Mitigating Impact of Coal Humic Acids and Their Si-enriched Derivative on Wheat Yield under Nitrogen Deficiency Conditions

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Nitrogen (N) is often the most deficient of all plant nutrients. However, excessive nitrogen causes lush succulent growth, resulting in greatly increased danger of lodging, delayed maturity and greater susceptibility to diseases. Humic acids (HA) are known to impose beneficial effects on plants, and a wide assortment of humic preparations is now available on the market. Biological activity of HA is of special interest due to bioadaptogenic properties of HA. They are able to mitigate negative environmental effects such as unfavorable weather and soil conditions, presence of toxicants or pathogenic organisms and others. Therefore, development of humic preparations of enhanced adaptive activity is of importance for modern organic agriculture. Silicon seems to be one of the most promising modifying agent which can be incorporated into the structure of HA to enhance adaptive activity. It increases plant resistance under biotic and abiotic stress conditions. In this study we hypothesized that Si-enriched humic preparations will mitigate effect of nitrogen deficiency which is one of the common stresses in plants.

To reach this goal, the silicon-enriched sample of humic materials was synthesized. The commercial potassium humate (Sakhalin Humate, Biomir 2000 Ltd., Russia) (CHS) was used for modification. 3-amino-propyltriethoxy-silane (APTES) was used as a source of Si. The choice of APTES was provided by the presence of reactive amino groups in its structure which can yield amide bonds upon reaction with carboxyl and carbonyl groups. In addition, APTES is commercially available organosilane suitable for preparative production of the corresponding derivatives. Silanol derivatives of CHS were obtained by its condensation with APTES. The reaction was run at ratios 0.2 g of APTES per 1 g of CHS. The corresponding samples was designated as CHS-APTES-20. To perform bioassay, field trials were performed using wheat *Triticum aestivum* L. Experimental design included blank, treatment with CHS and CHS-APTES-20. Wheat was grown according to common practice under adequate supply of nitrogen and without nitrogen application. Humic preparations were applied by means of foliar treatment. The obtained results are shown in Fig. 1.

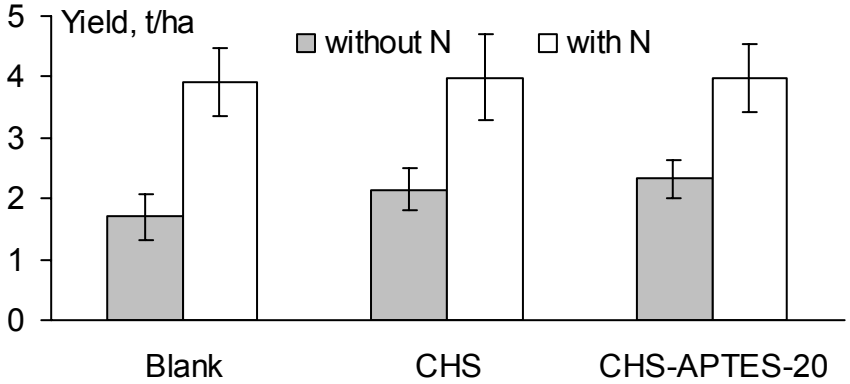

Figure 1. Influence of HA and their Si-enriched derivative on wheat yield under physiological and nitrogen deficiency conditions.

As it can be seen wheat grown with an adequate supply of nitrogen was not influenced by the both humic treatments, whereas a distinctive mitigating effect was observed under N deficiency conditions.