Mitigating Activity of Humic Substances and their Si-enriched Derivatives in relation to Wheat Seedlings under Salt-Stress Condition

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1. INTRODUCTION

Humic substances (HS) are known to possess bioactivating properties in relation to plants. Mitigating activity of HS is observed under various stress conditions including both biotic and abiotic ones, therefore non-specific action of HS towards plants can be hypothesized. The main non-specific damage induced by all the stresses is the plant cell injury. As silicon is responsible for cell wall stability, artificial enrichment of HS with silicon could results in increase in their mitigating activity.

This study was aimed to estimate bioactivating properties of coal humic acids and their derivatives enriched in silica under salt stress conditions induced by 0.15 M NaCl.

2. MATERIALS AND METHODS

Leonardite humic acids were obtained by desalting of the commercial potassium humate Powhumus – CHP-Pow (Humintech Ltd., Germany) and used for modification with 3-amino-propyltrimesthoxy-sylane (APTS) according to (1). Obtained derivatives were designated as CHP-APTS-5, CHP-APTS-20, CHP-APTS-50, CHP-APTS-100, CHP-APTS-200 and contained 2.58, 3.24, 6.44, 7.89, 11.27% of Si respectively.

To estimate mitigating activity of the CHP-Pow and produced derivatives, bioassay technique with seedlings was applied. Seedlings of wheat *Triticum aestivum* L. were used as a target object, and a length and weight of shoot was used as a response. Ten wheat seeds were placed in Petri dishes with solutions containing 10 mL of 5, 10, 25, 50 mg/L of parent humic material or humic derivatives. Distilled water was used for blank.

The stock solutions of humic materials were prepared by dissolution of a certain amount of the sample in a small volume of 1M NaOH. Values of pH of all the solutions were adjusted to 5.5-5.9 using 0.1M HCl. Seeds were grown for 72 hours at 25°C in the dark. Then 5 seedlings from every dish were transferred to plastic pots containing 0.5 l of

Knopp's nutrition solution for 96 hours. Salt stress was induced by sodium chloride (0.15 M) when required. Then wheat seedlings were harvested and shoots' and roots' length and weight were measured. Based on the data obtained, length increase as a difference between final and initial lengths was calculated. The experiment was performed in duplicate.

3. RESULTS AND DISCUSSION

The obtained data demonstrated that introduction of 0.15 M NaCl resulted in decrease in wheat seedlings growth. When seedlings were germinated in the presence of both parent and modified humic materials, they were more resistant to the salt stress as compared to those germinated in distilled water. At that, mitigating activity of used humic materials was more pronounced in relation to the shoots rather than roots.

The results of bioassay experiments are presented in Figures 1 and 2.

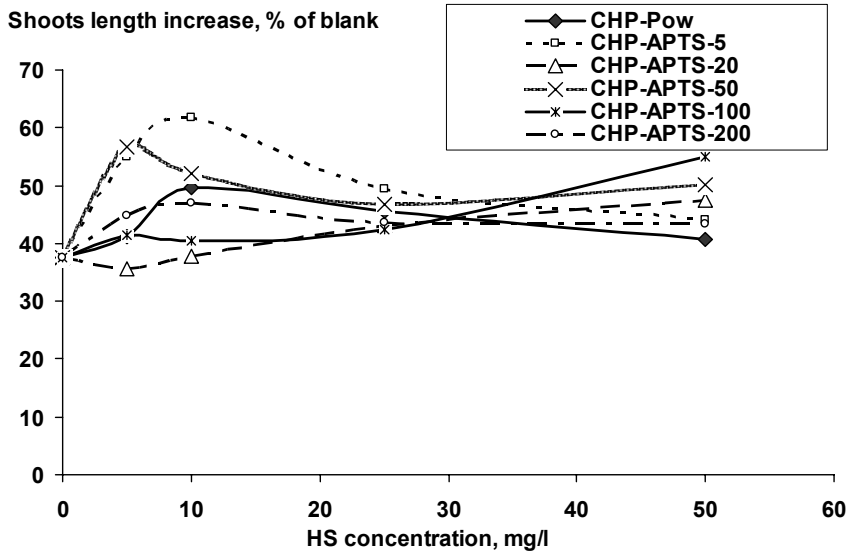

Figure 1. Concentration dependent wheat shoots' length increase in the presence of parent humic material CHP-Pow and its silicon derivatives under salt stress condition.

As it can be seen from the Figure 1, the most marked effect for CHP-Pow was registered at concentration 10 mg/l and was 49.6% of blank. That value exceeded significantly negative control (0.15 M NaCl), where increase of length was 37.6% of blank value. Derivatives CHP-APTS-5 and CHP-APTS-50 demonstrated maximal beneficial

effect in relation to the shoots of wheat seedlings at concentrations of 5-10 mg/l (56.6-61.7% and 56.6-52% of blank respectively). Responses of wheat shoots to treatment with humic material CHP-Pow and its silica enriched derivatives at 25 mg/l gave no significant difference. The exception was CHP-APTS-100, where the length increase was 55%. When HS concentration was increased to 50 mg/l the maximum values were registered for CHP-APTS-50 (50% of blank) and CHP-APTS-100 (55% of blank).

To reveal relationship between mitigating activity of HS and contents of silicon, data on shoots' length increase and weight at HS concentration of 50 mg/l were compared (Figure 2). The highest values of both parameters were observed in case with CHP-APTS-100 containing 7.89% of silicon.

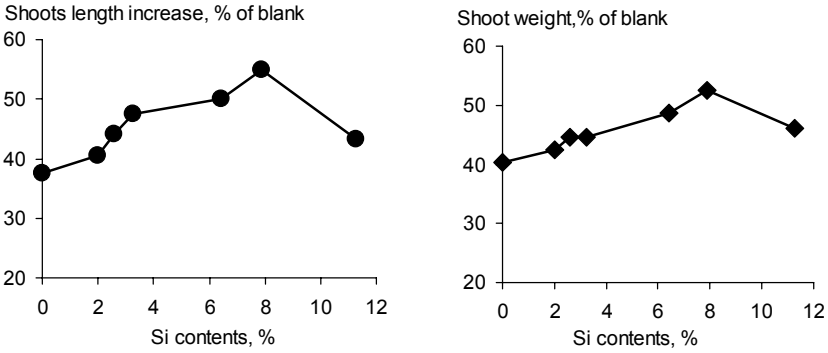

Figure 2. The influence of parent humic material CHP-Pow and its Si-enriched derivatives of different silica contents on wheat shoots' weight and length increase.

Therefore, Si-enriched humic derivatives were demonstrated to mitigate salt stress injury of wheat seedlings. At that himic derivative with silicon content of about 8 % was seemingly the most efficient.

4. CONCLUSIONS

The bioassay experiments with wheat seedlings aimed to estimate mitigating activity of coal humic acids and their derivatives enriched in silica under salt stress conditions induced by 0.15 M NaCl were performed.

The obtained results showed that both parents and Si-enriched humic materials mitigated salt stress damage of wheat seedlings. Among studied HS, derivative CHP-APTS100 with silicon content of about 8 % was seemingly the most efficient preparation.

Our findings indicated clearly that Si-enriched derivatives are the promising humic preparations for the further research in the field of development of agricultural humic-based materials.

ACKNOWLEDGEMENTS

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