

Regulation of phytopathogenic background at use of biological preparations in agro-ecosystems of potato and in conditions of its storage

Borodai V.¹, Parfeniuk A.²

Institute of Agroecology and Nature Management of Institute of Agroecology and Environmental Management of NAAS, 12 Metrolohichna Str., Kyiv, 03143, Ukraine; e-mail: ¹veraboro@gmail.com, ²verespar@ukr.net

The purpose. To determine the role of biological preparation Planriz and its compositions with biological preparations Diazofit and Fosfoenterin in regulation of phytopathogenic background in agro-ecosystems of potato and in conditions of its storage. **Methods.** Field, laboratory (microbiological, biochemical, phytopathologic), mathematical statistics. **Results.** Results of researches in effect of biological preparation Planriz on the basis of growth-stimulating bacteria *Pseudomonas fluorescens* AP-33 together with Diazofit (nitrogen-fixing bacteria *Agrobacterium radiobacter* 204) and Fosfoenterin (phosphate-mobilizing bacteria *Enterobacter nimipressuralis* 32-3) on regulation of phytopathogenic background of microorganisms of mycological and bacterial etiologies in agro-ecosystems of potato and during its storage are brought. It is proved that indicated biological preparations are the important biotic factor in regulation of phytopathogenic background at growing and storage of potato. They stipulate the induced resistance of plants of potato to causal organisms of diseases, heightening exit of standard part of potato, essential decrease of sick rate of tubers at storage. It is fixed that joint application of biological preparation Planriz and fungicide Ridomil Gold stipulates effective control of phytopathogenic microbiota in agro-ecosystems of potato. **Conclusions.** Biological preparations Planriz, Diazofit and Fosfoenterin (on the basis of bacteria with different multifunctional action *P. fluorescens* AP-33, *A. radiobacter* 204 and *E. nimipressuralis* 32-3 accordingly) are characterized by high performance in regulation of phytopathogenic microbiota in agro-ecosystems of potato in conditions of Western Ukraine and during storage of tubers, promote level recession of biological pollution of agroecosystems, potential bioecological risks in agroecosystems, and increase of quality of planting stock of potato.

Key words: *phytopathogenic microbiota, biological pollution, vegetative period, storage, grades of potato, biological preparations, bioecological risks.*

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The problem of food safety in Ukraine is associated with an increase in the productivity of crops, including potatoes. However, the increase in the yield of the crop is limited by the development of a complex of diseases, among which the highly harmful are fusarium and alternaria dry rots of potato, which are caused by various types of toxigenic fungi of genera *Fusarium* and *Alternaria*. Increasing of the harmfulness of pathogens on potato plants during vegetation and tubers storage induces by the high adaptive capacity, metabolic activity, phylogenetic features, organotropic specialization, the ability to change over to saprotrophic nutrition and the formation of high-resistance to external factors propagules [1]. Pathological processes, that develop during plant growth and potato storage, are aggravated by the effects of various mixed infections, annual meteorological fluctuations, etc. [2].

The listed factors lead to the emergence of potential bioecological risks in agroecosystems. The using of microbial preparations, created on the basis of agronomical valuable bacteria, is one of directions of biological pollution and ecological safety of agrophytocenoses decrease. These bacteria stimulate growth and increase the plant productivity due to the assimilating of plant food compounds and biologically active substances, also induce of the system plant immunity [3].

Among about 135 biological preparations in the State register of pesticides and agrochemicals database permitted for using in Ukraine in 2018, there are 18 biopreparations which are recommended for potatoes,

among which only 4 are used for protection against mycological and bacterial diseases: Phytocide based on *Bacillus subtilis* (Ukraine), Pseudobacterium-2 based on *Pseudomonas aureofaciens* (Ukraine), EKOpop - based on several strains of bacteria, micromycetes and arbuscular endomycorrhizal fungi (Germany, Italy) and Phytolavin based on phytoantibiotic (Estonia), the remaining biopreparations are recommended for yield enhancement [4]. Bacteria of the genus *Pseudomonas*, which are the basis of the biological preparation Planriz in Ukraine, produce a variety of secondary metabolites of antibiotic nature with fungicidal and bactericidal activity, are widely used in the world for the biocontrol of phytopathogenic microorganisms, are characterized by growth-stimulating activity due to the production of growth regulators and other physiologically active substances [5,6, 7]. However, the effectiveness of *Pseudomonas fluorescens* using during storage of potatoes in Ukraine, induce of the system plant immunity to regulate the phytopathogenic fond and the improvement of the quality of the planting material are little-studied problems.

The purpose of the research is to investigate the peculiarities of the regulation of phytopathogenic microbiota in potato agrophytocenoses with the use of the biopreparation Planriz on the basis of bacteria *Pseudomonas fluorescens*.

Materials and methods of research. Evaluation of fungicidal and bactericidal activity of biopreparations was carried out by diffusion in agar method using appropriate methods [8]. Determination of the activity of polyphenol oxidase (C.E.1.14.18.1), structural-functional changes, anatomical and histological studies in potato tissues for the action of biopreparations and pathogens, as well as biotechnological studies *in vitro* were carried out in accordance with known methods [9, 10].

The study of the protective and stimulating action of biological preparations in agrophytocenoses during potato vegetation and storage was carried out in conditions of experimental fields and storage facilities of the basic farms of the Phytosanitary control in seed and seedling Department of Phytosanitary Safety of the State Service of Ukraine on Food Safety and Consumer Protection in the Lviv Region and the Institute of potato farming of the National Academy of Sciences of Ukraine, which are located within the provinces of Polesye Western, Polesye Right Bank, Forest-Steppe Western, Precarpathian and Carpathian Mountains [12]. Variants of experiments were: control - treatment with water; biological standard – bacteria *Bacillus subtilis* (biological preparation Phytocid, titer 1×10^9 cells/ml, 2.0 l/ha, t); Biopreparation Planriz on the basis of bacteria *Pseudomonas fluorescens* AP-33 (titer 2×10^9 cells/ml; 2.5 l/ha, t); The composition of Planriz, Diazophyt, Phosphoenterin (2,5 + 0,2 + 0,2 l/ha, t), chemical standard – Ridomil Gold, 2,5 l/ha, t, or Rovral Aquaflo, 0,4 l/ton; a mixture based on Planriz and chemical fungicide Ridomil Gold (2.0 + 2.5 l / ha, t). The working solutions of the biological preparations were prepared according to the recommendations of the manufacturer. Two terms of potato cultivation were investigated: the second decade of April (1st period of planting) and the first half of May (2nd period of planting). Biological efficacy of biological agents was investigated according to generally recognized methods [11].

The influence of biomaterials on the taxonomic structure of microbiota in the vegetation period of potato was estimated using generally accepted methods [13]. The containing of the standard part of the tubers, the amount of dry matter, starch, affected potato tubers under the influence of abiotic and biotic factors was studied in accordance with DSTU 4013-2001, DSTU 4014-2001 and corresponding methods [11]. Statistical processing of experimental data was performed using Microsoft Office® for Microsoft Windows®.

The research results. Currently, phytopathogenic micromycetes of necrotrophic type of nutrition, which are characterized by high harmfulness and they are factors of biological contamination of agrophytocenoses and decrease in quality and safety of products, dominate in potato agrophytocenoses in Ukraine during vegetation and post-harvest period [14]. This is due to the increased resistance of pathogenic microorganisms to fungicides of various nature, a significant amount of latent infection, both in the tubers and in the soil, with the emergence of fundamentally new types of phytopathogenic consortia, significant warming of the climate [1,2].

It has been established that Planriz revealed a wide range of antibiotic activity against different types of phytopathogenic microorganisms belonging to the genera *Fusarium*, *Alternaria* and *Pectobacterium*, and inhibit of their growth in 1.2-1.5 times greater than control. The quantitative and qualitative composition of soil microbiota significantly changed during the vegetation period of potato plants according to the action of the biological preparation Planriz in the conditions of the Polesye Right Bank province. An increase of the total

number of saprotrophic bacteria was observed in the soil for the predominance of genera *Pseudomonas*, *Bacillus*, *Micrococcus*, among the saprotrophic fungus – micromycetes of genera *Penicillium* and *Trichoderma* by 8.8-30.3% compared with control.

With the use of multifunctional microbial preparations Planriz, Diazophyt and Phosphoenterin in different soil and climatic conditions of the Lviv region, there was a decrease in the infectious load in the soil during the growing of potatoes, the number of pathogens of fusariosis and alternate rots was significantly reduced – on average in 1.6-3.5 times compared to control irrespective of the time of potatoes. As part of the epiphytic microflora of the tubers, the decreasing of the populations of *Fusarium* spp., *Phoma* spp. and *Pectobacterium* spp. in 1,9-4,3 times compared with the control.

It was established that the using of the biopreparations Planriz contributed to a decrease of potato tubers affected by fusarium rot (*F. sambucinum*) and bacteriosis (*P. carotovorum*) – an average of 32.2-73.6% due to the artificial inoculation of potato varieties of different groups of maturation. The efficiency of Planriz for bacterial rot was lower compared with standards – on average in 1.7 times. Biological efficacy of biopreparations for fusariosis varied between 13.5% and 31.3% in the early, middle and mid-ripening varieties, and in the middle late – in the range of 7.4-27.1%, which did not exceed the level of standards. This may be due to an increase in 1.2-1.5 times the activity of the enzyme polyphenol oxidase, the enhancement of which activity and oxidation processes under the influence of Planriz, contributed to the development of induced resistance at the tissue level, which was characterized by thickening of secondary cell walls, as well as intense deposition of lignin and suberin in parenchyma tissue of potatoes.

The treatment of tubers by biopreparations Planriz, Diazophyt and Phosphoenterin before planting and at the budding and flowering phases significantly reduced the damage of potato varieties by pathogens in the soil and climatic conditions of Western Ukraine (Fig. 1).

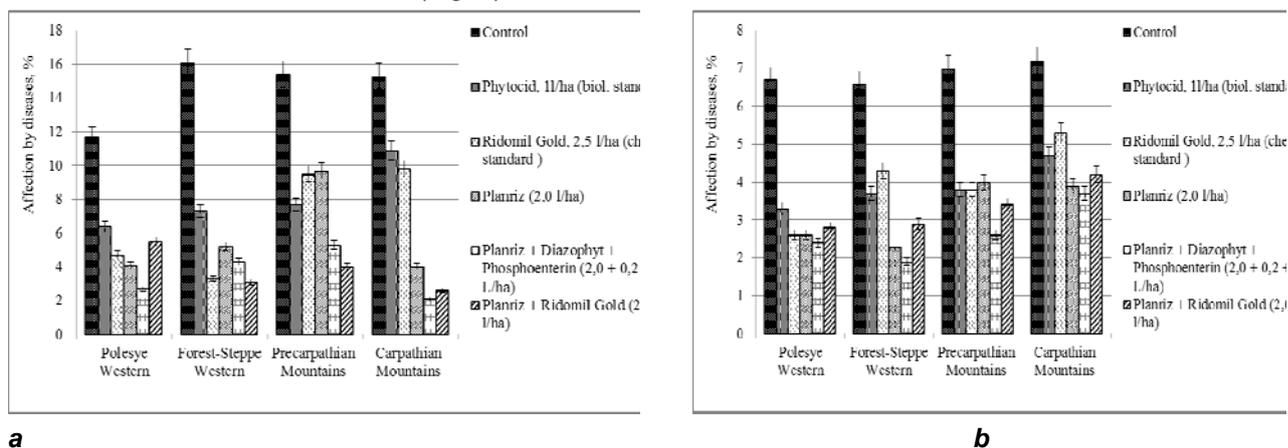


Fig. 1. Regulation of the phytopathogenic fond at the using of biopreparations (Lileia variety, 1 st planting), 2009-2012: a – post-harvest period; b – at the end of storage

Thus, in the post-harvest period, the affected by the disease was 2.1-9.7%, compared with 11.7-16.1% in the control variant, and at the end of storage – 1.9-5.5 versus 6.7-7.2% in accordance. The biological (technical) efficiency of the inhibition of the development of potato diseases in the conditions of the Western Forest-steppe and Western Polesye during the first planting period after the application of Planriz was 42.2-55.0%, and the compositions of Planriz, Diazophyt and Phosphoenterin – 51.7-53, 1% compared to the control. The effectiveness of biopreparations in the Precarpathian Mountains (44.4-46.9%) and the Carpathians (45.8-48.6%) was somewhat lower due to acidity of soils (pH = 4.1-5.0), decrease the activity of nitrogen fixing and phosphate-mobilizing bacteria, which depends to a large extent on edaphic factors and climatic conditions. Sod – burozemic – podzolic surface-gleyed soils of the Carpathian forest of a very wet subzone and burozemic, podzolic of the subsoil of the mountain forest wet ultra-lost Carpathian brown-earth region with hydro-thermal coefficient (V-IX = 1,8-3,8) are characterized by weak permeability and high acidity.

It was established that the treatment of tubers of different varieties of potatoes with the biologic preparation Planriz contributed to a decrease in the natural losses of their mass (in 1.2-1.6 times) compared with the control

and chemical standard, and also to reduce the loss of starch and dry substances during the storage of tubers in 1.2-1.3 times compared to control.

The using of Planriz, Diazophyt, Phosphoenterin increased the quality of the planting material and the standard part of the tubers in 1.2-1.4 times irrespective of the term of the gardening. In the conditions of the Western Forest-Steppe and Western Polesye, the part of standard potato tubers, grown for the using of biopreparations, varied from 85.0 to 86.8%, at the Precarpathian Mountains and the Carpathians - was slightly lower and amounted to 77.6-80.9 % (Fig. 2).

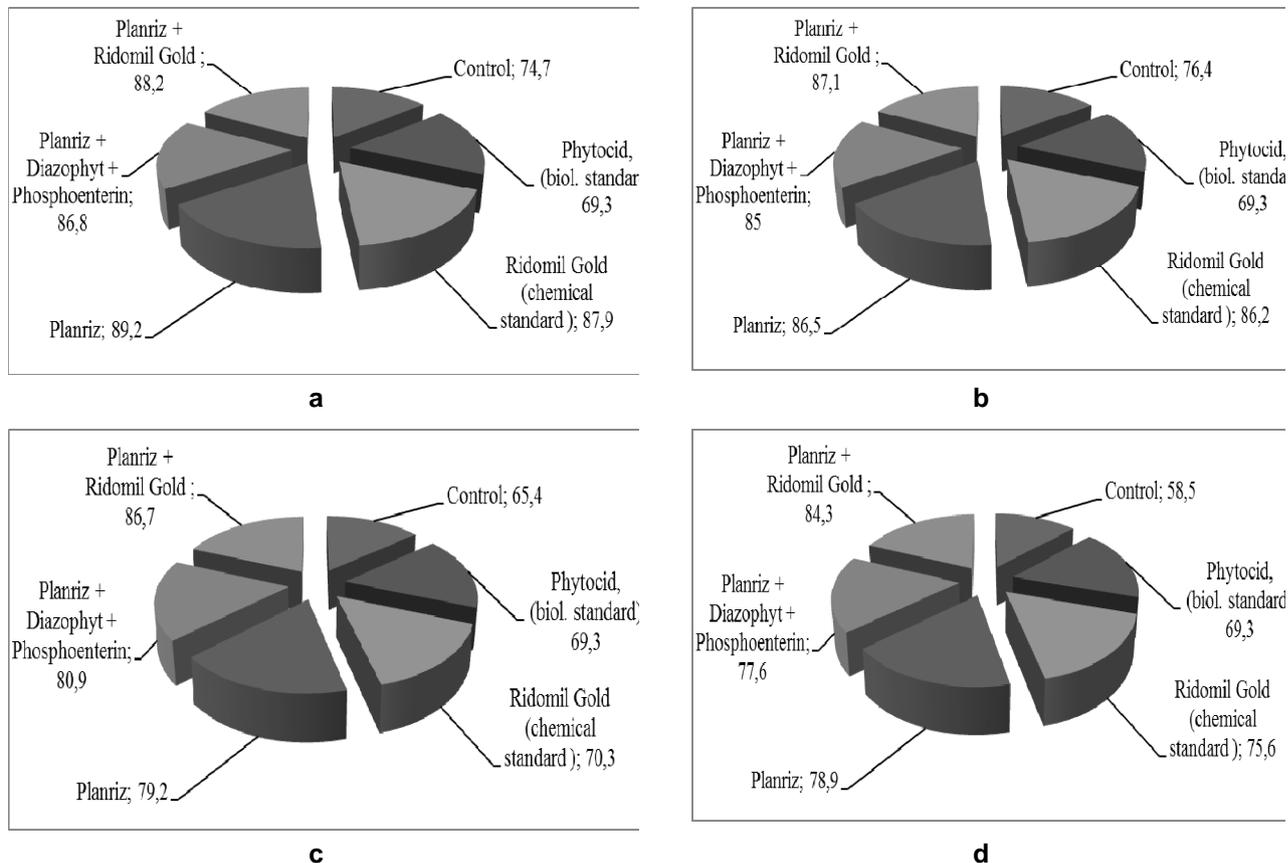


Fig. 2. The effect of biological preparations on the formation of the standard part of the crop, % (Skarbnytsya variety, 1st planting, 2009-2011):

a – Western Polesye

b – Western Forest-Steppe

c – Precarpathian Mountains

d – the Carpathians

The loss of Lilia and Skarbnytsya during the storage varieties of potatoes significantly reduced at the use of biopreparations for both time of planting in different soil and climatic conditions (Fig. 3).

Thus, the total losses of potatoes of the Lille variety during the first planting were: 11.3-27.1% in control, at the variant with Planriz, Diazophyt and Phosphoenterin – 8.4-16.3% in all studied zones (mainly due to natural losses of potato mass, the affected of tubers and sprouts). The smallest tuber loss was recorded in the variant with the use of Planriz and Ridomil Gold – 7.5-11.8%. It should be noted that the total losses were higher at the second period of planting, and the highest – at the end of storage of potato tubers, grown in the Carpathian Mountains on the burozemic podzolic soil.

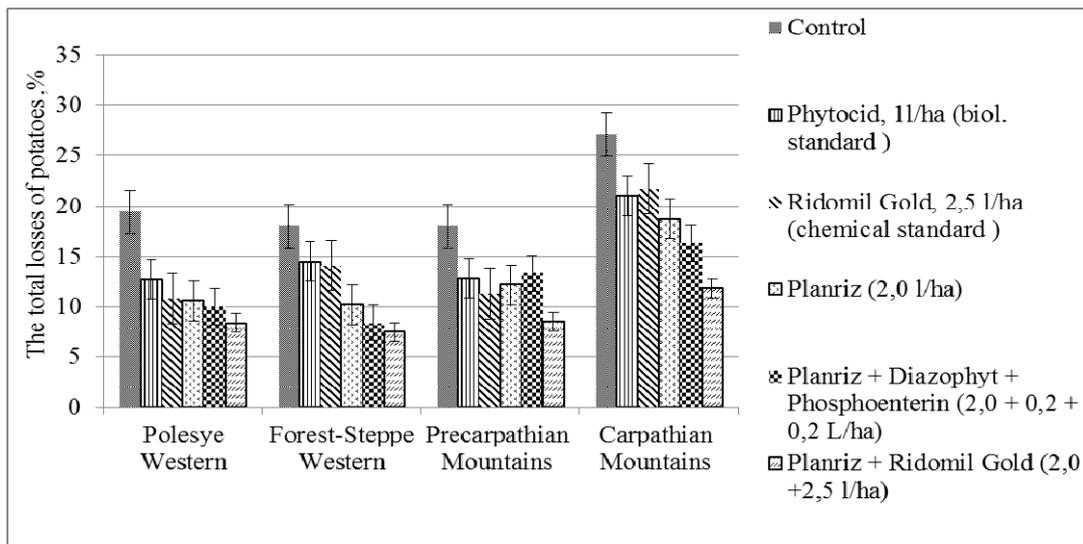


Fig. 3. The preservation of potatoes of the Lille variety for the using of biopreparations (1st planting, 2009-2012)

The adaptation of regeneration plants to *ex vitro* conditions is the ultimate and complex step in obtaining planting material. Biopreparations Planriz, Diazophyt and Phosphoenterin positively influenced on the processes of rooting and contributed to the application of potato regeneration plants at the stage of adaptation to the non-sterile conditions at 16.2-27.0%.

It has been established that the combined use of the biological preparation Planriz and fungicide Ridomil Gold in the conditions of the Western Forest-steppe and Polesye reduced the affected of potato tuber by diseases at an average in 1.5 times, in the Precarpathian Mountains – from 2.2 to 2.4 and in the Carpathians – by 2.5-3.8 times compared to control. This contributed to an increase in the effectiveness of preparations, an increase of the standard part of potato tubers, grown in all the soil-climatic conditions of the Lviv region. In addition, it was found that the complex application of the biological preparation Planriz with chemical fungicide Ridomil Gold MC reduced the number of phytopathogens of genera *Fusarium* and *Alternaria* in potato agrophytocenoses – an average of 1.3-2.9 times, regardless of the timing of potato planting and the soil-climatic conditions of its cultivation compared with the use of only one fungicide.

Conclusions

The using of a biologic preparation Planriz created on the basis of bacteria P. fluorescens AP-33, both individually and in combination with Diazophyt and Phosphoenterin, irrespective of agroclimatic conditions of potato cultivation, contributes to the increase of the total number of saprotrophic microorganisms in the soil in comparison with control, the regulation of population and reduction of the number of phytopathogens – an average in 1,6-4,3 times in agrophytocenoses of potatoes, and at the storage of tubers. Due to the influence of Planriz, Diazophyt and Phosphoenterin, which are characterized by phyto-protective and growth-stimulating properties, ecological and physiological compatibility of bacteria and prolonged action, there is a decrease in the phytopathogenic fond in agrophytocenoses, and also for storage of potatoes – in 1.7-5.6 times depending on the terms planting and soil-climatic conditions, which contributes to the reduction of biological contamination and the improvement of the quality of the planting material.

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