Biological agents in the Khabarovsk Territory crop production

T M Trifonova
Pacific State University, Khabarovsk, Russia

E-mail: zam-obcs@MAIL.RU

Abstract. In the research course for the period from 2007 to 2020, the high biological agents' biological efficiency in the growing black currant berry culture technologies, as well as on vegetable crops, such as tomato, cucumber, asparagus beans, eggplant, was experimentally established. The biological agents stimulating effect on the leaf surface area, the plant development phases passage rate, as well as the crop yield is noted.

1. Introduction
The agricultural products modern production in Russia, as well as in the world other countries, has been confronted for several years with the need to solve several major problems. Among them, the main ones can be distinguished: firstly, it is crops guaranteed protection from phytophages, phytopathogens and weeds, and secondly, the environment protection from technogenic pollution' various sources [1]. The desire to solve the first problem as soon as possible led to the era of euphoria in the fight against harmful organisms, which swept the whole world in the 40-th 50s of the last century, thanks to an action wide spectrum' effective pesticides' emergence, but very soon mankind faced quite serious challenges [2]. Among the main environmental problems arising from the pesticides use, Rogozin M.Yu. indicates a decrease in the crops biological productivity, a disruption in the soil microbiocenoses functioning, the pesticide residues accumulation and their derivatives in water sources and groundwater, a fertility restoration violation, a decrease in the crops nutritional value [3]. That is why all over the world, including Russia, there is a renewed interest in the environmentally friendly technologies' development for the agricultural crops' cultivation. The need to integrate the main approaches to combating pests into a single system was confirmed not only by domestic scientists but also by foreign ones [4-6]. According to the deputy director for scientific work of the All-Russian Research Institute of Biological Plant Protection Vladimir Ismailov, pesticide-free organic farming justifies itself economically and ecologically. Organic farming systems long-term use (which include crop protection without the chemical plant protection products use) leads to the fact that the ecosystem can begin to cope with diseases and pests on its own, the treatments and protective measures number will decrease, and climatic stresses will also decrease. However, at the moment the organic agrobiotechnologies introduction level in the agro-industrial complex does not exceed 2%, since not all enterprises decide to abandon chemical plant protection products [7]. But at the same time, scientists were able to significantly expand and deepen their microorganisms' role understanding in plant life and formulate priority practical tasks to reduce the chemical fertilizers use when growing plants, replace pesticides with microbiological preparations, protect plants from stress, etc. [1]. According to E. Chernyshova, plants have from 20 to 40% of the unused potential, which can be extracted with the growth regulators help. Today these
preparations are presented in large quantities on the Russian market, but not all agricultural enterprises are in a hurry to use them. Plant growth and development regulators have been used in agriculture for almost a hundred years. These drugs, as a rule, are used to accelerate the plants' maturation, as well as to stimulate flowering and fruit formation, and to increase the crops' resistance to adverse environmental factors. To date, more than eight thousand different compounds have been synthesized in the world that affect a plant physiological effectiveness, and this list is updated every year. However, only 4% of physiologically active substances have found active use [8]. The biological agents used in the growing agricultural used crops technology is a promising direction in agricultural production, especially on the Khabarovsk Territory under extreme agriculture and an increased infectious background condition. In this regard, since 2007, the author has been testing biological agents' various types to increase the cultivated plants' adaptive properties to abiotic and biotic environmental factors.

2. Methods
The studies were carried out on black currants, tomatoes, cucumbers, asparagus beans, cauliflower, sweet pepper, eggplant. The studied crops agricultural technology is generally accepted for the Khabarovsk Territory. For field experiments, zoned varieties were used. The experiments repeatability is 3-fold. All records and observations in field experiments were carried out under the current methods and guidelines [9].

Experiment options 1. The biological agents' effectiveness study on black currant plantings (2007-2016):

- Control (spraying with distilled water in the budding phase, budding, flowering beginning, flowering end, intensive fruit growth).
- Plants spraying in the flowering phase beginning and 12 days after the first treatment at the Novosil 40 g/10 l rate/water.
- Spraying in the budding phase, the flowering beginning at the rate of DV-47–4 10 ml/10 l of water.
- Spraying in the flowering phase beginning at the Sodium Humate rate' 9.3 g/10 l of water.
- Spraying in the budding phase, budding and 10 days after the second treatment at the water Albite 1 g/10 l rate.
- Spraying in the budding phase, the flowering end and 20 days after the second treatment at the water Immunocytophyte 6.5 tablets/101 rate. The tablets were poured into 30 ml (2 tablespoons) of cold water, after 20–30 minutes they were stirred until complete dissolution, and the water rest was added to the solution. The resulting solution was sprayed on the plants.
- Spraying in the budding phase, after flowering and in the intensive fruit growth phase at the water Energen 3 capsules/10 l rate.

Experiment options 2. The biological agents' effectiveness study on black currant plantings (since 2017):

- Control - spraying with water in the budding phase and after flowering.
- Epin-extra - 1 ml/5 l of water.
- Cytovit - 1.5 ml/1 l of water.
- Zircon - 1 ml/10 L of water.
- Epin-extra + Cytovite tank mixture - 1 ml/5 l of water + 1.5 ml/1 l of water.
- Zircon + Cytovite tank mix - 1 ml/10 l of water + 1.5 ml/1 l of water.
- Fitoverm - 2 ml/1 l of water.
- Phytomer+Zircon tank mixture – 2 ml/10 l of water+1 ml/5 l of water.
Black currant plants spraying was carried out in the budding phase and after flowering. Sugars qualitative and quantitative determination in black currant berries was carried out by the thin-layer chromatography method on the silufol in the FSBEI of Higher Education the Pacific State University laboratory.

Experiment options 3. Growth processes stimulation in tomato plants of varieties Red De Barao and Basilisk's Tooth.

- Control (soaking seeds in distilled water).
- Seeds soaking in the working solution Energen Aqua, as well as a top dressing in the seedlings' emergence phase 0.6 g/1 l of water.
- Seeds soaking in the Baikal humate working solution, as well as fertilizing in the seedlings' emergence phase 1.5 – 2.0 g/10 l of water.

Experiment options 4. Growth processes stimulation in the Bochkovoj Zasolochnyj variety, grown in open field conditions.

- Control (soaking seeds in distilled water);
- Zircon - 1 mg/10 l of water.
- Hydrogen Peroxide - 20 drops of 3% hydrogen peroxide solution/1 l of water.

In the experiment course, cucumber seeds were soaked in a working solution according to the experiment variants, as well as feeding in the sprouting phase.

Experiment options 5.

- Control (soaking seeds in distilled water).
- Krepysh - 0.5 mg/l 1 of water.
- Kornevin - 0.5 mg/l 1 of water.
- Krepysh (0.5 mg/l 1 of water) + Kornevin (0.5 mg/l 1 of water).

The seeds were soaked in working solutions according to the experiment variants, and the plants were also fed in the emergence phase, budding and in the fruiting period.

Experiment options 6. Study of the biological products' effectiveness in stimulating growth processes in the Alekseich F cucumber variety seeds 1, Pink Leader tomato variety, Viking sweet pepper variety.

- Control (seed treatment with distilled water).
- NV-101 - soaking seeds in a solution at the rate of 2 drops/1 l of water.
- Energen - seeds soaking in a solution at the rate of 1 capsule/1 l of water.
- Stimul - soaking the seeds in a solution at the rate of 4 drops/1 l of water.

Experiment options 7. Growth processes stimulation in cauliflower seeds.

- Control (soaking seeds in distilled water).
- Agricola for cabbage and cauliflower - 1.25 mg/0.5 l of water.
- Agricola aqua - 5 ml/0.5 l of water.
- Amulet - 0.5 tablets/0.5 ml of water.
- Siyanie - 5 g/0.5 ml of water.
- Amulet - ¼ tablets/0.5 ml water + Agricola aqua 2.5 ml/0.5 ml water.

Cauliflower seeds were soaked in the working solution, as well as feeding was carried out in the emergence phase and the inflorescences formation phase.
Experiment options 8. The biological agents' effectiveness study in stimulating growth processes in eggplant plants grown in open ground.

- Control (soaking seeds in distilled water);
- Seedling - working solution with a concentration of 0.25%.
- Seedling - working solution with a concentration of 0.5%.
- Seedling - working solution with a concentration of 1.0%.
- NV-101 - working solution with a concentration of 0.25%. 
- NV-101 - working solution with a concentration of 0.5%.
- NV-101 - working solution with a concentration of 1.0%.

Eggplant seeds were soaked in working solutions according to the experimental scheme, and the seedlings were irrigated in the two true leaves appearance phase and after planting in open ground.

3. Results and discussion

Studies on black currant were carried out in the period from 2007 to 2020. During 2007-2016, Novosil, DV-47-4, sodium humate, Immunocytophyte, Albit, Complex 3, and Energen were studied as growth and development regulators. Among the biological preparations, which effectiveness was studied on the black currants plantings, were such as Fitoverm, Bactofit, Lepidocid. In the study course, it was revealed that the growth and development regulators use during the black currant growing season, in comparison with control, promotes the development main phases passage acceleration by an average of 1–4 days; an increase in plant height up to 38%, leaf surface area up to 39%, chlorophyll content in leaves \(a+b\) by 10.861 mg/l, the dry matter proportion up to 27%, sugars up to 25%, yield from 0.276 to 0.997 kg/m\(^3\). At the same time, the most effective technologies turned out to be using Novosil, Immunocytophyte and Complex 3. Among biological products, Phytoverm and Lepidocid had the best effect on the plants' reproduction and vegetation under the abiotic and biotic factors influence. In 2017, it was decided to start testing the biological agents Epin-extra, Zircon and Cytovite. In the research course, it was found that the Epin-extra inclusion in its pure form, as well as a Zircon with Cytovite tank mixture in the growing black currants technology, increases the glucose amount in the culture berries by an average of 5–11% and sucrose by an average of 4%. In the experiment variants with the Phytoverm with Zircon, Epin with Cytovite mixtures use), as well as in the Cytovite preparation pure form, an increase in the dry substances' proportion in berries was revealed in comparison with the control by 38–55%. In 2018, research began to identify the most effective growth regulators that are appropriate to use in the tomato cultivation general technology in the Khabarovsk Territory. The research was carried out on tomato varieties De Barao Red and Zub Vasiliska. Energen aqua and humate Baikal were used as the tomato plants growth and development defence reactions multipurpose stimulants. The study results were as follows. In comparison with the control variant, an increase in the leaf surface area was revealed up to 296.46% in the experiment with the variety Zub Vasiliska plants and up to 8.92% in the experiment with the variety De Barao Red plants. However, the greatest significant increase in the yield of tomato fruits of 11.5% was observed in the experiment variant in the variety De Barao Red plants, treated with the Energen aqua. In the experiment with the Zub Vasiliska variety plants, the greatest increase in yield was observed in the variants with Energen Aqua and Baikal humate and amounted to 2.5 and 2.6 kg/1 bush, respectively. Cucumber, like tomato, is the most common agricultural crop grown in the Khabarovsk Territory. Therefore, in 2018-2020, research was conducted to develop a technology for growing cucumbers in sharp changes in conditions in daily temperatures and uneven precipitation during the growing season, which are the study region climatic conditions characteristic. Zircon and hydrogen peroxide was studied as biological agents for planting a cucumber cultivar of the Bochkovoi Zasolochny variety. The study revealed a hydrogen peroxide 3% high biological efficiency. Its use in the growing cucumber technology contributed to an increase in germination energy and crop germination up to 90-100%. In the experiment variants, in which the cucumber seeds were soaked in a hydrogen peroxide working solution, as well as feeding in the sprouting phase, an increase in the leaf blade area by 0.3
times was noted. The largest significant increase in yield was found in the experiment’ all variants and amounted to 32–89% concerning the control variant.

In a modern person life, the natural, environmentally friendly products use is of great importance. There is no doubt that in our country any citizen diet should be complete and contain, in addition to bakery products and meat, plant origin food products: fruits and vegetables. One of the low-calorie, fat-free foods high in saturated fatty acids is asparagus beans. As an agricultural crop, beans are demanding light, do not tolerate drought and waterlogging. This is a limiting factor in its widespread cultivation, especially in the Khabarovsk Territory soil and climatic conditions, which, like the whole Amur region, belongs to the risky farming zone. Therefore, in 2018, biological agents studies were carried out on two varieties’ Octava and Gerda asparagus beans plantings. The experimental scheme included variants with a Krepysh, a Kornevin and a Krepysh and a Kornevin tank mixture use. In the investigated preparations the highest efficiency was revealed in the experiment variants with the Oktava variety seeds: the increase in the germination energy in comparison with the control variant was from 7 to 40%, the germination rate was from 13 to 36%, this variant plants mass flowering occurred earlier than the control one by 1-2 day. The plants’ leaf surface size, as the main nourishing organ, is of particular importance in their productivity. In variants with the use of Krepysh and Kornevin, an increase in the leaves surface area in the Octava variety was revealed from 1.2 to 3.6%, in the Gerda variety plants - from 3.5 to 5.8%. In our studies, the beans with the highest yield were obtained in the variant with the Krepysh use in its pure form. These varieties bean plants average yield in this variant was 0.83 and 0.97 kg/1 bush. A significant increase in the beans yield was when using the Kornevin biostimulant in its pure form and amounted to 0.61 and 0.81 kg/1 bush. In the variant with a Krepysh fertilizer with a biostimulant Kornevin tank mixture use, an increase in the crop yield was also noted in comparison with the control. The yield in this variant was 0.59 and 0.72 kg/1 bush. The seeds sowing qualities main indicators include germination and germination energy. Germination energy is the germinated seeds percentage for a time certain period, 3 or 4 days, which characterizes the seeds’ ability to give friendly and even shoots in field conditions, which means plants good evenness and survival. In 2019, under the T.M. Trifonova leadership studies were carried out to identify the most effective plant growth regulators, which are advisable to use in the region for cucumber variety Alekseich F1 seeds pre-sowing treatment, pepper variety Viking and Pink leader tomato variety. NV-101, Energen and Stimul, were chosen as growth and immunostimulating drugs. In the study course, it was revealed that to increase the various crops seeds germination energy, it is necessary: to soak the cucumber variety Alekseich F1 seeds and the pepper variety Viking seeds - in solution NV-101. In the experiment variants with Energen Energy, the cucumber seeds germination energy was 100%. Since ancient times, cauliflower has been considered the vegetable queen. This subspecies beneficial properties are superior to those of this species other members. It contains a rich mineral and vitamin composition. Cauliflower contains vitamins C, A and B a large amount, as well as the rare vitamin U, which is involved in the enzymes’ formation. This composition makes this subspecies of cabbage indispensable in the human diet. Therefore, more and more summer residents are paying attention to cauliflower and growing it in their summer cottages. But, unlike other subspecies, it makes higher demands on the cultivation conditions. Cauliflower grown on the Khabarovsk Territory is largely exposed to adverse climatic factors that have developed in the region. In 2019, studies were conducted to identify the effectiveness of the biological products Agricola, Agricola Aqua, Amulet, Siyanie, as well as the Amulet with Agricola Aquatank mixture in the Alpha variety growing cauliflower technology. High efficiency in increasing the germination energy and germination was noted in the experimental variants with working solutions Agricola, Agricola Aqua and Amulet and averaged 10-10 % and 5-7. 5%, respectively. The period reduction from sawing to the first two real leaves appearance to two days was revealed in the experiment variant with Agricola Aqua. However, it was not possible to take into account the studied crop yield. The 2019 growing season was characterized by the soil excessive waterlogging and high air humidity in the phase during the intensive leaf growth period and at the head formation beginning. All this contributed to all plants intensive rotting, which indicated the need to change the experiment scheme with further research. In 2019, studies were carried out to identify the seedling growth regulators effectiveness and NV-101 in stimulating...
growth processes in Boyarin F1 eggplant culture seeds and seedling and Mishutka varieties. In the study course, a slowdown in growth processes was noted in the experiment variants, in which the seeds were soaked in the studied preparations working solutions with a concentration of 0.25%, 0.5%, 1% compared to the control variant, in which the seeds were soaked in water. Eggplant plants morphological parameters analysis in the ontogenesis initial stage - in the period from the seed germination moment to the main shoot leaf unfolding moment - revealed that in the experiment variant with tissue (0.25%) germination revealed an increase in the leaf plates length by 8% -13%, shoot length by 7%-17%, respectively, compared with control. Plants treatment with a 0.5% seedling solution contributed to a significant increase in the leaf blade length by 6% -11%, the stem length by 8% -15%. The drug NV-101 showed high efficiency with a working solution concentration of 0.25%. The increase in the leaf blade length in the Mishutka variety plants was up to 35%, the stem length up to 20% compared with the control variant. In the plant development phase from two true leaves to planting seedlings in open ground, a growth processes high rate was noted in variants with NV-101 with a working solutions' concentration of 0.25% and 0.5%.

4. Conclusion
Thus, long-term studies have shown that biological agents are modern phytoregulators, which are effective and sufficiently promising for their use in phytosanitary technologies for the crops' cultivation grown in unfavourable soil and the Khabarovsk Territory climatic conditions. They allow the growing season bioclimatic potential most complete use since it has been experimentally proven that, when used in small concentrations, it activates the plants' photosynthetic activity, exhibit a growth-stimulating effect and contribute to an increase in crop yield. The most effective were: on black currant - Novosil, Immunocytophyte, Complex 3, Fitoverm, Epin, Cytovit; on tomatoes - Energen Aqua, Humate Baikal; on a cucumber - Hydrogen Peroxide; on asparagus beans - Kornevin, Krepysh, as well as a tank mixture of a Krepysh with a Kornevin; on eggplants - sprout and NV-101. For the cucumber and sweet pepper seeds pre-sowing treatment, it is advisable to use Energen, for tomato seeds - NV – 101.

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