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Evaluation Effect of Biological Fertilizer (Nitroxin case study) on Corn (*Zea mays* L.) Crop Production

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RESEARCH ARTICLE

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ABSTRACT

The use of renewable resources and inputs is one of the fundamental principles of sustainable agriculture that enables maximum crop productivity and minimal environmental risk. Nutrient management may be achieved by the involvement of organic sources, biofertilizers, and micro-nutrients. Indiscriminate use of chemical fertilizers to achieve high yield and to compensate for lack of nutrients and consequently the increase of production costs and destruction of soil and water resources have made the specialists interested in healthy and stable crop systems in terms of ecology. 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 nutrient mobilization. The bacteria in the Nitroxin biological fertilizer, in addition to stabilizing nitrogen of the air and balancing the absorption of macro and micronutrient elements, stimulate growth of the hormones by synthesizing and securing growth promoters such as hormones. Current research was conducted according evaluate results of valid researcher. Assessment result of many researchers revealed apply biofertilizer (especially Nitroxin) had positive effect to improve seed yield, biologic yield, plant height, harvest index, seed weight, number of seed per ear, number of row per ear, number of seed per row, ear length, seed protein content and chlorophyll content in compare control treatments. It seems consume according result of valid researchers consumption 150 kg Nitrogen ha^{-1} with 1 $L.ha^{-1}$ Nitroxin led to achieve maximum corn seed yield and it can be advice to producers.

KEYWORDS: *Fertility, Nutrition, Organic carbon, Seed yield, Sustainable agriculture.*

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1. BACKGROUND

Khuzestan is one of the most important provinces in Iran, which has very hot and sunny summers due to specific climatic conditions. One of the crops widely cultivated in this province in recent years is the corn. However, despite the availability of suitable climatic conditions in this province, corn production in Khuzestan is not more than that of other provinces. Among various types of management that can be used to enhance crop per area unit, supplying sufficient nutrients for crops in a proper way is highly significant among which nitrogen has a special stand. According to the wide studies conducted on the management and consumption of chemical fertilizers, particularly nitrogen, it can be concluded that timely and sufficient distribution of nitrogen can significantly increase the yield and improve the efficiency of nitrogen (Izadian, 2016). The use of renewable resources and inputs is one of the fundamental principles of sustainable agriculture that enables maximum crop productivity and minimal environmental risk (Kizilkaya, 2008). Chemical fertilizers are significant to succor nutrients in soil. Heavy doses of chemical fertilizers and pesticides are commonly used in order to enhance corn yields. Excessive nitrogen content in soil causes an inappropriate high uptake of this macronutrient by plants, which may result in inadequate growth and development due to the accumulation of nitrogen compounds in plant tissue (Szulc, 2013). Crop produced with chemical fertilizers is not good for health and contains heavy metals which are harmful for good health (Table 1). In organic agriculture, one management goal is to increase and maintain soil quality with a high biological activity.

Table 1. Adverse effect of nitrogenous fertilizers on human health and environment (Jehangir *et al*., 2017a)

Effect	Causative agent
Human health	ExcessNO_3 and NO_2 in water and food
Methemoglobineemia cancer	Nitrosomine illness from NO_2, secondary amines, Peroxyacyl nitrate.
Environmental health Environment	Excess NO_3 in feed and water.
Eutrophication	Inorganic and organic water in surface water
Materials and ecosystem damage	HNO_3 and aerosols in rainfall

Organic cropping system often has to deal with a scarcity of readily available nutrients in contrast to high input cropping system which relies widely available on soluble fertilizers (Soleimanzadeh and Ghooshchi, 2013). Nutrient management may be achieved by the involvement of organic sources, biofertilizers, and micro-nutrients (Singh *et al*., 2002). Indiscriminate use of chemical fertilizers to achieve high yield and to compensate for lack of nutrients and consequently the increase of production costs and destruction of soil and water

resources have made the specialists interested in healthy and stable crop systems in terms of ecology (Tilak *et al*., 1992). More recently, a real challenge faces the workers in the agricultural research field to stop using the high rates of agro-chemicals which negatively affect human health and environment (El-Kholy *et al*., 2005). Zhang *et al*. (2019) reported Organic fertilizer application significantly increased soil organic carbon content and enzyme activities, root length density down the soil profile, plant biomass and nutrient uptake compared to the lime treatment and the control. Changes in the soil microbial community in the organic fertilizer treatment compared to the control followed the same direction as in the lime treatment. So, the relative abundances of Actinobacteria and Ascomycota increased significantly 280 days after planting and potential pathogenic fungi including Fusarium decreased (Fig.1).

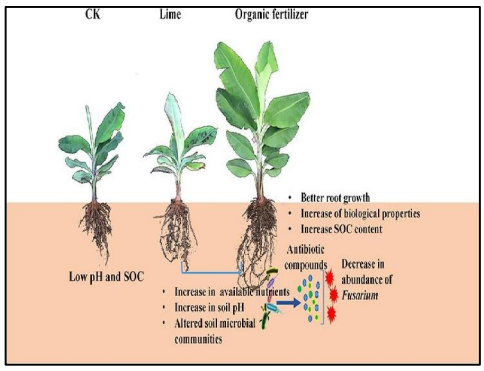

Fig.1. Effect of organic fertilizer to increase biomass, soil organic carbon and modifies soil microbiota.

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 nutrient mobilization (Venkatash-Warlu, 2008). Nitrogen is a basic component, playing decisive role in intensification of plant production (Scharf, 2002). Biofetilizer had great share in input agriculture market and this trend will be continuing (Fig.2).

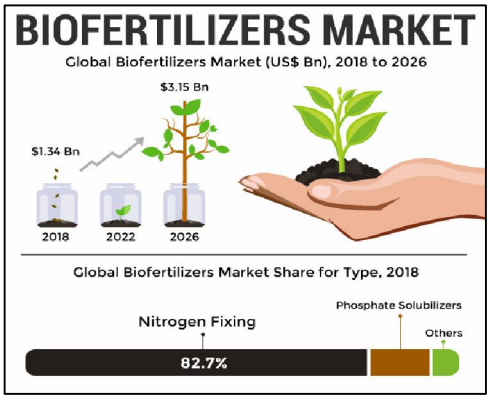

Fig.2. Global biofertilizer market share

Bio-fertilizers are classified into different types depending on the type or group of microorganisms they contain. Several microorganisms and their association with crop plants are being exploited in the production of biofertilizers. They can be grouped in different ways based on their nature and function (Table 2). Nitrogen is the major constituent of chlorophyll so increases in nitrogen availability leads to increase chlorophyll content. Nitrogen is supplied more quickly and chlorophyll synthesis proceeds rapidly while in organic treatment nitrogen release slowly and supply required nitrogen during time. The differences between chemical and organic treatments may be attributed to higher levels of nutrients besides growth stimulating substances available in vermicompost (Vadiraj *et al*., 1998).

Table 2. Different microorganisms used in Bio-fertilizer production (Umesha *et al*., 2018)

Nature of organisms	Functions	Examples
Free-living	N_2-fixing biofertilizers	*Azatobacter, Beijerinkia, Clostridium, Klebsiella, Anabaena, and Nostoc*
Symbiotic		*Rhizobium, Frankia, and Anabaena azollae*
Associate symbiotic		*Azospirillum*
Bacteria	P-solublizing biofertilizers	*Bacillus megaterium var phosphaticum, Bacillus subtilis, Bacillus circulans, and Pseudomonas striata*
Fungi		*Penicillium sp. and Aspergillus awamori*
Arbuscular mycorrhiza	P-mobilizing biofertilizers	*Glomus sp., Gigaspora sp., Acaulospora sp., Scutellospora sp., and Sclerocystis sp.*
Ectomycorrhiza		*Laccaria sp., Pisolithus sp., and Boletus sp.*
Ericoid mycorrhizae		*Pezizella ericae*
Orchid mycorrhiza		*Rhizoctonia solani*
Silicate and zinc solubilizers	Biofertilizers for micronutrients	*Bacillus sp.*
Pseudomonas	Plant-growth-promoting rhizobacteria	*Pseudomonas fluroscence*

Table 3. Effect of Azotobacter on crop yield (Jehangir *et al*., 2017b)

Crop	Increase in yield over yields obtained with chemical fertilizers (%)	Crop	Increase in yield over yields obtained with chemical fertilizers (%)
Wheat	8-10	Potato	16
Rice	5	Carrot	40
Maize	15-20	Cauli-flower	2-24
Sorghum	15-20	Tomato	7-27
Other	13	Cotton	9-24

Growth prompting bacteria are including *Azotobacter*, *Azospirillum* and *Pseudomonas* (Banerjee *et al*., 2006). *Azobacter*, a free living and heterotrophic bacteria fixes nearly 20 to 40 kg nitrogen ha^{-1} and increases yield up to 50% 30. However, their effectiveness is found to vary greatly, depending largely on soil condition, temperature and farming practices (Table 3). Tilak (1992) reported positive effects of double-inoculation of *Azotobacter* and *Azospirillum* on dry matter of maize and sorghum. To alleviate the problem, integrated plant nutrient management is an option as it utilizes available organic and inorganic nutrients to build ecologically sound and economically viable farming system. Research has suggested that integrated nutrient management strategies involving chemical fertilizers and bio-fertilizers enhance the sustainability of crop production. Integrated plant nutrient management is the combined use of mineral fertilizers with organic resources such as cattle manures, crop residues, urban/rural wastes, composts, green manures and bio-fertilizers (Kemal and Abera, 2015).

The application of bio fertilizers has become of great necessity to get a yield of sufficient high quality and to avoid environmental pollution (Shevananda, 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 the 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 the 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 bio-fertilizers (Elkholy, 2005). The bacteria in the Nitroxin biological fertilizer, in addition to stabilizing nitrogen of the air and balancing the absorption of macro and micronutrient elements, stimulate growth of the hormones by synthesizing and securing growth promoters such as hormones (Fulchirri and Frioni, 1994). Azimi *et al*. (2013a) found that application of Super nitroplass bio-fertilizer with Phosphate barvar2 treatment has the highest seed yield (7.6 $t.ha^{-1}$) and non-application of bio-fertilizers treatment has the Pishtaz cultivar has the lowest seed yield (6.3 $t.ha^{-1}$). Azimi *et al*. (2013b) was reported that grain yield and biomass yield increasing with the bio fertilizer application, also which account important benefit, causing decreasing in the inputs of production because of economizing much money to chemical fertilizers and increasing in yield and biological yield.

2. OBJECTIVES

Current research was carried out to assessment the effects of biofertilizer on agrophysiological traits of corn crop.

3. EVIDENCE ACQUISITION

Current research was conducted according evaluate results of valid researcher.

4. RESULT AND DISCUSSION

4.1. Seed yield

Yield is a complex trait resulting from interaction of morphological, physiological and environmental parameters on the growth of plants. Identification of the variations of morphological and physiological traits influencing the yield of a plant in a certain environment is an essential tool for selecting and breeding of yield (Azarpour *et al*., 2014). Seed yield is a function of interaction among various yield components

that are affected differentially by the growing conditions and crop management practices (Delkhoshi and Jalilian, 2012). 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 boost plant growth quantitative and qualitative (Ram-Rao *et al*, 2007). Nouraki *et al*. (2016) reported mixing of biological fertilizers with chemical fertilizers could reduce the needs of chemical fertilizers up to 25% and these results are comparable to the application of 100% chemical fertilizers. Therefore, the best hybrid maize is the single cross 704 that has good yield potential when the chemical fertilizer is used at either 25% or 50% of the current application when mixed with the bio-fertilizer. Other studies determined that plant growth was improved even when the nitrogen fertilizer applied was reduced by 30-35% as long as the seeds had been inoculated with growth promoting bacteria. An increase in the biomass of the microbial community was related to the soil health as this had an effect on the balance and availability of nutrients in the rhizosphere of the roots that lead to a higher yield (Biari *et al*., 2008). Tarang *et al*. (2013) reported applications of Nitroxin bio-fertilizer and chemical fertilizer (400 $kg.ha^{-1}$ urea with 300 $kg.ha^{-1}$ ammonium phosphate) had a significant effect on traits of root dry weight, number of seed per row (36.5), number of seeds per ear (458.56), 1000-grain weight, seed (13.23 $t.ha^{-1}$) and biological yield (26.4 $t.ha^{-1}$) , and harvest index (53.88%).

4.2. Biological yield

Bio-fertilizers by increasing nitrogen the efficiency and uptake cause most shoot growth and consequently increasing the biological yield. Other reports have indicated that seed inoculation of corn with plant promoting bacteria in addition to 30 to 35% reduction of nitrogen fertilizer improved plant growth. Increased microbial biomass is directly related to soil health; it enhances the balance of nutrient elements and nutrient availability in root rhizosphers that promotes growth and ultimately affects a higher yield (Biari *et al*. 2008). Nouraki *et al*. (2017) reported that the spraying of biological fertilizers containing amino acids along with nitrogen fertilizers increases the growth and production of dry matter. Application of fertilizer of triple super phosphate 50% with bio-phosphate had a significant effect on increasing total dry weight of corn.

4.3. Harvest index

The physiological ability of a hybrid to convert total dry matter in to grain yield is determined by its harvest index (HI). Increase of harvest index due to the increase of nitrogen fertilizer in maize can physiologically attribute to the increase of leaf area continuity and, nitrogen availability. In fact by creating balance between the nutrients bio-fertilizers increase both vegetative and reproductive growth and by creating adequate destination (seed), the assimilates will mobilize into seeds and ultimately the harvest index of plant seed increase (Araei *et al*., 2014).

4.4. 1000 seed weight

The increase amount of nutrients available by the application of chemical fertilizers and bio-fertilizers has largely lead to increasing the 1000 seed weights (Hassanpour *et al*., 2011). Due to producing plant hormones, bio-fertilizer, 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).

4.5. Number of seeds per ear

Number of seed per ear is an important yield determining factor in maize (Delkhoshi and Jalilian, 2012). 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 *et al*., 2009). Nitrogen enhances assimilates availability for Ear through the 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 growth regulating hormones (Hamidi *et al*., 2009). Alizadeh *et al.* (2008) reported that increasing the number of seeds per ear by using Azospirillum with optimal chemical fertilizers significantly, and said that inoculation corn with Azospirillum in tropical areas can reduced 10 to 20 percent of nitrogen fertilizer. Fallahi *et al.* (2008) founded that Nitroxin bio-fertilizer had significant effects on main yield components, seed yield; essential oil .They concluded that this bio-fertilizer can be considered as a replacement for chemical fertilizers the absorbed nitrogen during this time leads to the increase of the number of spikelet.

4.6. 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). Naserirad *et al.* (2011), report the effect of increasing the number of rows per ear with inoculation the Azotobacter and Azospirillum. Yasseri *et al.* (2008) stated Azotobacter alone cannot make a significant difference in number of row per ear and adding inorganic nitrogen, phosphorus and potassium is necessary.

4.7. Number of seeds per row

Increased levels of nitrogen leads to removing restrictions nitrogen for maize and increase photosynthetic efficiency, 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 number of seed per row. Alizadeh *et al.* (2008) expressed that increasing number of seed per ear using Azospirillum associated with consumption of chemical fertilizers was significantly.

4.8. Ear length

Mohammadi *et al*. (2003) reported a positive effect and strong correlation between ear length and crop production. 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. Khayat-Nezhad *et al*. (2010) reported that 500 seed weight, the seed per row and ear length had the significant correlation with seed yield.

4.9. Plant height

An important reason that can increase the impact of bio-fertilizers components for plant height this is that use of mentioned fertilizers leading to increased internodes length and it can stimulate the production of plant hormones produced by these fertilizers (Hassanpour *et al*., 2011). Potals (2017) reported that the maximum plant height was produced in rice plant with the use of biological fertilizers with consumption of 180 $kg.ha^{-1}$ nitrogen. Eydizadeh *et al*. (2010) also described the effect of the combined application of biological fertilizers with the chemical fertilizers in maize crop, and reported which increased the plant height in terms of their combined application compared to the individual application of each fertilizer, which was consistent with the results of this experiment. Probably the main reason of that matter due to increasing the absorption of food by the plant in the combined application. Zahir *et al*. (1998) also reported an increase in the corn heights traits affected by inoculation with the phosphorus-soluble bacteria, such as Pseudomonas.

4.10. Seed protein content

Increase protein percentage with using bio-fertilizers is due to the effect of bacterial inoculation that increased the effective regulation of the growth, physiological and metabolic activity of the plant (Eidy Zadeh *et al*., 2012).

4.11. Chlorophyll content (SPAD)

Amanolahi-Baharvand *et al*. (2014) reported integrated fertilizer (50% urea and 50% vermicompost) management improved corn growth, chlorophyll content and remobilization in corn plants. Soleimanzadeh and Ghooshchi (2013) reported bio-fertilizer had significantly effects on leaf chlorophyll, because inoculation with mycorrhiza increased the leaf chlorophyll (2.66 $mg.g^{-1}$ FW).

5. CONCLUSION

Nitroxin fertilizer had a significant effect on all the measured traits. It seems consume according result of valid researchers consumption 150 kg Nitrogen ha^{-1} with 1 $L.ha^{-1}$ Nitroxin led to achieve maximum corn seed yield and it can be advice to producers.

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FOOTNOTES

CONFLICT OF INTEREST: Author declared no conflict of interest.

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