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THE INFLUENCE OF SALIN STRESS ON THE SOIL CHEMICAL COMPOSITION AND THE PRODUCTION OF PLANTS TO SOME BEAN GENOTYPES FROM NORTH-EASTERN ROMANIA

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Abstract: *Among environmental stressors, salinity remains the main factor, which questions the future of agriculture. At the same time, the resistance to this factor is determined by the morpho-anatomic and physiological properties of the plants, which ensure their tolerance to the high salt concentration.Considering that beans are a salt-sensitive species, this study has analyzed the effect of excess NaCl on soil chemical composition and plant production to 7 bean populations collected from saline soils in North-East Romania.The experiment was conducted under green conditions at the USAMV Iaşi Fitotronduring in period 2017-2018, the plants being exposed to saline stress for 30 days with concentrations of 100 mM and 200 mM NaCl.The experience was bifactorial, organized as randomized blocks with three rehearsals. The overall objective of the study is to identify local populations of beans tolerant to this stress factor. In this regard, after 30 days of treatment, the results showed a significant effect of salinity on the studied genotypes. Changing neutral alkaline pH and high EC values compared to the control group when applied to the two treatments reduced cell membrane permeability by inhibiting water absorption in some of the local populations studied. The results obtained show that the Blăgeşti 2 and Blăgeşti 4 genotypes recorded the highest productions to all experimental variants, which confirms the resistance of these populations to saline stress.The lowest values were recorded at the local population of Moșna, with the specification that the variant treated with 200mM NaCl did not fructify at all. The data was analyzed by calculating the correlation coefficient with Microsoft Excel.*

Key words: *pH, EC, productivity, beans*

INTRODUCTION

Soil salinity levels vary widely from one environment to another. Therefore, their classification may also be site-specific. Compared to nonsaline soils (<2 dS/m), strongly saline soils have conductivity values of 8–16 dS/m. In very strongly saline soils, conductivity values may exceed 16 dS/m. As electrical resistance increases from the surface to a depth of 2–4 feet (60–120 cm), conductivity values increase correspondingly (mostly double). If a soil has high quantities of Na^+ and the EC is low, soil permeability, hydraulic conductivity, and the infiltration rate are decreased due to swelling and dispersion of clays and slaking of aggregates (SHAINBERG, 1990).

The presence of salt reduces plant growth as a result of its adverse effects on plant morphology and physiology. Toxic effects of Na^+ and Cl^- on plant morphological traits such as root system size; toxic effects of Na^+ and Cl^- on plant physiology including the activity of enzymes, the function of cell membranes, and the production of plant hormones (MUNNS AND JAMES, 2003) and increased oxidative stress caused by high Na^+ and $Cl^−$ levels.

Plants use different mechanisms to alleviate the stress of salinity, with the most important one considered to be the adjustment of osmotic potential through the production of solutes in plant cells. Plants can accomplish this osmotic adjustment by the exclusion of Na^+ and $Cl^−$ from plant leaves, and/or by increasing the concentration of Na^+ and $Cl^−$ in plant cells to balance the soil salt concentration. Na^+ and $Cl^−$ ions must be allocated to vacuoles to keep the concentration of Na^+ and $Cl^−$ less than toxic levels; the increased concentration of potassium (K^+) and organic solutes follows to regulate the cellular ionic concentration (MUNNS AND TESTER, 2008).

If a soil has high quantities of Na^+ and the EC is low, soil permeability is decreased due to swelling and dispersion of clays (SHAINBERG, 1990). A saline soil is one that has an EC of 4 dS/m (40M NaCl). The crop yield is reduced to this value (MUNNS, 2005). saline-alkaline soils have one pH (6.8-8.7) and EC of 2-14 dS m^{-1} (BELTRAN-HERNANDEZ ET AL, 1999). Bean is considered as a sensitive crop to saline conditions than 2 dS m^{-1}.

MATERIAL AND METHODS

The biological material was represented by seven bean genotypes, collected from saline soils in the Moldavian region, in period 2017- 2018 and exposed to salt stress over a 30-day period. They were constantly wetted with saline at a concentration of 100 mM and 200 mM NaCl. The bifactorial experience was performed in a randomized three-repeat block experiment. The pH of the soil was determined using the pH Meter apparatus and electroconductivity soil with the appliance EC Meter. The harvesting of the beans was made at full maturity when they reached the specific dimensions, being soft and flexible, and the grains in the upper pastes were strong enough. To assess the correlation between two sizes, we introduced the Bravais-Pearson linear correlation coefficient. In practical applications, we are interested not only in the presence and the meaning of the correlation, but also in the extent to which it manifests it self; this degree is appreciated by various statistical calculations.

RESULTS AND DISCUSSIONS

- **Influence of saline stress on soil pH**

Saline conditions are caused by high concentrations of the following ions: sodium, calcium, magnesium, chloride, and sulfate (occasionally bicarbonate and nitrate) in different combinations. The injury that occurs to crops from saline soil is of three types: high osmotic pressure affecting water intake by the plants, disturbed metabolism, especially of nitrogen, due to the high ion concentration of certain minerals, and the indirect effect of some of the ions, especially sodium, on soil structure. Knowledge of soil reaction (pH) is of particular importance for pedological studies and soil characterization. Value of pH, determined in aqueous soil suspension, is an easy to obtain analytical index to characterize soil reaction-the acid-base properties of the soil-water system. Thermodynamically, soil pH is the soil acidity intensity factor, corresponding to the "actual acidity".

Soil pH ranges between 7.5-8.4, both due to the flocculant effect exerted by the salts present on the colloidal fraction in the soil diminishing the hydrolysis of the exchangeable sodium and the saline effect of the predominantly accumulated neutral salts at these intensities salinisation (NaCl) (STOICA ET AL., 1986). Excess water in the soil, which leads to the reduction of the redox potential in the soil solution, affects the pH of the soil causing it to change to approx. 7.0 by lowering the pH of alkaline soils and increasing the pH of acidic soils. The soils under anaerobic conditions may have a pH of about 7.0. Both acidic and alkaline soils have unfavorable physical properties: degraded structure, reduced porosity, very low permeability, so an aerobic regime. As a rule, the soil pH is seasonally variable and is lower in dry and higher temperatures when the salt content of the soil solution increases, especially nitrates and sulphates (saline effect) (LUNGU AND RIZEA, 2017). Changing pH, especially in alkaline, reduces the permeability of cell membranes, inhibiting water absorption.

After 15 days of application of saline treatments, based on soil analyzes, the pH recorded superior values to the control group, which varied between 7.88-8.04. Following saline treatments, in the 100 mM treated version, the values increased, oscillating between 7.97 and 8.34. With the application of 200 mM saline solutions, the values were constant at the seven genotypes; the pH was maintained in the range 8.17- 8.28 (figure 1). These results demonstrate that pH values have changed due to the application of saline solutions, with a low alkaline pH, which allows optimum growth of plants, according to the data presented in the literature (LUNGU AND RIZEA, 2017).

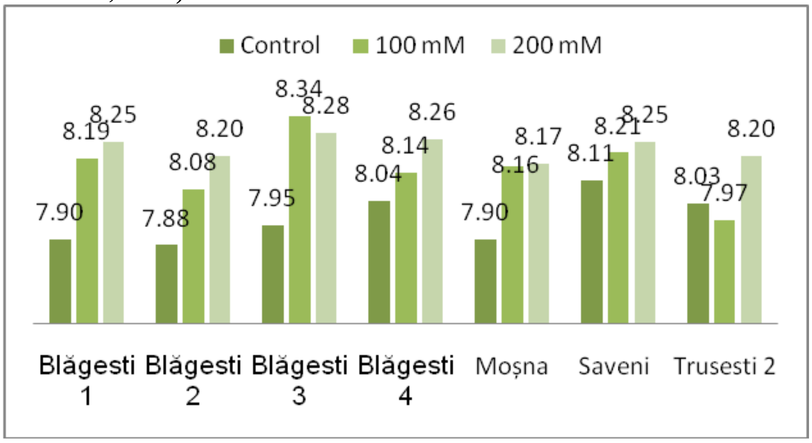

Figure 1. Influence of saline stress on soil pH 15 days after saline treatment

After 30 days of applying saline treatments, the pH recorded high values against the control group, oscillating between 8.02-8.19. With saline treatments, to the 100 mM treated version, pH values increased, ranging from 8.11 to 8.28. At the same time, a high growth was also seen in the variant treated with 200 mM; these values oscillated between 8.42 and 8.77 (figure 2). After this period, a moderately alkaline pH has been observed in the experience, affecting plants, hindering the accessibility of certain chemical elements in the soil (iron); at the same time, ferrous chlorosis, particularly serious for plants.

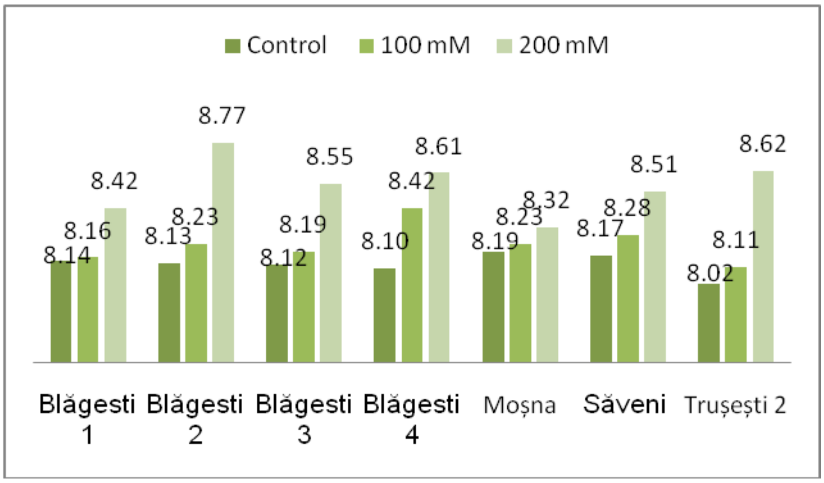

Figure 2. Influence of saline stress on soil pH after 30 days after saline treatment

- **Effect of saline stress on the EC of the soil**

Soil electrical conductivity (EC) affect crop productivity. This indicator is expressed mS/m (ANDERSON-COOK ET. AL., 2002).

While pH is a good indicator of the balance of nutrients available in soil, electrical conductivity can almost be seen as the amount of nutrients available in the soil. In the soil, the electrical conductivity reading (EC) indicates the level of capacity that soil water has to transport into an electric current. EC soil water levels are a good indication of the amount of nutrients the plant absorbs (https://www.hecta.ro/). The EC is directly related to the ionic strength of the soil solution and the ionic strength depends on the concentration (and charge) of electrolytes. So EC is a measure of salt concentration. The units of EC are decisiemens per m (dS /m). It is measured in laboratory using a soil water extract. A non-saline soil is one that has an EC between 0-2 dS / m^{-1}, in which case the salinity effects are negligible; a mild salt is one that has an EC of 2-4 dS/m^{-1}, and yields of susceptible crops can be restricted. At a moderate salinity of 4-8 dS/m^{-1}, the yield of many crops is restricted; a saline soil has an electrical conductivity, which is between 8-16 dS/m^{-1}, and in this case only tolerant crops produce satisfactory. In the case of bean culture, at an EC of 1.0 dS/m, salinity produces an initial decline in production.

After 15 days of application of saline treatments, after analyzes performed on the ground, the EC recorded superior values to the control group in both variants. Thus, these values oscillated between 1.96-3.32 dS/m^{-1}, which shows a mild saline soil. Following saline treatments the values increased, oscillating between 3.82 and 5.04 dS/m^{-1} to the variant treated with 100 mM, indicating that the soil has a moderate salinity. With the application of 200 mM saline solutions, the EC values have changed even more; in this case the values oscillated between 5.34-6.33 dS/m^{-1}, which allows us to conclude that the yields of these populations could be restricted by the treatments applied (figure 3).

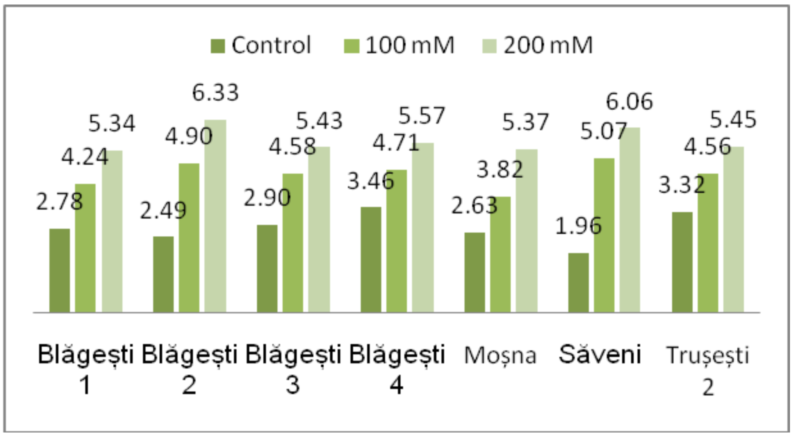

Figure 3. Influence of saline stress on soil EC 15 days after saline treatment

After 30 days after application of saline treatments, the EC recorded higher values compared to the control group in both variants. For the control variant the EC values oscillated between 3.31-3.84 dS/m^{-1}, chlorine in the soil does not affect the yield of these soils. To the 100 mM treated bay, after application of saline the values increased, ranging between 4.28 and 8.74 dS/m^{-1}, indicating that the soil has a moderate salinity. To the 200 mM version, the values are much higher, ranging from 4.87 to 15.82 dS/m^{-1}, indicates just that only tolerant crops yield satisfactorily, in this case the populations (Blăgeşti 2 andr Truşeşti 2) (figure 4).

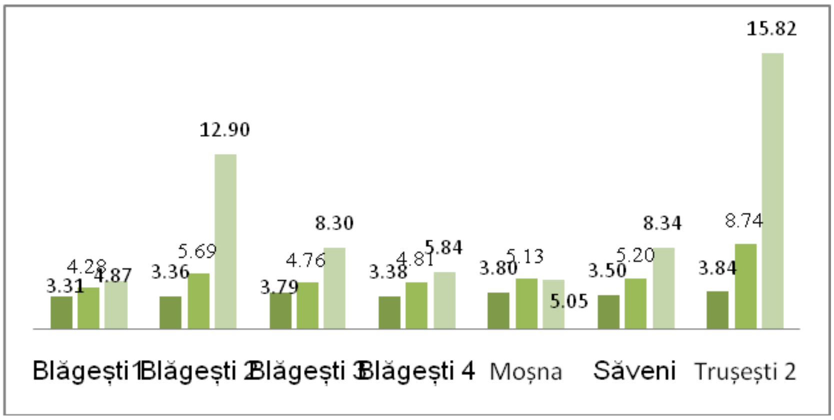

Figure 4. Influence of saline stress on soil EC 30 days after treatment

- **Influence of saline stress on production / plant**

It is necessary to know the way in which salinity affects plant production, because in this way new crop techniques can be applied that can alleviate the negative effects of saline excess and at the same time it can lead to the identification of genotypes resistant to saline stress (CUARTERO AND MUNOZ, 1998; COVAȘĂ, 2016). Regarding the average production per plant compared to the control variant, after 30 days of saline stress, it is observed that it decreases with the application of saline treatments to all seven genotypes studied. Thus, the highest production was recorded in the Blăgeşti 4 genotype, both at the control variant (152 grains) and in the case of the variant treated with saline, respectively 100 mM and 200 mM (134 and 96 grains), followed by Blăgesti 2 genotype, which had a production of 110 grains at the control variant, 59 grains at 100 mM and 32 grains at 200 mM. The smallest production was recorded at the Moșna genotype, to all experimental variants (figure 5). The results obtained in the analyzed experiment are consistent with the literature. Thus, we can conclude that high salt concentrations have negatively influenced bean production (GIANNAKOULA ET ILIAS, 2013).

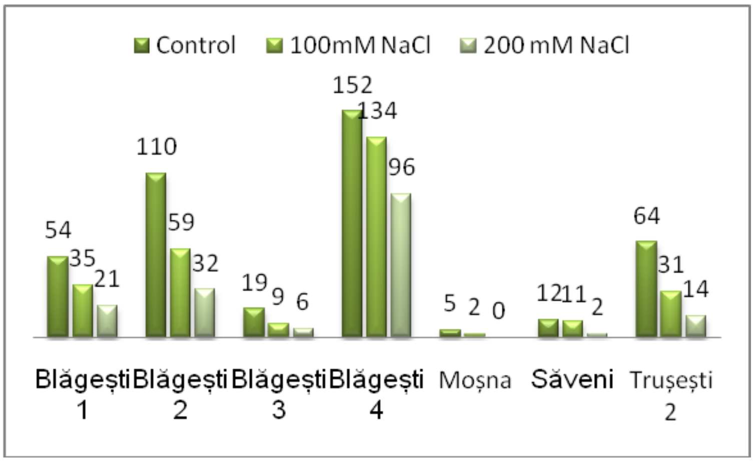

Figure 5. Effect of saline stress on plant production after 30 days of treatment

- ❖ **Determination of correlation coefficient between pH, soil EC and plant productivity**

In nature, phenomena are in close contact with the environment. That is why in practical applications we are interested in not only the presence and the meaning of the correlation, but also the extent to which it manifests it self; this grade is appreciated by statistical calculations. In this respect, the linear correlation coefficient Bravais-Pearson was introduced to assess the correlation between two sizes.

The correlation between soil pH and plant productivity, as well as soil pH and productivity, after 30 days of exposure to saline stress, is very good (Figure 6), according to the rules established by Colton (1974), and the statistical interpretation suggests that there is a positive correlation between soil pH and productivity, as well as soil EC and plant productivity under saline stress conditions (figure 7).

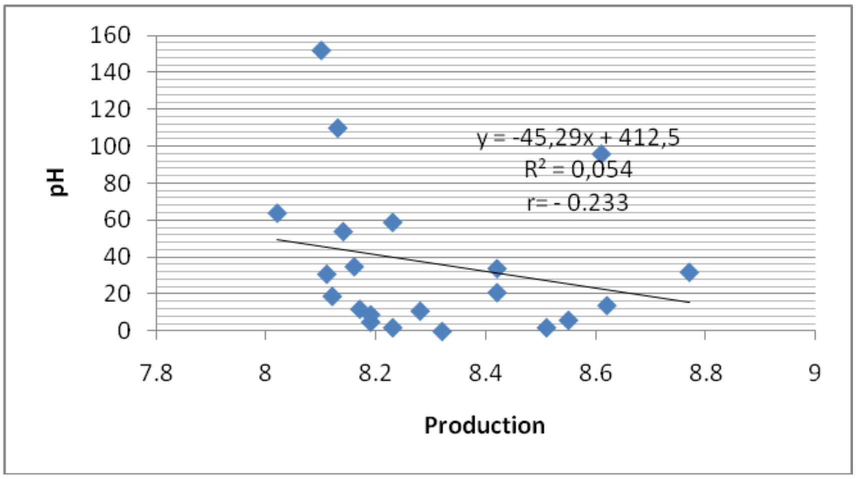

Figure 6. Correlation between soil pH and plant productivity

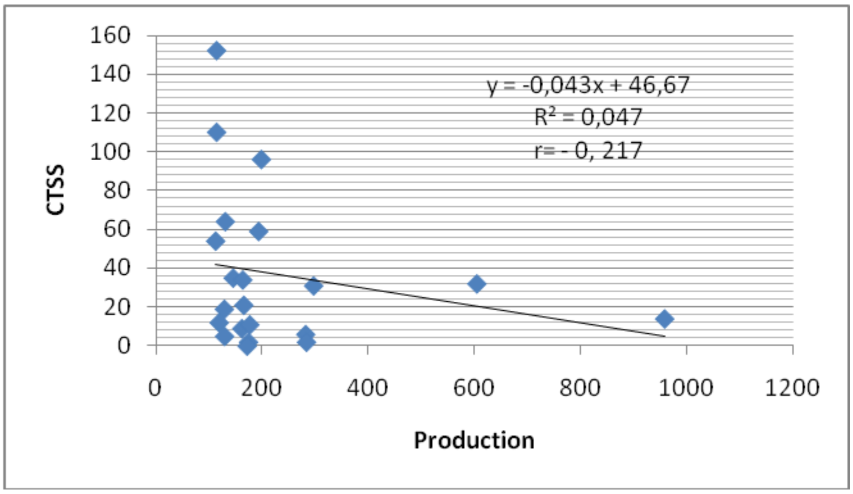

Figure 7. Correlation between soil EC and plant productivity

Instead, after 30 days of saline treatment, the correlation between pH and soil EC is moderate to good, consistent with all these rules established by Colton (1974).

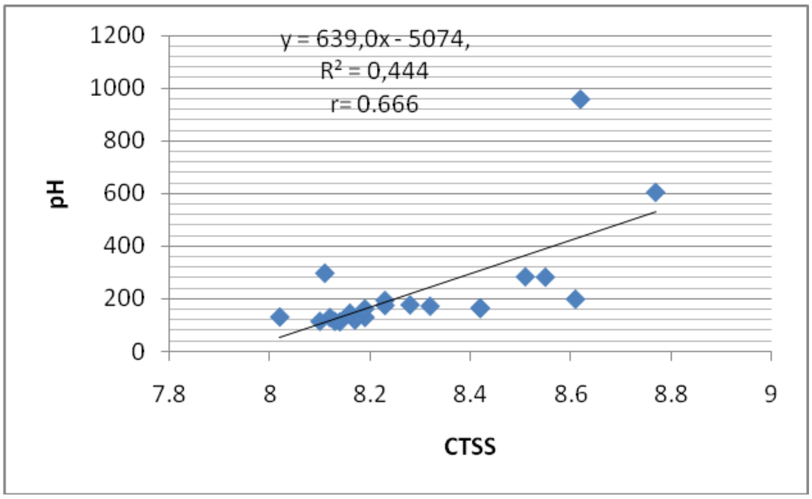

Figure 8. Correlation between pH and soil EC

CONCLUSIONS

1. The pH of the soil under the influence of saline stress has become moderately alkaline; such a pH affects plants because it prevents the accessibility of certain chemical elements in the soil.
2. After 30 days of saline treatment, the results indicate that EC ul just only tolerant crops would produce satisfactorily, in this case the populations (Blăgeşti 2 and Truşeşti 2).
3. The highest production was recorded in the Blăgeşti 4 genotype, both at the control variant and in the case of the variant treated with saline, respectively 100 mM and 200 mM, followed by Blăgesti 2 genotype.
4. The best correlation was recorded between soil pH and plant productivity, as well as soil pH and productivity, after 30 days of exposure to saline stress.

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