the soil fungi mycelium and access a greater volume of soil (Hayman, 1983).

MATERIAL AND METHODS

The experiment was conducted at the khash which is situated between 28° North latitude and 68° East longitude. Composite soil sampling was made in the experimental area before the imposition of treatments and was analyzed for physical and chemical characteristics. The field experiment was laid out in factorial design with randomized complete block with four replications.Treatments included variety of corn (700, 703, 704 and 647) and (control, *Azospirillum*, *Azotobacter*, *Azospirillum* + *Azotobacter*). Data collected were subjected to statistical analysis by using a computer program MSTATC. Least Significant Difference test (LSD) at 5 % probability level was applied to compare the differences among treatments` means.

RESULTS AND DISCUSSION

A. Stem dry weight

Analysis of variance showed that the effect of variety on stem dry weight was significant (Table 1). The maximum of stem dry weight of treatments 647 was obtained (Table 2). The minimum of stem dry weight of treatments 703 was obtained (Table 2). Analysis of variance showed that the effect of bacteria on stem dry weight was significant (Table 1). The maximum of stem dry weight of treatments *azospirillum* was obtained (Table 2). The minimum of stem dry weight of treatments control was obtained (Table 2).

B. Leaf dry weight

Analysis of variance showed that the effect of variety on leaf dry weight was significant (Table 1). The maximum of leaf dry weight of treatments 704 was obtained (Table 2). The minimum of leaf dry weight of treatments 700 was obtained (Table 2).

Table 1: Anova analysis of the corn affected by variety of corn and bacteria.

S.O.V	df	Stem dry weight	Leaf dry weight	Stem diameter	Stem height	Number of leaf per plant
R	3.00	0.07^{ns}	0.54ns	0.03^{ns}	0.78^{ns}	0.14^{ns}
variety (A)	3.00	1906.5***	17.46***	1.06***	2.62*	0.15^{ns}
Bacteria (B)	3.00	1811.49***	56.44***	0.36***	142.65***	2.48***
A*B	9.00	1808.11***	8.14***	0.24***	1.32^{ns}	0.09^{ns}
Error	45.00	1.22	0.92	0.03	0.82	0.25
CV	-	0.10%	0.39%	7.70%	0.54%	3.67%

*, **, ns: significant at p<0.05 and p<0.01 and non-significant, respectively.

Table 2: Comparison of different traits affected by variety of corn and bacteria.

Treatment	Stem dry weight	Leaf dry weight	Stem diameter	Stem height	Number of leaf per plant
Variety					
700	1077.73^{b}	242.38^{c}	2.02^{c}	168.23^{ab}	13.68^{a}
703	1063.11^{d}	243.83^{b}	2.16^{b}	168.25^{ab}	13.55^{a}
704	1075.98^{c}	244.93^{a}	2.48^{a}	167.88^{b}	13.78^{a}
647	1089.79^{a}	243.70^{b}	2.57^{a}	168.85^{a}	13.73^{a}
Bacteria					
control	1062.73^{d}	241.65^{d}	2.31^{b}	165.43^{d}	13.33^{c}
Azotobacter	1074.00^{c}	242.93^{c}	2.26^{bc}	166.83^{c}	13.48^{bc}
Azospirillum	1085.76^{a}	244.21^{b}	2.15^{c}	168.63^{b}	13.70^{b}
Azotobacter + Azospirillum	1084.11^{b}	246.05^{a}	2.51^{a}	172.33^{a}	14.23^{a}

Any two means not sharing a common letter differ significantly from each other at 5% probability

Analysis of variance showed that the effect of bacteria on leaf dry weight was significant (Table 1). The maximum of leaf dry weight of treatments *Azotobacter + Azospirillum* was obtained (Table 2). The minimum of leaf dry weight of treatments control was obtained (Table 2).

C. Stem diameter

Analysis of variance showed that the effect of variety on leaf dry weight was significant (Table 1). The maximum of leaf dry weight of treatments 704 was obtained (Table 2). The minimum of leaf dry weight of treatments 700 was obtained (Table 2). Analysis of variance showed that the effect of bacteria on leaf dry weight was significant (Table 1). The maximum of leaf dry weight of treatments *Azotobacter + Azospirillum* was obtained (Table 2). The minimum of leaf dry weight of treatments control was obtained (Table 2).

D. Stem diameter

Analysis of variance showed that the effect of variety on stem diameter was significant (Table 1). The maximum of stem diameter of treatments 647 was obtained (Table 2). The minimum of stem diameter of treatments 700 was obtained (Table 2). Analysis of variance showed that the effect of bacteria on stem diameter was significant (Table 1). The maximum of stem diameter of treatments *Azotobacter + Azospirillum* was obtained (Table 2). The minimum of stem diameter of treatments *Azospirillum* was obtained (Table 2).

E. Stem height

Analysis of variance showed that the effect of variety on stem height was significant (Table 1). The maximum of stem height of treatments 647 was obtained (Table 2). The minimum of stem height of treatments 700 was obtained (Table 2). Analysis of variance showed that the effect of bacteria on stem height was significant (Table 1). The maximum of stem height of treatments *Azotobacter + Azospirillum* was obtained (Table 2). The minimum of stem height of treatments *Azospirillum* was obtained (Table 2).

F. Number of leaf per plant

Analysis of variance showed that the effect of variety on number of leaf per plant was not significant (Table 1). The maximum of number of leaf per plant of treatments 704was obtained (Table 2). The minimum of number of leaf per plant of treatments 703 was obtained (Table 2). Analysis of variance showed that the effect of bacteria on number of leaf per plant was significant (Table 1). The maximum of number of leaf per plant of treatments *Azotobacter + Azospirillum* was obtained (Table 2). The minimum of number of leaf per plant of treatments control was obtained (Table 2).

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