

Preventive approach of phytosanitary control of locust pests in Kazakhstan and adjacent areas

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Abstract— On the Eurasian continent, many areas within which usually increases sharply the number of harmful locusts and there is an emergency, are in the border areas of the Republic of Kazakhstan, the Russian Federation, the Kyrgyz Republic, Uzbekistan, Republic of Turkmenistan, Tajikistan and the China. In the border areas of the preventive approach is highly relevant for long-term solution to the problem. In modern conditions outbreaks of these insects are fraught with disastrous consequences for the agricultural sector and the economy as a whole, have a strong effect on phytosanitary and food safety. The article presents the discussion and study of preventive measures to control the number of locust pests. In this case, the slope is on strengthening phytosanitary pest management and environmental monitoring of chemical treatments. A review of mass outbreaks of locust pests in Kazakhstan and adjacent areas and identified the major patterns of change in the phase state of these pests. Just made an analysis of the world experience the traditional locust control, the main shortcomings identified and given specific ways to improve them. As an alternative a proactive approach, ensuring long-term sustainable solution to the locust problem was proposed. This strategy is the result of many years of research, which has a solid scientific basis, and confirmed by extensive practice.

Keywords—Locust pests, pest populations, Kazakhstan and adjacent areas, phytosanitary and environmental control, preventive approach

I. INTRODUCTION

SUDDEN and large-scale mass flights locust pests in Kazakhstan and border areas were observed for a long time. In many cases, the devastating nature of the outbreak had unexpected intrusion of huge flocks numbering tens and

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hundreds of millions of individuals, which led to a genuine disaster, thousands of people to starvation. In modern conditions outbreaks of these insects are fraught with disastrous consequences for the agricultural sector and the economy as a whole, have a strong effect on phytosanitary and food safety [1-7].

Of the many and varied ways to combat locust most efficient and effective use of insecticides is based on a high biological effect of chemicals on the insect. However, conducting a massive chemical treatment in the "fire-fighting" in the midst of outbreak and spread of locusts when dangerous pests already occupied a vast territory is problematic with general ecological point of view [7-10]. Such an approach to the problem of mass breeding Millennium has caused many environmental, economic and social problems in many countries.

In our view, the problem of the invasion of locusts pests closely related to the solution of global problems such as the reduction of anthropogenic pressure, desertification and restoration of biological diversity. Steppe ecosystems of natural areas, dry and arid steppes of Kazakhstan, is a hotbed of territorial especially dangerous locust pests, were the most vulnerable to climate change on a global scale, to anthropogenic impacts in the form of large-scale cultivation of virgin lands, which led to the extinction of many species of animals and plants, note forests without adequate remedial measures ... But right now, in terms of innovative development, modernization and technological change were possible to get rid of the burden of accumulated problems. And those odds are based on the knowledge gained in previous decades and are associated with the strategy of preventive control of locust populations.

II. THE BODY

Locusts insects associated by many as a dangerous pest, only destroy crops. In fact, the locusts in vivo are an essential and integral component of ecosystems to maintain the stability of the steppes and their functioning. In a small number of locust insect, nibbling the leaves and stimulates plant growth. Locusts themselves are food for many different animals - from roundworms to birds and mammals. In some areas, people also use locusts as food: 150 Locust especially large enough to cover the entire daily requirement of protein and 10% of the required energy.

If a person is profoundly changing the natural landscape, then there are favorable conditions for the development of

locust outbreaks. Locusts go into the so-called gregarious phase, a large larval able to migrate in flocks over long distances. Fluctuations in the number of leads to changes in the morphological, physiological and behavioral characteristics of the same species: increased metabolism and physical activity of insects, the colors change and external morphology. Thus, the change in population density leads to a transformation phase.

Theory of phase transformation, proposed by world-renowned scientist-akridologist B.P.Uvarov [11-12], reflects one of the fundamental aspects of biology gregarious species of locusts and grasshoppers. Such species may exist in different phases: single (they are found in certain strictly limited areas of origin of flocks and do not produce devastation), transition (intermediate between single and gregarious phases) and gregarious (at certain moments locust swarms are leaving the area of origin and make their devastating invasion). In the gregarious phase locusts can destroy thousands of tons of plants per day, which puts it together with the drought, fires and other natural disasters - major risks in agriculture. The practical application of the basic provisions of the theory of phase transformation allows to predict the trend in the number of species and more accurately plan the volume of protective measures [1,13-15].

Given the high risk of infestation, all the costs of monitoring the territory and the chemical processing in Kazakhstan are financed from the state budget. The most serious threat to agriculture and the economy of the state are now three types of gregarious locusts: Asian, Moroccan and Italian locusts, belonging to the category of especially dangerous pests of agricultural plants [5-7].

In Kazakhstan the area inhabited by more than 270 species and subspecies of grasshoppers insects. Among them periodically heavy damage farmland causes only 15-20 species [2-6]. Fauna of pest grasshoppers is presented mainly *Calliptamus italicus* L. - one of the most harmful species, *Dociostaurus maroccanus* Thunb., *Locusta migratoria migratoria*.

Along with a gregarious species of grasshoppers in the territory respubiliki no small importance and have nongregarious locust species. The most common types include: *Dociostaurus kraussi* Ingen, *Dociostaurus brevicollis* Ev., *Aeropus sibiricus* L., *Arcyptera microptera* FdW, *Chorthippus albomarginatus* Deg. and *Sturoderus scalaris* FW, *Stenobothrus fischeri* Ev. [10,11]. Of these, the most frequent types are *Stenobothrus fischeri* Ev., *Chorthippus albomarginatus* Deg., *Aeropus sibiricus* L., *Dociostaurus brevicollis* Ev. They are found on all of the above habitats, waste lands, pastures and hayfields. Other species are less common [8-9]. If gregarious locusts types substantial further migration and invasion from one territory to another, the nongregarious species are permanent inhabitants of the steppe and cultural habitats. Depending on weather conditions and the cyclicity for them are also characterized by massive outbreaks of.

Asian or migratory locust (*Calliptamus italicus* L.) causes significant damage to agriculture and makes periodic crashes in almost all temperate and tropical regions of the Eastern

Hemisphere. Nestles on the banks of rivers, lakes and seas, in the reeds, forming large arrays - Smooth. Breeding grounds of the Asiatic locust most active currently operational: it Balkhash-Alakol and Syrdarya breeding grounds, reeds in the West Kazakhstan region (the system Reed-Samar lakes) in the Atyrau region (the lower reaches of. Oral, coast of the Caspian Sea), smaller - in the area Irgiz (Aktobe region), Lake Zaisan (East Kazakhstan region). For departures outside the breeding grounds locust eats a very wide range of plants belonging to dozens of families. Each individual eats from 300 to 500 grams of green fodder for life here - Epiphytotic and very big damage. Cross-border flights of locust swarms occur mainly between the West Kazakhstan and neighboring regions of the Russian Federation, between East Kazakhstan and China.

Moroccan Locust (*Dociostaurus maroccanus* Thunb) is one of the most dangerous pests and annually causes significant damage to agriculture around the world, including in the southern part of Kazakhstan. Zone of mass reproduction of the Moroccan locust located in Saryagash and Otyrar areas, minor lesions - in Ordabasy, Shardarinsky, Arys, Tolebi, Sairam and Kazygurt areas of South Kazakhstan region. In addition, the secondary outbreaks of locusts are in separate areas of Zhambyl and Almaty regions. Cross-border flights swarms occur mainly between South Kazakhstan and Uzbekistan and Kyrgyzstan.

Mainly particularly dangerous locust pest assessment of the Food and Agriculture Organization of the United Nations (FAO) is an Italian locust (*Calliptamus italicus* L.). According to years of research found that the main centers (about 70-75%) of the species in Eurasia is on Kazakh territory in natural areas steppe, dry and arid steppes [1,7,8,10]. During the invasion of locusts migrate over long distances, significantly extending the range. During the XX century the number of ascents and outbreaks of Italian locusts in Kazakhstan occurred 9 times (1909-1912; 1924-1927; 1931-1933; 1944-1947; 1953-1956; 1967-1970; 1977-1982; 1988-1991; from 1997-2003.) [2,5,6,7,16,17]. In such years the locusts cover great distances without dismantling borders. Cross-border flights occur mainly between the West, North and East Kazakhstan and neighboring regions of the Russian Federation, between South Kazakhstan and Kyrgyzstan, between East Kazakhstan and China.

To resist the invasion of locusts, which just is not used (digging grooves, livestock, trampling and burning of homes, harrowing, air-treatments repelling sound, etc.), but avoid the "locust disaster" has become possible with the advent and use of effective insecticides have high biological effects on the insect. A good result is obtained from a regular machining and plowing techniques territories, leading to the destruction of egg capsules and, consequently, to a decrease in the number of locusts. The simultaneous effect of these factors at the time contributed to a sharp reduction in breeding centers and centers of locusts. The number of locusts in the late 1950 - early 1960 reduced to such an extent that in some places it was difficult to find at all. Therefore, it was thought that locust problem b. The Soviet Union, including Kazakhstan, as a whole is solved, and the most dangerous types "brought to economically friendly state" [18].

After a few "relatively" quiet years since the late 1960 increased significantly populated area of locusts. Further deterioration of the phytosanitary situation was closely associated with profound political and socio-economic changes in the former Soviet Union after its collapse and reform of Agriculture of Kazakhstan, exposing many topical issues of agriculture and plant protection [7,19].

Anthropogenic influences climate changes in general and global warming in particular were the most vulnerable ecosystems of the dry and arid climate, including Kazakhstan. Millennium devastating outbreak of locusts swept Africa, Australia, South America, East and South-East Asia [1]. One of the most powerful manifestations of this natural phenomenon was the outbreak of mass reproduction and large-scale migration of locusts from 1997-2003., Which created emergencies in all regions of Kazakhstan [2,4,5,7,16]. Peak numbers came in 1999, when formed four major focuses: northeast (about 60 million ha), West (about 30 million ha) Torgai Priaralye (about 18 million ha), southeast (about 5 million ha). The main foci were found in the deposits of different ages and wastelands, as well as in remote areas: in Rynpeskah, in the sands of Taisoigan, Big Badgers, Ayyrkum, Sarysikatyraukum, Water shores of the Caspian Sea, in the Reed-Samar lakes, and along the banks of the rivers Syr bush Darya, Ural, Torgau Irgiz, Chu, lake Balkhash, Sasykkol, Alakol, which is very difficult to get and spend processing its destruction.

The main regularities of the locust invasion are important for the general analysis of the phytosanitary situation and identify trends in its development. The most important factors contributing to the previously unprecedented locust invasion were: a fundamental structural change in agricultural landscapes due to the withdrawal of the treatment of large areas of arable land and the emergence of wastelands; insufficient financing for the locusts; weakening phytosanitary State Plant Protection Service; decline in locust necessary protective measures. So, locusts infested areas with a population above the economic threshold (EPV) were left untreated in 1997-1998 1 million hectares, and in 1999 - more than 2 million hectares. These years were very arid, which contributed to increasing migration activity of insects. As a result of the expansion of locust swarms from untreated plots were formed multiple foci in the new lands.

Locust invasion caused significant damage to agricultural land and harvest crops to 220 thousand. Ha was destroyed. The total amount of damage suffered by agriculture in 1999 by locusts, estimated at about 2.5 billion tenge (\$ 1 = 131 tenge). Locust invasion caused damage not only to farmers. Mass migration of locusts caused several traffic accidents, overheating engines in vehicles and limiting visibility.

Massive locust invasion of the situation demanded adequate solutions. According to the instructions of the President of the Republic of Kazakhstan has developed "the Republican program for the prevention of mass reproduction and distribution of especially dangerous pests and diseases of crops" were defined legislative, organizational and technological measures. Was reformed and strengthened Plant Protection Service in the country.

To eliminate the plague of locusts were created republican, regional and district headquarters of locust. Experience has shown that such an approach is justified. To fight the locusts from the state budget was allocated in 2000 2.8 billion tenge (equivalent to 20.1 million US dollars), but at the expense of local budgets - more than 400 million tenge. Chemical treatments performed in 2000 in the vast area of 8.1 million hectares. In 2001 - 4.8 million ha. In addition, the growing practices used by 5 million ha (processing roadside fields, virgin and fallow areas, additional pre-sowing cultivation, harrowing, etc.) [5,7,19].

The problem of locusts caused a powerful impetus to scientific research. Have been refined and adapted rate and regulations for the application of insecticides foreign production to create an effective system of chemical protection against locusts. Were developed and implemented for the practice of new and efficient technologies for locust control. We are talking about how to make preparations based on continuous integration, local, regional and barrier treatments using modern equipment optimum dispersion. The appearance on the market of pesticide formulations long protective action on the basis of "diflubenzuron" and "fipronil" permitted extensive use of barrier treatment when treated with 80-120 m wide strips alternate with untreated (100-300 m). In 2000-2001 this technology has been applied in 13 regions of the country on more than 3.5 million ha biological efficiency of 95-99%. This reduces the cost of pesticides and handling, reduced pesticide load on the environment [1,7,10].

Large scale in dry or arid steppe, semi-desert and desert regions received ultra low volume spraying (ULVS) using special sprayers and foggers controlled dispersion. The advantage of this method of treatment is a low cost, high performance, consumption of very small amounts of water to prepare the working fluid [1,7,10,19].

Taken unprecedented measures (in 2000-2001 Unheard previously treated area of 12.9 million ha) limited the locust invasion and subsequent treatments volumes decreased: 2002 - 1.2 million hectares, 2003 - 601.5 thousand hectares, 2004 - 506 thousand ha. Since 2005, the area of treatments against locusts has increased 7.3 times and reached in 2013 to 3 million 678.3 thous. ha (in 2014 it is planned to treat locust on the area of 4 million. 246.3 thousand. Ha). As can be seen from the data, despite the large amounts of chemical treatments spread of locusts in the last 8 years is increasing dramatically.

In 2011-2013 organized scientific expeditions in the western and northern regions of Kazakhstan, paying attention to the border areas with the Russian Federation [20-25]. It was found that the mass migration of Italian locusts on the land of Kazakhstan took place in 2011, the border territories of the Russian Federation (uncontrolled migration of locusts remain to this day). There is also a massive migration of natural foci of the Italian Locust (Rynpeski, Taisoigan sands, sandy deserts Big Badgers, Ayyrkum Sands, Sands Mamytskie Sands, Sands Ayyrkyzyl, Kumzhargan Sands et al.) [20-25].

In addition, the 2012 chemical processing due to the low efficiency did not provide suppression of dangerous pests and was admitted expansion of locusts in large parts of. Locust

swarms elated and migrated in Atyrau, West Kazakhstan, Aktobe, Kyzyl-Orda and Kostanai areas Zharkainsky and Esilsky areas Akmola region [20].

Long-term experience of locust companies worldwide during the twentieth century has shown the futility of massive use of chemical weapons during the peak of the outbreak. Unprecedented measures chemical control in Kazakhstan during the outbreak of 1997-2003 are another proof of this, because at the beginning of the emergence of hopper bands and swarms Phytosanitary Service is not ready either materially or morally to conduct locust control treatments. As a rule, they begin to take place after two or three years after the outbreak when gregarious locusts already occupied a vast territory. Insecticides usually provide only a temporary reduction in the number and severity in the centers of their application, but in general, can not practically affect dramatically the course of population dynamics. In contrast, chemical processing destabilize the ecological situation due to destruction of natural enemies and natural epizootic that extends the period of mass reproduction for several years [7,10].

Existing approaches to solving the problem of the invasion of locusts - a massive chemical treatments in large areas in the midst of outbreaks and large-scale migration of harmful organisms, or compromise of action in response to the risks of hard foci, ie when zalet flocks has already taken place - such methods may not be satisfactory. Important strategic disadvantage massive chemical treatments was their conduct in the "fire fighting", as the initial stages of accumulation of locusts in primary foci, especially in remote or inaccessible areas remain unnoticed.

In our opinion, the only possible alternative for today massive chemical treatments in large areas in the midst of an outbreak of a proactive approach, providing long-term sustainable solution to the problem of locust. This strategy is the result of many years of applied research with under a solid scientific basis and confirmed extensive practice [1,7,10,26].

III. CONCLUSION

Preventive approach based on effective monitoring of places locust habitats during critical periods of its annual cycle in order to lift the number of early detection and behavior change; thereby providing adequate early warning and effective response aimed at reducing the frequency and intensity of locust outbreaks local and preventing their development into large-scale outbreak. It contains a long-term and sustainable management of locust populations, is a comprehensive strategy that takes into account all the situations and all aspects, including preparedness plans and contingency. To curb the number of locusts is necessary to improve current methods of prediction and observation, based on remote sensing, GIS and GPS/GLONASS technologies. It is imperative to study the patterns of development continuously locust populations, with strategic change in the direction of preventive measures, including the use of low-risk insecticides, biopesticides and biological agents.

According to the Food and Agriculture Organization of the United Nations (FAO), a proactive approach has the following comparative advantages [26].

- Reduce damage to crops and pastures, and hence food security and livelihoods of most vulnerable rural population. Properly organized preventive struggle allows reacting to the situation before the increase dramatically the number of locusts. The large-scale fight or compromise solutions are possible only when the flash is already in full swing, which means much more serious damage with negative consequences for food security.

- Reducing the negative effects on human health and the environment. Preventive approach can detect changes in behavior and an increase in the number of locusts in the early days of the outbreak. This means that the locust processing can be carried out: a) at an early stage of locusts when young larvae are more sensitive to drugs; b) local, limited areas rather than large-scale outbreaks of infection; c) completion of locust control to its transition to the gregarious phase; d) in the absence of a direct threat to cultivated crops. This allows the use of low risk products as chitin synthesis inhibitors barrier method - they are less dangerous to human health and the environment.

- Gain control action treatments on non-target objects. In the context of preventive possible to use lower doses of drugs against clearly defined goals (eg, hopper bands), thereby significantly reducing the impact on non-target fauna (including beneficial arthropods such as bees).

- Reduction in financial expenses. Existing in the world literature estimates show that the costs of protecting farmland from locust huge. Typically, the money spent on suppression of locusts within one year flash, sufficient to cover the costs of its prevention for at least 15-20 years. Preventive approach is a great way to significantly reduce the costs.

Many areas within which usually increases sharply the number of harmful grasshoppers and there is an emergency, are in the border areas of the Republic of Kazakhstan, the Russian Federation, the Kyrgyz Republic, Uzbekistan, Republic of Turkmenistan, Tajikistan, the People's Republic of China. In the border areas of the preventive approach is highly relevant for long-term solution to the problem.

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