Testing of Forage Crops Resistant to Abiotic Factors in the Aral Sea Region with a Harsh Ecological Environment

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Abstract. As a result of the decrease in water in the Aral Sea, deserts covering millions of hectares have formed. Currently, more than half of the irrigated lands in Uzbekistan are saline to varying degrees. In addition, the republic is facing increasing problems such as water scarcity and anomalous summer heat year after year. Naturally, in water-scarce and saline lands, the possibilities of obtaining high yields from agricultural crops, including fodder crops, are diminishing. One of the important tasks for agriculture is to develop agrotechnology for growing varieties of fodder crops suitable for livestock, such as alfalfa, white sorghum, fodder beet, and rye, adapted to local soil and climatic conditions in the Aral Sea region. For this reason, the Kibray variety of alfalfa and the Shalola variety of rye, developed at our institute, were sown using various methods on the dried bottom of the Aral Sea and in the surrounding areas. In addition, several local and foreign varieties and samples of suitable crops were sown and studied to select crops resistant to abiotic factors appropriate for the region.
This article presents the data obtained from work carried out in experimental nurseries planted using different methods on the dried bottom of the Aral Sea and in the surrounding areas.
Keywords: dried bottom of the Aral Sea, Aral Sea region, livestock breeding, fodder base, fodder crops, seed farming, yield

1. INTRODUCTION

In order to achieve the intended indicators for improving livestock productivity, first of all, it is necessary to have a strong feed base. In general, the feed base plays an important role in the successful development of the livestock sector. The main portion of feed for livestock is grown on agricultural lands. Therefore, the effective use of agricultural land and achieving high yields from forage crops are among the urgent tasks. To obtain high yields from forage crops, it is necessary to conduct primary seed production work on a scientific basis by variety. In recent years, abiotic factors observed in nature, such as water scarcity and soil salinity, have been negatively affecting the yield of forage crops along with other agricultural crops. Such changes on the Earth's surface are impacting the efficient use of land and water resources, as well as increasing the productivity and quality of forage crops. This, in turn, requires ensuring food product safety and improving consumption rations, increasing soil fertility, preserving and protecting it. The decrease in the water level of the Aral Sea has been observed to have negative consequences not only for the ecology of Uzbekistan but also for the ecology of the entire world. On the dried-up lands of the Aral Sea, millions of hectares have turned into deserts. Recent studies show that about 53 percent of irrigated lands in Uzbekistan are salinized to various degrees, and in nearly 69 percent of topsoil, the humus content is only 0.5-1 percent. For information, as of October 1, 2020, 44.7 percent of irrigated lands in Uzbekistan were salinized to various degrees, specifically 31.0 percent slightly, 11.9 percent moderately, and 1.9 percent strongly salinized (https://kun.uz/kr/45695026). Depending on the degree of salinity, the yield potential of corn and other agricultural crops can decrease by 2-4 times.

In recent years, global warming has been observed to have a negative impact on the ecological environment of our planet. As a result, during the summer season, air temperatures rise and the demand for water increases, leading to drought and a decrease in the productivity indicators of agricultural crops. Under these conditions, alfalfa, sorghum, fodder beet, and rye have an advantage over other crop species in terms of their biological characteristics and nutritional value. Alfalfa plays an important role in maintaining soil fertility through crop rotation.

The livestock sector also occupies a special place in the share of gross agricultural output of Uzbekistan, playing an important role in providing our people with valuable food products. Therefore, further development of animal husbandry, increasing livestock productivity, and significantly increasing the volume of livestock production are among the important tasks of today. For this purpose, it is crucial to create a stable feed base in the sector and increase the feed units produced per hectare of land, taking into account soil and climatic conditions.

Improving the feed base in animal husbandry requires obtaining high yields of fodder crops on agricultural lands allocated for feed production. To achieve high yields of fodder crops and increase the feed units obtained per hectare, it is crucial to correctly select fodder crop types and varieties suitable for the soil and climatic conditions of each region, as well as to sow high-quality seeds. It is known that in conditions of extremely high temperatures, water scarcity, and saline soil, corn, which is an important fodder crop in animal husbandry, may reduce its yield potential to a certain extent.

Initial sources are of great importance in creating new high-yielding varieties of fodder crops. For selection processes, it is necessary to thoroughly study the initial sources to properly choose the starting materials.

For testing at the zero point on the dried bottom of the Aral Sea and in the Aral Sea region, the Qibray variety of alfalfa and the Shalola variety of rye, both fodder crops created at the institute, were sown using various methods. Their seeds were sown in fields treated with various local and foreign preparations. Additionally, to correctly select crop types and varieties suitable for this region, local and foreign varieties and samples of fodder crops resistant to water scarcity and soil salinity were sown.

Primary seed production work was carried out on new varieties created at the institute's experimental farm.

LITERATURE REVIEW

To increase the cultivation of food crops on irrigated lands of Uzbekistan, crop types and varieties were selected for green mass harvesting and planting of repeated crops. Their influence on soil biological activity, the effect of crop rotation on cotton wilt disease and yield were studied by N.A. Malitsky (1969), B.Yu. Dimitrov (1969), A. Davlatov (1971), I.V. Massino, I.S. Sultanov (1971), I.S. Sultanov (1976), A.S. Kholiqov (1976), E.P. Gorelov, I.R. Rasulov (1980), and others.

V.G. Berezovsky, M.A. Sorokin (1969), as well as a number of authors including V.S. Khankishev (1970), V.G. Berezovsky, N. Sofiev (1971), Kh.R. Romanov (1973), Kh.I. Boyqobilov (1975), A.S. Bolkunov (1986), R. Tillyaev, A. Ligay (1987), M. Tojiev (1991), A.M. Qo'chqorov (1993), Umbetaev I., Guseynov I., Makhmadzhanov S., Zolina V (2013) emphasize that annual fodder plants used in cotton crop rotation are important in increasing soil fertility.

In order to improve the food supply in saline soils, M.I. Annaeva, F.N. Toreev, M.M. Yakubov, B.D. Allashov, N. Mavlonova conducted research on the development of agricultural technology for growing Melilotus albus. Studies have found that on saline lands, *Melilotus albus* produces a higher yield than alfalfa.
The article presents data obtained from testing crotalaria samples in the Aral Sea region. The experiments were conducted on moderately saline soils and yielded good results.
Experiments were conducted on the combined sowing of white sweet clover with cereal crops and their effect on cattle productivity. The article presents the data obtained as a result of these experiments.
B.D. Allashov, M.Kh. Zulfikarov, F. Toreev conducted research on the development of agricultural technology for growing fodder crops resistant to drought and salinity, studied crops for different varieties and rates of white sweet clover "Kibray," oats "Uzbek broadleaf," rye "Shalola," triticale "Prague silver" and corn "Uzbekistan-2018." The economic efficiency of each option was considered. An effective option for sowing white sweet clover in combination with cereals and legumes has been identified.
Scientists of the All-Russian Institute of Plant Growing (ARIPL) conducted research in Russian conditions on 15 varieties of sweet clover in terms of green mass, dry mass, and protein yield per hectare. Out of the 15 studied varieties, 3 varieties showed good results. The "Sretensky" variety yielded 549, 122.4, and 20.7 c/ha, the "Grozinsky" variety yielded 499, 125, and 16.8 c/ha, and the "Shaveken" variety yielded 446, 100.8, and 16.0 c/ha, respectively.
According to the data from the Orenburg Agricultural Research Institute (Orenburg ARI), sweet clover can produce up to 30 t/ha of green mass even in areas with water scarcity, providing the possibility to obtain 5 tons of feed units per hectare.
When cultivating cereal crops, their phytomass contains 70-80 g of digestible protein per feed unit. According to zootechnical standards, there should be 105-115 g of digestible protein per feed unit. The phytomass of Qashqarbeda contains up to 180 g of digestible protein per feed unit. In addition, the composition of qashqarbeda is rich in calcium, phosphorus, iron, zinc, copper, as well as vitamins A, B, E, and PP groups. Furthermore, the coumarin substance contained in qashqarbeda helps prevent feed spoilage and aids in better digestion when consumed by livestock. The protein content of qashqarbeda is similar to that of chicken eggs in terms of composition, and its amino acid content surpasses that of chickpeas, vetch, and soybeans (V. Trots, M. Trots 2003). Qashqthe content of oqin watermelon exceeds the content of jihin chickpeaq in chickpeaqin eggs, amino acid miqin chickpeahin chickpea, vetch and soybeans (V.Tros, M.Tros 2003).
According to E.I. Chekel, P.V. Yakimets, R.A. Kishko, the nutritional value of sweet clover (white melilot) is not inferior to that of alfalfa and fodder clover. One kilogram of sweet clover green mass contains 0.23 feed units, while 1 kg of hay contains 0.50 feed units. During the budding period, it contains 170 g of digestible protein. In Belarus conditions, the average yield is 350-450 c/ha. Sweet clover serves to strengthen the feed base in animal husbandry and is also important in agriculture, like other legumes. It has the ability to accumulate nitrogen in its roots, and when grown for 2 years, it leaves plant residues containing 0.3% nitrogen, 0.05% phosphorus, and 0.3% potassium. The roots accumulate 150-200 kg/ha of nitrogen, which is equivalent to applying 30-40 tons of manure. Furthermore, it improves soil water permeability by 20-30%, enhances moisture retention in the soil up to 1 m depth, increases exchangeable calcium by 20% in the top 35 cm of soil, and increases soil biological activity by 1.2-2 times.
The importance of biological nitrogen in world agriculture is very significant. Even in Western European countries, where 1-1.2 tons of mineral fertilizers are applied per hectare, only 25% of the plant's nitrogen requirement is met by mineral fertilizers. In the future, as the productivity of agricultural crops increases, their nitrogen requirements will also increase. In agriculture, solving the problem of plant protein is important through the

fixation of atmospheric nitrogen by free-living and nodule bacteria in the roots of leguminous crops. The introduction of atmospheric nitrogen into biological nitrogen causes an increase in the protein content of plants.

According to V.B. Trots and R.R. Abdullaev, cattle eat sainfoin well, consuming up to 50-60 kg per day. When fed with sainfoin, dairy cows' daily milk yield increased by up to 3 liters. They also write that the famous Swiss cheeses are made from the milk of cows fed with sainfoin.

Animals enjoy consuming the green mass of sainfoin, and its green mass is used for hay, haylage, and silage. 1 kg of green grass contains 19 feed units, 3.3 g of calcium, 0.8 g of phosphorus, 45 mg of carotene, and 1 feed unit contains 163 g of protein. 1 kg of hay contains 0.46 feed units, 110 g of digestible protein, 13.7 g of calcium, 2.2 g of phosphorus, 35 mg of carotene, and 1 feed unit contains 239 g of protein (M. F. Tomme).

A.S. Golub and I.A. Donets (2016) studied the chemical composition of the dry mass of sainfoin grown on black soil lands of Russia. They found that it contained 20.6-21.9% crude protein, 2.2-2.5% fat, 21.1-22.4% fiber, 8.2-11.2% ash, 2.0-2.2% calcium, 0.6-0.7% phosphorus, and 36.9-39.0% nitrogen-free extractive substances. It was established that 1 kg of dry mass contained 0.66-0.71 feed units and 164.8-180.0 g of digestible protein.

To further improve the feed base in animal husbandry, it is advisable to follow this system for cultivating fodder crops and establishing seed production: original, super-elite and elite seeds should be produced at research institutes, their experimental farms or branches; first, second and third generation seeds at farms specializing in fodder crop seed production; and subsequent commercial seeds at livestock farms or farms engaged in mass seed multiplication and sales. If this system is properly implemented and good relations are established between these organizations, it will be possible to achieve the intended goals in cultivating fodder crops and their seed production, according to N.S. Aytuganov (2013).

1. Methods

Research was conducted in the Aral Sea region, on the dried bottom of the Aral Sea, and in the experimental field of the institute. The research objects were varieties created at the institute, as well as varietal samples of food crops obtained from the National Genbank and from abroad. The Qibray variety of alfalfa and the Shalola variety of rye were sown in the Aral Sea region after being treated with various preparations. Experimental nurseries were established with 4 replications for all variants. Field experiments were carried out according to the Dospekhov (1985) method. Analyses

2. Analyses

In the Aral Sea region and on the dried-up seabed of the Aral Sea, land was selected for experiments at the zero point to test the Qibray and Shalola varieties of fodder crops such as alfalfa and rye created at the institute. Measures were taken to establish experimental nurseries on the selected lands, and a selection nursery for fodder crops was organized. Alfalfa and rye crops were sown in four replications in the selection nursery. Fodder crop seeds were sown using various treatments according to the following schemes: The Shalola rye variety seeds were treated with preparations such as Probiofito, Teriya-S, and Fitovak; seeds were moistened and treated with mycorrhiza; seeds were treated with infrared light; two types of hydrogels, organic fertilizer "Udachniy sezon," and local biohumus were applied to the sowing furrows. In the control variant, seeds were not treated, and nothing was applied to the sowing furrows; manual sowing was carried out under natural conditions using the conventional method. All variants were repeated in four replications. The sowing scheme for the Shalola rye variety is presented in Scheme 1 below. The experimental variants were sown on September 29, 2025. Sowing of experimental variants was carried out on September 29, 2025.

The Shalola rye variety is a new variety created by scientists of the Research Institute of Animal Husbandry and Poultry Breeding and has been included in the State Register since

2021. This variety can be sown in spring and autumn, and its grain can be used as nutritious feed for livestock, while its straw can also be used as roughage for livestock.

Diagram 1. Scheme for sowing the Shalola variety of rye on the dried bottom of the Aral Sea

10	9	8	7	6	5	4	3	2	1
Biohumus	Organic Fertilizer "Udachniy sezon"	Hydrogel-2	Hydrogel	Irradiated	Mycorrhiza	Phytovac	Control	Teriya-S	ProBioPhyto
10	9	8	7	6	5	4	3	2	1
Hydrogel	ProBioPhyto	Mycorrhiza	Biohumus	Teriya-S	Organic Fertilizer "Udachniy sezon"	Irradiated	Hydrogel-2	Phytovac	Control
10	9	8	7	6	5	4	3	2	1
Mycorrhiza	Phytovac	Teriya-S	Irradiated	Control	ProBioPhyto	Hydrogel-2	Biohumus	Hydrogel	Organic Fertilizer "Udachniy sezon"
10	9	8	7	6	5	4	3	2	1
Phytovac	Mycorrhiza	Organic Fertilizer "Udachniy sezon"	Teriya-S	Hydrogel-2	Hydrogel	Control	Irradiated	ProBioPhyto	Biohumus

On the dried bottom of the Aral Sea, the Kibray variety of Kashgar alfalfa was also sown using various methods according to the following scheme 2.

Diagram 2 Planting scheme of the Kibray variety of Kashgar alfalfa on the dried bottom of the Aral Sea

10	9	8	7	6	5	4	3	2	1

Phytovac	Mycorrhiza	Organic Fertilizer "Udachniy sezon"	Teriya-S	Hydrogel-2	Hydrogel	Control	Irradiated	ProBioPhyto	Biohumus
10	9	8	7	6	5	4	3	2	1
ProBioPhyto	Control	Hydrogel	Biohumus	Irradiated	Organic Fertilizer "Udachniy sezon"	Phytovac	Teriya-S	Hydrogel-2	Mycorrhiza
10	9	8	7	6	5	4	3	2	1
Mycorrhiza	Phytovac	Teriya-S	Irradiated	Control	ProBioPhyto	Hydrogel-2	Biohumus	Hydrogel	Organic Fertilizer "Udachniy sezon"
10	9	8	7	6	5	4	3	2	1
Hydrogel-2	ProBioPhyto	Organic Fertilizer "Udachniy sezon"	Hydrogel	Biohumus	Phytovac	Mycorrhiza	Control	Irradiated	Teriya-S

In the Aral Sea region, the Shalola variety of rye was sown in 4 replications with different variants according to the following scheme 3 on the land of the "Qayrat tabisli" farm of the Kokuzak APJ in the Kegeyli district of the Republic of Karakalpakstan.

Scheme 3. Sowing scheme of the Shalola rye variety in the Aral Sea region

7	6	5	4	3	2	1
Control	Mycorrhiza	Phytovac	ProBioPhyto	Hydrogel	Irradiated	Teriya-S
7	6	5	4	3	2	1

Hydrogel	ProBioPhyto	Mycorrhiza	Phytovac	Teriya-S	Control	Irradiated
7	6	5	4	3	2	1
Irradiated	Teriya-S	Hydrogel	Control	ProBioPhyto	Phytovac	Mycorrhiza
7	6	5	4	3	2	1
Phytovac	Irradiated	Teriya-S	Control	Mycorrhiza	ProBioPhyto	Hydrogel

The experimental nursery planting was carried out on September 27, 2025. Observation and control work on germination was conducted in the experimental nursery under field conditions. Some differences in germination time were observed between the variants. The differences in emergence observed as a result of the observations are reflected in Diagram 1 below.

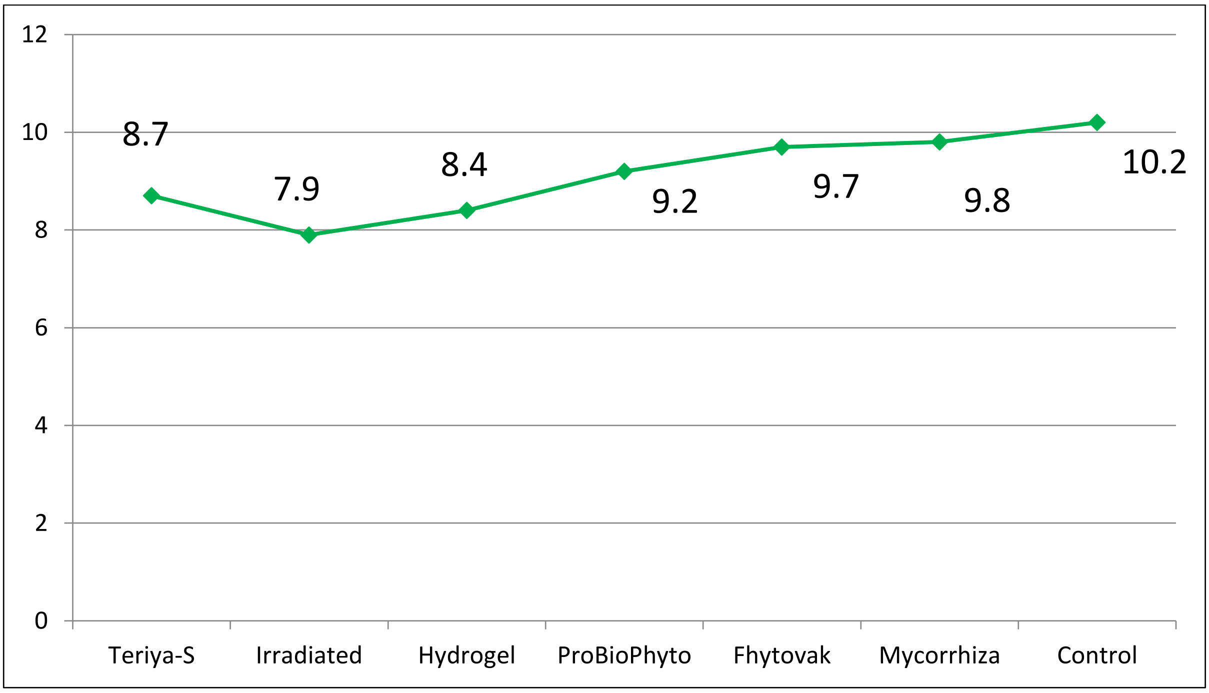

Diagram 1. Average indicators of field germination of the Shalola rye variety seeds (days)

From the data of Diagram 1 above, we can see that the average germination rate of the Shalola rye variety under field conditions for 4 replications was as follows: in the variant sown with Teriya-S preparation treatment - 8.7 days, in the variant sown with infrared irradiation - 7.9 days, in the variant sown with hydrogel application in the furrow - 8.4 days, in the variant sown with Probiofito treatment - 9.2 days, in the variant sown with phytovac

treatment - 9.7 days, in the variant treated with mycorrhiza - 9.8 days, and in the control variant sown using the conventional method - 10.2 days on average. Thus, treating crops with preparations before sowing affects seed germination in field conditions. In this case, when seeds were irradiated with infrared rays before sowing, they germinated 2.3 days earlier than the conventional method. When sown with hydrogel, they germinated 1.8 days earlier, and when sown after treatment with the Teriya-S preparation, they germinated on average 1.5 days earlier than the control variant. This, of course, will subsequently affect the growth and development of the plant.
In the same farm, the Qibray variety of alfalfa was also sown in various variants with 4 replications according to the following scheme.

Diagram 4. Sowing scheme of the Qibray variety of alfalfa in the Aral Sea region

7	6	5	4	3	2	1
Control	Mycorrhiza	Phytovac	ProBioFito	Hydrogel	Irradiated	Teriya-S
7	6	5	4	3	2	1
Hydrogel	ProBioFito	Mycorrhiza	Phytovac	Teriya-S	Control	Irradiated
7	6	5	4	3	2	1
Irradiated	Teriya-S	Hydrogel	Control	ProBioFito	Phytovac	Mycorrhiza
7	6	5	4	3	2	1
Phytovac	Irradiated	Teriya-S	Control	Mycorrhiza	ProBioFito	Hydrogel

The experimental nursery planting was carried out on September 27, 2025. Observation and control work was conducted in the experimental nursery under field conditions to monitor germination. Some differences in germination time were observed between the variants. The differences in emergence identified as a result of the observations are reflected in Diagram 2 below.

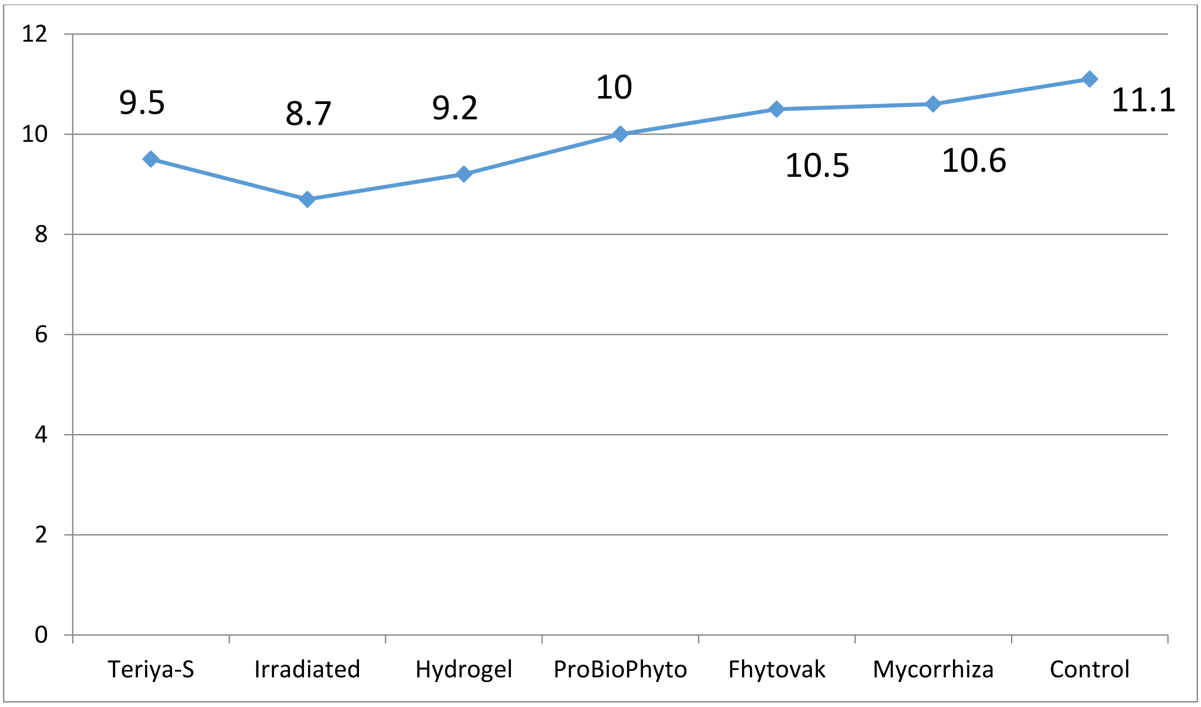

Diagram 2. Average indicators of field germination (in days) for seeds of the Kibray variety of alfalfa

From the data presented in Diagram 2 above, we can see that the germination of the Kibray variety of alfalfa in field conditions, based on the average indicator for 4 replications, took 9.5 days in the variant treated with the Teriya-S preparation, 8.7 days when sown after infrared irradiation, 9.2 days when hydrogel was applied to the furrow, 10 days in the variant treated with Probiofito, 10.5 days in the variant treated with phytovac, 10.6 days in the variant treated with mycorrhiza, and an average of 11.1 days in the control variant sown by the usual method. Therefore, treating crops with preparations before sowing affects seed germination in field conditions. In this case, when seeds were irradiated with infrared rays before sowing, they germinated 2.4 days earlier than the usual method, when sown with hydrogel application, they germinated 1.9 days earlier, and when sown after treatment with the Teriya-S preparation, they germinated an average of 1.6 days earlier than the control variant. When seeds were sown after treatment with pre-sowing preparations, a positive effect on germination was observed.

Furthermore, in this farm, various local and foreign varieties and samples were sown and studied to select suitable crop types, good varieties, and samples that match the soil and climate conditions of this region. Foreign and local varieties and samples of fodder crops were sown according to the following scheme 5.

Scheme 5 Sowing scheme of food crops in the "Kayrat tabisli" farm of Kokuzak Agricultural Production Unit, Kegeyli district, Republic of Karakalpakstan

11	10	9	8	7	6	5	4	3	2	1
10 rows	2 rows	2 rows	2 rows	2 rows	2 rows	2 rows	1 row	2 rows	5 rows	4 rows

Protection zone - red clover
Broad bean (horse bean) - Tundra variety
Winter chickpea
Sainfoin - new strain
Leafy cabbage
Clover (red clover)
Phacelia - new sample
Mustard - new sample
Rapeseed - new sample
Fodder beet - Uzbekistan-83 variety
Mixture of cereals and legumes

The experimental nursery planting was carried out on September 27, 2025. Red clover was sown in 4 rows as a protection zone at the beginning of the experimental plot. Then, 5 rows of broad bean Tundra variety imported from the Netherlands, 2 rows of new winter chickpea sample imported from Germany, 1 row of local new sainfoin sample, 2 rows of new imported winter leafy cabbage sample, 2 rows of local new red clover sample, 2 rows of new foreign phacelia sample, 2 rows of new foreign mustard sample, 2 rows of new foreign rapeseed sample, 2 rows of fodder beet Uzbekistan-83 variety, and 10 rows of cereal and legume crops mixture, including alfalfa, oats, and triticale, were sown. Observation and control work on germination under field conditions was carried out in the experimental nursery (Diagram 3).

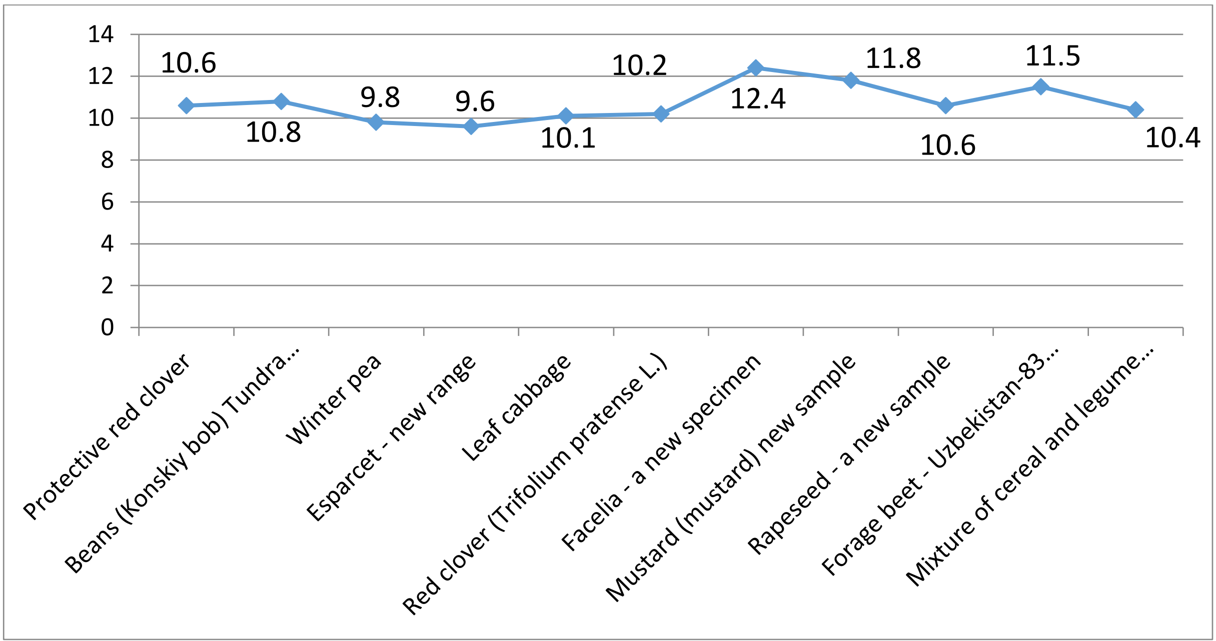

Diagram 3. Average indicators of seed germination of local and foreign varieties and samples under field conditions (days)

From the data presented in Diagram 3 on the germination of local and foreign varieties and samples of fodder crops, we can see that all varieties and samples germinated well, including red clover planted in the protected zone on average in 10.6 days, the foreign variety of beans in 10.8 days, a new sample of winter peas imported from abroad in 9.8 days, a new local sample of sainfoin in 9.6 days, a new sample of winter leaf cabbage imported from abroad in 10.1 days, a new local sample of red clover in 10.2 days, a new foreign sample of phacelia in 12.4 days, a new foreign sample of mustard in 11.8 days, a new foreign sample of rapeseed in 10.6 days, the Uzbekistan-83 variety of fodder beet in 11.5 days, and a mixture of legumes and cereals in 10.4 days.

3. CONCLUSION

Based on the conducted research and the obtained results, the following conclusions can be made:

- It has been established that the varieties of fodder crops created at the institute, namely the Shalola variety of rye and the Kibray variety of alfalfa, grow well even in the Aral Sea region, where the ecological conditions are difficult;

- Sowing the Shalola rye variety after treating the seeds with preparations gives good results, particularly when treated with the Teriya-S preparation, germination is observed on average 1.5 days earlier than in the control variant;

- қашқарбеданинг Қибрай нави уруғларини ҳам Оролбўйи ҳудудида экиб етиштиришда препаратлар билан ишлов бериб экиш яхши натижа бериши, Teriya-S препарати билан ишлов бериб кейин экилганда назорат вариантига нисбатан ўртача 1,6 кунга, инфрақизил нур билан нурлантириб экилганда 2,4 кунга эртароқ, гидрогел қўллаб экилса эса 1,9 кунга эртароқ униб чиқиши аниқланган;

- More than 10 varieties and samples of fodder crops planted for testing in the region of the Aral Sea region germinated on average in 10.6 days, including red clover in 10.8 days, foreign variety of beans in 10.8 days, qnew sample of winter peas imported from abroad in 9.8 days, fresh sample of sainfoin in mahallium in 9.6 days, qnew sample of winter leaf cabbage imported from abroad in 10.1 days, qnew sample of red clover in mahnew sample of allium in 10.2 days, foreign fresh sample of facilities in 12.4 days, foreign fresh sample of mustard in 11.8 days, foreign fresh sample of rapeseed in 10.6 days, hthe Uzbekistan

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