

The use of chelated microfertilizers applied for rice on saline soils of the Kazakhstan Aral Sea region

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ABSTRACT

The article provides the results of theoretical and applied studies of the use of chelate microfertilizers for rice cultivation on the saline soils in the Kazakhstani Aral Sea region. The RezFree enzymatic organic bacterial fertilizers (produced in the USA), an enzyme preparation (produced in Japan), the KN2 domestic preparation and Khelaphos have been used in the experiment. The results of the studies showed the effect of microorganisms on the rice yield. The positive features of the studied RezFree organic bacterial fertilizer have been identified. The blend with other preparations promoted a yield increase under the given conditions. The developed highly effective methods allow solving the basic problems: soil and water desalinization; increase in humus content in soil and nutrient elements to environmentally safe level; decrease in the supply of toxic substances from the soil to the agricultural crops' yield; and increase in the fertilizers' efficiency to the required level.

Key words : Crop yield, Chelates, Microfertilizer, Organic enzyme, Preparation, Rice, Agro-industrial complex.

Introduction

The intensification of the agrarian sector has been recognized as one of the priority directions of the economy development, which is reflected in the Development Concept of the Agro-Industrial Complex of Kazakhstan. The implementation of this concept resulted in the transfer of agricultural production to sustainable economic development in a market economy. This process is impossible without the formation and implementation of a new agrarian policy providing for the development of highly effective nanotechnologies that promote for the increase in soil fertility and yields of agricultural crops.

The currently used technological developments

aimed at agrotechnology intensification increase the microbiological load on the soil, which in turn leads to intensive decomposition of humus. This leads to an increase in the soil degradation and to a decrease in its fertility (Dzhamantikov *et al.*, 2009). As a result, a lack of organic substances in the soil results in the depletion of the soil microflora (Beysenbayev, Dygay, Umirzakov; Dzhamantikov *et al.*, 2015).

Rice is the main culture of the Kyzylorda region, and the economic development of the entire region depends on the productivity of this sector. At the same time, it is important to use technologies that not only increase the agrarian sector productivity, but also the ecologically safe and resource-saving ones. The lack of proper agromeliorative work to reproduce fertility and improve the ecological condi-

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tion of soils used in rice growing and periodically flooded has led to a decrease in soil productivity.

There are studies on the effectiveness of the use of phosphates and their compositions with organic substances for soil enrichment. The use of phosphorus fertilizers has shown their high efficiency for increasing the fertility of degraded rice fields of the Aral Sea Region (Beysenbayev, Dygay, Umirzakov, Dzhamantikov *et al.*, 2015). However, the lack of developments in the technology of application and the ratio in the compositions does not allow their complex use.

The ecological state of the main components (soil-humus within 0.8-1.0%, irrigation water from the Syr Darya River, the mineralization of which in the spring is 0.6-0.8 g/l and reaches 1.2-1.8 g/l in summer and autumn) of rice agrocenosis needs improvement with the investment of large financial resources.

In this regard, the need for using minitechnologies against the background of the basic technology increases that contributes to raising the shala rice yields to 20-25%, depending on its base level, when seeds are treated with the new KH2 exogenous synthetic stimulator of domestic production (Kazakhstan) and foreign-made preparations (Rez Free, the USA, organic enzyme (F), Japan) (Yanishhevskiy, Tuyev, Dzhamantikov and Dzhamantikova, 2000; Dzhamantikov, Beisenbayev, Toktamysov and Aldanazar 2016).

The scope of this work is to study the effectiveness of the application of the enzymatic organic bacterial fertilizer Rez Free in combination with Chelate fertilizers (Chelaphos), organic ferment (F) and the KN2 stimulating preparation on saline lands in the soil and climatic environment of the Kyzylorda region of the Republic of Kazakhstan.

Rationale

In natural conditions, the fertility of soils is closely related to the vital activity of the saprophyte microflora (soil microorganisms), which performs the functions of the organic matter mineralization, atmospheric nitrogen fixation, the transfer of potassium and phosphorus compounds into forms accessible to plants, etc. The current stage of the agriculture intensification is associated with the widespread use of mineral fertilizers and pesticides, which significantly change the living conditions of microorganisms in the soil. Many of these changes have negative consequences, for example, the con-

tent of beneficial microorganisms in the soil decreases under the influence of pesticides and, as a consequence, the humus level decreases.

It is known that traditional technological methods are not enough for the reproduction of useful microorganisms in soil. There is a need to treat plant seeds with promising microbial preparations or by introducing them into the soil.

Biochemical preparations being a part of organic substances contain a balanced complex of biologically active substances and microelements that allow to purposefully regulate the most important processes of plant growth and development, and to effectively fulfill the potentialities of varieties and hybrids that are incorporated into their genome by nature or by selection and genetic engineering. They increase plant resistance to adverse factors of natural and anthropogenic nature - critical temperature changes, moisture deficiency, cytotoxic action of pesticides, and diseases and pests.

The accumulated practical experience has shown that for successful application of microbiological preparations as an integral and important component of modern crop production technologies, it is necessary to study their effectiveness, mechanism of action and side effects in their use. The wide use of microbial preparations should become an integral stage of the integrated biologization of soil management, which does not exclude the use of mineral fertilizers and chemical plant protection products.

Thus, the introduction of high energy-saving technologies into agriculture and the use of various biotechnological technologies are the modern trends in improving the fertility of saline soils of the Aral Sea region, the quality and productivity of crop production

Materials and Methods

Object of the research was the process of cultivation of the KazEr-6 (local selection) rice culture on saline lands in soil-climatic conditions of the Kyzylorda region with the application of the enzymatic organic bacterial fertilizer Rez Free (developed by the USA) in combination with Chelate fertilizers (Helaphos), organic enzyme (F) and KH2.

Methods of the research were the following: agrochemical laboratory, field research.

Field experiments had been carried out on the stationary site of the Kazakh Research and Development Institute of Rice Growing named after I. Zhakayev. The stationary site was located in the

Karaultobe village, at a distance of 12 km from the city of Kyzylorda.

Agrotechnics of field experiments was generally accepted for this zone of rice-growing, developed by scientists of the Kazakh Research and Development Institute of Rice Growing named after I. Zhakayev.

One check plot with the medium- and heavily saline soil was isolated for the experiment.

The check plot area was 2.2 hectares. The check was divided into 4 parts of 0.55 hectares each. Before the rice planting on the 1st plot (No. 1) and on the 3rd check plot (No. 3), an aqueous solution of the enzymatic organic bacterial fertilizer Rez Free (developed by the USA) had been dispersed over their soil surface under pressure using special liquid spraying equipment.

Phenological observations of the growth and development of rice plants were made on the main phases of the vegetation period. The beginning of the vegetation phase was the date when 10% of the mass of plants on the crop entered the main phase of growth and development, and it was considered complete when 75% of the plants entered this phase.

The density of plants was calculated in the phase of full seed rise, and analysis of the crop structure - during the full ripening of plants.

During the growing season, works were carried out to comply with the water regime in the experimental areas from the plant germination period to full ripening of the crop.

Results and Discussion

Effectiveness of the effect of the enzymatic organic bacterial fertilizer Rez Free (developed by the USA) in combination with Chelate fertilizers (Helaphos), organic enzyme (F) and KH₂ depends on the level of soil salinity.

To eliminate the results of herbicidal stress in plants, without disturbing the natural rhythm of the

rice plants' feeding process, it is necessary to ensure dosed feeding through the leaf apparatus using a chelate microfertilizer (Helaphos) preparation in the polymer humic complex. This preparation has been obtained by the Kazakhstan scientists from brown coal after introduction of the following necessary microelements in the humic complex: Zn, Cu, B, No, Fe, Mn, Ca, Co, Si, Mg, K, P, N. These microelements are especially necessary for nutrition in the metabolic system of rice plants under extreme conditions during the growth and development of the body's organs.

Under the influence of aqueous solution of the enzymatic organic bacterial fertilizer Rez Free introduced by spraying on plants in two terms during tillering and booting on the soil surface of the check plot No. 1 with the dense residue of aqueous extract salts equal to 1.140%, and combined with a chelated fertilizer (Helaphos), an enzyme preparation (F) and KH₂ the productivity of rice grains of the KazEr-6 variety equaled to 48 c/ha.

At the same level of soil salinity (1.10%) in the area of the plot check No. 2, where Rez Free had not been applied, the yield of rice grain was 40 c/ha, and in the second control plot No. 4 it was 45 c/ha. The data of control options (40-45 c/ha) clearly show that Rez Free has a significant impact on reducing the level of soil salinity, creating favorable conditions for plant nutrition, contributing to an increase in the rice grain within 3-8 c/ha. Table 1 shows the indicators of biomeasurements of the above-ground organs of model rice plants taken from the sections of the check plots No. 1-4 at the rice booting beginning phase of KazEr-6 variety in weakly and medium saline soils.

The data provided in Table 2 indicate that under the influence of the Rez Free preparation on medium saline soils (No. 3, No. 4) rice grain yield is formed, respectively, in the interaction of soil and plants with the Rez Free enzymatic organic bacterial

Table 1. The indicators of biomeasurements of the above-ground organs of model rice plants taken from the sections of the check plots No. 1-4 (the rice booting beginning phase), KazEr-6 variety. The soil is salted to the medium saline one under the action of the Rez Free preparation

Biometric measurements indicators	No. 1 Medium saline	No. 2 Medium saline	No. 3 Medium saline	No. 4 Medium saline
Plant height	56	52	60	55
Number of leaves	16	13	15	12
Tilling capacity	2.3	2.0	2.2	2.5
Plant weight, g.	3.378	2.826	3.702	2.848

Table 2. The effect of Rez Free compositions in combination with Chelate fertilizer (Helaphos), enzyme preparation (F) and KN2 stimulant preparation on the productivity of rice of KazEr-6 variety (local selection)

No.	Experiment Options	Grain yield, c/hectare	Mass of 1,000 grains, g
1	2	3	4
1	No. 1, RF option	48	32
2	No. 2, O option	40	31
3 (1)	No. 3, RF option	49	32
3 (2)	No. 3, RF + Chelaphos option	54	31
3 (3)	No. 3, RF + ÊÍ2 option	51	32
3 (4)	No. 3, RF + Chelaphos + ÊÍ2 option	57	32
4	No. 4, 0 option	45	31
	HCP 0.5, c		1.0
	P, %		2.0

fertilizer as combined with Chelate fertilizer (Chelaphos), an enzyme preparation (F) and KH_2 of 57 c/ha, and of 45 c/ha without its use.

In the area of check plot No. 3, where the soil had been treated only with the organic bacterial fertilizer Rez Free, the yield of rice grain was 49 c/ha, when combined with Chelaphos - 54 c/ha, when combined with KH_2 - 51 c/ha, and its combination with KH_2 and Kelafos contributed to the yield of 57c/ha, and, as a result, the increase in grain amounted to 3-4 and 8 c/ha.

On the part of the check plot No. 4 an enzyme preparation (P) was applied to the plants without the enzymatic organic bacterial fertilizer Rez Free.

Conclusion

1. The results of the field experiments conducted in the period of 2014-2015, on low-fertile soils typical for the Aral Sea region, have shown the effectiveness of the application of the enzymatic organic bacterial fertilizer Rez Free in combination with Chelate fertilizers (Chelaphos), organic enzyme (F) and the KH_2 stimulant preparation, as well as their environmental safety.
2. The use of chelate microfertilizers of the Chelaphos series in aqueous solution with foliar rise dressing, after the use of herbicides, painlessly removes the stress factor of the pesticide and
3. restores the uninterrupted course of enzymatic reactions inside plants.
4. Microelements of the Chelaphos preparation penetrating through the intercellular spaces normalize the balance of nutrition; as a result, the genetic potential is restored in plants lead-

ing to the effective use of the photosynthesis reserve products.

5. The use of Chelaphos in the leaf-feeding dressing activates the metabolism, stimulates the increase in the volume of photosynthetic products and the intensive outflow of plastic substances from the leaves to the organs of plants that need them, and contributes to the acceleration of the grains' maturation.
6. It is recommended to use the chelate complex polymer-containing microfertilizers of the Chelaphos series on the basis of phosphoric sludge and brown coal both for pre-sowing seed treatment and for the rise leaf-feeding dressing.

The obtained experimental data allow further research in this direction to determine the optimal conditions for the application of environmentally safe and productive ameliorants in the environment of the Aral Sea region.

References

- Beysenbayev, O.K., Dygay, A.V., Umirzakov S.I., Dzhamantikov Kh. *et al.*, 2015. Application for the grant of the innovative patent of the Republic of Kazakhstan to the invention "Method for the preparation of the Chelaphos-1 and Chelaphos-2 microfertilizers on the basis of technical waste". the RSE for PHV South Kazakhstan State University named after S. Ajezov of the Ministry of Education and Science of the RK. Shymkent.
- Dzhamantikov Kh., Beisenbayev, O.K., Toktamysov, A.M. and Aldanazar D.N. 2016. Vliyaniekhelatnykhmikroudobreniinaurozhaynost' risa v usloviyakhPriaral'skogoregiona [The influence of chelate microfertilizers on rice yield in the environment of the Aral Sea region]. Agricultural

- sciences and agro-industrial complex at the turn of the century: Materials of the International Conference. *Novosibirsk*. pp. 38-42
- Dzhamantikov KH., Yeleshov, R.Ye. and Usmanov, S. 2009. Effektivnost' primeneniya otechestvennogo preparata MERS nasortakhrisaiyego vliyaniyena plodorodiyepochvy [Efficiency of the application of the native MERS preparation on rice varieties and its effect on soil fertility]. *Vestnik Nauki Kazakhstana. Ser. Agr. 5* : 21-26.
- Yanishevskiy, F.V., Tuyev, N.A., DzhamantikovKh. and Dzhamantikova, T.O. 2000. The effect of ortho- and polyphosphate fertilizers on the rice yield and the phosphorous regime of meadow-bog soils of the Kazakhstani Aral Sea Region.-Almaty: *Agrochemistry*. pp. 49-52.
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