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EFFICIENCY OF APPLICATION OF BACTERIAL AND HUMIC PREPARATIONS IN THE ARID REGIONS OF EGYPT

Inoculation of soil with by rhizospheric nitrogen-fixing bacteria of the genus Azospirillum and non-root treatment of crops by humic preparations ALCRI-CropHelp and ALCRI-CropHelp-M in Egypt arid lands significantly increased wheat grain crops on 156, 167 and 178% relative to the control, accordingly. At the same time, the water use efficiency has increased by more than 2.5 times. This effect was achieved due to multiple effects on metabolism of agricultural plants.

Инокуляция почвы ризосферными азотфиксирующими бактериями рода Azospirillum и некорневая обработка посевов гуминовыми препаратами ALCRI-CropHelp и ALCRI-CropHelp-M в условиях засушливых территорий Египта достоверно повышали урожайность зерна пшеницы на 156, 167 и 178 % относительно контроля, соответственно. При этом, естественно, возросла эффективность водопотребления — более, чем в 2,5 раза. Такой эффект достигался за счет множественного действия на метаболизм сельскохозяйственных культур.

Keywords: Azospirillum brasilense; ALCRI-CropHelp; ALCRI-CropHelp-M; humic substances; complex action; grain crop, wheat.

Ключевые слова: Azospirillum brasilense; ALCRI-CropHelp; ALCRI-CropHelp-M; гуминовые вещества; комплексное действие; урожайность; пшеница.

Introduction

To obtain a high economically viable yield with a simultaneous improvement in the quality of crop production, in addition to creating favorable conditions for the growth and development of agricultural crops through chemical farming and various reclamation measures, it is necessary to directly influence plant biology [1]. Such effective and economically justified methods of influencing the production process of plants are soil inoculation with rhizosphere nitrogen-fixing bacteria of the genus *Azospirillum* [2; 3] and foliar treatment of crops with solutions of humic substances (HS) [4; 5].

The purpose of this publication was to demonstrate the effectiveness of the use of *Azospirillum brasilense* and two humic preparations: ALCRI-CropHelp and ALCRI-CropHelp-M on the grain yield of wheat grown in the arid regions of Egypt.

Research Methods

Field trials of the effectiveness of the use of bacterial and two humic preparations: ALCRI-CropHelp and ALCRI-CropHelp-M were carried out from December 2019 to April 2020 on irrigated old arable calcareous saline soils located (30°53′33.17″ N, 29°22′46.43″ E) Alexandrea, Egypt. Object – wheat (*Triticum* L.). The area of one plot is 500 m^2. The repetition is threefold.

Experiment scheme: 1) control; 2) NPK - mineral fertilizers: urea – 38 g/m^2, P_2O_5 (45%) – 10 g/m^2, K_2O – 12 g/m^2; 3) *Azospirillum brasilense* – rhizosphere nitrogen-fixing bacteria were introduced into the soil around the plant in an amount of 0.7 ml of the original culture suspension per 1 m^2;

4) ALCRI-CropHelp – neutral HS solution, 5) ALCRI-CropHelp-M – neutral HS solution with essential microelements in a stable dissolved state. Both HS solutions were used as follows: 0.5 ml/m^2 were used for spraying the plants and 1.0 ml/m^2 was applied to the soil (in terms of the content in the mother solution).

Humic substances were isolated by a special saline solution from vermicompost, which was produced from spent grain – organic wastes of brewing. They did not contain chlorides, carbonate ions, polyaromatic hydrocarbons, lipids and radio-nuclides.

Results and Discussion

The data obtained in the course of field trials of the bacterial preparation (*A. brasilense*) and the humic preparations ALCRI-CropHelp and ALCRI-CropHelp-M indicated that these preparations allowed obtaining a significant increase in wheat grain yield relative to the control (Table). Soil inoculation with *A. brasilense* and foliar treatment of crops with humic preparations contributed to an almost 2-fold increase in wheat grain yield compared to the variant with NPK. In addition, as a result, the efficiency of water consumption has significantly increased.

Influence of *A. brasilense* soil inoculation and foliar treatment of crops with ALCRI-CropHelp and ALCRI-CropHelp-M preparations on wheat grain yield

Treatments / Parameters	Grain yield, c / ha	Increase in yield		Water consumption efficiency, kg grain / m^3 water per 1 ha
		c / ha	%	
Control	34.5 (*a*)	0	0	0.48 (*a*)
NPK	47.7 (*b*)	13.2	38	0.67 (*b*)
A. brasilense	88.4 (*c*)	53.9	156	1.24 (*c*)
ALCRI-CropHelp	92.2 (*cd*)	57.7	167	1.29 (*cd*)
ALCRI-CropHelp-M	95.8 (*d*)	61.3	178	1.34 (*d*)
F_{05}	3.48	—	—	3.48
$F_{c.}$	167.51	—	—	167.51
LSD_{05}	6.93	—	—	0.097

Note: one centner (c) = 100 kg; F_{05} – theoretical Fisher's criterion; F_C. – Fisher's criterion actual; LSD_{05} – the lower significant difference at P = 95%.

As is known [2], associative nitrogen-fixing rhizosphere bacteria of the genus *Azospirillum* have a beneficial effect on plant growth and development due to nitrogen fixation, biosynthesis of phytohormones and ionophore organic compounds, reducing the effect of stressors, controlling numerous phytopathogens, as well as mobilizing phosphates, improving water and nutritional regimes.

Humic substances, getting inside plants, are capable of: accelerating the circulation of nutrients in plants, causing induction of gene expression, enriching energetically, optimizing: respiration, photosynthesis, biosynthesis, the ratio of organic and inorganic anions, synthesizing phytoncides and phytoalexins [6; 7], to increase the resistance of plants to the action of ionizing radiation and pesticides [8]. Management of crop productivity using the achievements of modern biotechnology refers to the biological correction of plant growth and development.

The methodology of biological correction is based on the following key provisions [1]: 1) green vascular plants are able to absorb and assimilate organic compounds; 2) in green vascular plants, one of the pathways that ensure the transport of substances in the system of protoplasts of plant cells, united into one whole by numerous plasmodesmata, which allows plants to absorb nutrients not only with the help of roots but also with leaves; 3) the production process of plants is largely determined by the rate of movement of nutrients both from the root to the leaves and from the leaves to the root.

In this case, soil fertility is considered as a consequence of the biological cycle of biophilic elements in ecosystems [9].

Conclusions

Inoculation of the soil with *Azospirillum brasilense* and foliar treatment of crops with humic preparations ALCRI-CropHelp and ALCRI-CropHelp-M contributed pronounced increases in wheat grain yield. Such biotechnologies are based on the principle of biological conformity. Finally, combination between natural materials and environmental friendly byproducts has become one of the most important practices concerning soil enhancement and yield increase.

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