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Research Paper

Study of Microorganism on Adjustment of Cation and Anion Level in the Wheat

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Abstract

Soil and water salinity are important factors in reducing the growth and yield of many agricultural crops. Wheat is one of the crops which belonged to the Poaceae (Gramineae) family and has been played an important role in human nutrition for thousands of years ago. If we control the growth of this plant under application of biological factors and superabsorbent, in addition to increasing the yield of this crop, we can maintain its quality and sustainable development. This manner is possible by the application of biofertilizers such as phosphate solubilizing bacteria. In terms of production and the area under cultivation, wheat is the most important agricultural product of Iran and has been increasingly attracting more attention. This plant is also economically valuable due to the supplies of the main food of people. The purpose of this study was to investigate the impact of salinity and the content of sodium in the aerial organ of wheat. An experiment was conducted to determine the effects of phosphate solubilizing bacteria, superabsorbent, and the different levels of salinity on the sodium content in the aerial organs and yield of the wheat plant in the 2012 growing season. This study was carried out as a factorial experiment based on a completely randomized design with 12 treatments in three replications. The studied treatments were such as 1) control, 2) phosphate solubilizing bacteria, 3) phosphate solubilizing bacteria + 0.5 kg of superabsorbent, and 4) phosphate solubilizing bacteria + 0.25 kg of superabsorbent under the three salinity levels of 1, 6, and 12 $dS.m^{-1}$ in greenhouse conditions. The used bacteria in this study were the bio-phosphate and superabsorbent bacteria of A200 types. The results showed that salinity stress had significant effects on assessed indices. Also, the results indicated that the sodium content had increased by increasing the salinity levels in pots. On the other hands, the mentioned index was decreased compared with the control treatment by the application of phosphate solubilizing bacteria and superabsorbent treatments.

Keywords: Phosphate Solubilizing Bacteria; Salinity Stress; Sodium; Superabsorbent of A200; Sustainable Development; Wheat

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1. Introduction

Similar to other agricultural products, increasing the wheat yield depends on the various factors which are related to both of increases the amount of product yield per unit area and increases the area under cultivation. Increasing the product yield in agriculture depends on specific factors which are the most important of them such as the selection and cultivation of high yielding seeds. Although the experts of agricultural sciences have stated that the presence of organic matter and soil organisms are as the main factors in the soil fertility, unfortunately, the basic issue has been forgotten, and the majority of farmers have been focused on chemical fertilizers for enhancing the profit of the products. Accordingly, farmers decide to irregular usage of chemical fertilizers. Nowadays, irregular and incorrect uses of chemical fertilizers have caused many problems in the economic and

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environmental fields. Some of these problems are related to the excessive annual costs of purchasing fertilizers, the presence of heavy elements such as cadmium and lead in these fertilizers, and the pollution of surface waters and underground waters due to the entrance of chemical fertilizers into the soil, etc. Application of biofertilizers, especially phosphate solubilizing bacteria and the use of superabsorbents are the most important nutritional strategies for sustainable management of agricultural systems instead of the application of chemical fertilizers. These fertilizers are environment-friendly compounds which reduce the environmental pollution caused by chemical fertilizers. Accordingly, in order to improve the solubility of low-soluble mineral phosphates, it seems necessary the application of biofertilizers, their management in the rhizosphere, and the optimal use of phosphate solubilizing bacteria which can develop mechanisms such as the production and secretion of organic acids, especially 2-keto-gluconic, citric, oxalic, malic, succinic, etc. Also, many of these compounds are capable of releasing and solubilizing the phosphorus element from organic phosphorus compounds by the production of phosphatase enzymes. Accordingly, it is natural that these microorganisms have completely different effects in terms of their types and amount of their production substances.

Several studies have been performed on the application of microorganisms as a biological fertilizer on cereals so that each of them has reported positive and significant effects of Azotobacter on growth and yield of wheat (Ram, 1985; Rai and Gaur, 1988; Ridge, 1969). The positive effects of this bacterium on corn have also been reported by Meshram and Shende (1982) and Martinez-Toledo (1988). In addition, the effect of azospirillum, as well as the combined effects of this bacterium and azotobacter on wheat, maize and sorghum, has been reported by Rai and Gaur (1988), and other researchers. Similar reports have been performed on the effects of other beneficial microorganisms on the types of cereals. In the middle east, numerous researches have also been carried out in these areas that can be considered as positive and significant effects of *Azotobacter chroococcum* on the growth of wheat by Khosravi (1997), *Azospirilum* on the growth of wheat and corn by Rosta (1996), and silicate bacteria toward the potassium adsorption on corn by Fallah-Nasrabad (1998).

Recently, new modifying materials have been introduced in the world, called superabsorbent polymers, which have been widely used. These polymers have a lot of speed and capacity for absorbing and storing water, act as a "Miniature Reservoir", and easily distribute the water in the root area of plants when plants need to it. It should be noted that the amount of stored water by these compounds in the soil depends on its moisture storage capacity. Superabsorbent polymers can increase the water holding capacity in light soils and can solve the problems of permeability in heavy soils. Since the superabsorbents have a capability of fast absorption of water equivalent to dozens of times their weight, they can convert to a swelled gel with good strength. Accordingly, these compounds have specific importance in agriculture, horticulture, forestry, open/green spaces, and soil erosion control. It has also been reported that superabsorbents were able to retain the absorbed water under high pressure so that they provide enough water for the plants while their roots need to water (Kabiri, 2005).

2. Material and Methods

The present study was carried out in the research greenhouses of the Soil Science Laboratory of Khakazma Pars, located in Shiraz, in early November 2012. Transgenic wheat seeds of Chamran cultivar were provided to perform the greenhouse experiment and after determining the seed vigor (with the ability of 80%) were cultured in pots. The soil for planting medium was collected from farms around Sadra town, located 5 km from Shiraz. In the next step, the collected soil was air-dried. Subsequently, the collected soils were passed through a 2 mm mesh and poured into each pot equal to 2 kg. After applying the treatments to the potting soil and transferring the soil moisture to the field capacity (FC), 20 healthy seeds were cultured in each pot. After ensuring the confirmation and germination of all seeds, 15 healthy and powerful seedlings were kept inside each pot and the remaining seedlings were removed. In this study, the content of sodium in the aerial organs of the seedling was measured. A Horticultural scissor was used for harvesting the aerial organs so that the wheat plants were cut from the crown part. The samples were placed in a pan filled with water to separate the soil of them. After completely separating the soil from the studied samples, they were washed with distilled water. The plants were placed in an oven for 72 hours at 65 °C. The samples were then completely powdered and passed through a 0.5-mm mesh. The samples were placed in plastic pockets and numbered. Measurable traits were estimated using routine methods recommended by the Soil and Water Research Institute.

3. Results and Discussion

Based on the results of the analysis of variance, salinity had a significant effect on the sodium content of aerial organs of wheat (at $p<0.01$) so that the sodium content increased in the aerial parts of

wheat into each pot through increasing salinity levels. On the other hand, the results showed that the application of phosphate solubilizing bacteria and superabsorbent reduced sodium content compared to control treatment at all salinity levels. From the results of this study, it can be concluded that seed inoculation with phosphate solubilizing bacteria and superabsorbent polymers reduce the sodium content in aerial organs of the wheat plant and reduce the negative effects of sodium presence. The presence of some special ions in a soil solution such as chlorine, sodium, or boron, either singly or in combination with each other, can directly create poisoning in plants and disrupting in plant absorption mechanisms. If both the soil is salty and the relative abundance of these ions is high, the plant will suffer from ion poisoning, in addition to saltiness caused by salinity. This effect was known as the "Special Effect of Ionic". Brenstiein (1975) explained that when leaves of woody plants had contained more than 5% of chlorine or sodium based on dry weight, usually were occurred the burns of the leaf tip and the leaf margin, which were common symptoms of the ionic special effect, or were shaped necrotic spots. The presence of high amounts of sodium, chlorine, and the same ions leads to a disorder in the balance of nutrients in the soil solution. Also, it has been stated that current conditions lead to a disturbance in absorption and transfer of other essential nutrients such as magnesium, potassium, and calcium from the soil to plant. The main reason for inhibiting plant growth due to the consumption of salt is the competitive problems of the sodium presence against the absorption of other minerals. Low concentration of sodium ion increases the uptake of potassium, but high concentrations of sodium ion decrease potassium adsorption (Homaei, 2002). One of the strategies to reduce the negative effects of salinity stress, which was considered by some researchers, was the inoculation of crop seeds with different types of beneficial soil fauna bacteria and fungi.

Sadat *et al*. (2009) reported that salinity decreases root growth in plants through increasing ethylene produce in host plants. On the other hand, the above researchers stated that seed inoculation with plant growth-promoting bacteria reduces the content of ethylene hormone by the production of ACC deaminase enzyme and the analysis of ethylene production precursor. Therefore, seed inoculation with plant growth-promoting bacteria through the mentioned reactions increases the growth and yield of plants under salt stress conditions. In above research, it was also shown that the application of plant growth-promoting bacteria was increased the availability of the content of microelements in salinity conditions by the production of siderophores and chelating materials. Superabsorbent polymers are synthetic hydrophilic polymer gels that can absorb large quantities of salt water or organic solvents, and keep them under high pressure. One of the obvious properties of these compounds is the insoluble ability of them. In fact, this index is the characteristic of all the colloids. More than one million tons of superabsorbent polymers are produced annually in the world. The action mechanism of superabsorbents is based on the fact that these compounds gradually evacuate their internal water after the water absorption process and drying the environment. Accordingly, the soil remains wet for a long time without the demand for re-irrigation. The volume of water absorption by these polymers is depending on their formulation, salinity, and water and soil characteristics from very low values of about 20 times of their weight to more than 2000 times of their weight (Allahdadi *et al*., 2005).

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