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Enhancement of Growth, Inoculation and Yield Production of Corn (*Zea mays* L.) Hybrids by Using Bio-Fertilizer

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ABSTRACT

Bio-fertilizers are naturally occurring soil bacteria that aggressively colonize plant roots and benefit plants by providing growth promotion. This investigation was aimed at determining the effect of Nitroxin bio-fertilizer application on growth, inoculation and yield production of corn hybrids. An experiment was conducted as split plot on the basis of randomized complete block design with four replications. Main plots were Included: use of the chemical and biological fertilizers in four levels (F_1: 100% urea + 0% Nitroxin; F_2:75% urea + 100% Nitroxin; F_3: 50% urea + 100% Nitroxin; F_4: 25% urea + 100% Nitroxin) and the sub plots included three maize hybrids (H_1: Single Cross 704 hybrid, H_2: Mobin hybrid, H_3: Karoun hybrid). Chemical fertilizers used included urea, triple super phosphate and potassium sulphate and Nitroxin as biological fertilizer. The results showed that the highest seed yield and 1000 seed weight was allocated to 50% urea with 100% Nitroxin application. Single cross 704 at the level of 100% chemical fertilizer had the highest number of seeds per ear, number of seeds per row and inoculation percentage. Seed yield had positive and significant correlation with seed number per ear, number of seed per row, seed weight and ear length. Also length of ear without a seed trait had the significant negative correlation by number of seed per row and ear length at 5% probability level, which shows a decrease length of ear without a seed by increasing ear length and seed number per row. Finally application of N fertilizer level at 50% chemical fertilizer + 100% biological fertilizer and Karoun hybrid was recommended.

Keywords*:* *Genotypes, Nitroxin, Nutrition, Seed weigh.*

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INTRODUCTION

Corn is one of the three most important cereal crops in the world. Maize is high yielding, easy to process, readily digested and cheaper than other cereal crops. (Audrac Erickson, 2006). During the last four production seasons (2010-2014), the average world maize areas were about the 176.19 million hectares producing 930.13 million metric tons with average yield estimated at 5.78 ton per hectare (FAO, 2014). Every part of the maize plant has economic value which the seed, leaves, stalk, tassel and cob can all be used to produce a large variety of food and nonfood production. Corn is the very versatile seed that benefits mankind in many ways (Audrac Erickson, 2006). Organic farming has emerged as an important priority area globally in view of the growing demand for safe and healthy food and long term sustainability and concerns on environmental pollution associated with indiscriminate use of agrochemicals. Though the use of chemical inputs in agriculture is inevitable to meet the growing demand for food in world, there are opportunities in selected crops and niche areas where organic production can be encouraged to tape the domestic export markets (Venkatash Warlu, 2008). Biofertilizers most commonly referred to as the fertilizer that contains living soil micro organisms to increase the availability and uptake of mineral nutrients for plants (Vessey, 2003). It is expected that their activities will influence the soil ecosystem and produce supplementary substance for the plants. Bio-fertilizers also include organic fertilizers, which are rendered in an available form due to the interaction of micro-organisms or due to their association with plants (Sujanya and Chandra, 2011). When bio-fertilizers are applied as seed or soil inoculants, they multiply and participate in nutrient cycling and benefit crop productivity (Singh *et al*., 2011). Bio-fertilizers play a very significant role in improving soil fertility by fixing atmospheric nitrogen, both, in association with plant roots and without it, insoluble soil phosphates and produces plant growth substances in the soil. They are in fact being promoted to harvest the naturally available, biological system of the nutrient to the mobilization (Venkatash-Warlu, 2008). Nitroxin contains nitrogen fixation bacteria (Azotobacter) not only fixes the air nitrogen and balance the uptake of macro and micronutrients but also enhances plant growth and increase the quality and quantity of products through the synthesis and secretion of growth promoting substances (Ansari and Rousta, 2008). In an experiment effect of Azotobacter on growth characteristics, showed that the inoculation with Azotobacter has significantly affected seed weight per plant, total plant weight, seed yield and the nitrogen content of seed, compared with control (Eidy Zadeh *et al*., 2012). Sharifi and Hagh Nia (2007) stated Nitroxin fertilizer had a significant effect on all measured traits except 1000-seed weight. Nitrogen is important for plant growth, however plants have a limited ability to extract it from the environment, and thus need microbes involved in nutrient recycling to help a plant uptake and absorb these nutrients at optimal concentration, while plants donate waste byproducts to microbes for food. With this symbiotic relationship, plants develop stronger and bigger root systems. The larger the plants' roots, the more living space and food there is for the microbes to use. In a way, microorganisms serve as biofertilizers (El kholy, 2005). Therefore this study was planned to examine effect of different level of chemical and biological fertilizers on growth, inoculation and yield production of Maize hybrids at the Khuzestan province, Iran.

MATERIALS AND METHODS

Field and treatment information

To determining the effect of Nitroxin bio-fertilizer application on growth, inoculation and yield production of corn hybrids an experiment was carried out in 2013 at the Shoushtar city of Khuzestan province with latitude 32° 14′ northern and longitude 48° 49′ eastern and 110 meters above sea level. The experiment was arranged as split plot based on the randomized complete block design in four replications. Main plots were Included: use of the chemical and biological fertilizers in four levels (F_1: 100% urea + 0% Nitroxin; F_2: 75% urea + 100% Nitroxin; F_3:50% urea + 100% Nitroxin; F_4: 25% urea + 100% Nitroxin) and the sub plots included three maize hybrids (H_1: Single Cross 704 hybrid, H_2: Mobin hybrid, H_3: Karoun hybrid).

Crop Management

Phosphorus and potassium fertilizers were used at rate of 150 kg.ha^{-1} triple super phosphate and 150 kg.ha^{-1} potassium sulfate. Biological fertilizer of Nitroxin was used as much as 2 liters per hectare as combined with seeds. Nitrogen chemical fertilizer was provided from the urea source, 50% during planting and 50% during 8-leaf stage. To determine some physical and chemical properties of the soil in the region two samples were taken from the depths of 0-30 and 30-60 cm (Table 1). Each sub plot included the 6 planting lines with a length of 5 m. The distance between row and seed on the row were 75 and 18 cm respectively. Irrigation was done every 3 or 4 days and after the plant establishment it was done every 7 to 10 days if necessary. The weeds were controlled via Cruise herbicide by 2 L.ha^{-1} at 4-to-5-leaf stage and Krakrown pesticide by 1 L.ha^{-1} against leaf and stem borer larvae.

Traits measured

The studied traits included seed yield, 1000 seed weight, number of seed per ear, number of seed per row, number of rows per ear, ear length, ear diameter, length of ear without a seed, percent of ear without seed, inoculation percentage and plant height. In order to determine the number of seed rows per ear, number of seed per row and number of seed per ear samples including 10 plants were selected randomly from each experimental unit and the mean values for each trait were recorded. After drying the samples (48 hours in oven at 75°C) and weighing, the biological yield was obtained. After separating seed from selected plants and weighing them, seed yield was calculated based on 14% moisture. In order to 1000 seed weigh, 5 samples of seed containing 100 seed were separated and the means were calculated. The final harvest area of each plot was 1.5 m^2. To determine the length of ear, randomly selected 10 number ears from each plot and ear length was measured by graduated ruler and the average length of 10 ears was recorded by centimeters. In order to determine ear diameter, randomly selected 10 number ears from each plot and ear diameter was measured and the average of 10 ears was recorded by centimeters. For determine the length of ear without a seed, randomly selected 10 number ears from each plot and the length of selective section without seeds (the lower part or the tip of the ear) was measured and its average was recorded in cm. Percent of ear without seed and inoculation percentage was obtained from the following equation (Farokhi and Eradatmand asli, 2008):

Equation. 1. Percent of ear without seed = (Length of ear without a seed - ear length) ×100
Equation. 2. Inoculation percentage = 100 - Percent of ear without seed
In order to determine height of plants ten plants were selected randomly from each plot and average of 10 plants was recorded in cm.

Statistical analysis

Analysis of variance for all traits was performed by SAS software (Ver.9) and mean comparison was done by Duncan test at 5% probability level. Simple correlation was performed by Minitab software (Ver.15).

Table 1. Physical and chemical properties of the experiment field

Soil depth (cm)	0-30	30-60
Acidity (pH)	8.44	8.51
Electrical conductivity ($ds.m^{-1}$)	4.07	2.69
Organic carbon (%)	0.51	0.36
Absorbable Phosphorus (ppm)	8	7
Absorbable potassium (ppm)	181	171
Clay (%)	26	24
Silt (%)	41	40
Sand (%)	33	32
Soil texture	Loam	Loam

RESULTS AND DISCUSSION

Seed yield

Seed yield is a function of interaction among various yield components that are affected differentially by growing conditions and crop management practices (Delkhoshi and Jalilian, 2012). According to results the combination of Nitroxin bio-fertilizer and chemical fertilizer was significant at 1% probability level and the difference between hybrids and the interaction effect of treatments on seed yield was significant at 5% probability level (Table 2). The mean comparison showed that mixing 50% urea with 100% Nitroxin fertilizer than the other treatments were significantly different and had the highest seed yield. 100% chemical fertilizer treatment, 75% urea + 100% Nitroxin fertilizer and 25% urea + 100% Nitroxin fertilizer were not significantly different (Table 3). The highest and lowest seed yield belonged to Karoun hybrid and Mobin hybrid respectively (Table 4). Interaction effect between treatments showed that the highest seed yield were for 50% urea + 100% Nitroxin fertilizer and Karoun hybrid and 50% urea by 100% Nitroxin fertilizer and SC. 704 and the lowest belonged to the 100% chemical fertilizer and Mobin hybrid. In all three hybrids reducing nitrogen consumption by 50% and using of biofertilizer increased seed yield (Table 3). Azospirillum and Azotobacter by the biological nitrogen fixation and development the roots, helped to optimize the absorption of water, nutrients, hormones, certain vitamins production and the boost plant growth quantitative and qualitative (Ram-Rao *et al*, 2007). The results of correlation showed seed yield had the significant positive correlation with the number of seeds per ear, number of seeds per row, seed weight, and ear length. With the increase ear length due to the reduction percent of ear without seed and its direct impact on yield components, seed yield also increased. By other traits such as plant height, ear diameter and the inoculation percentage had a positive correlation and between the number of seed row per ear, length of ear without seed and percent of ear without seed was negatively correlated, however correlation wasn't significant (Table 5).

Table 2. Analysis of variance of effect of fertilizers and hybrids on measured traits

S.O.V	Df	Seed Yield	1000 seed weight	Number of seeds per ear	Number of rows per ear	Number of seeds per row	Ear length	Ear diameter	Length of ear without seed	Percent of ear without seed	Inoculation percentage	Plant height
Replication	3	0.25^{ns}	413.96^{ns}	302.81^{ns}	0.61^{ns}	5.96^{ns}	0.37^{ns}	0.021^{ns}	0.11^{ns}	2.57^{ns}	2.57^{ns}	71.43^{ns}
Fertilizer (F)	3	11.48**	3136.90**	12641.43**	0.23^{ns}	67.92**	1.07^{ns}	0.026^{ns}	0.25^{ns}	4.46^{ns}	4.46^{ns}	244.56^{ns}
Error a	9	1.31	487.81	5195.33	1.02	10.61	1.24	0.042	0.25	5.95	5.95	120.02
Hybrid (H)	2	6.77*	5442.77**	7098.93^{ns}	13.82**	122.71**	47.91**	0.099^{ns}	2.61**	93.96**	93.96**	298.57^{ns}
F × H	6	4.99*	3430.15**	10913.2**	0.31^{ns}	42.98**	1.47*	0.072**	0.16*	4.15*	4.15*	235.40^{ns}
Error b	24	2.17	670.47	2933.75	0.55	12.70	1.32	0.026	0.22	5.12	5.12	158.08
CV (%)	----	11.29	7.89	9.78	5.1	9.37	5.31	3.45	32.69	33.39	2.42	7.34

ns, * and **: no significant, significant at 5% and 1% of probability level, respectively.

Table 3. Mean comparison of the effect of different level of biological and chemical fertilizer on measured traits

Fertilizer treatment	Seed yield ($t.ha^{-1}$)	1000 seed weight (g)	Number of seeds per ear	Number of rows per ear	Number of seeds per row	Ear length (cm)	Ear diameter (cm)	Length of ear without a seed (cm)	Percent of ear without seed (%)	Inoculation percentage (%)	Plant height (cm)
100% chemical fertilizer (N1)	12.74^{b}	311.67^{b}	562.97^{ab}	14.45^{a}	39.18^{a}	21.35^{a}	4.66^{a}	1.32^{a}	6.35^{a}	93.96^{a}	167.75^{a}
75% chemical fertilizer + bio-fertilizer (N2)	12.81^{b}	319.92^{b}	549.37^{ab}	14.48^{a}	38.02^{a}	21.55^{a}	4.67^{a}	1.58^{a}	7.51^{a}	92.48^{a}	170.76^{a}
50% chemical fertilizer + bio-fertilizer (N3)	14.46^{a}	349.00^{a}	589.47^{a}	14.71^{a}	40.19^{a}	22.06^{a}	4.73^{a}	1.45^{a}	6.66^{a}	93.34^{a}	168.51^{a}
25% chemical fertilizer + bio-fertilizer (N4)	13.74^{b}	331.33^{ab}	511.55^{b}	14.70^{a}	34.71^{b}	21.65^{a}	4.76^{a}	1.47^{a}	6.89^{a}	93.10^{a}	177.66^{a}

*Similar letters in each column show non-significant difference at 5% level via Duncan's multiple rang test

Table 4. Mean comparison of the effect of different hybrids on measured traits

Hybrids treatment	Seed yield ($t.ha^{-1}$)	1000 seed weight (g)	Number of seeds per ear	Number of rows per ear	Number of seeds per row	Ear length (cm)	Ear diameter (cm)	Length of ear without seed (cm)	Percent of ear without seed (%)	Inoculation percentage (%)	Plant height (cm)
S.C 704 (H1)	13.14^{*ab}	322.87^{b}	577.52^{a}	14.42^{b}	40.06^{a}	22.28^{a}	4.72^{ab}	1.11^{b}	4.98^{b}	95.25^{a}	175.6^{a}
Mobin (H2)	12.37^{b}	312.62^{b}	543.56^{a}	15.58^{a}	34.87^{b}	19.70^{b}	4.77^{a}	1.86^{a}	9.45^{a}	90.54^{b}	166.97^{a}
Karoun (H3)	13.66^{a}	348.43^{a}	538.95^{a}	13.75^{c}	39.15^{a}	22.98^{a}	4.62^{a}	1.11^{a}	6.12^{b}	93.87^{a}	170.93^{a}

*Similar letters in each column show non-significant difference at 5% level via Duncan's multiple rang test.

1000 seed weight

Effects of combining fertilizer treatment and hybrids and interaction between treatments on 1000 seed weight were significant at the 1% probability level (Table 2). The mean comparison results of mixing fertilizer showed that the highest 1000 seed weight belonged to 50% chemical fertilizer by 100% Nitroxin biofertilizer and there was not significant difference between 100% chemical fertilizer and the 75% chemical fertilizer treatments (Table 3). The highest 1000 seed weight belonged to Karoun hybrid (Table 4). Interaction of treatments showed highest 1000 seed weight in SC.704 hybrid and Karoun hybrid belonged to 25% chemical fertilizer with 100% Nitroxin bio-fertilizer and 50% chemical fertilizer by 100% Nitroxin bio-fertilizer treatments and the lowest one were in 25% chemical fertilizer by 100% Nitroxin bio fertilizer treatments in Mobin hybrid (Table 5). The increase amount of nutrients available by use chemical and bio fertilizers has largely lead to increasing seed weight (Hassanpour *et al*., 2011). Due to producing plant hormones, biofertilizer, through stimulating cell division, increase the reservoir capacity in plant and develop the root and provide conditions for nutrients uptake lead to increase of photosynthesis, when plant approaches to maturity stage, it transfers assimilates into reproductive seeds (Biswas *et al*., 2008). Correlation analysis showed significant positive correlation between seed weight and seed yield. Since one components of seed yield was seed weight, it can be increased by increasing yield be expected. Seed weight with number of seeds per row, ear length, and length of ear without seed positive correlation and by number seed per ear, number of seed row per ear, ear diameter and percent of ear without seed had negative correlation, but correlation was not significant (Table 5).

Number of seeds per ear

Number of seed per ear is an important yield determining factor in the maize (Delkhoshi and Jalilian, 2012). The results showed that effect of fertilizer combination and interaction effect of treatments on the number of seed per ear were significant at 1% probability level (Table 2). The interaction effect of the treatments showed that highest and lowest number of seeds per ear belonged to treatments with 100% urea + 0% Nitroxin S.C. 704 and 25% urea + 100% Nitroxin – Karoun hybrid (Table 3). Those results were consistent with finding Hemati (2010). Nutrients availability particularly nitrogen during the critical stage of seed formation influences the number of seed through increasing plant growth rate which leads to strong correlation between the number of seed per ear and leaf area index at the silking stage (Hamidi, 2006). Nitrogen enhances assimilates availability for Ear through duration of photosynthesis and number of seed per ear increases due to decrease of seeds competition for nutrients (Hamzeie and Sarmadi Nayebi, 2009). Nitroxin effectively increased number of seed per ear by expanding area and depths of root and Azotobacter ability in nitrogen fixation and production of plant regulating hormones (Hamidi *et al*., 2009). Correlation analysis showed that number of seeds per ear with seed yield and number of seeds per row had significant positive correlation (Table 5). Although this trait by number of seed row per ear, ear length and ear diameter had a positive correlation and with seed weight, length of ear without a seed and percent of ear without seed had negative correlations, but this correlation was not significant (Table

5). By increasing number of seeds per ear, seed yield was increased, that this increases due to significantly positive correlation with number of seed row. Alizadeh *et al.* (2008) reported that increasing the number of seeds per ear by using *Azospirillum* with chemical fertilizers significantly said inoculation corn by *Azospirillum* in tropical areas reduced 10 percent of nitrogen.

Number of rows per ear

Row number per ear is one of the very important agronomic traits, related to maize yield (Liu *et al*., 2010). The combination of biological and chemical fertilizers treatment on the number of row per ear was not significant, but difference between the hybrids was significant at 1% probability level (Table 2). The results of mean comparison showed that there was no significant difference between incorporation of fertilizer treatments. The most number of row per ear belonged to the Mobin hybrid and the lowest one belonged to Karoun hybrid (Table 3). Interaction between the treatments showed that the most number of row per ear belonged to the Mobin hybrid and 25% chemical fertilizer with the 100% bio-fertilizer application and Karoun hybrid at the level of 25% chemical fertilizer by 100% bio-fertilizer had the minimum number seed rows per ear than the other treatments (Table 4). The result was similar to the results of Eydi Zadeh *et al.* (2012). It seems that the higher amount of nitrogen increased the photosynthesis, flowering period and the fertility of flowers and thereby increased the number of row per ear. Naserirad *et al.* (2011), report the effect of increasing the number of rows per ear with inoculation Azotobacter and Azospirillum. Yasseri *et al.* (2008) stated that the Azotobacter alone cannot make a significant difference in the number of row per ear and adding the inorganic nitrogen, phosphorus and potassium is necessary. The correlation analysis showed because number of rows seeds per ear is genetic trait, did not has significant impact on seed yield. But this trait with ear diameter, length of ear without a seed and percent of ear without seed had significant positive correlation and ear length had negative and significant correlation. This trait was positively correlated by number of seeds per ear and seed yield, seed number per row and seed weight had negative correlation but correlation was not significant (Table 6).

Number of seeds per row

According to ANOVA results effect of the mixing fertilizer and different between the hybrids and the interaction between treatments on number of seed per row was significant at the 1% probability level (Table 2). Results of the mean comparison showed that although the maximum number of the seed per row was 50% urea with 100% biofertilizer treatments, but this difference with two treatments treated by 100% urea and 75% urea with 100% Nitroxin biofertilizer was not significant and 25% chemical fertilizer by 100% Nitroxin bio-fertilizer treatments. Among hybrids, there was the no significant difference between single cross 704 and Karoun hybrid. The Mobin hybrid in number of seed per row was less and significant with other hybrid (Table 3). The results of interaction treatments showed maximum number of seeds per row belonged to 100% urea fertilizer and S.C 704 hybrids and lowest number of seeds per row was in 100% urea fertilizer and Mobin hybrid (Table 4).

Table 5. Mean comparison of interaction effects of treatments on measured traits

Fertilizer treatments	Hybrids	Seed yield ($t.ha^{-1}$)	1000 seed weight (g)	Number of seeds per ear	Number of rows per ear	Number of seeds per row	Ear length (cm)	Ear diameter (cm)	Length of ear with-out a seed (cm)	Percent of ear without seed (%)	Inoculation percentage (%)	Plant height (cm)
	Sc704	13.45^{abc}	284.00^{d}	638.42^{a}	14.40^{bc}	44.35^{a}	22.2^{ab}	4.83^{ab}	0.97^{c}	4.23^{e}	96.71a	180.95^{a}
100% chemical fertilizer	Mobin	11.00^{d}	299.75^{bcd}	494.33^{cd}	15.45^{ab}	32.05^{e}	18.92^{d}	$4.\ 6^{b}$	1.8^{ab}	9.58^{ab}	90.41cd	156.20^{a}
	Karoun	13.77^{ab}	351.25^{a}	556.16^{abc}	13.50^{c}	41.15^{abc}	22.95^{ab}	4.56^{b}	1.2^{bc}	5.24^{cde}	94.75ab	166.10^{a}
	Sc704	11.28^{cd}	294.75^{cd}	535.77^{bcd}	14.05^{c}	37.97^{bcd}	21.37^{bc}	4.53^{b}	1.06^{bc}	5.05^{cde}	94.94ab	175.53^{a}
75% chemical fertilizer+ bio-fertilizer	Mobin	13.34^{abc}	336.25^{ab}	537.64^{bcd}	15.40^{ab}	35.05^{de}	20.1^{cd}	4.8^{ab}	2.22^{a}	11.1^{a}	88.89d	167.60^{a}
	Karoun	13.81^{ab}	328.75^{abc}	574.72^{abc}	14.00^{c}	41.05^{abc}	23.17^{ab}	4.68^{ab}	1.47^{abc}	6.38^{bcde}	93.61abc	169.15^{a}
	Sc704	14.84^{a}	356.25^{a}	618.64^{ab}	14.45^{bc}	42.97^{ab}	22.8^{ab}	4.73^{ab}	1.3^{bc}	5.75^{cde}	94.24ab	163.38^{a}
50% chemical fertilizer+bio-fertilizer	Mobin	13.41^{abc}	335.75^{ab}	573.68^{abc}	15.70^{ab}	36.45^{cde}	19.85^{cd}	4.78^{ab}	1.7^{abc}	8.48^{abcd}	91.52bcd	165.60^{a}
	Karoun	15.14^{a}	355.00^{a}	576.1^{abc}	14.00^{c}	41.15^{abc}	23.55^{a}	4.7^{ab}	1.35^{bc}	5.74^{cde}	94.25ab	176.55^{a}
	Sc704	12.98^{abcd}	356.50^{a}	517.25^{cd}	14.80^{abc}	34.95^{de}	22.75^{ab}	4.8^{ab}	1.12^{bc}	4.88^{de}	95.11ab	182.55^{a}
25% chemical fertilizer+bio-fertilizer	Mobin	11.72^{bcd}	278.75^{d}	568.6^{abc}	15.80^{a}	35.95^{cde}	19.92^{cd}	4.93^{a}	1.72^{abc}	8.67^{abc}	91.33bcd	178.50^{a}
	Karoun	11.91^{bcd}	358.75^{a}	448.8^{d}	13.50^{c}	33.25^{de}	22.27^{ab}	4.54^{b}	1.58^{abc}	7.13^{bcde}	92.86bc	171.95^{a}

*Similar letters in each column show non-significant difference at 5% level via Duncan's multiple rang test.

Table 6. The correlation coefficient of some indicators in maize hybrids

Traits	Seed yield	1000 seed weight	Number of seeds per ear	Number of rows per ear	Number of seeds per row	Ear length	Ear diameter	Length of ear without seed	Percent of ear without seed	Inoculation percentage	Plant height
Seed yield	1										
1000 seed weight	0.58*	1									
Number of seeds per ear	0.63*	-0.23ns	1								
Number of rows per ear	-0.28ns	-0.42 ns	-0.44ns	1							
Number of seeds per row	0.71**	0.02ns	0.86**	-0.44ns	1						
Ear length	0.65*	0.55ns	-0.82**	-0.82**	0.65*	1					
Ear diameter	0.23ns	-0.27ns	0.67*	0.67*	0.11*	-0.21ns	1				
Length of ear without a seed	-0.19ns	0.01ns	0.59*	0.59*	-0.61*	-0.66*	0.20ns	1			
Percent of ear without seed	-0.32ns	-0.13ns	0.68*	0.68*	-0.66*	-0.79**	0.21ns	0.98**	1		
Inoculation percentage	0.31ns	0.06ns	0.39ns	-0.66*	0.68**	0.76**	-0.16ns	0.98**	-0.99**	1	
Plant height	0.04ns	-0.16ns	0.17ns	-0.15ns	0.21ns	0.39ns	0.40ns	-0.49ns	-0.51ns	0.53ns	1

ns, * and **: no significant, significant at 5% and 1% of probability level, respectively.

Increased levels of nitrogen leads to removing restrictions nitrogen for maize and increase photosynthetic efficiency and plant production and increase the number of seeds per row (Naserirad *et al*., 2011). Some researchers believe that hormonal effects induced by plant growth promoting bacteria, directly increases the number of seed per row. Alizadeh *et al.* (2008) expressed that increasing the number of seed per ear using Azospirillum associated with consumption of chemical fertilizers was significantly. Correlation analysis showed number of seed per row had a positive correlation with seed yield, number of seeds per ear and the ear length. It can be expected that by increasing the number of seeds per row, increases seed yield that also increased harvest index. With the increasing ear length, because there is enough space for more production. There was negative correlation between number of seed per row, length of ear without a seed and percent of ear without seed, as amount of length of ear without a seed increases, the number of seeds per row was reduced (Table 5).

Ear length

Effect of fertilizer combination on ear length was not significant, but different between hybrids and interaction effects of treatments were significant at 1% and 5% level (Table 2). Mean comparison showed treatments was not significant differences in ear length, however highest ear length belonged to 50% urea + 100% Nitroxin. Also Karoun and SC.704 hybrid had no significant difference in ear length and lowest of this trait was belonged to Mobin hybrid (Table 3). The results of interaction treatments showed that the maximum ear length belonged to 50% urea fertilizer with 100% Nitroxin bio-fertilizer and Karoun hybrid and the lowest of this trait was in 100% urea fertilizer and Mobin hybrid (Table 4). Correlation analysis showed that ear length had a positive correlation with seed yield and number of seeds per row and by the number of rows per ear, length of ear without a seed and percent of ear without seed had a negative correlation (Table 5). Mohammadi *et al.* (2003) reported a positive and strong correlation between ear length and seed yield. There is a positive correlation between traits was increasing in this trait due to increased ear length that decreases the length of ear without a seed and percent of ear without seed. Because with increasing the ear length, more number of goals in each row was possible to inoculated and reduced the percent of ear without seed. Other characters such as number of seeds per ear and thousand seed weight was positively correlated with this trait and traits such as ear diameter had negative correlation, but this correlation was not significant (Table 5). Khayat-Nezhad *et al.* (2010) reported that 500 seed weight, the seed per row and ear length showed the correlation with seed yield. Mohammadian Roshan *et al*. (2010) and Shoa-Hosseini *et al.* (2009). Obtained results for seed yield showed that, ear length had more effect in seed yield.

Ear diameter

Effect of fertilizer combination on ear diameter was not significant, but different between the hybrids and interaction effects of treatments were significant at 5% probability level (Table 2). The mean comparison of treatments showed among treatments was not Significant differences in terms of ear diameter, however highest ear diameter belonged to 25% urea + 100% Nitroxin bio-fertilizer that reducing consumption of chemical fertilizer and Nitroxin biofertilizer application revealed positive effect of PGPR to increasing the diameter of ear corn plants. Among hybrids, maximum ear diameter with 4.77 centimeters belonged to Mobin hybrid and Karoun hybrid by 4.62 cm had the lowest ear diameter (Table 3). The results of interaction treatments showed that the maximum ear diameter belonged to 25% urea fertilizer with 100% Nitroxin bio-fertilizer and Mobin hybrid and the lowest of this trait was in 75% urea fertilizer by 100% Nitroxin bio-fertilizer and SC.704 hybrid (Table 4). Correlation analysis showed that ear diameter with number of rows per ear and number of seed per row had a significant positive correlation at 5 percent. This means that by increasing the diameter of ear, number of rows per ear and number of seed per row shows a significant increase (Table 5). Torbert *et al*. (2001) and Singh *et al*. (2000) reported that nitrogen levels affected ear diameter and thinner ears were obtained at high nitrogen levels.

Length of ear without a seed

Effect of fertilizer combination on length of ear without a seed was not significant, but different between the hybrids and interaction effect of treatments was significant at 1% and 5% probability level (Table 2). Results of means comparison showed that despite the absence of significant differences, but the maximum length of ear without a seed was in 75% chemical fertilizer and 100% bio-fertilizer and the lowest this trait was in 100% chemical fertilizer. Among hybrids, Mobin hybrid had a maximum length of ear without a seed and SC.704 with Karoun hybrid showed no significant difference in terms of this trait (Table 3). The results of interaction treatments showed that the maximum ear tinea length belonged to 75% urea fertilizer by 100% bio-fertilizer and Mobin hybrid and the lowest of this trait was in 100% urea fertilizer and SC.704 hybrids (Table 4). According to the results of correlation (Table 5) this trait had a significant correlation with percent of ear without seed at 1 percent. As well as this trait had a significant positive correlation with the number of seed row per ear and by number of seeds per row and ear length had a significant negative correlation at 5%. By increasing the ear length and number of seeds per row, length of ear without a seed shows a significant decrease. Cheng and Lur (2008) stated that ethylene and ACC may contribute to the development of hollow corn, since the seeds are in the early stages of growth are sensitive to ethylene and ACC is a precursor in synthesis of ethylene production, Therefore it can inferred that stimulate plant growth bacteria by producing ACC- Deaminase enzymes cause decomposition of ACC and thus reduce the concentration of ethylene in plants and reduce the negative impacts of increased ethylene and reduced the percent of ear without seed.

Percent of ear without seed

Effect of fertilizer combination on percent of ear without seed was not significant, but different between the hybrids at 1% probability level and interaction effect of treatments was significant at 5% probability level (Table 2). Results of means comparison showed that despite absence of significant differences, but the maximum percent of ear without seed was in 75% chemical fertilizer and 100% bio-fertilizer and the lowest this trait was in 100% chemical fertilizer. Among hybrids, Mobin hybrid had a maximum percent of ear without seed and SC.704 with Karoun hybrid showed no significant difference in terms of this trait (Table 3). The results of interaction treatments showed that the maximum percent of ear without seed of ear belonged to 75% urea fertilizer by 100% bio-fertilizer and Mobin hybrid and the lowest of this trait was in 100% urea fertilizer and single cross 704 hybrids (Table 4). According to the results of correlation (Table 5) percent of ear without seed had significantly positive correlation with the number of seed row per ear, number of seeds per row, ear length and length of ear without a seed. There was significant correlation between percent of ear without seed of ear and length of ear without a seed. This positive correlation with length of ear without a seed meaning that the length of the ear is more; percent of ear without seed will be even more. Also seen significant negative correlation between ear length, percent of ear without seed and seed number per row. In other words, by increasing the length of the ear, due to increased seed number per row percent of ear without seed was reduced. This means that by increasing the number of rows per ear inoculation of flowers decreased.

Inoculation percentage

Effect of fertilizer combination on inoculation percentage was not significant, but different between the hybrids at 1% probability level and interaction effect of treatments was significant at 5% probability level (Table 2). Results of means comparison showed that despite the absence of significant differences, but maximum inoculation percentage was in 100% chemical fertilizer. Among the hybrids, Mobin hybrid had a maximum inoculation percentage and SC.704 with Karoun hybrid showed no significant difference in terms of this trait (Table 3). Results of interaction treatments showed that the maximum inoculation percentage belonged to 100% urea fertilizer and single cross 704 and the lowest of this trait was in 75% urea fertilizer by 100% bio-fertilizer and Mobin hybrids (Table 4). Correlation analysis showed inoculation percentage by the number of rows per ear, length of ear without a seed and percent of ear without seed had a significant negative relationship and with number of rows per ear and ear length had significant positive relationship (Table 5). Results showed that by increasing the number of rows per ear, inoculation rate of flowers decreased. Moreover, the inoculation rate of flowers increased, the percent of ear without seed and length of ear without a seed showed very significantly decrease. This is despite fact that by increasing inoculation percentage, the row number is also significantly increased. Also, by increasing length of ear, inoculation rate of flowers was increased.

Plant height

The effect of fertilizer treatment and the hybrid and interaction between treatments was non-significant (Table 2). Results mean comparison the effects of mixing fertilizer treatment showed that there was no significant difference between treatments. Also in terms of Plant height was not significantly different between hybrids (Table 3). Interaction treatments showed that there was no significant difference between the treatments; the maximum plant height belonged to 25% chemical fertilizer with 100% biofertilizer treatments and hybrid SC.704, and the minimum plant height was of 100% chemical fertilizer and the Mobin hybrid treatment (Table 4). An important reason that can increase impact of bio-fertilizers for Plant height this is that use of fertilizers leading to increased internodes length and it can stimulate production of plant hormones produced by these fertilizers

(Hassanpour *et al*., 2011). According to results of correlation (Table 5) these traits with other traits such as number of seeds per ear, number of seed per row, ear length, ear diameter and inoculation percentage had positive correlation with number of rows per ear, thousand seed weight and length of ear.

CONCLUSION

Soil testing and application of the Nitroxin bio-fertilizer at recommended levels can reduce chemical fertilizer application rate by 50%, while increasing plant height and stem perimeter of corn plants. So, this study provides additional evidence that reduced use of the N fertilizer is feasible for reduction of environmental pollution and the cost of agricultural practice.

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