American Journal Of Agriculture And Horticulture Innovations
(ISSN – 2771-2559)
VOLUME 03 ISSUE 12 Pages: 18-23
SJIF IMPACT FACTOR (2021: 5. 705) (2022: 5. 705) (2023: 7. 471)
OCLC – 1290679216
Publisher: Oscar Publishing Services

Journal Website: https://theusajournals.com/index.php/ajahi

Research Article

EFFECT OF SOIL SALINITY LEVELS ON PHYTOGORMONE BALANCE IN POTATO ADAPTATION

Submission Date: December 02, 2023, Accepted Date: December 06, 2023,
Published Date: December 11, 2023
Crossref doi: https://doi.org/10.37547/ajahi/Volume03Issue12-04

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ABSTRACT

The comprehensive study of changes in the content of cytokinins, indole acetic acid (IAA) and abscisic acid ABA, growth rates, and development of potatoes during soil salinity NaCl. Studies have shown that the hormonal balance of potato organs throughout ontogenesis under the influence of NaCl salinity undergoes significant changes: the content of cytokines and auxins decreases, the level of ABA increases, as a result, the ratio of cytokines +IAA/ABA falls. These changes in the hormonal balance are not only the result of a stress response but also have an adaptive value. The conducted research allowed us to find out the relationship between changes in hormonal balance and physiological processes.

KEYWORDS

Salinity, Potatoes, Cytokines, Auxin, Hormone balance.

INTRODUCTION

One of the most important tasks of modem biology and chemistry is to increase the resistance of plants at the stages of growth and development to external stress factors. Topical issues of these Sciences in this direction are considered to be the study of phytohormones, which play a major role in the development of plants.

Potatoes, unlike other agricultural plants, are characterized by relative instability to the influence of external factors. But some abiotic and biotic factors

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Crossref doi Google Scholar WorldCat MENDELEY
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lead to negative consequences at the stages of growth and development of potatoes. In most cases, increased salinity of the soil can lead to the death of potatoes. In such cases, methods of phytohormonal regulation of growth and development of seedlings are widely used, which is of strategic importance in obtaining potential products [1-3].

Salts have a double effect on plant seedlings. First, they create high osmotic pressure in the soil solution, which leads to strong binding of water. This makes it difficult for the roots of plants to absorb water, which is called osmotic stress. Secondly, salt ions absorbed together with water have a depressing effect on the metabolic processes of plants, which is called ion stress [4].

Most researchers have linked the effect of salts on plants with the deterioration of the water balance and the toxicity of Na+ and Cl-ions [5-7]. However, the role of phytohormones in protective and adaptive mechanisms is not sufficiently covered.

In this work, a comprehensive study of changes in the content of cytokinins, IAA, and ABA, growth rates, and development of potatoes during salinization of NaCl soil was carried out.

MATERIAL AND METHODS

The experiment involved 5 cloned potato varieties (Solanum tuberosum L)-C-16, C-17, C-4, C-5, Santa, and I local variety scissors leaf. The research was carried out in laboratory and vegetation experiments.

Embedded experiments: 1. control; 2. 2% NaCl, 3. 2.5% NaCl, 4. 3% NaC1, 5. control + 6-benzyl amino purine (BAP), 6. 2% NaCl + 6-BAP, 7. 2.5% NaCl :- 6-BAP, 8. 3% NaCl 6-BAP, 9. control, ABA, 10. 2% NaCl + ABA, 11. 2.5% NaCl, ABA, 12.3% NaC1 + ABA. NaCl was introduced as a solution with irrigation water during germination (laboratory experiments), and during the vegetation phase (vegetation experiments). Spraying with a solution of 6-BAP (’ lx lo 6 M) and ABA (’1x lo 6 M) in vegetation experiments was carried out in the vegetation phases, in laboratory experiments — the next day after applying NaCl. The concentrations of the introduced hormones and NaCl were determined by selecting the specific features of the selected object. Control plants were sprayed with water. During ontogenesis, the intensity of growth processes (the mass of plant organs), the number of free cytokines (zeatin), auxins (IAA), and abscisic acid were determined using the ELISA (enzyme-linked immune electro diffusion essay) test method.

Plant samples were selected in the main phases of ontogenesis, starting from the three-leaf phase, in 4-fold biological and 3-fold analytical repetitions. When evaluating the differences between the options, the student's criterion was used, considering the differences to be reliable at a confidence level of 0.95.

RESULTS AND DISCUSSION

The effect of extreme factors is manifested in many metabolic reactions of plants, and primarily affects the state of the phytohormonal system [lo,ll].

The analysis of the obtained data allows, first of all, to compare the change in the ontogenesis of the hormonal balance with the growth rate of potatoes. During the growing season, the content of zeatin, auxin, and the cytokines IAA/ABA ratio changes along a single-vertex curve with a maximum in the flowering phase (Fig. 1). An increase in the level of cytokines in the first half of vegetation may be due to an increase in the formation of tubers [8]. The ABA content in potato organs increases continuously during ontogenesis (Fig. I). The dynamics of the hormonal balance to a certain extent corresponds to the change in the growth rate of potatoes. In the first half of the growing season,

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against the background of an increase in the content of zeatin, and IAA, the intensity of growth processes increases. In the second half of the growing season, a decrease in growth-stimulating hormones and an increase in ABA levels is accompanied by a decrease in the growth rate of potato organs. This once again demonstrates the increasing role of ABA in the processes of aging and transition to a state of rest [8].

The change in growing conditions — the introduction of NaCl-significantly affected the hormonal situation and, as a result, the growth rate of potatoes. This was especially pronounced at a high dose of NaCl (3%). Plants of this variant were characterized by a sharp decrease in the content of zeatin, IAA and an increased level of ABA (Fig. 1), which led to a decrease in the cytokines +IAA/ABA ratio. At the same time, a greater deviation in the reaction of the phytohormonal system from the norm (the variant without applying NaCl) was observed in the first phases (after applying NaCl), while by the end of the growing season, the effect of salt was smoothed (Fig. 1).

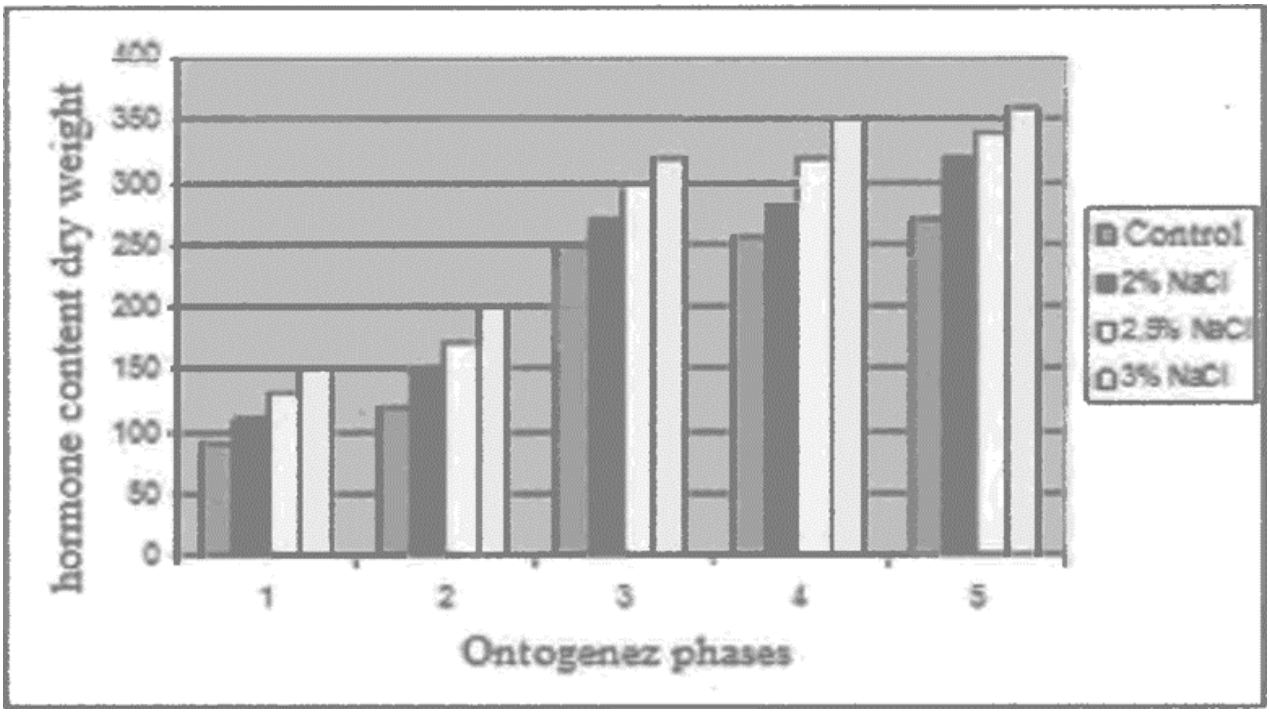

Figure 1. The contents of endogenous hormones at different levels of NaCl salinity, ng/g dry weight

Variant	Cytokines		IAA		ABA		6-BAP/IAA/ABA
Control	301,1±0,5	100	236,6±2,3	100	281,3±3,1	100	1,9
Control+BAP	288,2±3,3	95,7	267,5±1,3	113	261,2±3,3	92,9	2,4
2% NaCl	298,7±2,1	99,2	144,9±2,1	61,2	321,2±2,5	114,2	1,4
2% NaCl+6-BAP	294,2±,3	97,7	232,5±2,2	98,3	301,2±l,3	107	1,8
2,5% NaC1	277,2±4,3	92	99,9±0,5	42,2	348,1±3,5	123,7	1,0

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2,5% NaCI+6-BAP	301,4±0,6	100,1	147±3,7	62,2	358,4±2,3	127,4	1,2
3% NaCI	266,5±2,5	88,5	72,7±2,8	30,7	363,3±2,5	129,2	0,8
3% NaCI+6-BAP	268,3±3,2	89,1	127,9±2,8	54,1	377,4±2,3	134,2	1,0

Table 1. Effect of 6-BAP treatment on the content of potato phytohormones at different levels of salinity (lowering phase), rig / g of dry weight

It is necessary to underline that changes in the content of endogenous hormones and their ratio under the influence of stress factors have an adaptive value [8,12-14]. External conditions, including salinity, are triggering mechanisms that include the response of the hormonal system and, thus, stand at the beginning of the chain of regulatory processes [8,12].

To find out the specifics of the action of 6-BAP and ABA under optimal conditions and the effect of salinity, the dynamics of phytohormones were analyzed. The choice of substances is related to the available data on their protective effect. The literature describes the antagonistic nature of the physiological action of 6-BAP and ABA [8,12].

Treatment of 6-BAP both in the variant without adding NaC1, and, most importantly, in the conditions of salinity, NaCl increased the content of growth-stimulating hormones (cytokinins and auxins) and ABA, while the ratio of cytokinin IAA/ABA increases (table 1).

At the background of such changes in the hormonal balance, there is an increase in the formation of tubers.

Thus, it can be considered that the exogenous introduction of cytokines contributes to the formation of adaptive abilities of potatoes to the action of salts. On the example of two wheat varieties, different sensitivity of plants to 6-BAP processing is shown. The Sante variety showed great responsiveness to the exogenous introduction of a synthetic analog of cytokines.

ABA treatment invariants without adding NaCl and against the background of salinization had the opposite effect on the course of plant physiological processes. In optimal conditions of growing potatoes, when applying ABA, the endogenous content of cytokines and auxins is reduced, the level of ABA is increased, and, as a result, the ratio of cytokines IAA/ABA is reduced.

Under the conditions of NaCl salinity, ABA treatment had a different effect on the hormonal system and the course of physiological processes in potatoes. An increase in the ratio of cytokines +IAA/ABA has been experimentally shown mainly due to the accumulation of cytokines and IAA.

Analysis of the obtained data showed that exogenous application of ABA against the background of NaC1 salinity reduces the stress load on the plant. The introduction of ABA increases the intensity of growth processes and productivity of potatoes growrt under the conditions ofNaCl salinity (Fig. 2). Thus, it can be considered that under the conditions of the stress factor, ABA processing had a protective effect.

Spraying potatoes with 6-BAP have a greater stimulating effect compared to ABA (Fig. 2). The protective effect of the exogenous 6-BAP treatment on potatoes was shown when the soil was salted at a concentration of 2.5% NaCl, while ABA only leveled the effect of salts.

CONCLUSIONS

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As our research has shown, changes in physiological processes under the influence of NaCl are at least partially mediated by changes in hormonal status. It can be assumed that the resistance of potatoes to NaCl salinity is mediated by the peculiarities of changes in the hormonal system. The research shows the possibility of using the exogenous application of phytoregulators to increase plant tolerance to salinity. ABA treatment of potatoes results in compensation for the effects of NaCl. In this case, the nature of the physiological response of plants depends on the level of salinity and is mediated by the direction of changes in the endogenous content of hormones and their ratio.

The study of mechanisms and possibilities for adjusting the hormonal balance opens up prospects for managing the adaptation process and increasing the stability of agricultural plants.

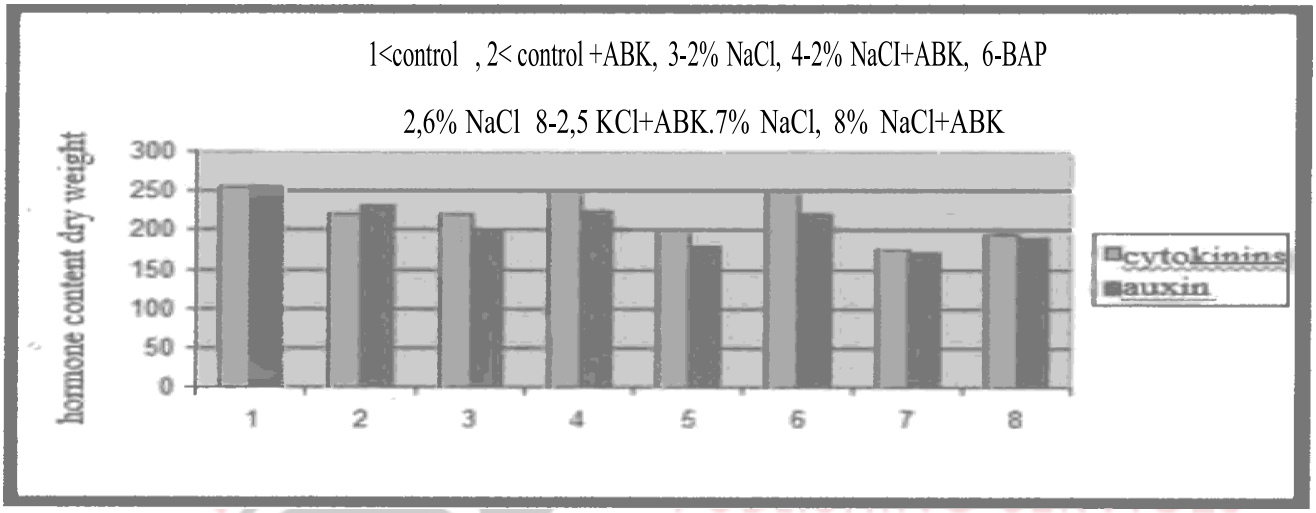

Figure 2. EfTect of ABA treatment on the content of phytohormones of potatoes at different levels of salinity (earing phase), ng / g of diy mass.

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