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The effect of the *Pseudomonas fluorescens* bacteria and substances of a stimulating nature on the productivity of the soybean plant and seed damage by pathogens

Abstract. Soybeans are a strategic leguminous crop for global agriculture and play an important role in ensuring food security in many countries. Therewith, biotic factors, in particular, pathogens prevent obtaining a rich and high-quality yield of the crop. Their control is conducted using various methods and technques. However, with an excessive increase in the use of chemical protective equipment, the environmental situation in agrocenoses becomes more complicated. Therefore, it is important to reduce the pesticide load in crop cultivation technologies. The purpose of the study is to assess the effect of the Pseudomonas fluorescens bacteria and stimulating substances on soybean plant productivity and seed damage by pathogens. The experiments were conducted in the conditions of the Ukrainian scientific-research station on plant quarantine of the Institute of Plant Protection of the National Academy of Agrarian Sciences of Ukraine. The soil of the experimental plot is grey forest heavy-loamy. The Ksenia soybean variety was used in the study. Field studies were conducted according to generally accepted methods. Soybean crops were sprayed during the growing season in the following periods: true three-leaf, flowering, and bean formation. For the treatment of soybean plants, a preparation based on the Pseudomonas fluorrescens bacteria with a titrant of $3x10^9$ CFU/cm^3 was used with a consumption rate of 5.0 l/ha per use in combinations with substances of stimulating action. Over the years of research, the amount of precipitation (in certain months of soybean vegetation) was higher than the average monthly perennial norm. Pre-harvest desiccation of crops was not conducted. Phytopathological examination of seeds obtained from soybean plants for various treatment options was conducted in accordance with DSTU 4138-2002. Studies show a positive effect of the drug based on P. fluorescens and substances of a stimulating nature on biometric

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indicators of soybean plants and their productivity. In particular, the weight of 1000 seeds in variants with spraying plants increased in the range from 16 to 66 g. Joint application on soybean crops of P. fluorrescens together with substances of the group of ammonium salts of dihydropyrimidine and stimulating substances provided an increase in the yield of soybean seeds up to 1.1 t/ha. There was also a decrease in infection of soybean seeds with pathogens of Fusarium, Alternaria and penicillosis – Fusarium oxysporum Schlecht, Alternaria spp., and Penicillium expanum Link fungi. The investigation of the immunoprotective and stimulating effects of combinations of biocomplexes is promising for the development of environmentally safe measures to increase soybean yield and reduce seed damage by pathogens

Keywords: bacteria; plant productivity; seed infestation; fungi

RELEVANCE

Soy (*Glycine max* (L) Merrill) is a strategic leguminous crop for global agriculture. Its seeds are one of the few complete plant-based protein products with nine essential amino acids (Michelfelder A. J., 2009). Soy plays an important role in the food security of many countries and is used for feed, food, technical, and other purposes (Cherenkov A.V. *et al.*, 2014)

In different countries, soybean acreage has been growing dynamically over the past decades (Babych A.A. Babych-Poberezhna A.A., 2012). The leaders in its production are mainly the countries of South America, in particular, Argentina, Paraguay, and Brazil (De Maria M. *et al.*, 2020). Ukraine is among the top ten leading countries (Berbenets O.V. 2019). Therewith, diseases prevent obtaining a high yield of high-quality soybean grain (Pikovskyi M.I., Kyryk M.M., 2012; Baetsen-Young, A.M., Swinton S.M., Chilvers M.I., 2021; Díaz-Cruz G.A., Cassone B.J., 2021). Their control is conducted using various methods and techyniques (Dorrance A.E. *et al.*, 2009; Kurle James, Grau Craig, Oplinger Edward, Mengistu Alemu, 2001; Reznikov S. *et al.*, 2019). However, with an excessive increase in the use of chemical protective equipment, the ecological situation in agrocenoses becomes more complicated due to the violation of natural processes of harmonious coexistence of representatives of natural biota. Therefore, the issue of biologisation of plant protection is relevant (Baranov V.F., Makhonin V.L., 2014).

ANALYSIS OF RECENT STUDIES AND PAPERS

Various methods can be used to prevent, reduce, or control plant diseases, including chemical pesticides that can pollute the environment. Therefore, as an alternative to crop cultivation technologies, there is the development of biological agents (Chandrashekara K.N. *et al.*, 2020). Studies of the effect of antagonist microbes against soy pathogens are being conducted in different countries of the world. In particular, the activity of the *Rhizobium japonicum* bacteria was evaluated against *Fusarium solani* and *Macrophomina phaseolina* soil pathogens – pathogens of root rot. It was identified that rhizobial culture filtrate caused inhibition of radial growth of phytopathogens *in vitro*. Sowing with seeds treated with bacterial culture (with the introduction of *F. solani* and *M. phaseolina* infection into the soil) substantially increased seed germination and caused a substantial decrease in the intensity of root rot development in the field. These results indicate that *R. japonicum* may be an important element for disease control (Alani Rakib *et al.*, 2012).

Arfaoui *et al.* (2018) evaluated bacteria extracted from rhizosphere soil and rhizoplanes of healthy soybean plants and investigated their antifungal effect against *Phytophthora sojae* soybean isolates. Among those tested, nine bacteria were identified (belonging to *Paenibacillus* and *Streptomyces sp.*), which inhibited the hyphal growth of *P. sojae in vitro*. Therewith, the use of bacterial strain S11 for seed treatment reduced the development of the disease by 57.1% and increased the mass of roots and shoots by 140 and 108%, respectively, compared to the control (Arfaoui A. *et al.*, 2018).

Potential research is also being conducted on *Pseudomonas sp.* as a biocontrol agent for soybean diseases caused by soil pathogens. in particular, *Pseudomonas sp.* CRB suppressed growth of pathogenic fungi (*Sclerotium rolfsii*, *Fusarium oxysporum*, and *Rhizoctonia solani*) *in vitro* by 11.1–60.0%. Therewith, CRB-16, CRB-44, CRB-86, CRB-102, and CRB-109 isolates are promising for the development of biological protection (Susilowat Ari *et al.*, 2013).

Gram-positive bacterium *Paenibacillus* BRF-1, showed strong antifungal activity against the brown stem rot pathogen soy fungus *Phialophora gregata*. Seed treatment also provided better growth of plant shoots (Zhou Keqin *et al.*, 2008).

Against the causative agent of soy anthracnose (*Colletotrichum dematium* fungus (Pres. Ex.Fr,)) antagonism of the *Trichoderma lignorum* and *Trichoderma viride* fungi and the *Bacillus megaterium* and *Bacillus brevis* bacteria was established. They inhibited the linear growth of *C. dematium*, and culture filtrates of the corresponding bioagents inhibited the germination of pathogen spores. Spraying soybean plants with antagonist suspensions or their culture filtrates resulted in a substantial reduction in the development of the disease (Jahan Akida *et al.* 2015). There is also information about the ability of *Trichoderma spp.* to suppress soybean stem rot caused by *Sclerotinia sclerotiorum* (Zhang Fuli *et al.*, 2016).

In the conditions of Ukraine, the effectiveness of preparations of biological origin for growing soybean plants was investigated. It was noted that combinations of Trichodermin (2 l/t) + Gaubsin (1.5 l/t) and phytodoctor (1.0 l/t) + Trichodermin (2 l/t) had the greatest effect on fungal infections (Solomiychuk *et al.*, 2020). The positive effect of pre-sowing seed inoculation with the microbial preparation Rizohumin, microfertiliser Reakom, and plant growth stimulator BioSil was also determined in various combinations. The effectiveness of using microfertiliser and BioSil solutions during the growing season of bactericidal plants on the formation and functioning of legume-rhizobial symbiosis and soybean grain yield was identified (Kabanets, Sobko, Murach, 2017). This indicates the importance of investigating the combinations of biocomplexes with drugs of a stimulating nature to assess their impact on plant yield and pathogen damage.

The purpose of the study is to conduct an assessment of the impact of the *Pseudomonas fluorescens* bacteria and substances of a stimulating nature on the productivity of the soybean plant and seed damage by pathogens.

MATERIALS AND METHODS

The study was conducted during 2019-2020 at the Ukrainian scientific-research station on plant quarantine of the Institute of Plant Protection of the National Academy of Agrarian Sciences of Ukraine. The soil of the experimental plot is grey forest heavy-loamy. Its availability of mobile forms of phosphorus is 148.4 mg kg, potassium – 185.4 mg/kg, and nitrogen – 83.0 mg/kg. Equilibrium soil density – 1.46 g/cm^3. The Ksenia soybean variety was used in the study. Sowing was conducted in the usual rowing way. In June and July 2019, precipitation was 129 and 99 mm, respectively, and in August – 110 mm, which was higher than the average monthly perennial norm. In June and July 2020, they were 130 mm per month at the norm of 75-85 mm. In September 2020, 104 mm of precipitation fell, which exceeded the perennial average. Desiccation of crops was not conducted.

A bacterial-based preparation *Pseudomonas fluorrescens* with a titrant of 3x10^9 CFU/cm^3 with a consumption rate of 5.0 l/ha was used in the study. In combinations, the use of a biological product based on the *P. fluorrescens* bacteria was combined with succinic acid (ethane-1,2 dicarboxylic acid $HOOC(CH_2)_2COOH$. Excipients were also examined: dimethyl sulfoxide (DMSO) – a chemical substance with the $(CH_3)_2SO$ formula, which is a bipolar solvent and is used to increase trans-tissue transport of active substances; dimethylaminoethanol (DMAE), which is an immunoprotector and affects various transmembrane functions.

Field research was conducted according to generally accepted methods (Tribel *et al.*, 2001). Soybean crops were sprayed during the growing season in the following periods: true three-leaf, flowering, and bean formation. During the biometric analysis of plants, the number of formed beans on plants was determined, pcs., the weight of 1000 seeds (g), and yield, t/ha. Phytopathological examination of grain obtained from soybean plants for various treatment options was conducted in accordance with DSTU 4138-2002 (Seeds of agricultural plants. Methods for seeds testing, 2003). Morphological analysis of pathogens was conducted through the creation of microscopic preparations, which were analysed using light microscopy and identified (Kyryk M.M., Pikovskyi M.Y., Azaiki S., 2015).

Statistical processing of experimental data was performed using the Microsoft Office® programme for Microsoft Windows®.

RESULTS

As the results of the study show, spraying soybean plants with a biological product based on the *P. fluorrescens* bacteria separately and *in* combination with substances of the group of ammonium salts of dihydropyrimidine and stimulating substances had a positive effect on the productivity of soybean plants. Thus, the number of beans formed under different spraying schemes increased by 0.4–5.9 pcs./ plant. In particular, in variants with spraying schemes *P. fluorrescens*, 5 l/ha + 0.1% xymedone solution + 2 ml DMAE + 2 ml DMSO, *P. fluorrescens*, 5 l/ha + 0.2% succinic acid solution + 2 ml DMAE + 2 ml DMSO, and *P. fluorrescens*, 5 l/ha + 0.1% xymedone solution + 0.2% succinic acid solution + 2 ml DMAE + 2 ml DMSO the most beans were formed – 11.3-14.2 pcs./plant (Table 1).

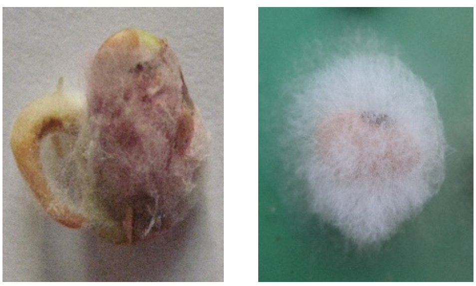
Table 1. Soybean productivity depending on the treatment of plants with the *Pseudomonas fluorescens* bacteria in combination with stimulating substances (Ksenia variety, average for 2019-2020)

Options	Number of formed beans per 1 plant, pcs.	Weight of 1000 seeds, g	Yield, t/ha
Control 1 (without treatment);	8.3	105	1.8
Control 2 *P. fluorrescens*, 5 l/ha	8.6	135	2.1
P. fluorrescens, 5 l/ha + 2 ml DMAE + 2 ml DMSO	8.7	148	2.2
P. fluorrescens, 5 l/ha + 0.2% succinic acid solution + 2 ml DMAE + 2 ml DMSO	12.9	152	2.7
P. fluorrescens, 5 l/ha + dihydropyrimidine derivatives (Amine 1 – 0.5% solution + 2 ml DMSO)	10.4	138	2.4
P. fluorrescens, 5 l/ha + dihydropyrimidine derivatives (Amine 3 – 0.25% solution + 2 ml DMSO)	10.8	121	2.3
P. fluorrescens, 5 l/ha + 0.1% xymedone solution + 2 ml DMAE + 2 ml DMSO	11.3	165	2.4
P. fluorrescens, 5 l/ha + 0.1% xymedone solution + 0.2% succinic acid solution + 2 ml DMAE + 2 ml DMSO	14.2	171	2.9
HIP_{05}	0.1	3.9	0.09

Positive dynamics were also noted regarding the mass of seeds. Thus, the weight of 1000 seeds in variants with spraying plants increased in the range from 16 to 66 g. Joint application *P. fluorrescens*, 5 l/ha + 0.2% succinic acid solution + 2 ml DMAE + 2 ml DMSO ensured the formation of seeds by plants, the mass of 1000 of which was 152 g; in the case of use *P. fluorrescens*, 5 l/ha + 0.1% xymedone solution + 2 ml DMAE + 2 ml DMSO – the weight of a 1000 seeds reached 165 g and for spraying with *P. fluorrescens*, 5 l/ha + 0.1% xymedone solution + 0.2% succinic acid solution + 2 ml DMAE + 2 ml DMSO – 171 g. These were the highest indicators compared to the control (without treatment).

In the end, separate and joint application on soybean crops of *P. fluorrescens* together with substances of the ammonium salts of dihydropyrimidine and stimulating substances increased the yield of soybean seeds from 0.3 to 1.1 t/ha. The best result was noted in the version using a preparation based on *P. fluorrescens*, 5 l/ha + 0.1% xymedone solution + 0.2% succinic acid solution + 2 ml DMAE + 2 ml DMSO. Therewith, the soybean yield was 2.9 t/ha, which is 0.8 and 1.1 more than in the control variants (without treatment and with *P. fluorrescens*).

According to the results of the phytopathological examination of soybean seeds, selected from various variants of the experiment, the damage by such micromycetes was identified: *Fusarium oxysporum* Schlecht, *Alternaria spp.,* and *Penicillium expansum* Link. During germination of seeds infected with the *F. oxysporum* fungus, weak, underdeveloped, deformed seedlings were formed, which later rotted. Seeds affected by Fusarium infection could also lose their ability to germinate and become covered with a whitish-pink coating (Fig. 1a). On the surface of soybean seeds affected by *Alternaria spp.* symptoms of the disease initially appeared in the form of a light, later smoky-grey – black coating. In many cases, normal seedlings were formed, but the seeds with severe damage did not germinate (Fig. 1b). *P. expansum* fungi developed on seeds in the form of a mouldy coating of green-blue colour (Fig. 1c).



a

b

c

Figure 1. Symptoms of soybean seed diseases with varying degrees of damage: a – Fusarium; b – Alternaria; c – mould caused by *P. expansum*

Analysis of using the *P. fluorrescens* bacteria and their combinations together with substances of ammonium salts of dihydropyrimidine group and stimulating substances showed that all of them provided a reduction in infection of soybean seeds with *F. oxysporum*, *Alternaria spp.*, and *P. expansum* fungi (Table 2). In particular, the number of seeds affected by the causative agent of Fusarium infection ranged from 8.7 to 12% (33.1% in the control). Infection with *Alternaria spp.* was detected in 7.2-10.8% of seeds (29.6% in the control).

Mould caused by the *P. expansum* fungus, infected 1.8-3.2% of soybean crops in various treatment options, while in the control this figure was 14.2%.

Table 2. Effect of treating soybean plants with the *Pseudomonas fluorescens* bacteria in combination with stimulating substances for seed infestation by fungi (Ksenia variety, average for 2019-2020)

Options	Seeds are affected by fungi, %		
F. oxysporum		*Alternaria spp.* *P. expansum*	
Control 1 (without treatment)	33.1 ± 3.6	29.6 ± 2.8	14.2 ± 2.4
Control 2 *P. fluorrescens*, 5 l/ha	11.2 ± 0.5	10.8 ± 0.5	3.2 ± 0.3
P. fluorrescens, 5 l/ha + 2 ml DMAE + 2 ml DMSO	9.8 ± 0.4	10.6 ± 0.3	3.0 ± 0.4
P. fluorrescens, 5 l/ha + 0.2% succinic acid solution + 2 ml DMAE + 2 ml DMSO	8.9 ± 0.6	9.7 ± 0.5	2.5 ± 0.4
P. fluorrescens, 5 l/ha + dihydropyrimidine derivatives (Amine 1 – 0.5% solution + 2 ml DMSO)	8.9 ± 0.4	9.2 ± 0.3	2.3 ± 0.5
P. fluorrescens, 5 l/ha + dihydropyrimidine derivatives (Amine 3 – 0.25% solution + 2 ml DMSO)	12.2 ± 0.7	9.2 ± 0.5	2.6 ± 0.4
P. fluorrescens, 5 l/ha + 0.1% xymedone solution + 2 ml DMAE + 2 ml DMSO	10.6 ± 0.5	7.9 ± 0.4	2.1 ± 0.2
P. fluorrescens, 5 l/ha + 0.1% xymedone solution + 0.2% succinic acid solution + 2 ml DMAE + 2 ml DMSO	8.7 ± 0.4	7.2 ± 0.3	1.8 ± 0.2

Among the various treatment options for soybean crops, the smallest number of seeds affected by pathogens was noted with the use of *P. fluorrescens*, 5 l/ha + 0.1% xymedone solution + 0.2% succinic acid solution + 2 ml DMAE + 2 ml DMSO, which is due to their immunoprotective and stimulating effect.

CONCLUSIONS

Studies showed that the combination of the *P. fluorenscens* bacteria with preparations of a stimulating nature and various derivatives of ammonium salts of dihydropyrmidine for spraying soybean plants provided an increase in the yield of soybean seeds from 0.8 to 1.1 t/ha. In addition, all of them led to a decrease in infection of soybean seeds with the *F. oxysporum*, *Alternaria spp.*, and *P. expansum* fungi. The use of combinations of biocomplexes is promising for further study as environmentally safe measures to increase soybean yield and reduce seed damage by pathogens.

REFERENCES

[1] Alani Rakib, Adhab Mustafa, Mahdi Haider, Abood Hadi. (2012). Rhizobium japonicum as a Biocontrol Agent of Soybean Root Rot Disease Caused by Fusarium solani and Macrophomina phaseolina. Plant Protection Science, 48(4), 149-155. https://doi.org/10.17221/16/2012-PPS

[2] Arfaoui A., Adam L.R., Bezzahou A. *et al.* (2018). Isolation and identification of cultivated bacteria associated with soybeans and their biocontrol activity against Phytophthora sojae. BioControl, 63, 607-617. https://doi.org/10.1007/s10526-018-9873-9

[3] Babych, A.A, Babych-Poberezhna, A.A. (2012). World and domestic trends in the location of production and use of soybeans to solve the problem of protein. Kormy i kormovyrobnytstvo. 71, 12-25.

[4] Baetsen-Young, A.M., Swinton, S.M., Chilvers, M.I. (2021). Economic Impact of Fluopyram-Amended Seed Treatments to Reduce Soybean Yield Loss Associated with Sudden Death Syndrome. Plant Disease, 105(1), 78-86. https://doi.org/10.1094/PDIS-04-20-0792-RE

[5] Baranov, V.F., Makhonin, V.L. (2014). About biological protection of soybean agrophytocenoses from harmful organisms. Maslichnyye kul'tury, 1, 152-164.

[6] Berbenets O.V. (2019). Svitove vyrobnytstvo soyi yak nevycherpnoho dzherela bilkiv roslynnoho pokhodzhennya ta mistse Ukrayiny na svitovomu rynku torhivli neyu [World soybean production as an inexhaustible source of proteins of plant origin and Ukraine 's place in the world market of its trade]. Ahrosvit, 10, 41-45. https://doi.org/10.32702/2306-6792.2019.10.41

[7] Chandrashekara, K.N., Manivannan, S., Chandrashekara, C., Chakravarthi, M. (2012). Chapter: 10. Biological Control of Plant Disease. Eco-friendly Innovative Approaches in Plant Disease Management. Editors: Vaibhav K. Singh, Yogendra Singh, Akhilesh Singh. Publisher: International Book Distributors, 147-166.

[8] Cherenkov, A.V. *et al.* (2014). Legumes: modern technologies of cultivation. Dnipropetrovsk: Akcent. 109 p.

[9] De Maria M., Robinson E.J.Z., Kangile J.R., Kadigi R., Dreoni I., Couto M., Howai N., Peci J., Fiennes, S. (2020). Global Soybean Trade. The Geopolitics of a Bean. UK Research and Innovation Global Challenges Research Fund (UKRI GCRF) Trade, Development and the Environment Hub. https://doi.org/10.34892/7yn1-k494

[10] Díaz-Cruz G.A., Cassone B.J. (2021). Amplicon Sequencing Reveals Extensive Coinfections of Foliar Pathogens in Soybean. Plant Disese, 105(1), 127-133. https://doi.org/10.1094/PDIS-06-20-1165-RE

[11] Dorrance, A.E., Robertson, A.E., Cianzo, S., Giesler, L.J., Grau, C.R., Draper, M.A., Tenuta, A.U., Anderson, T.R. (2009). Integrated management strategies for Phytophthora sojae combining host resistance and seed treatments. Plant Disease, 93, 875-882.

[12] Jahan Akida, Jahan Nushrat, Hossain Mohammad, Hossain Muhammed. (2015). Biological control of anthracnose of soybean. Research in Agriculture Livestock and Fisheries, 2(3), 419-426. https://doi.org/10.3329/ralf.v2i3.26164

[13] Kabanets, V.M., Sobko, M.H., Murach O.M. (2017). Functioning of symbiosis "Japonicum – soy" and soybean yield under the influence of rhizohumin and physiologically active substances. Kormy i kormovyrobnytstvo, 83, 58-66.

[14] Kurle James, Grau Craig, Oplinger Edward, Mengistu Alemu. (2001). Tillage, Crop Sequence, and Cultivar Effects on Sclerotinia Stem Rot Incidence and Yield in Soybean. Agronomy Journal, 93(5), 973-982. https://doi.org/10.2134/agronj2001.935973x

[15] Kyryk, M.M., Pikovskyi, M.Y., Azaiki, S. Diseases of seeds of agricultural crops. Kyiv: CP Komprynt. 2015. 340 s.

[16] Michelfelder, A.J. (2009). Soy: A complete source of protein. American Family Physician, 79(1),43-47.
[17] Nasinnya sil's'kohospodars'kykh kul'tur. Metody vyznachennya yakosti: DSTU 4138-2002 [Seeds of agricultural plants. Methods for seed testing]. Kyiv: Derzhspozhyvstandart Ukrayiny, 2003. 173 s.
[18] Pikovskyi, M.Y., Kyryk, M.M. (2012). Symptomatyka biloyi hnyli soyi [Symptoms of white mold of soybeans]. Karantyn i zakhyst roslyn, 7, 2-5.
[19] Reznikov, S., De Lisi, V., Claps, P., González, V., Devani, M.R., Castagnaro, A.P., *et al.* (2019). Evaluation of the Efficacy and Application Timing of Different Fungicides for Management of Soybean Foliar Diseases in Northwestern Argentina. Crop Protection, 124. https://doi.org/10.1016/j.cropro.2019.104844
[20] Solomiychuk, M.P., Kordulyan, Y.V., Melnyk, A.T., Pikovskyi, M.Y. (2020). Influence of biological complexes and biostimulating material growth and development of soybean plants in the Western Forest-Steppe of Ukraine. Peredhirne ta hirs'ke zemlerobstvo i tvarynnytstvo, 67(2), 182-197.
[21] Susilowati Ari, Wahyudi Aris, Lestari Yulin, Suwanto Antonius, Wiyono Suryo. (2013). Potential Pseudomonas Isolated from Soybean Rhizosphere as Biocontrol against Soilborne Phytopathogenic Fungi. HAYATI Journal of Biosciences, 18(2), 51-56. https://doi.org/10.4308/hjb.18.2.51
[22] Tribel, S.O. *et al.* (2001). Methods of testing and application of pesticides. Kyiv: Svit. 448 s.
[23] Zhang Fuli, Ge Honglian, Zhang Fan, Guo Ning, Wang Yucheng, Chen Long, Ji Xiue, Li Cheng-Wei. (2016). Biocontrol Potential of Trichoderma harzianum isolate T-aloe against Sclerotinia sclerotiorum in soybean. Plant Physiology and Biochemistry, 100, 64-74. https://doi.org/10.1016/j.plaphy.2015.12.017
[24] Zhou Keqin, Yamagishi Masumi, Osaki Mitsuru. (2008). Paenibacillus BRF-1 has biocontrol ability against Phialophora gregata disease and promotes soybean growth. Soil Science & Plant Nutrition, 54, 870-875. https://doi.org/10.1111/j.1747-0765.2008.00308.x

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Вплив бактерій *Pseudomonas fluorescens* і речовин стимулюючої природи на продуктивність рослини сої та ураження насіння патогенами

Анотація. Соя є стратегічною зернобобовою культурою для світового сільського господарства та має важливу роль у забезпеченні продовольчої безпеки багатьох країн. Водночас отриманню високого і якісного урожаю культури перешкоджають біотичні чинники, зокрема збудники хвороб. Їхній контроль здійснюється за допомогою різних методів і способів. Однак за надмірного збільшення об'ємів застосовування хімічних засобів захисту ускладнюється екологічна ситуація в агроценозах. Тому актуальним є зменшення пестицидного навантаження в технологіях вирощування культури. Метою досліджень є проведення оцінки впливу бактерій Pseudomonas fluorescens і речовин стимулюючої природи на продуктивність рослини сої та ураження насіння патогенами. Експерименти проводили в умовах Української науково-дослідної станції карантину рослин Інституту захисту рослин НААН. Грунт дослідної ділянки – сірий лісовий важко суглинковий. Для досліджень використовували сорт сої Ксеня. Виконанняпольовихдосліджeньпроводилизгідноіззагальноприйнятимиметодиками.Посіви сої обприскували впродовж вегетації у такі періоди: справжній трійчастий листок, цвітіння та формування бобів. Для обробки рослин сої використовували препарат на основі бактерій *Pseudomonas fluorescens* з титром 3 х 109 КУО/см^3 з нормою витрати 5,0 л/га за застсоування у комбінаціях із речовинами стимулюючої дії. За роки досліджень кількість атмосферних опадів (в певні місяці вегетації рослин сої) була вище середньомісячної багаторічної норми. Передзбиральну десикацію посівів не проводили. Фітопатологічну експертизу насіння отриманого з рослин сої за різних варіантів обробок здійснювали згідно з ДСТУ 4138-2002. У дослідженнях відмічено позитивний вплив препарату на основі Pseudomonas fluorescens і речовин стимулюючої природи на біометричні показники рослин сої і їхню продуктивність. Зокрема, маса 1000 насінин у варіантах з обприскуванням рослин збільшувалася в межах від 16 до 66 г. Сумісне внесення на посівах сої *Pseudomonas fluorescens* разом із речовинами групи амонійних солей дигідропіримідину та стимулюючих речовин забезпечувало зростання урожайності насіння сої до 1,1 т/га. Також відмічено зниження інфікування насіння сої збудниками фузаріозу, альтернаріозу та пеніцильозу – грибами Fusarium oxysporum Schlecht, Alternaria spp. та Penicillium expansum Link. Вивчення імунопротекторної та стимулюючій дії комбінацій біокомплексів є перспективним для розробки екологічно безпечних заходів підвищення урожайності сої та зниження ураження насіння патогенами

Ключові слова: бактерії; продуктивність рослин; зараженість насіння; гриби