AFoCO Project Document

Project code	*AFoCO/020/2020*

Project Profile			
Project title	**Investigation of the resistance of black saxaul (Haloxylon aphyllum) forms to gall-forming insects**		
Project duration	Start date: 1 October 2020 End date: 30 September 2022		
Implementing Agency	A.N. Bukeikhan Kazakh Research Institute of Forestry and Agroforestry (A.N. Bukeikhan KazRIFA)		
Participating countries	Kazakhstan		
Project site	Kyzylorda region		
Main objective	Study the resistance of individual black saxaul plants within a species to damage of insect gall-forming plants		
Thematic areas	• Forest Disaster Management		
Budget and source of finance	Total: US $32,864 - AFoCO: US $ 32,864 - National: N/A - Others: N/A		
Proponent Profile			
Name/ Position	Ms.: Krekova Y.A. Position: Research Leader		
Organization	A.N. Bukeikhan Kazakh Research Institute of Forestry and Agroforestry (A.N. Bukeikhan KazRIFA)		
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Abbreviation and Acronyms

A.N. Bukeikhan KazRIFA	A.N. Bukeikhan Kazakh Research Institute of Forestry and Agroforestry

Summary

Among the types of sand forests, saxaul occupies the most. It is saxaul which forms a special zonal type of desert vegetation, the so-called saxaulniki (saxauls). Saxaul - the most important forest-forming species of deserts, with economic use, and the sand-strengthening role of saxaul is widely known.

The fauna of insect pests of saxaul is represented by a large number of multinivorous and specialized species that damage the roots, vegetative and generative organs. In 2019 sanitary surveys, the fossils in the saxaul of Kazakhstan were formed by the saxaul gall midge. Earlier, in the south-east of Kazakhstan, 213 forms of galls were found, caused by echoptera proboscis, coleoptera, hymenoptera, diptera, lepidoptera, and mites. Of these, 71 on the soil, 64 on the shoot , 44 on the leaves, 15 on the flowers, 6 on the seeds, 1 on the roots. In previous studies, organizational, technical, agricultural, chemical and biological measures were proposed. But scientific works by identifying resistant plants within a species to this group of insects in Kazakhstan were not conducted.

The goal of this research is to study the resistance of specified black saxaul plants among the species damaged by gall-forming insects.

Tasks:

1) Analysis of the pest foci and clarification of the species composition of gall-forming pests in the foci of saxaul, the allocation within the population of individual plants of saxaul not damaged by pests in the lesion;

2) Carrying out laboratory tests for biochemical composition in plants and their genetic structure, as well as the study of anatomical and morphological features of plants not damaged by pests;

3) Collection of planting materials from resistant plants within the species for the possibility of further study of the heritability of this property.

Results:

Resistant plants will be identified, anatomical and morphological features, biochemical properties and genetic structure will be established. Proposals will be made for the specific resistant forms of saxaul plants.

Section A. Project Context and Need Analysis

1. Background and Research Context

According to the State Enterprise "Republican Forest Breeding and Seed Center" as of November 15, 2019, the areas of foci of the saxaul gall midge were spread over 12,672.5 ha, of which 11,963.5 ha were concentrated in the Kyzylorda region. Infected plants were greatly weakened, sharply reduced growth, decreased fruiting and amount of seeds. With gall midges,

control measures are very difficult. In valuable plantings, they can be destroyed by trimming galls with larvae and spraying with intrasystemic insecticides. At the biological level, the number of insects forming galls mainly depends on the activity of beneficial insects (equestrians, carnivores, ladybugs), the application of which involves intrarenal resettlement.

In previous researches it was emphasized that selectivity damage of individual plants of saxaul. Therefore, the question arises about the insensitivity of some trees in this group pests. It is necessary to examine existing pest foci in order to identify resistance to saxaul damage by gall formers of individual plant specimens within the species.

2. Problem Statement

The nature of the responses of plants to damage by pests (the formation of chemical, mechanical and growth barriers, the ability to regenerate damaged tissues, replace lost organs) plays an important role in the immunity of plants to insect pests. So, a number of metabolites (alkaloids, glycosides, terpenes, saponins, etc.) have a toxic effect on the digestive apparatus, endocrine and other systems of insects and other plant pests.

With the advent of modern equipment and new teaching methods, it became possible to study plant resistance to damage by pests at a high level. These studies will help to reveal the concept of the specificity of saxaul resistance.

3. Specific Research Objectives

Perhaps some of the trees are resistance to this group of pests, and plant some way ruining testicles, deferred by insect galls formed insects. The aim of the project is to determine the factors causing the damage to individual plants for subsequent breeding and propagation of the saxaul cultivar resistant to this group of pests. When choosing resistant forms of plants, it is necessary to focus primarily on the specifics of local conditions that determine the pathogen aggressiveness.

Plant resistance is due to both structural and functional characteristics of the body, and a deep restructuring of its physiological processes associated with changes at the molecular and cellular levels. Therefore, in this study, laboratory studies aimed at studying the biochemical composition and molecular genetic analysis of plant tissues are also necessary.

Section B: Materials and Methodologies

1. Literature Reviews

In a number of previous studies it was identified the species composition of insects and especially it was studied biology and harmfulness of the most abundant species, one of which is arthropod-gall formed insects. Most of the harmful species are *Caillardia azurela*, *C. robusta*, *Stefaniola deforans*, *Halodiplosis vernalis*, and *H. Inornata*.

With mass lesion *C. azurela* a certain part of saxaul's energy storage is alienated to form galls to the detriment of the normal development of the plant. Affected plants are greatly weakened, growth is sharply reduces. *C. robusta* everywhere and constantly in massive quantities affects saxaul. This type is most harmful when populates to bushes with *C. azurela*. At the same time, bushes affected in the complex by two pests are dry out by the end of the growing vegetation.

The larvae of the *S. deforans* cause the formation of single-chamber oblong galls. In subsequent years, the affected branches break off. The gall midge of these species is one of the primary pests of saxaul and is found everywhere.

H. vernalis is one of the serious pests of saxaul, which forms foci with high numbers. It mainly affects fruiting young and middle-aged bushes of black saxaul. And because of the mass damage, the plants are oppressed and it is noted that many galls develop in years especially favorable for fruiting.

In the south-east of Kazakhstan midge *H. inornata* causes the development of a small cone-shaped gall in place of the flowers of black, white and Zaisan saxaul. Its number is uneven in different areas of saxaul growth, and it is spread by foci, and the plants themselves are selectively affected. Gall has a direct negative effect on the crop, directly reducing the fruiting and number of seeds, interferes with their collection and inhibits the growth of saxaul. Given that saxaul abundantly bears fruit every 5-7 years, the harm caused by saxaul gall midge becomes obvious.

An interesting peculiarity was noted for these species, that once the gall midge infestation of individual plants is significant, while completely healthy bushes can be nearby. Therefore, the question arises of isolating and studying this feature of individual plants of the species. Scientific research in this direction was not carried out for black saxaul in Kazakhstan, which is going to be the purpose of this project.

2. Information on Project Target Area and Criteria for Site Selection

Available information on foci in the study area with survey areas will be examined. A comprehensive study of saxaul forests will begin with a reconnaissance survey of the foci. The purpose of this study is to obtain general information about the nature of saxaul damage in the territory where the research is supposed to be carried out, to establish correspondence between the available cartographic data, forest inventory materials and the actual distribution of various foci. Detailed examinations will be carried out in typical locations. In order to solve the tasks, it is necessary to conduct 2 trips a year - in May-June and September-October.

In natural saxaul forests, plants have several eco forms. There are forms that are resistant to diseases and pests or single plants (individual resistance) that have good seed quality and high taxation rates, which is very important for genetic research and for working in the first stages of breeding.

During the implementation of this project, the identification of the genomic constitution of saxaul is to be provided, as it has not been studied before. This stage will serve as a prerequisite for the identification of the gene for resistance to a certain type of insect in

further studies, since the genome of higher plants is huge and it will take much more time to study this issue.

3. Research Design and Methodology

Objective 1: Analysis of the pest foci and clarification of the species composition of gall-forming pests in the foci of saxaul, the allocation within the population of individual plants of saxaul not damaged by pests in the lesion.

Methodology: field and laboratory studies of fauna will be conducted using methods: hand-picking, a visual inspection. With collected galls, it is supposed to anesthetize in 70% alcohol in previously prepared bottles and then determine the type of insect in the laboratory.

In the field, the phenotypic variability of damaged and healthy plant specimens, structural features of the plants, taxation characteristics and a general description of the growing conditions of the studied plants will be visually studied. Field studies will be carried out by methods of forest inventory and botany.

Conduct laboratory methods for detecting the presence of metabolites, saxaul and its degree of toxicity, as well as molecular genetic studies will be performed by employees of third-party laboratories with the Korean side.

Seed harvesting will be carried out in accordance with the recommendations for selection and seed production of black saxaul in South Kazakhstan.

Section C: Implications and Contributions to Current Body of Knowledge

1. Expected Outcomes and Outputs

As a result of the research, resistant plants will be identified, their anatomical and morphological features, biochemical properties and genetic structure will be established. Proposals will be made on the allocation of resistant forms of saxaul plants.

2 seminars will be held with employees of regional forest institutions. Will be prepared to the publication of an article in the foreign and domestic scientific journals, as well as publications in the media.

2. Practical Implications

The use of pest-resistant forms of saxaul is an essential part of an integrated plant protection system and must necessarily be one of the foundations of environmental protection, since it does not pose any danger to ecosystems and can be highly effective. Therefore, an understanding of the factors manifesting the resistance of individual plants to damage by insects of gall formers will improve the sanitary state of saxaul plants and increase its bearing.

Isolation of economically valuable forms of saxaul (not damaged by pests) is the initial stage for creating sustainable plantings. The need for widespread use of resistant forms of

saxaul is due to the need for highly productive plantations, field and pasture forestation, the creation of green umbrellas, the protection of settlements from drifting sand, etc.

3. Theoretical Implications

The obtained knowledge in this direction will expand understanding of looking at the interaction between insects and plants. The establishment of factors affecting the resistance of black saxaul plants will serve as the scientific basis for a practical solution to the problem. The results of the study will help to increase the level of professional training of forestry worker

Section D. Research Budget of Objectives/Outputs/Activities

1. Work Plan and Schedule

Outputs	Performance Indicator	Responsible Person/ Body	Annual Timeline								Remarks
			2020	2021				2022			
			Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	
Objective 1: Study of the resistance of individual black saxaul plants to damage of insect gall-forming plants											
Output 1: Analysis of the pest foci and clarification of the species composition of gall-forming pests in the foci of saxaul, the allocation within the population of individual plants of saxaul not damaged by pests in the lesion											
A.1: Analysis and processing of collected secondary data through in-house researchers of A.N. Bukeikhan KazRIFA	*Consolidated and analyzed data report and publication in the scientific journal of Kazakhstan*	*A.N. Bukeikhan KazRIFA*									In the Project Document it was not reflected correctly by Q. This version is correct.
A.2: Field survey and collection of plant samples in the research area (Kyzylorda Region)	*3 field surveys conducted and 3 reports prepared*	*A.N. Bukeikhan KazRIFA*									
A.3: Ananlysis and processing of secondary and field survey data through engagement of an experts on saxaul and gall formed insects	*ToR developed and experts engaged*	*A.N. Bukeikhan KazRIFA*									
A.4: Conduct of site monitoring in Q2 of each year	*2 field surveys conducted and 2 reports prepared*	*A.N. Bukeikhan KazRIFA*									
A.5: Consolidation and analysis of field survey results	*Consolidated and analyzed field survey results*	*A.N. Bukeikhan KazRIFA*									
A.6: Engagement of local guide	*ToR developed and experts engaged*	*Forestry agency of Kyzylorda region*									
A.7: Translation services	*translation of documents into English*										In 2021, the task was moved from Q2 to Q3, because the service is necessary for the correction and correct presentation of the scientific report at the

Outputs	Performance Indicator	Responsible Person/ Body	Annual Timeline								Remarks
			2020	2021				2022			
			Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	
											end of the year.
Output 2: Carrying out laboratory tests for biochemical composition in plants and their genetic structure, as well as the study of anatomical and morphological features of plants not damaged by pests											
B.1 Conduct laboratory analysis of a saxaul sample	*Analysis, interpretation of results (report), joint publication with KFRI*	NIFoS									
Output 3: Collection of planting materials from resistant plants within the species for the possibility of further study of the heritability of this property											
C.1 Field trial planting and analysis	*Data gathering, consolidation and analysis*	*A.N. Bukeikhan KazRIFA*									
C.2 Field survey and collection of plant samples in the field trial site (Kyzylorda region)	*1 field surveys conducted and 1 reports prepared*	*A.N. Bukeikhan KazRIFA*									
C.3 Engagement of an experts on saxaul and gall formed insects	*ToR developed and experts engaged*	*A.N. Bukeikhan KazRIFA*									

2. Budget Plan

Activity	Allocation by Unit				Allocation by Year/ Quarter									Remarks
	Unit Cost (USD)	Quantity	Unit	Total Cost	2020	2021				2022			Total Cost	
					Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3		
Objective 1: Study of the resistance of individual black saxaul plants to damage of insect gall-forming plants														
Output 1: Analysis of the pest foci and clarification of the species composition of gall-forming pests in the foci of saxaul, the allocation within the population of individual plants of saxaul not damaged by pests in the lesion														
A.1: Analysis and processing of collected secondary data through in-house researchers of A.N. Bukeikhan KazRIFA	872,5	2	person	7 745	147					049	049		7 745	A discrepancy in the calculations was revealed. In the original document, in Program Support (12% of subtotal) (II) was more than Subtotal (Objective 1 ~ xx) (I), so a cost was added to this task in 2021 in Q1 and Q2
A.2: Field survey and collection of plant samples in the research area (Kyzylorda Region)	430	2	business trip	860	904		526				430		860	
A.3: Ananlysis and processing of secondary and field survey data through engagement of an experts on saxaul and gall formed insects	076,5	2	person	4153	379		516				1258		153	
A.4: Conduct of site monitoring in Q2 of each year	013	2	person	026			516				510		026	
A.5: Consolidation and analysis of field survey results		1	person											Same reason as A.1

Activity	Allocation by Unit				Allocation by Year/ Quarter									Remarks
	Unit Cost (USD)	Quantity	Unit	Total Cost	2020	2021				2022			Total Cost	
					Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3		
A.6: Engagement of local guide	260	1	person	260			882				378		260	
A.7: Translation services	375	1	person	375	125			125			125		375	
Output 2: Carrying out laboratory tests for biochemical composition in plants and their genetic structure, as well as the study of anatomical and morphological features of plants not damaged by pests														
B.1: Conduct laboratory analysis of a saxaul sample	300	3	service	900				300	300		300		900	
(Output 3: Collection of planting materials from resistant plants within the species for the possibility of further study of the heritability of this property														
C.1: Field trial planting and analysis		2	person	2 500										Same as A.1 and A.5
C.2: Field survey and collection of plant samples in the field trial site (Kyzylorda region)	372	2	business trip	744					744				744	
C.3: Engagement of an experts on saxaul and gall formed insects	258	2	person	2 516					516				516	
Subtotal (Objective 1~xx) (I)														Subtotal value (Objective 1 ~ xx) (I) changed due to added value in A.1, A.5 and C.1
Program Support (12% of subtotal) (II) Financial Regulations 3.4				3 521									3 521	Due to above calculation
Total (I + II)													32 864	

*(*Note: Original budget indicated in the Project Document.)*

Section E. Research Team Members Information

1. Research Leader

- Personal Information

Name	Krekova Yana Alekseevna	Date of birth	04/30/1985
Position	Senior researcher		
Contact information	Kazakhstan, Akmola region, Schuchinsk , Chekhov 8 Email: yana24.ru@mail.ru	Tel: Fax:	8-702-91-91-930
Work description	Forest breeding, forest seed production, cultivation of planting stock of forest species with open and closed root systems, cultivation of grafted planting stock, introduction of tree and shrub species, conservation of the gene pool of forest species.		

- Education (starting from college to highest Degree earned)

Years (From ~ To)	Education	Major	Degree
2000-2004	College of ecology and forestry	Ecologist	Technician
2004-2007	Kokshetau University named after Abay Myrzakhmetov	Ecologist	Bachelor
2012-2014	Omsk State Pedagogical University	Environmental education	Master
2014-2018	Ural State Forestry University	Forestry	Research teacher

- Work Experience (for the last 3 years)

Years (From ~ To)	Institution	Position	Other
2012- present	A.N. Bukeikhan Kazakh Research Institute of Forestry and Agroforestry	Senior Researcher - Head of Breeding Department	PhD

- Related Research Achievement (with relevance to the research proposal)

a) Report/Publication

Title	Content
Variability of the main taxation and morphological indicators of fir trees (*Picea Dietr*.) introduced to Northern Kazakhstan	Ya.A. Krekova, S.V. Zalesov, N.K. Chebotko // Bulletin of Science of the Kazakh Agro Technical University. S. Seyfullin. - 2019 .-- No. 1 (100). - S. 67-76.
History and development of forest breeding in Kazakhstan	Ya.A. Krekova, N.K. Chebotko // Improving the efficiency of the forest complex [Electron. resource]: Mater. Fifth All-Russian. nat. scientific-practical conf. from the international study; MNiVO RF, FSBEI HE Petrozavod. state un-t - Petrozavodsk: From: PetrSU, 2019 .-- S. 54-56.
Index evaluation of test cultures of “hybrids” of plus trees of Scots pine	Ya.A. Krekova, Chebotko N.K. // Conservation of forest genetic resources: Mater. 6th Int. Conf. - Kokshetau, because of the "World of the Press", IP. Ustyugova, 2019 .-- S. 120-122.
Assessment of the living condition and aesthetic value of common oak (Quercus robur L.) in the collection plantations of the arboretum of KazNIILHA	Ya.A. Krekova, N.K. Chebotko // Bulletin of state. Univer. them. Shakarima Semey. - Semey, 2016. - No. 4 (76). - S. 210-215.

b) Research Work / Projects Involvement

Research Work / Projects	Nature of involvement	Important Remarks
Improving technologies to increase forest cover and increase forest resilience in the main forest zones of Kazakhstan	Executor	
Development of technologies to ensure the conservation of forests and increase their sustainability for 2015-2017.	Executor	
Accelerated cultivation of forest-forming species (Scots pine) due to hybridization and the creation of new varieties.	Executor	

2. Other Research Team Members

(All members should be listed: add addition pages with the same format as required)

Team Member 1

- Personal Information

Name	Vibe Ekaterina Petrovna	Date of birth	01/22/1986
Position	Senior Researcher		
Contact information	Address: Kazakhstan, Akmola region, Shchuchinsk, St. Sadovaya 23 e-mail: wiebe_k@mail.ru	Tel: Fax:	8-771-06-04-200
Work description	Forest protection		

- Education (starting from college to highest Degree earned)

Years (From ~ To)	Education	Major	Degree
2001-2005	College of Ecology and Forestry	Ecology and rational use of natural resources	Technician
2005-2008	Kokshetau State University named after S. Ualikhanova	Ecology	Bachelor
2012-2014	Omsk State Pedagogical University	Environmental education	Master
2014-2018	Ural State Forestry University	Forestry	Research teacher

- Work Experience (for the last 3 years)

Years (From ~ To)	Institution	Position	Other
2010- present	A.N. Bukeikhan Kazakh Research Institute of Forestry and Agroforestry	Senior Researcher - Head of the Department of Forestry	PhD

- Related Research Achievement (with relevance to the research proposal)

a) Report/Publication

Title	Content
Addition to the sanitary scale for pine of the Kazakh small hills according to external characteristics	Vibe E.P., Zalesov S.V. // International Research Journal. - 2018. - No. 10 (76). Part 1. - S.56-60.
Dynamics of the state of pine stands and outbreaks of mass reproduction of phytophagy in the Burabay State National Natural Park	Telegin O.S., Vibe E.P., Zalesov S.V. // NZ Vesnik AGAU, No. 12, 2014. - P.71-75.
Mass outbreaks of dangerous species of phytophagy insects in the forests of Kazakhstan	Vibe E.P., Telegin O.S. / Materials of the Republican scientific-theoretical conference "Seyfulinsky readings-12:" Youth in science - innovative potential of the future. " Volume I, Part 3. - Astana, 2016 . - S.76-78.

b) Research Work / Projects Involvement

Research Work / Projects	Nature of involvement	Important Remarks
Transfer and adaptation of technologies for accelerated cultivation of planting material of the main forest-forming species	Executive officer	
The study of climatogenic and anthropogenic dynamics of Kazakhstan’s pine forests using dendrochronology methods	Executor	