JOURNAL OF CRITICAL REVIEWS

ISSN- 2394-5125 VOL 7, ISSUE 08, 2020

COMPARATIVE EVALUATION OF THE INFLUENCE OF BIO FERTILIZERS ON *MELILOTUS* YIELD IN THE ARAL SEA REGION OF KAZAKHSTAN

Amankeldy K. Sadanov, Zhanar Sh. Zhumadilova*, Yerik Zh. Shorabaev
Karlygash M. Abdieva

LLP "Research and Production Center of Microbiology and Virology"
Bogenbai Batyr Street, 105, 050010, Almaty, Kazakhstan
*corresponding author zhanarzhumadilova@list.ru

Acknowledgements. The research was carried out at the *LLP 'Research and Production Center of Microbiology and Virology'* as part of the grant financing project AR05132366 "Study of the synergistic effect of *Melilotus* cultivation and the use of domestic biofertilizers to increase the fertility of saline soils of the Kyzylorda oblast" No. State Registration 0118PK00180.

Abstract. The present work reveals the results of field experiments. The novelty lies in the fact that the presented biological fertilizers are obtained from local indigenous strains. The work aimed to study the effect of biological fertilizers on the germination and yield of *Melilotus* varieties when cultivated in the rice crop rotation of the irrigated zone of the Kazakhstan Aral Sea region. By presowing treatment, the seeds were treated with biological fertilizers Phytobacirin and Rizovit-AKS. Phenological observations and accounting of biometric indicators revealed that during this complex treatment of seeds, the first seedlings appeared 7-17 days after sowing. Field germination of seeds in the control variant was 56.9-50.1%; before harvesting the number of plants was 95.2-89.9%. Thus, the complex treatment of seeds with biofertilizers has a synergistic effect on the yield in comparison with separate treatment with biological preparations. At the same time, seed treatment with bio-fertilizers Rizovit-AKS and Phytobacirin provides a reliable increase in the yield of green mass (431.2-440.1 c/ha).
Key words: *Melilotus*, phytomelioration, salt tolerance, soil fertility, salinity, productivity, clover

Introduction

In Kazakhstan, large-scale studies are being conducted to develop new salt-tolerant, high-yielding, high-quality *Melilotus* varieties that meet the requirements of modern agriculture and animal husbandry. In the first year of life, the growth and development rates of these plants are slow; however, one harvesting gives relatively high yields. The variety Saraichik is distinguished by large leaves, branched stems and high leafiness, and thus, has an advantage of making better use of groundwater with high salinity for growth and development (Zhumadilova et al. 2019).

When sowing *Melilotus*, special attention is paid to the quality of the seeds – they should be conditioned and purified from weeds, having good germination and high energy (Sagalbekov 2007).

Hard seeds have a shell that delays the access of water to the seed germ and, therefore, prevents their germination. They are able to not germinate in the soil for more than 5 years; however, they remain viable, and can germinate at any time in favorable conditions. Consequently, hard seeds can be a source of field contamination, since they retain germination capacity up to 20–40 years, according to the seed science laboratory at Vavilov Institute of Plant Industry (Selection and… 1976).

Mechanical impact on the shell of solid seeds is the simplest for production conditions when processing significant batches of seed material. Often in practice it is used to reduce the amount of hard seeds on various machines (clover graters, hammer crushers) that are not specifically designed for scarification. As a result, in most cases, seed germs are damaged during processing (Skalozub 2012).

The main issues of crop production are nourishing the crops, maintaining fertility and reducing soil degradation in modern conditions. Traditional agriculture is developing stably due to its strong dependence on chemicals, yet fertilizing cannot compensate for the reduction in the natural fertility of the soil under the traditional farming system. Despite the fact that fertilizers can increase productivity many times over, they negatively affect and alter soil fertility, causing irreparable damage. Thus, soils cultivated in the traditional way become more and more dependent on chemical fertilizers, and in the end, the cost – benefit ratio becomes negative. Rising fertilizer prices and an active decline in fertility due to the unreasonable use of land make farmers think about finding cheap and effective ways to saturate the soil with humus. All living things thrive thanks to the soil, but the soil itself is a

ISSN- 2394-5125 VOL 7, ISSUE 08, 2020

product of this prosperity; in other words, soil fertility is created by billions of soil bacteria, microscopic fungi, plants, insects and animals that convert minerals and organic matter into a digestible form. In order to effectively cultivate land, it is necessary to attract these little helpers, that is, to work not contrary to the laws of nature but in accordance with them. Agricultural production can be profitable only with constant growth of fertility (Harley 1959, Antanyuk 2008).

The roots of plants are surrounded by microorganisms that create a kind of cover – the rhizosphere, and are trophic intermediaries between the soil and the plant. The symbiotic relationship between the plant and the fungi is called mycorrhiza; it lets plants use a larger volume of soil. Fungus hyphae are much thinner than root hairs and, therefore, are able to penetrate the smallest pores of the soil. The fungus provides for the plant, working like a powerful pump that absorbs moisture from the soil and extracts balanced nutrients. In sum, mycorrhiza enhances root nutrition 15 times; the plant, in its turn, gives its symbiont a generous share of up to 40% of the products of its synthesis (Crovetto 1999).

Unfortunately, in some soils, certain types of beneficial microorganisms are on the brink of extinction, being replaced by microorganisms atypical for soil-forming processes and for effective interaction with plants. At the same time, pathogenic microorganisms inhabit plant roots and perform atypical functions – they do not 'feed' crops with nutrients but parasitize on the plant. In this regard, the mobilization of biological factors is becoming increasingly important and, being one of the main links in eco-agricultural production, allows for high yields while ensuring e soil fertility reproduction (Kharchenko 2011).

The reasons for using biological products in agriculture are as follows:

- environmental friendliness. They are not toxic to humans, plants, or animals, and they do not accumulate in soil or the body, since the living cultures of microorganisms integrate into the agrocenosis over time, and their metabolic products decay in 24 hours. Moreover, they do not require special protective measures – for instance, trichoderma and hay bacillus are present in the human body in large quantities;
- lack of resistance. Pathogenic insects, fungi and bacteria quickly get used to the pesticides, which reduces the effectiveness of protective measures. Biological products, on the contrary, do not allow developing immunity, thus being highly effective;
- high selectivity. When using plant protection products, exposure selectivity is very important, especially for insecticides. Every agronomist knows that the destruction of harmful insects inevitably leads to a decrease in the number of beneficial insects, and this is fraught with a shift in the ecological balance. Bioinsecticides exclude this problem, since they act selectively and destroy only a certain spectrum of pests without disturbing the natural balance;
- possibility of usage at any vegetation phase. Using plant protection chemicals often imposes certain limitations. This applies primarily to treatments during the flowering period (and immediately after), as well as before harvesting. Biological products do not have a waiting period - the fruits can be used immediately after the plants were processed; they just require being rinsed;
- high profitability. The return on costs for chemical plant protection products is on average 2.5-5 times, while in case of microbiological preparations, it is up to 30 times. This is due to several reasons: firstly, the cost of biological protection is often much lower with higher efficacy, and second, biological products differ from chemical pesticides in their complex effect; thus, the cost of the crop becomes lower. The crucial point for the issue of biological products profitability is as follows: in the future, the soil is not depleted but improved in terms of fertility (Kharchenko 2014a).

These arguments are substantial enough to start using cultures of living bacteria and fungi instead of chemical preparations. Getting acquainted with biological products based on living microorganisms and on products of their vital functions means, in fact, recruiting the nature itself to take care of plants.

The benefits of using biological products are massive and undeniable. Microorganisms on which these products are based closely interact with plants, forming mycorrhiza, and are able to perform a number of functions useful for their symbiont:

- strengthening the fixation of atmospheric nitrogen on the roots, thus replacing 30-50 kg/ha of mineral nitrogen fertilizers;
- stimulating growth and development of plants by producing physiologically active substances (ripening is accelerated by 10-15 days);
- suppressing phytopathogenic microorganisms, reducing plant susceptibility to diseases 1.5-10 times and improving the phytosanitary state of the soil;
- strengthening the resistance of plants to adverse conditions;
- increasing the utilization rates of mineral fertilizers and the intake of nutrients from the soil;
- altering soil nutrients inaccessible to plants into accessible forms (Kotlyarov et al. 2015).

ISSN- 2394-5125 VOL 7, ISSUE 08, 2020

Various methods are used to increase the germination capacity of plant seeds. Researcher E. Ates notes (Ates 2011) that mechanical scarification, deep freezing and chemical scarification using concentrated sulfuric acid for various periods of time can be included that in pre-sowing seed treatment. Deep freezing for 15 days, mechanical scarification for 5 minutes and chemical scarification for 15 minutes significantly improved the germination ratio of seeds of different flowers to 68.4-91.2%, 70.3-90.4% and 67.4 -90.1%, respectively.

Processing seeds with biological products solves key tasks for crop formation – firstly, the increase in sowing qualities of seeds (energy, germination, and viability) and second, the formation of a powerful root system (the quantity and length of roots increase, and numerous root hairs are formed in deeper and wetter layers of the soil, making it impossible to pull out a bush of wheat manually). Moreover, seed treatment can inhibit diseases mostly transmitted through seeds or through contaminated soil (Kharchenko 2014b).

The authors of the present research aimed to analyze the effect of biological fertilizers on the germination and yield of *Melilotus* varieties cultivated in the rice crop rotation of the irrigated zone of the Aral Sea region of Kazakhstan.

Materials and methods

The experimental part of the research on *Melilotus* cultivation was carried out in the Karaultyubinsk stronghold of the Kazakh Research Institute of Rice Production named after I. Zhakhaev. The soil of the experimental plots was meadow-swamp, old-arable, typical of rice systems; the humus horizon had insignificant thickness (0.4-0.5 m) with the humus content of 0.8-1.1%, which indicates low fertility. In all the variants of the experiment (four repetitions), the terrain, soil and hydrological conditions were the same. The area of the accounting plot was 50 m^2; plots for variants and variants repetitions were randomized.

The objects of research were: *M. albus* (Arkas variety) and *M. dentatus* (Saraichik variety) created by biotypic selection by Doctors of agricultural sciences G.T. G.T. Meirman and B.Mukhambetov, and biological fertilizers Phytobacirin and Rizovit-AKS created at the *LLP Research and Production Center of Microbiology and Virology* (Biological products... 2018).

Four types of pre-sowing treatment of seeds with biological fertilizers were studied in the experiment:

1) without processing (control);
2) Phytobacirin;
3) Rizovit AKS;
4) complex treatment - Phytobacirin + Rizovit AKS.

Biological fertilizers were dosed according to the instructions for their use. In Variant 4, the ratio of biological fertilizers was 1:1.

Phenological observations were carried out by eye assessment with determining the initial (10%) and the full (70%) developmental phases.

Results

In the years of research, rice was the precursor of *Melilotus* varieties. The agricultural technology of the field experiment in the rice system was carried out according to the recommendation on the spring fieldwork for diversification crops of rice crop rotation in the Kyzylorda oblast (Recommendations for ... 2011).

To achieve this goal, a research program was fulfilled to study the influence of biological fertilizers on the integrity and yield of *Melilotus*. In the course of research, censuses and observations of the growth and development of plants were carried out, and indicators of their productivity in the field experience were determined. Table 1 shows the germination of *Melilotus*.

Table 1. Effect of biofertilizers on field germination of *Melilotus* varieties (2019, average value)

Indicators	MU	Experiment variant			
		Control	Phytobacirin	Rizovit AKS	complex treatment

ISSN- 2394-5125 VOL 7, ISSUE 08, 2020

M. albus (Arkas variety)					
Field germination	pcs/m^2	227.4	364.8	330.3	385.2
	%	56.9	91.2	82.6	96.3
Plant safety	pcs/m^2	216.5	348.5	316.0	376.8
	%	95.2	95.5	95.6	98.8
M. dentatus (Saraichik variety)					
Field germination	pcs/м^2	200.5	348.3	302.9	371.5
	%	50.1	87.1	75.7	92.8
Plant safety	pcs/м^2	180.3	316.5	275.0	347.4
	%	89.9	90.9	90.8	93.5

It was revealed that for Arkas, in the control variant the field germination of seeds was 56.9% (227.4 pcs/m^2), and the plant safety was 95.2%. With Rizovit-AKS, the ratio was 82.6% (330.3 pcs/m^2); with Phytobacirin, it amounted to 91.2% (364.8 pcs/m^2). These indicators were 34.3% higher than the control (137.4 pcs/m^2 more seedlings). However, the complex treatment provided the highest results – 96.3% (385.2 pcs/m^2) of field germination, 39.4-5.1% (157.8-20.4 pcs/m^2) higher than the other options. During that year, the safety of plants before mowing reached 95.2-98.8%.

Seedlings of the Saraichik variety had low field germination as well; however, plant safety increased. In particular, in the control variant, the field germination of seeds was 50.1% (200.5 pcs/m^2), and the plant safety was 89.9%. With Rizovit-AKS, it was 75.7% (302.9 pcs/m^2), Phytobacirin, it was 87.1% (348.3 pcs/m^2). These indicators were 37% higher than in the control (147.8 pcs/m^2 more seedlings).

However, the best results were achieved with the complex treatment – 92.8% (371.5 pcs/m^2); compared with other options, it was higher by 42.7-5.7% (171-23.2 pcs/m^2).

In the course of the research, indicators of productivity in the field experiment were determined (Table 2).

Table 2. Effect of biofertilizers on the productivity of *Melilotus* varieties (2019, average value)

Experiment variant	*M. albus* (Arkas variety)			*M. dentatus* (Saraichik variety)		
	Mowing					
	1	2	Σ	1	2	Σ
Control	103.4	223	326.4	102.3	372.2	474.5
Phytobacirin	216.3	441.1	657.4	204.8	700.9	905.7
Rizovit AKS	218.5	444.0	662.5	211.9	697.5	910.4
complex treatment	230.1	434.9	665.0	215.5	699.1	914.6
MID 0.05 c/ha			5.52			5.64

In 2019, the yield of green mass was the highest with the complex use of biological fertilizers - 665.0 c/ha; it is 338.6 c/ha more than in the control (326.4 c/ha). The smallest yields of green mass of the Saraichik variety were determined in the control variant (474.5 c/ha). The individual and complex use of biofertilizers ensured high yields – 905.7 c/ha with Phytobacirin, 910.4 c/ha with Rizovit-AKS, and 914.6 c/ha with the complex use. These indicators are 431.2-440.1 c/ha more than the control option. The MID was 5.52 c/ha (Arkas) and 5.64 c/ha (Saraichik).

Discussion

The biological features allow *M. albus* Arkas and *M. dentatus* Saraichik to provide such high productivity in the most nutritious branching phase, the duration of which for the season is 120-145 days. With the complex use of bio fertilizers, productivity can be increased on average to 665-914.6 c/ha.

The research revealed that complex treatment with biological fertilizers has a positive effect on the field germination of seeds and on the safety of plants.

The advantages of Phytobacirin and Rizovit-AKS in comparison with foreign analogues are such that the microorganisms included in the composition of these fertilizers are native strains derived from local soils.

Conclusion

It is possible to increase the yield of *Melilotus* Arkas and Saraichik varieties with pre-sowing complex treatment of seeds with biological fertilizers Phytobacirin and Rizovit-AKS for strengthening the feed base.

ISSN- 2394-5125 VOL 7, ISSUE 08, 2020

Field germination of seeds with complex treatment was 96.3-92.8%; before harvesting, the plant safety was 98.8-93.5%. Thus, Rizovit-AKS + Phytobacirin provide a reliable increase in the yield of green mass by 665-914.6 c/ha.

The studies prove once again that *Melilotus* is more drought tolerant, with a shorter growing season; this allows reducing irrigation rate without significant damage to productivity.

Recommendations

When saturating the rice crop rotation with the two *Melilotus* varieties (Arkas and Saraichik), not only the productive period of hay harvesting is extended but the need for agricultural machinery, fuels and lubricants, energy resources, etc. is reduced drastically due to the technological features of *Melilotus* cultivation – lengthening the sowing period, reducing the depth and rate of sowing.

Conflict of interests

The authors would like to declare no conflict of interest.

Data availability

The **data** that support the findings of this study are available from the corresponding author upon request.

References:

[1]. Antanyuk P. 2008. Life in the field. Agriculture 10.
[2]. Ates E. 2011. Influence with solid processing on Persian clover germination (*Trifolium resupinatum ssp. Typicum Fiori et Paol*.) Romanian agricultural research 28:229–236.
[3]. Biological products for environmental protection, agriculture and medicine. 2018. Industrial Microbiology LLP 3–6
[4]. Crovetto C. 1999. Agricultura de Conservation: El grano para el hombre, la paja para el suelo [Conservation agriculture: the grain for man, the straw for the soil]. Madrid: Eumedia.
[5]. Kharchenko AG. 2011. Restoration of soil fertility. Resource-saving agriculture 3:36–40.
[6]. Kharchenko AG. 2014a. Adaptive agrobiology. Resource-saving agriculture 5.
[7]. Kharchenko AG. 2014b. To cure the land before it is too late. Resource-saving agriculture 2:17–20.
[8]. Kotlyarov VV, Sedinina NV, Donchenko DYu, Kotlyarov DV. 2015. Systemic use of drugs based on bacteria and fungi in plant protection and improving the microbiological composition of soils. Bulletin of KSAU 105:21–23.
[9]. Recommendations for spring field work in the Kyzylorda oblast. 2011. Astana.
[10]. Sagalbekov UM. 2007. Zoning of natural fodder land. Valikhanov Readings 12(7):6–7.
[11]. Selection and seed science of perennial grasses. 1976. Moscow: Kolos.
[12]. Skalozub OM. 2012. The influence of cover crops on the economic efficiency of cultivating *M.albus* forseeds. Bulletin of the ASAU 6:26–29.
[13]. Zhumadilova ZhSh, Tautenov IA, Abdieva KM, Shorabaev Y Zh, Sadanov AK. 2019. Bioproduction phytomelioration of the salted soils in rice field systems in the Aral sea region of Kazakhstan. Journal of Ecological Engineering 20(7):98–102.
[14]. Harley JL. 1959. The Biology of Mycorrhiza. London: Leonard Hill.