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Study of some physiological characteristics of potato tissue under salinity stress

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ABSTRACT: Potato is one of the most important crop plants and plant tissue culture is very important in the cultivation of plants. Salinity is one of the environmental factors that affects plant growth. In this research, some of the physiological characteristics of potatoes cultivated by tissue culture method are investigated. After preparing the lateral buds and sterilizing, were cultured in the MS medium. For the effect of salinity, concentrations of 0, 25, 50, 75 and 100 mM NaCl have been used. After the growth of buds, the leaves were sampled and the photosynthetic pigmentation, soluble sugars, proline, protein, and other characteristics were evaluated. The results show that salinity reduces photosynthetic pigmentation. The amount of protein, soluble sugars and fresh weight have also been reduced with salt stress, but the amount of proline has increased somewhat due to salinity, which is in response to salinity stress.

***Keywords*:** Potato, Salinity stress, Plant tissue culture, Physiological characteristics.

INTRODUCTION

Potato is one of the most important crops in the Solanacea family, which produces 325 million tons of crop, which is ranked fourth in the world after wheat, rice and corn (Woolf 1986). The potato plays a major role in nutrition of the people of the world. Due to its high yield, its energy and protein content per unit area is more than wheat and rice (Khwajapour, 2004). Potato is grown in about 100 countries under temperate, subtropical and tropical conditions. The potato is basically a crop of temperate climates. The best growth of this plant is in cold regions with cool nights and moderate days with full radiation.

Vegetative proliferation, as the most important method for growing potatoes, makes the plant susceptible to contamination with a variety of bacteria, fungi and viruses (Tovar et al., 1985). Providing healthy and disease-free plant material for commercial cultivation is essential for the production of plants in vitro by tissue culture. The high reproductive coefficient, its feasibility throughout the year, and the low space requirement are among the benefits of tissue culture.

Salinity stress is one of the most important environmental stresses that affects the entire plant growth period and limits the growth and yield of crops by reducing the osmotic potential and impairing the absorption of certain nutrients. Increasing sodium and chloride ions also reduces the absorption of essential ions, including potassium ions, calcium, ammonium and nitrate, and decreases the activity of enzymes and blocks the structure of the membrane (Kaya et al., 2006). The accumulation of toxic amounts of salts in leaf apoplast causes plasmas,

reduces inflammation and death of leaf cells, and the high ratio of sodium to potassium, by disabling enzymes, affects metabolic processes, such as photosynthesis in plants, and decreases growth

Assessing the physiological characteristics of plant responses in salt stress helps us to discover biochemical pathways and use these results to increase the yield. The aim of this experiment was to study the physiological characteristics of potato under salt stress through tissue culture. In this research, the length of seedlings, the amount of photosynthetic pigments, proline, protein and soluble sugars are evaluated.

Material and Methods

In this research, the lateral buds of the vegetative stems were used. After providing the lateral buds, they were sterilized in 5% sodium hypochlorite for 20 minutes and after three times washed sterilized distilled water for 15 minutes in a laminar-floe hood for cultivation Was used. MS medium with 3% sucrose and 0.8% agar with pH5.5 were used. Each side buds or nodes were transferred to culture medium with different concentrations of salt (0, 25, 50, 75 & 100 mM NaCl) with three replications. After Four weeks of physiological characteristics of seedlings such as stem length, number of leaves and nodes, photosynthetic pigments (Lichtenthaler 1987), proline (Bates et al., 1973), protein (Bradford 1976) and soluble sugars (Roberts and Martin1959) were evaluated.

Results and Discussion

The results show that salinity reduces the amount of chlorophyll a, chlorophyll b, total chlorophyll and carotenoids(Figure:1). Also, with increasing salinity concentration, their amount decreases more. The highest amount was observed in the control group and the lowest in the 100 mg group(Figure:1). Chloroplasts are organelles that have the greatest effect on salinity. Salinity causes damage to the chloroplast structure and the instability of the colored protein compounds. Carotenoids are also affected. Due to salinity, the amount of chlorophyll is reduced due to more chlorophyllas activity in salt stress conditions. According to previous reports, with increasing sodium chloride content, the amount of total chlorophyll, chlorophyll a and chlorophyll b decreased significantly in two tomato cultivars.

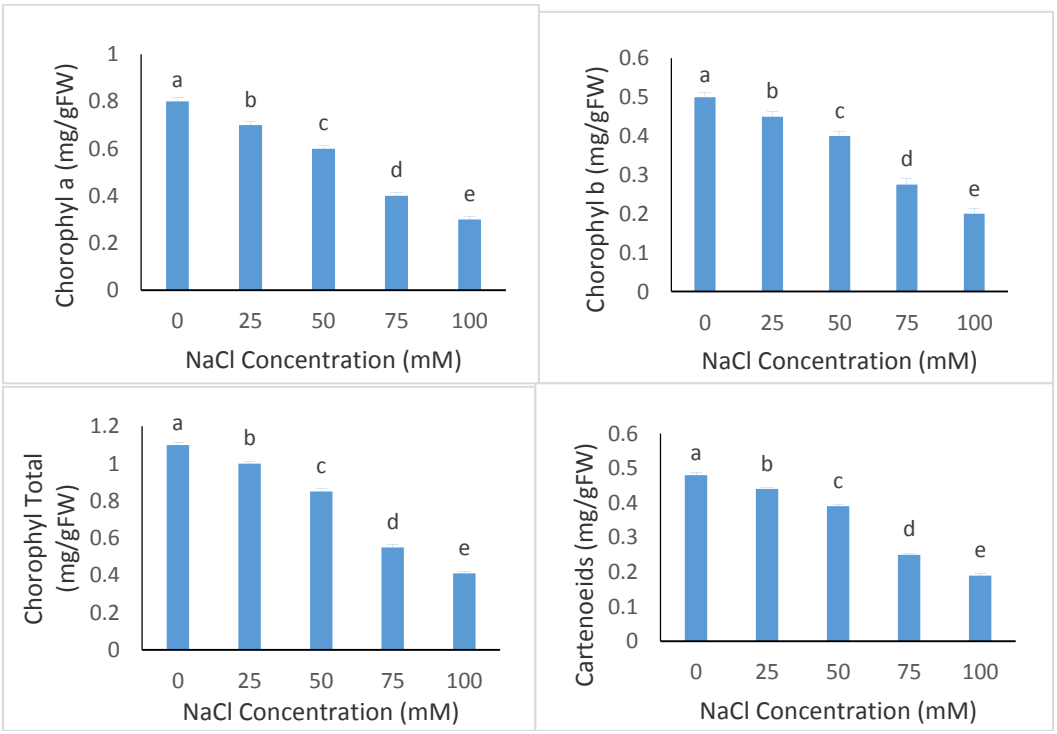

Figure 1: The effect of salinity on photosynthetic pigments in potato (Means ± SE). Same letter indicated not significant (p≤0.05) based on Duncan's test.

Reducing the amount of chlorophyll can be due to a change in the nitrogen metabolism associated with the formation of compounds such as proline, which is used in osmotic regulation. Increasing proline production makes glutamate, a precursor of chlorophyll and proline, less involved in the chlorophyll biosynthesis pathway. Salt has an irritating effect on glutamine kinase activity, the first enzyme in the proline pathway is biosynthesis (Pioter Grazyana, 2005, David et al., 1996). The first chlorophyll biosynthesis enzyme is glutamate ligase, which prevents salt from its activity. Therefore, in salinity conditions, the production of chlorophyll due to reduced activity of the glutamate ligase activity on the other side the consumption of more glutamate by the enzyme activated glutamine lipase on the other, is reduced (Rosa- Ibara and Maiti, 1995 Yeonghoo, et al., 2004). Measuring the amount of proline shows that it has increased with concentrations of salinity, which is consistent with the results. However, there is no significant difference between the two groups of 75 and 100 mM but there is a significant difference between the control. Sairam et al. Experiments showed that increased proline resulted in increased plant resistance to salinity, and this change depends on plant species(Sairam et al., 1998). Proline accumulation during tension is the result of genetic manipulation of proline metabolism in plants. Sometimes, the amount of proline in the plant under salinity stress increases to 100 times its in control. Because its accumulation has a contractile role in the plant and is proposed as a carbon-nitrogen storage osmolite (Tari et al., 2002).

Salinity has reduced the amount of protein. The results show that with increasing salt stress, the amount of protein also decreased in the same way(Figure:2). High levels of sodium and chloride ions in the protoplasm cause imbalance in ion balance (ion ratio of potassium and calcium to sodium ion) and the specific effects of ions on membrane enzymes; consequently, photophosphorylation and phosphorylation in the respiratory chain produce very little energy therefore nitrogen assimilation is disrupted, protein metabolism is disturbed, and the accumulation of diamines and polyamines occurs. In germinated rice seeds and during the next stages of plant growth, salinity damages protein synthesis and decreases Changes in the pattern of proteins under salt conditions are probably due to the effect of salinity on protein metabolism (Bajguz and Hayat, 2008).

Measuring the amount of soluble sugars shows that there is a slight increase in concentrations of 25 and 50 mM, but this difference is not significant(Figure:2). In concentrations above 50 mM, the soluble sugars content decreases. Researchers have named sugar production as one of the best protectors of the plant in terms of tension. 187 They also said that the increasing carbohydrates, amino acids and polyamines are one of the most effective ways of tolerance to stress(Hussein et al., 2007).

It has also been reported that in tomato leaves, the amount of soluble sugar and total saccharides can be significantly increased in the salt treatment, but the amount of starch did not change significantly (Gao et al., 1998, Khavarinejad and Ghafarzadeh, 1998). It has also been reported that in tomatoes, sucrose concentration and activity of sucrose phosphate synthase increased in leaves, but invertase activity decreased. Kerepesi and Galiba reported that the amount of leaf sugar in the wheat genotype was reduced to salt stress, but it increased in drought, which indicates the role of soluble carbohydrates in resistance to stress (Kerepesi and Galiba, 2000).

The figure 3 show the explant buds grown in concentrations of 0, 25 and 100 mM NaCl. Growth and length of bud and length were completely affected by salinity stress.

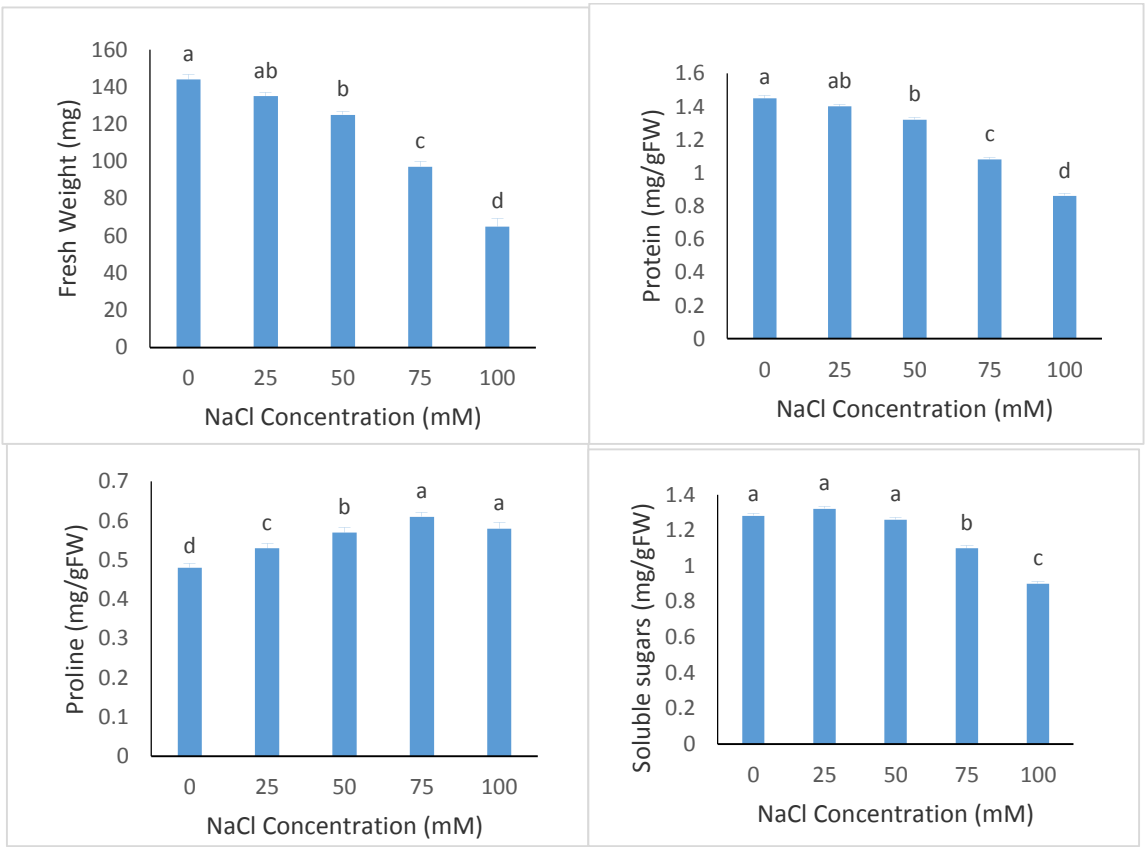

Figure 2: The effect of salinity on fresh weight, protein, proline and soluble sugars in potato (Means ± SE). Same letter indicated not significant (p≤0.05) based on Duncan's test.

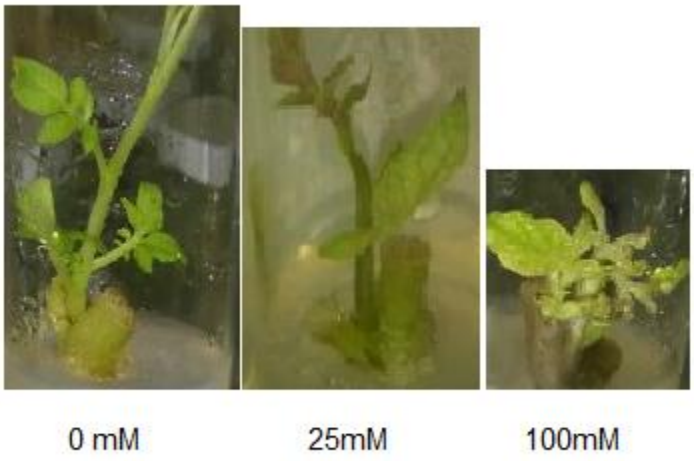

Figure 3: The effect of salinity on potato explant of lateral bad.

Conclusions

However, salinity is one of the problems of agriculture today, and by limiting it reduces the crop, but scientific methods can identify the potential of plants and use them to cope with tensions. In this research, we examined the physiological characteristics of tissue culture potato in salinity stress. The plant has increased the proline response,

but photosynthetic pigments and protein and soluble sugars have decreased. However, these responses in low salt concentration indicate resistance to plants, but in plants with a salinity of more than 25 mM, the plant is weakened and its growth limited. It seems that by knowing the physiological processes and strengthening them, they can overcome tensions to a great extent.

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