Potato Farming Biologization as a Food Security Basis

F V Nikolaeva¹, F A Lukina¹

¹Federal State Budgetary Educational Institution of Higher Education "Arctic GATU", Yakutsk, Russia

E-mail: fedora-lukina@mail.ru

Abstract. The paper discusses the experimental results of growing potatoes based on scientifically grounded crop rotations and biologized technologies. The main biological agriculture problem is to maintain the ecological balance in the biosphere based on the search for natural reserves to increase crop productivity while improving soil fertility and quality of crop products and reducing costs for energy and resources required for their production. The studies have revealed that green manure affects not only the yield of potatoes but also the population of soil microorganisms, which leads to increased reproduction of bacteria and actinomycetes. The highest yield was recorded in the crop rotation with sweet clover – 16.8 t/ha; when plowing the pea-oat mix, it reached up to 15.4 t/ha, and when plowing oats - up to 16.3 t/ha, which increased yield by 0.5-2.9 %. From among the most effective environmentally sound technologies, organic fertilizers, growth stimulants, and various fungicides are also applied. When using various organic fertilizer doses in combination with mineral fertilizers, the yield of potatoes and the content of phosphorus and potassium increase. Complex treatments of plants with ‘Ridomil Gold’ and ‘Cuproxat’ fungicides during the growing season reduce the incidence of fungal and bacterial diseases in both plants (by 3.7-3.9 %) and tubers (by 2.7-3.5 %) during the storage period.

1. Introduction
In the modern world, the food security issue is more relevant than ever. Being one of the main economic sectors, agriculture is characterized by low profitability, long payback period, and, most importantly, dependence on natural and climatic conditions [1].

Currently, domestic agriculture can be characterized as import-dependent, however, every effort should be made and scientific potential used for import substitution since agriculture ensuring sustainable production of basic food products and their availability to the population is among the main food security aspects.

To achieve food security, domestic agricultural producers in the regions should work effectively to provide the population with local agricultural products.

Sustainable development of potato growing is one of the main food security problems.

Potatoes are among the most widespread crops. That is why potato growing is recognized as one of the priority areas of agriculture.

In the world crop production, it ranks high along with wheat, rice, and corn. Potato tubers are widely used as a food product in industrial processing and animal husbandry.
2. Relevance
Among the Yakutia crops produced for the nutrition of the population, potatoes occupy a leading position. Currently, potatoes are grown in all farm categories. However, the average yield in the republic does not exceed 70-90 c/ha; along with objective economic reasons, such a low efficiency of potato growing is explained by the lack of knowledge in the technology for cultivating new potato varieties and underestimated role of the variety [2].

In modern agricultural production conditions with a reduced impact of technogenic factors, developing techniques for cultivating new varieties, the role of which has significantly increased, allowing to increase potato production and pass to ecologically sound biologized crop cultivation technologies based on optimizing plant nutrition in the crop rotation system, using biologically active growth and development regulators and the new generation of systemic-action fungicides becomes practically important [3, 4].

Applying scientifically grounded crop rotations and biologized technologies ensure the maximum use of genetic, soil-climatic, and technical resources.

Long-term breeding research and studying economically valuable traits under the conditions of Yakutia allowed breeding and zoning Yakutyanka and Severny potato varieties, the highest productivity of which averages 25.0-30.0 t/ha.

The Yakutyanka Variety growing season is 58-60 days. It is resistant to cancer, rhizoctonia, common scab, moderately resistant to rhizoctonia, early dry leaf spot, and viral and bacterial diseases. Its tubers are characterized by high storability and are slightly affected by dry rot. Herewith, it has good taste, and its biochemical composition leaves behind significantly the zoned varieties: 21.2 % of dry matter, 15.2 % of starch, and 10-15 mg/% of ascorbic acid [5].

The Severny Variety growing season is 65-70 days. It is resistant to cancer, nematodes, rhizoctonia, common scab, late blight, early dry leaf spot, viral diseases, and moderately resistant to bacterial diseases. It is characterized by good storability and contains 14.0 % of starch, 21.0 % of dry matter, 15.0 % of ascorbic acid, and 16.0 mg/% of vitamin C. The taste is good [5].

3. The study results
Crop rotations. Studying various predecessors in specialized potato crop rotations allowed establishing the significant aftereffect of green manure crops on the yield of potato tubers, depending on the plowed crop, although the tendency to growth was traced for all options; an important property of green manure crops was also their ability to effectively crowd out and displace weeds [6].

When potatoes were grown without rotation and fertilizers, the yield was 13.4 t/ha. The highest yield of 16.8 t/ha was recorded in the crop rotation with sweet clover; when plowing the pea-oat mix, it reached up to 15.4 t/ha, and when plowing oats - up to 16.3 t/ha, which increased yield by 0.5-2.9 %.

The studies have revealed that green manure fertilizer affects not only the population of microorganisms but also their group composition, which leads to increased reproduction of bacteria and actinomycetes.

This indicates an increase in the microbiological activity of permafrost soils, which in turn reduces pathogenic microflora [7].

The soils under study contain pathogenic fungi of the Rizoctonia Solani Kuhn, Fusarium Oxysporum Solani, and Phoma Exiqua genus, which are the causative agents of the most common potato diseases such as rhizoctonia, fusarium, and common scab. When monocropping potatoes, the amount of pathogenic microflora ranges within 10.0-19.5 %. Crop rotation reduces pathogenic microflora by 1.2-5.8 times. The most significant decrease in the fungi percentage was recorded with the scheme of the pea-oat mix for green manure – potato [8].

Organomineral fertilizers. From among the agrochemical soil properties, the most significant are reserves of organic matter, the soil medium reaction, and reserves of available nitrogen, phosphorus, and exchangeable potassium. Almost all soil properties are directly dependent on the content and composition of soil organic matter. The use of organomineral fertilizers (OMF) with a combination of certain factors can ensure an increase in the content of soil humus [9].
Studying in 2012-2014 the impact of various organic fertilizer doses (rotted cattle manure) in combination with mineral fertilizer in the following variants: manure 20 t/ha; manure 40 t/ha; manure 60 t/ha; manure 20 t/ha + NPK46; manure 40 t/ha + NPK46; manure 60 t/ha + NPK46 allowed revealing a certain efficiency of their application. The complex use of manure and mineral fertilizers in all variants increased the nitrogen content in the soil, and the phosphorus content increased when using manure in the amount of 40 t/ha + NPK46. The greatest increase in the potassium content was recorded with manure 60 t/ha + NPK46.

Growth stimulants and fungicides. Currently, the yield can be increased, and the product quality improved with only the widespread implementation of the entire complex of agrotechnical, preventive, and protective measures based on the latest scientific and practical achievements. The use of biologically active substances increasing the plant resistance to the negative environmental impacts is one of such effective measures.

They also include plant growth regulators (PGR), the use of which allows both more specifically regulating the plant growth and development and fully using the variety potential. It is also important that using PGRs contributes to increasing plant disease resistance and tuber storability in winter [10, 11].

We studied the use of PGRs in potatoes from 2006 to 2008. Before planting, the tubers were treated with the following PGRs: ‘Mival TAB’, ‘Bouton P’, ‘Agat 25K’, ‘Zircon, R’, ‘Immunocytophyte’, ‘Ekost 1/3’, and ‘Epin-Extra, R’.

Treatment with growth stimulants increases the aboveground mass growth intensity in potato plants, which contributes to the formation of a larger number of tubers and creates the preconditions for high yields. According to our data, ‘Ekost 1/3’ had the greatest impact on the growth of tubers, and ‘Agat 25K’, ‘Zircon’, and ‘Immunocytophyte’ – on the plant growth and development.

Some of the preparations used provided a significant increase in potato yields. When treated with ‘Ekost 1/3’, the yield increased by 3.0 t/ha, and with ‘Epin-Extra’ and ‘Bouton’ – by 1.5-1.6 t/ha. Thereat, the highest marketability (92 %) was obtained when treated with ‘Immunocytophyte’ and ‘Epin-Extra’; the increase was 5 % relating to the standard.

The visual assessment of potato plants showed that treatment with ‘Agat 25K’ and ‘Mival’ significantly decreased susceptibility to diseases (by 6.0-7.0 %). Reference potato plants without treatment had the highest susceptibility to diseases (19 %). Such diseases as common and wrinkled mosaics were widespread. From among the fungal diseases, rhizoctonia and common scab were recorded. Bacterial diseases have not been observed in all experimental variants during the growing season. In this regard, treatment of seed-growing potatoes with ‘Agat 25K’ and ‘Mival’ growth regulators can be used to obtain more productive material [12].

The potato is the crop most affected by harmful microorganisms compared to other basic food crops.

In this regard, the use of the most effective environmentally sound fungicides is a very relevant and significant element of the biologized potato cultivation technology [13].

In 2010-2013, treatment of potato tubers with ‘Fitosporin’ before planting significantly reduced fungal diseases in plants and tubers by 6.5 and 2.1-3.9 times, respectively. Complex treatment of plants with ‘Ridomil Gold’ and ‘Cuproxat’ fungicides during the growing season also reduced fungal and bacterial diseases in both plants (by 3.7-3.9 %) and tubers (by 2.7-3.5 %) during the storage period.

4. Conclusions
1. It is recommended to use the following specialized crop rotations: sweet clover - sweet clover - potatoes; pea-oat mixture - potatoes - potatoes.
2. The use of organic fertilizers (manure 60 t/ha + biological preparations) increased the yield of potatoes compared to the reference group by 6.5 t/ha; the potato tuber marketability also tended to increase; thus, the highest marketability (75 %) was recorded for the variant (NPK46) + manure 20 t/ha.
3. The use of the preparations studied in the cultivation of potatoes ensured a significant increase in yield by 5.1-6.4 t/ha due to reduced losses from diseases.

5. References

[1] Yarkova T M 2019 Food safety: Russian experience and foreign practice: monograph Ministry of Agriculture of the Russian Federation, Federal State Budgetary Educational Institution of Higher Education “Perm State Agrarian and Technological University named after Academician D.N. Pryanishnikov” (Perm: IPC "Prokrost") 192 p

[2] Okhlopkova P P 2004 Potatoes of Yakutia / RAAS Sib. department YANIISH (Yakutsk: Publishing house of the SB RAS”) pp 3-4

[3] Rafalsky S V 2008 Biologization of potato cultivation in the Far East Potato growing: research results, innovations, practical experience Materials of the scientific - practical conference and coordination meeting "Scientific support and innovative development of potato growing” Ros.acad. with. NS. Sciences, All-Russian Research Institute of Potatoes. hoz - va; under. ed. E A Simakova (M) Vol II pp 266 - 271

[4] Lukina F A, Vasi'eva R D, Fedorov A Ya 2017 Biological bases of potato cultivation in Yakutia In the collection: Innovative mechanisms for solving problems of scientific development Collection of articles of the international scientific and practical conference: in 3 parts pp 17-20

[5] Okhlopkova P P, Stepanov A I, Lukina F A, Efremova S P, Yakovleva N S 2018 Agrotechnics of potato cultivation in the conditions of Yakutia Methodological guide (Yakutsk)

[6] Lukina F A, Nikolaeva F V 2017 The use of green manure crops in the cultivation of potatoes in Yakutia In the collection: Innovative approaches to the problems and prospects of the development of the agro-industrial complex in the Republic of Sakha (Yakutia) Materials of reports of the International Scientific and Practical Conference dedicated to the 100th anniversary of the birth of Professor Mikhail Grigorievich Safronov and the 60th anniversary of the Yakutsk Scientific Research Institute of Agriculture named after M G Safronov Yakutsk Scientific Research Institute of Agriculture named after M.G.Safronov pp 118-121

[7] Lukina F A, Nikolaeva F V, Okhlopkova P P 2016 Influence of the aftereffect of green manure crops on the yield and quality of potato tubers in the conditions of Yakutia Science and education 1(81) pp 127-129

[8] Nikolaeva F V, Okhlopkova P P, Lukina F A 2015 Soil microflora, depending on the crop rotation in the cultivation of potatoes Michurinsky agronomic bulletin 2 pp 16-19

[9] Stepanov A I, Pribulykh E I, Fedorov A Ya, Nikolaeva F V 2011 Influence of the use of fertilizers and biological products on potato productivity and fertility indicators of permafrost meadow-chernozem soil in Central Yakutia Achievements of science and technology of the agro-industrial complex 11 pp 47-49

[10] Nikolaeva F V, Lukina F A 2020 The use of biological products in the cultivation of potatoes in Yakutia Agricultural science 7-8 pp 124-126

[11] Yakovleva N S, Lukina F A, Okhlopkova P P 2009 Recommendations for the use of plant growth regulators in potato cultivation in Central Yakutia Recommendations (Yakutsk) 17 p

[12] Yakovleva N S, Lukina F A 2009 Influence of growth regulators on productivity and disease susceptibility of potato plants in Yakutia In the collection: Agricultural science - agricultural production in Siberia, Mongolia, Kazakhstan and Bulgaria Materials of the XVII International Scientific and Practical Conference pp 106-108

[13] Ivanova M N, Lukina F A 2014 The effectiveness of the complex application of biological products and fungicides on potatoes in the conditions of Yakutia Chief agronomist 6 pp 55-56