# THE EFFECT OF *Azotobacter chroococcum* (A22 ISOLATE) ON IMPROVING THE GROWTH AND NUTRIENTS ABSORPTION OF MAIZE PLANTS TREATED WITH DIFFERENT LEVELS OF NITROGEN AND GROWN UNDER DIFFERENT SALT LEVELS

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**ABSTRACT**

**The pots experiment was carried out in the canopy wired, College of Agriculture, University of Basrah, during 2018 season, to determine the effect of *Azotobacter chroococcum* (A22 isolate) to improving the growth of maize grown in salt-affected soils, the experiment included four levels of nitrogen 0, 50, 75 and 100% of the nitrogenous fertilizer recommendation of 150 kg N.ha$^{-1}$, with three levels of Salinity 3, 6 and 12 ds.m$^{-1}$ and two inoculates with (A22 isolate), un-inoculate to estimate the growth and the absorbed amount of N, P and K. The results showed that A22 isolation inoculate increased a dry weight by 22.25% and the absorbed amount of N, P and K by 37.04, 89.4 and 27.6% respectively, compared with control un inoculates, inoculation with this isolate A22 reduced the nitrogen fertilizer recommendation by 25% and improved the growth of maize under salt stress conditions.**

**Keywords:** *Azotobacter chroococcum* bacteria; A22 isolate; maize; nitrogen; salt.

## INTRODUCTION

Soil salinity is defined as the accumulation of salts in the soil and at levels toxic to the plant, the main factors contributing to the salting process, the quality of irrigation water used in agriculture [1,2]. Soil salinity affects plant growth and production in two ways, directly through the accumulation of salts in the root zone, causes an imbalance of nutrients and low plant water absorption and indirectly, by influencing the soil properties and microbial activity [3,4]. There were many strategies used globally to reclaim salinity-affected soils, including physical and biochemical, the biological method is an environmentally friendly method, uses the Plant Growth Promoting Rhizobacteria (PGPR), contains a large group of bacteria useful for the plant, including nitrogen-fixing azotobacter bacteria that fixed 20 kg N. $ha^{-1}$ per year [5,6].

Azotobacter bacteria were encouraged plant growth by several mechanisms, including: Production of hormones such as indole acetic acid (IAA), cytokinins, gibberelins and abscis acid. Production of siderophores (materials produced by bacteria of low molecular weights) that enable the plant to absorb iron ion mineralization of nutrients dissolve phosphorous. Fixed of atmospheric nitrogen and production of hydrogen cyanide [7].

Chaudhary et al. [3] found that inoculation of wheat plants, with azotobacter bacteria strain (ST24) isolated from saline soils, using three levels of nitrogen fertilizer 0, 90 and 120 kg.$Nha^{-1}$, led to an increase in plant height, green dry weight, grain production and nitrogen percent compared to the control without inoculated.

Abd El-Gawad [8] indicated that inoculation of the maize plant with azotobacter bacteria, increased the grain content of N, P and K elements, compared to the control without inoculated.

The research aim to use azotobacter bacteria to improve the growth of maize plant under saline stress conditions and absorption of nitrogen, phosphorous and potassium elements.

## MATERIALS AND METHODS

Soil was taken from Abi Al-Khaseeb district was salted from the electrical conductivity 8.66 to 12 ds.$m^{-1}$, by washing with a balanced mixture of $MgSO_4.7H_2O$, NaCl, $CaSO_4.2H_2O$ and $CaCl_2.H_2O$ reach a state of equilibrium between the added saline solution and the filter water, levels 3 and 6 ds.$m^{-1}$ were obtained, by washing the soil with desalination water RO until reaching the required level, the soil was dried and passed through a sieve 4 mm in diameter, the chemical, physical and biological properties are estimated as Table 1.

### The Pots Experiment

The pots experiment was carried out in the canopy wired, College of Agriculture, University of Basrah, at 3/4/2018 pots were filled with 5 kg of soil salinized to 3, 6 and 12 ds.$m^{-1}$. The soils were treated in with four levels of nitrogen fertilizer 0, 50, 75 and 100%, from the nitrogen fertilizer recommendation for the maize, 150 kg N. $ha^{-1}$, as urea fertilizer form before planting, 30 days after planting add super concentrated phosphate fertilizer, at the level of 90 kg. P $ha^{-1}$, potassium sulfate fertilizer, at a level of 120 kg.K $ha^{-1}$ and mixed thoroughly with the surface layer of the potted soil, maize seed was inoculated, soaking with container azotobacter inoculate $0.5 \times 10^{-8}$ cells.$ml^{-1}$ (cfu) for one hour, with the addition of gum Arabic to increase adhesion, some seeds were left without inoculation as control, the inoculated and un inoculated seeds were planted with 8 seeds.$pot^{-1}$, the Ro water was added untill field capacity, the lost moisture is replaced by weight, after the germination, the plants decreased to 3 plants.$pot^{-1}$. After two months of growth, the green part were cutting at the soil surface level, after

**Table 1. Physical, chemical and biological properties of the soil**

| Characteristic | Value | Unit |
|---|---|---|
| pH | 7.37 | - |
| E.C. | 8.66 | ds. $m^{-1}$ |
| CEC | 16.03 | Cml $^{+}$.kg-1 |
| $Ca^{++}$ | 19.04 | mmol. $L^{-1}$ |
| $Mg^{++}$ | 9.00 | mmol. $L^{-1}$ |
| $K^{+}$ | 180 | mmol. $L^{-1}$ |
| Total count bacteria | $1.1\times10^{-6}$ | CFU.$gm^{-1}$ soil |
| Total count fungi | $1.8\times10^{-4}$ | CFU.$gm^{-1}$ soil |
| Total count Azotobacter | $3.8\times10^{-5}$ | CFU.$gm^{-1}$ soil |
| Sand | 166.7 | |
| Silt | 500.0 | gm.$kg^{-1}$ |
| Clay | 333.3 | |
| Texture | Silty clay loam | |

cleaning from the soil, the plants were dried at 65°C, take dry weight, the plants were crushed, digested with the acid mixture: 96% concentrated sulfuric acid and 4% concentrated perchloric acid, according to [9], in a digestible solution, nitrogen by Kaldal system, phosphorus by spectrophotometer potassium with a flame photometer were estimated according to [10].

## RESULTS AND DISCUSSION

Inoculation by A22 isolate bacteria led to a significant increase in the dry weight of maize grown at all levels of saline (3, 6 and 12 $ds.m^{-1}$), compare to without inoculation treatments at the same saline levels (Table 2). The inoculation with isolation A22, increased in the dry weight of the maize grown in all three saline levels, when adding nitrogen level 75%, compared to all inoculation and un inoculation treatment at 100% of the three nitrogen fertilizers, at the three saline levels, indicates that inoculation with azotobacter bacteria reduced the nitrogen fertilizer recommendation by 25% and improve the growth of maize grown under conditions of salt stress.

Inoculation with azotobacter bacteria (isolation A22), led to increase the amount of nitrogen absorbed by the dry weight of the plant 206.92, 155.76 and 67.38 $mgN.pot^{-1}$, at salt levels 3, 6, and 12 $ds.m^{-1}$, compared to the without inoculation 172.15, 120.61 and 44.55 mg. $N.pot^{-1}$, for different salt levels (Table 3). This due to The efficiency of azotobacter bacteria in improving plant growth and nitrogen absorption for growing plants under conditions of saline stress [8], inoculation treatment with azotobacter A22 isolates, outperformed the amount of nitrogen absorbed, compared to inoculated and un inoculation at level 100% of fertilizer recommendation at all levels of salinity. Inoculation reduced the nitrogen fertilizer recommendation by 25% improve plant growth against conditions of salt stress, which helps reduce the cost of production and environmental pollution, result of adding high levels of nitrogen fertilizer. Due to the ability of the bacterium azotobacter to produce the amino acid proline, which various vital functions, collects in a number of bacteria or plant cells that live in saline conditions as a protective agent against osmotic stress [11].

The inoculation with azotobacter isolate A22, increased the absorbed amount of phosphorus 29.82, 23.52 and 14.68 $mg.P.pot^{-1}$, at the salinity levels 3, 6 and 12 $ds.m^{-1}$, respectively, compared to the un inoculation (treatment), which gave 15.58, 12.51 and 7.84 $mg.P.pot^{-1}$ at the same levels of saline (Table 4). This indicates that inoculation with azotobacter bacteria improved phosphorus uptake by maize under conditions of saline stress, due to the fact, when plants were exposed to conditions of salt stress, produces the ethylene from ACC, causes delaying root growth and plant aging, azotobacter bacteria produces the ACC de aminase enzyme, breaks the ACC compound, reduces the level of ethylene, plants help to resist salt stress and absorb phosphorous [12].

Inoculation with isolate (A22), increased the absorption of potassium by maize, by 156.61, 87.79 and 52.61, at the saline levels of the soil 3, 6 and 12 $ds.m^{-1}$, respectively (Table 5), indicates the ability of azotobacter bacteria to improve plant growth in saline soils, it was also noted that the treatment of inoculation with azotobacter bacteria

**Table 2. Effect of inoculation with azotobacter isolate A22 and different levels of nitrogen in dry weight ($g.Pot^{-1}$) of maize grown under different salt levels**

| Salinity levels | Bacterial inoculation | Nitrogen fertilization levels | | | | Average |
|---|---|---|---|---|---|---|
| | | $N_0$ | $N_1$ | $N_2$ | $N_3$ | |
| $S_1$ | A0 | 25.14 | 29.88 | 35.87 | 37.90 | 32.2 |
| | A22 | 32.22 | 34.16 | 43.00 | 40.10 | 4.73 |
| $S_2$ | A0 | 22.15 | 23.77 | 33.02 | 35.70 | 7.7. |
| | A22 | 28.98 | 30.51 | 41.13 | 39.33 | 4.73 |
| $S_3$ | A0 | 16.51 | 18.48 | 22.63 | 29.67 | 7.7. |
| | A22 | 20.03 | 24.36 | 36.03 | 34.40 | 28.7 |
| $RLSD_{0.01}$ | | | | 0.81 | | |

**Table 3. Effect of inoculation with azotobacter isolate A22 and different levels of nitrogen in the amount of nitrogen absorbed (mg.Pot$^{-1}$) of maize grown under different salt levels**

| Salinity levels | Bacterial inoculation | Nitrogen fertilization levels | | | | Average |
|---|---|---|---|---|---|---|
| | | $N_0$ | $N_1$ | $N_2$ | $N_3$ | |
| $S_1$ | A0 | 126.36 | 156.60 | 195.16 | 210.48 | 172.15 |
| | A22 | 168.00 | 185.16 | 249.40 | 225.11 | 206.92 |
| $S_2$ | A0 | 78.99 | 91.46 | 147.73 | 164.25 | 120.61 |
| | A22 | 115.15 | 122.45 | 197.72 | 187.73 | 155.76 |
| $S_3$ | A0 | 29.83 | 36.33 | 46.56 | 65.47 | 44.55 |
| | A22 | 40.58 | 51.93 | 94.88 | 82.13 | 67.38 |
| $RLSD_{0.01}$ | | | | 2.91 | | |

**Table 4. Effect of inoculation with azotobacter isolate A22 and different levels of nitrogen in the amount of phosphorus absorbed (mg.Pot$^{-1}$) of maize grown under different salt levels**

| Salinity levels | Bacterial inoculation | Nitrogen fertilization levels | | | | Average |
|---|---|---|---|---|---|---|
| | | $N_0$ | $N_1$ | $N_2$ | $N_3$ | |
| $S_1$ | A0 | .37.7 | .4733 | ..731 | 7377. | ..7.. |
| | A22 | 77774 | 7.733 | 4.7.3 | 4174. | 737.7 |
| $S_2$ | A0 | .771 | 3711 | .37.3 | ..74. | .77.. |
| | A22 | ..7.. | .37.7 | 7.773 | 7.7.. | 747.7 |
| $S_3$ | A0 | .7.. | 1734 | .743 | ..7.1 | .7.3 |
| | A22 | 373. | ..7.. | ..73. | ..7.. | .371. |
| $RLSD_{0.01}$ | | | | 0.96 | | |

**Table 5. Effect of inoculation with azotobacter isolate A22 and different levels of nitrogen in the amount of potassium absorbed (mg.Pot$^{-1}$) of maize grown under different salt levels**

| Salinity levels | Bacterial inoculation | Nitrogen fertilization levels | | | | Average |
|---|---|---|---|---|---|---|
| | | $N_0$ | $N_1$ | $N_2$ | $N_3$ | |
| $S_1$ | A0 | 3.733 | .337.. | .44734 | .3473. | ..374. |
| | A22 | .73744 | .3.7.3 | ..7717 | ..77.3 | ..171. |
| $S_2$ | A0 | 33731 | 33713 | .373. | .47.. | 147.. |
| | A22 | 137.3 | .377. | .3773. | .3.7.3 | ..7.3 |
| $S_3$ | A0 | 74734 | 7.733 | 4.73. | .374. | 437.. |
| | A22 | 447.. | 347.. | 117.. | 11743 | .771. |
| $RLSD_{0.01}$ | | | | 2.52 | | |

at the nitrogenous level 75% of fertilizer recommendation 182.62 and 66.78 mg K increased then, the amount of potassium absorbed at the nitrogenous level 100% 172.7.7 and 66.30 mg K, at salt levels 3 and 12 ds.m$^{-1}$ indicates that inoculation with isolate A22 reduced the N-fertilization recommendation by 75%.

## CONCLUSIONS

We concluded that using Azotobacter bactetia (isolate A 22) lead to improve the growth of maize may plants under the saline condition, and reduced the nitrogen fertilizer recommendation by 25%.

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