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# **APPLICATION OF THE METHOD OF PHYTOREMEDIATION OF PESTICIDE CONTAMINATED SOILS IN A FIELD EXPERIMENTAL PLOT In Chim-Korgon village**

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- The widespread use of pesticides in agricultural practices has led to the fact that countries, in one way or another, are facing pesticide waste problems.
- The management and disposal of obsolete pesticides, as well as the remediation of pesticide-contaminated soils, are important global issues important for agriculture, environmental health and quality of life.
- One of the sources of pesticides entering the ecosystem are old pesticide warehouses, landfills, and agricultural aviation airfields.
- For the Kyrgyz Republic, the problem of disposal of obsolete pesticides is relevant, since there are more than 200 storage sites in the republic, and more than half of them are in an unusable condition, with contaminated degraded soil.
- These studies are implemented as part of the project “Technical assistance in implementation of trials on bioremediation of POPs contaminated soils” for successful cleaning of soil from toxic substances and application of bioremediation and phytoremediation technology in the field at the experimental site

# Object of study

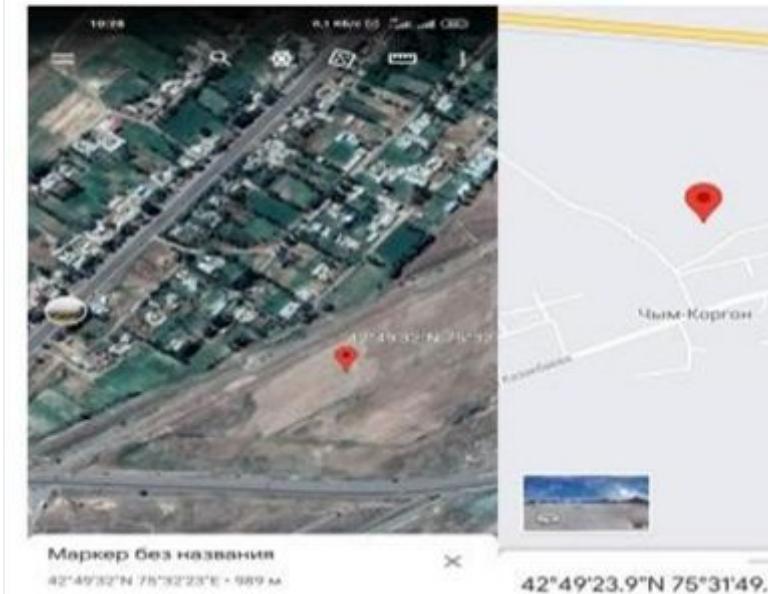
To evaluate the effectiveness of bioremediation and phytoremediation technology for contaminated soils with obsolete pesticides, an experimental site was selected - a former airfield in the village of Chym-Korgon (JPS data: N 42049'23.9" and E 75031'49.8", and elevation 974 m above sea level). This site, was used during agricultural works for aircraft refueling and aerial spraying of pesticides, and was also used for pesticide storage.



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Coordinates : N 49° 49' 23.2", E 75° 31' 49"  
 Elevation: 974 m above sea level.



№	Name	Soil samples	
		May 2021	
1	<b>A-BHC</b>	0.231±0,01	0.270±0,04
2	<b>B-BHC</b>	0.225±0,03	0.380±0,03
3	<b>G-BHC</b>	0.240±0,02	0.170±0,01
4	<b>D-BHC</b>	0.926±0,01	0.686±0,01
5	<b>Heptachlor</b>	0.476±0,01	0.550±0,02
6	<b>Aldrine</b>	0.903±0,03	1.418±0,02
7	<b>Heptachlor-epox</b>		2.544±0,01
8	<b>Trans-Chlordane</b>	<b>1.439±0,02</b>	<b>2.625±0,01</b>
9	<b>G-Chlordane</b>  <b>-Endosulfan-1</b>	<b>0.916±0,02</b>	<b>2.048±0,03</b>
10	<b>4,4 DDE</b>	<b>1.062±0,01</b>	<b>2.060±0,02</b>
11	<b>Dieldrine</b>	<b>1.350±0,03</b>	<b>4.347±0,01</b>
12	<b>Endrine</b>	<b>1.022±0,02</b>	<b>2.223±0,04</b>
13	<b>4,4 DDD</b>	<b>3.662±0,01</b>	<b>9.706±0,01</b>
14	<b>Endosulfane-2</b>	<b>2.615±0,01</b>	<b>2.088±0,01</b>
15	<b>Endrine-Aldehid</b>	<b>1.128±0,03</b>	<b>1.876±0,03</b>
16	<b>4,4 DDT</b>	<b>1.734±0,03</b>	<b>3.298±0,02</b>
17	<b>Endosulfan-sulfat</b>	<b>2.174±0,01</b>	<b>5.079±0,01</b>
18	<b>Metoxichlor</b>	<b>0.733±0,02</b>	<b>0.307±0,01</b>
19	<b>Endrine-ketone</b>	<b>1.314±0,01</b>	<b>0.130±0,02</b>

At this experimental site during 2021 a number of measures on Bioremediation technology were carried out

✓ Agrotechnical



✓ Watered

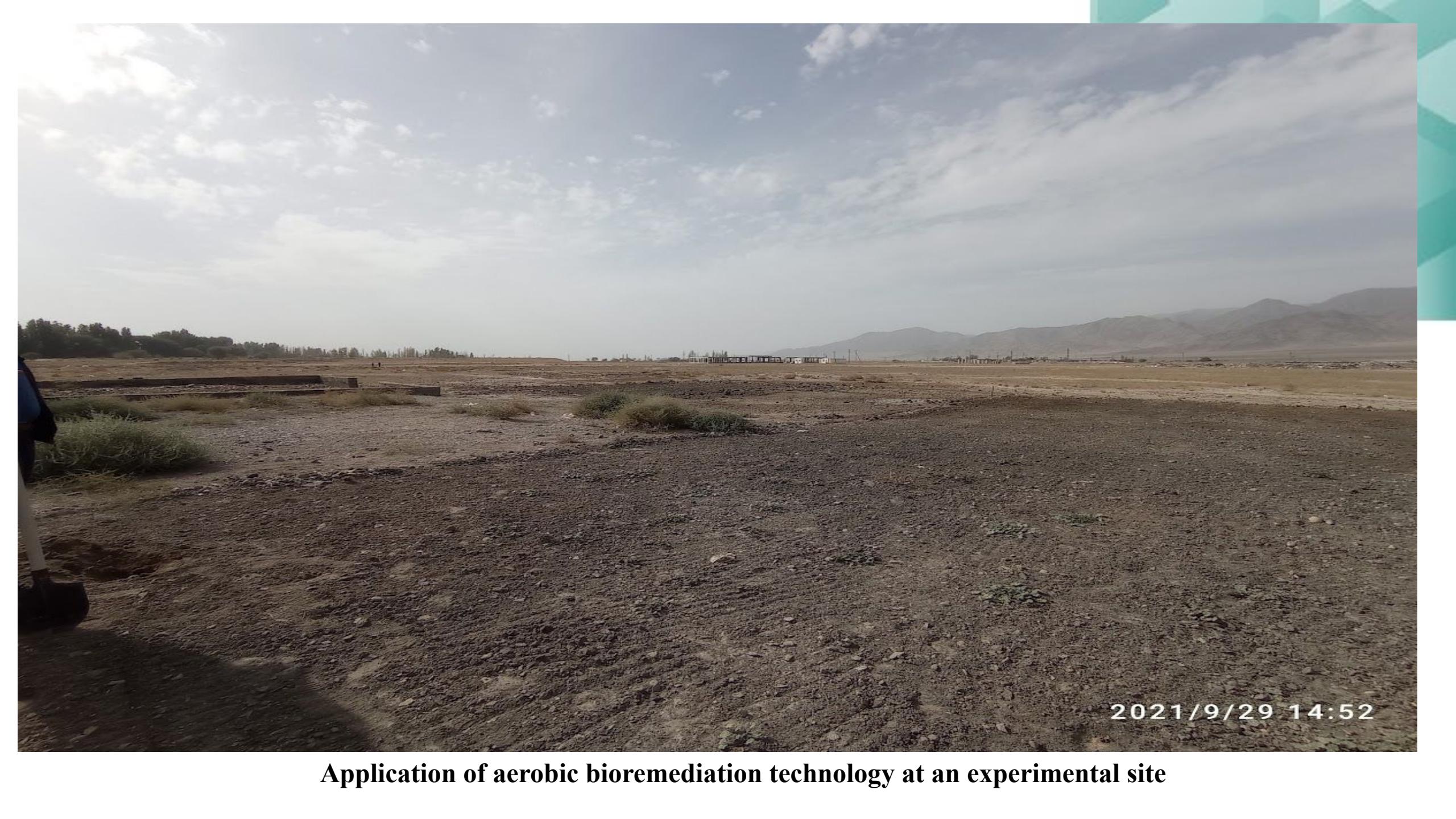
✓ Fertilized soil

✓ Spraying with biopreparation  
based on soil active bacteria association



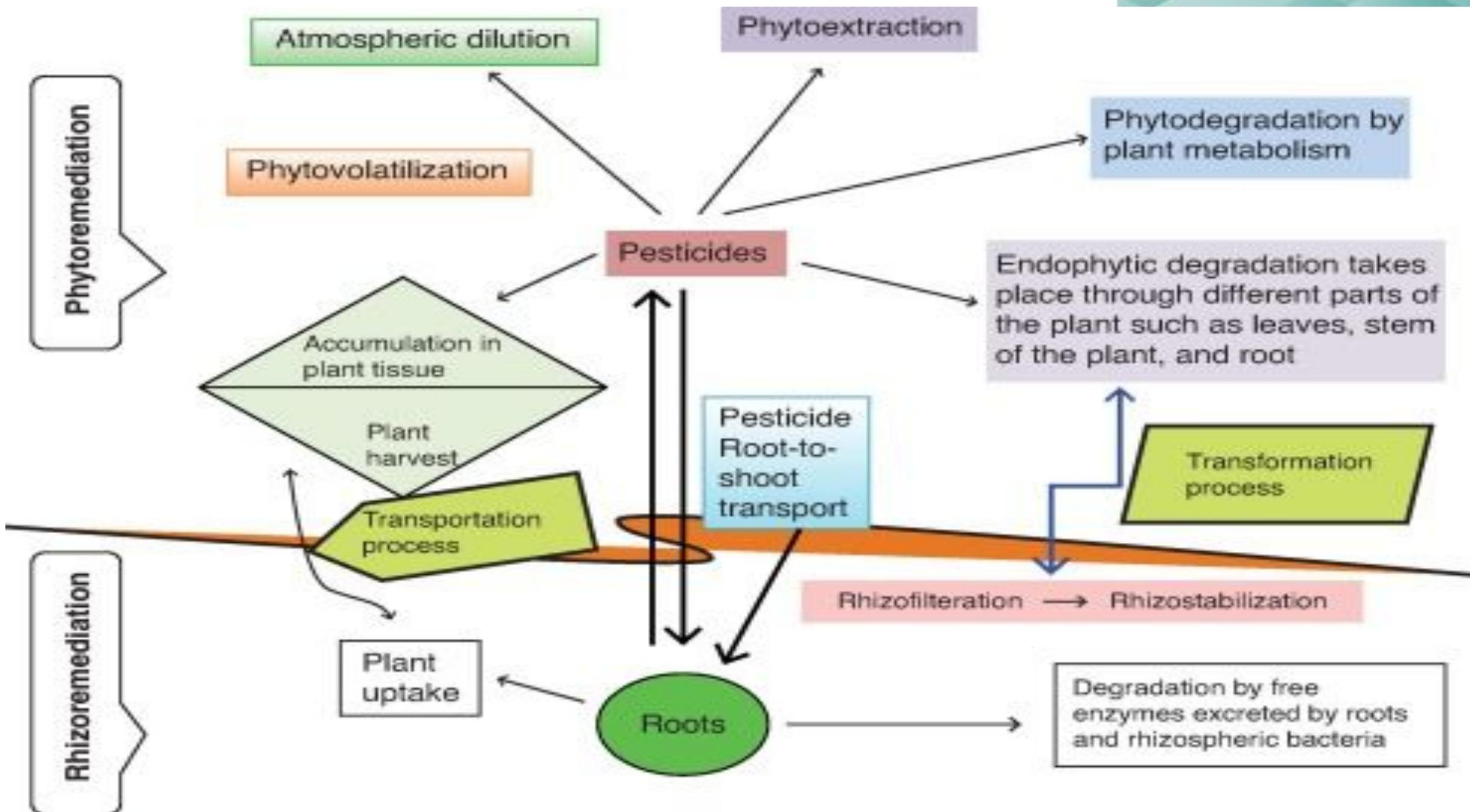
# Comparative analysis of soils with the previous year 2021

№	Name	Concentration in control soil (fertile soil + no bioprod) mg/kg ± SD			Concentration in control soil (fertile soil + no bioprod) mg/kg ± SD		
		May 2021	December 2021	March 2022	May 2021	December 2021	March 2022
1	<b>A-BHC</b>	0,231±0,01	0,019±0,03	0,077±0,01	0,270±0,04	0,047±0,01	0,032±0,02
2	<b>B-BHC</b>	0,225±0,03		0,080±0,02	0,380±0,03	0,043±0,01	0,061±0,01
3	<b>G-BHC</b>	0,240±0,02	0,007±0,02	0,061±0,02	0,170±0,01	0,015±0,02	0,042±0,01
4	<b>D-BHC</b>	0,926±0,01	0,008±0,03	0,044±0,01	0,686±0,01	0,046±0,02	0,035±0,02
5	<b>Heptachlor</b>	0,476±0,01	0,016±0,02	0,032±0,01	0,550±0,02	0,005±0,01	0,028±0,01
6	<b>Aldrine</b>	0,903±0,03	0,146±0,02	0,142±0,02	1,418±0,02	0,044±0,02	0,130±0,03
7	<b>Heptachlor-epox</b>			0,406±0,03	2,544±0,01	0,039±0,03	0,354±0,02
8	<b>Trans-Chlordan</b>	1,439±0,02	0,259±0,01	0,052±0,02	2,625±0,01	0,011±0,01	0,078±0,02
9	<b>G-Chlordan-Endosulfan-1</b>	0,916±0,02	0,365±0,01	0,419±0,03	2,048±0,03	0,009±0,01	0,177±0,01
10	<b>4,4 DDE</b>	1,062±0,01	0,260±0,02	0,153±0,01	2,060±0,02	0,138±0,02	0,105±0,01
11	<b>Dieldrine</b>	1,350±0,03	0,216±0,02	1,492±0,02	4,347±0,01	0,035±0,04	0,637±0,03
12	<b>Endrine</b>	1,022±0,02	0,452±0,03	0,122±0,03	2,223±0,04	0,105±0,03	0,092±0,02
13	<b>4,4 DDD</b>	3,662±0,01	0,028±0,03	0,665±0,02	9,706±0,01	0,060±0,01	0,324±0,01
14	<b>Endosulfane-2</b>	2,615±0,01	1,584±0,02	1,053±0,03	2,088±0,01	0,079±0,02	0,339±0,04
15	<b>Endrine-Aldehid</b>	1,128±0,03	0,774±0,01	0,332±0,02	1,876±0,03	0,273±0,02	0,292±0,02
16	<b>4,4 DDT</b>	1,734±0,03	0,101±0,02	0,194±0,01	3,298±0,02	0,248±0,01	0,144±0,01
17	<b>Endosulfan-sulfat</b>	2,174±0,01		0,100±0,01	5,079±0,01	0,064±0,01	0,071±0,03
18	<b>Metoxichlor</b>	0,733±0,02	0,307±0,01	0,344±0,02	0,974±0,02	0,006±0,02	0,125±0,02
19	<b>Endrine-ketone</b>	1,314±0,01	0,130±0,02	0,422±0,02	2,057±0,01	0,002±0,03	0,192±0,01

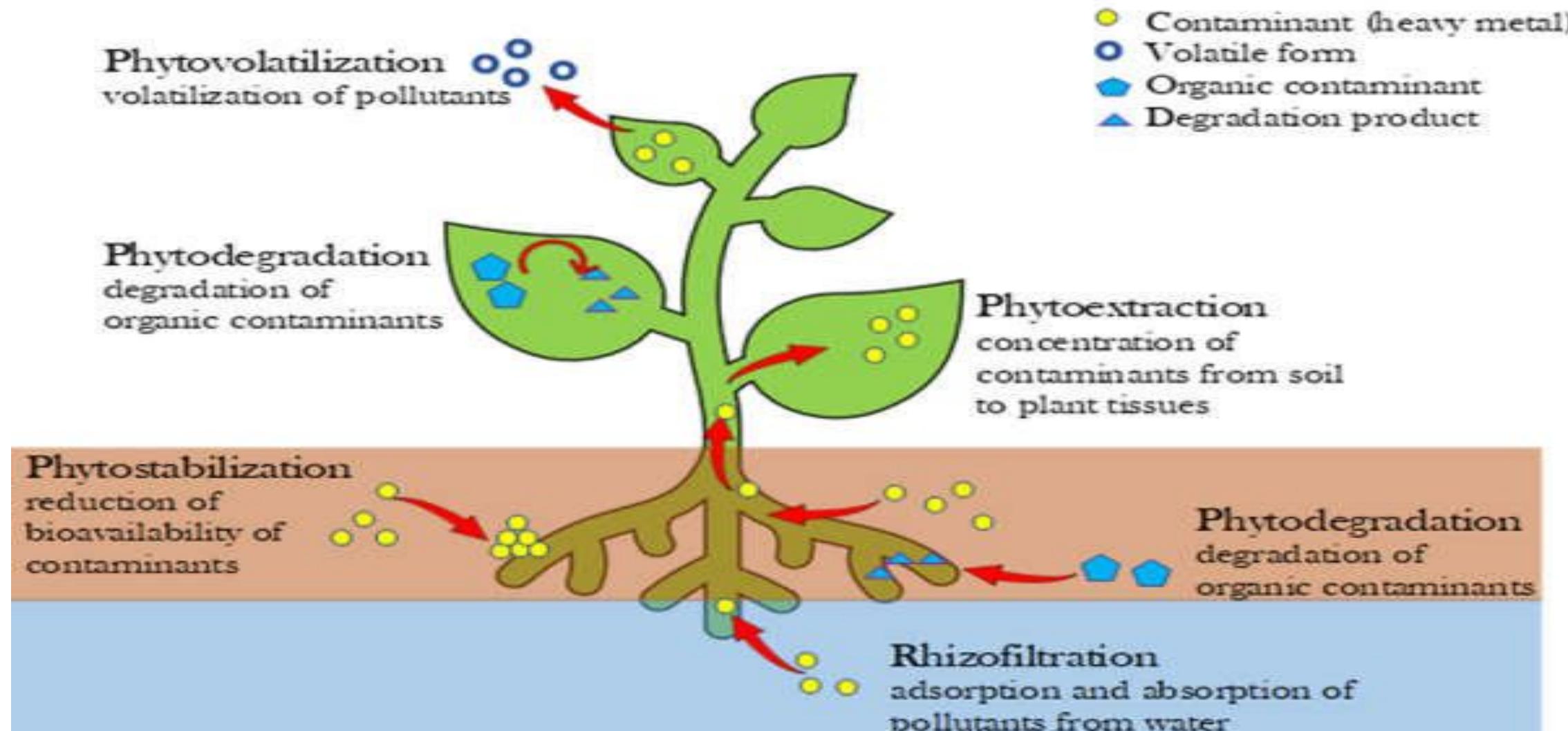


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**Application of aerobic bioremediation technology at an experimental site**



# What is phytoremediation?





*Artemisia* sp



*Capsella bursa-pastoris*



*Brassicaceae*



*Erodium* sp

# The plant species that grow in this area



*Cirsium vulgare*



*Péganum harmala*

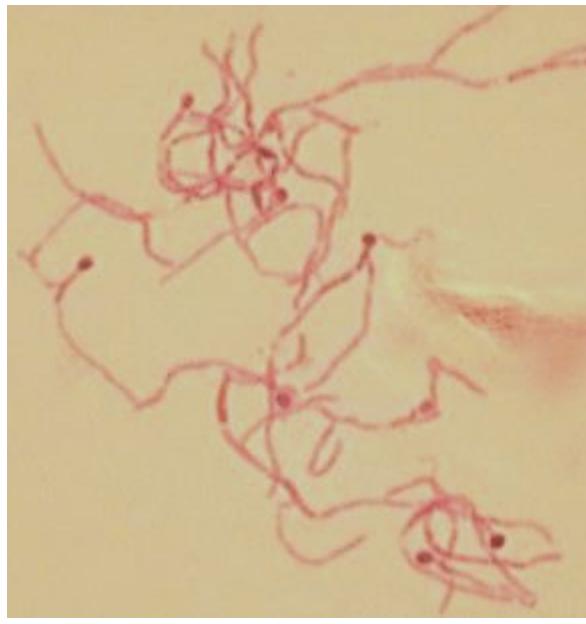


*Artemisia  
absinthium*

# Sowing scheme

Experience variant with control soil (fertile soil + no bioproduct)			Experience variant with soil (fertile soil + bioproduct)		
<i>Zea mays</i>	<i>Triticum aestivum</i>	<i>Beta vulgaris</i>	<i>Beta vulgaris</i>	<i>Triticum aestivum</i>	<i>Zea mays</i>
Experience variant with control soil (heavy pollution, plants don't grow)					

# «Rostin» microbiology bio product



Crop seeds were pre-treated with a bio preparation from our laboratory collection, which was created on the basis of cultures of live soil streptomycetes (*Streptomyces fumanus*). The **microbial** culture is unique because it was isolated from the soils of Kyrgyzstan and represents the local soil microflora adapted to our environmental conditions. The bio preparation is produced in liquid form, poured into 500 and 1000 ml containers, and contains spores  $3 \times 10^7$  cells/ml medium. Treatment of seeds with bio preparation "ROSTIN", improves seed quality, affects germination, and also protects it from the action of phytopathogens.

# Preparation of the experimental plot for sowing of agricultural plants



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# 20 days after sowing



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# 20 days after sowing, the variant where the bioproduct for soil bioremediation was used



# wheat seedling samples

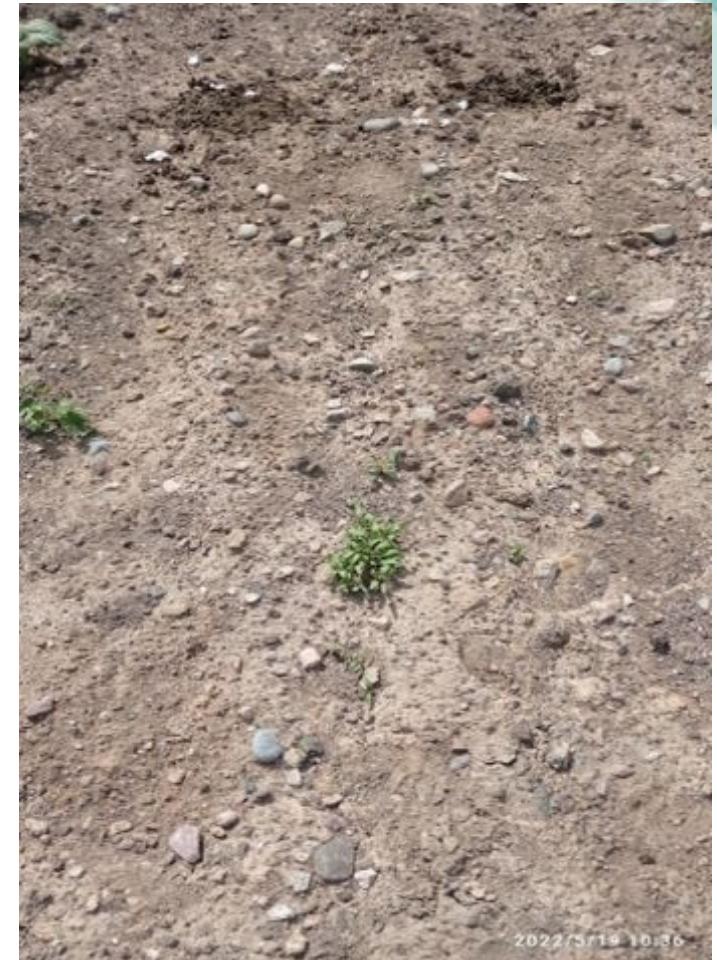
Experience variant with control soil  
(fertile soil + no bioproduct)  
wheat samples



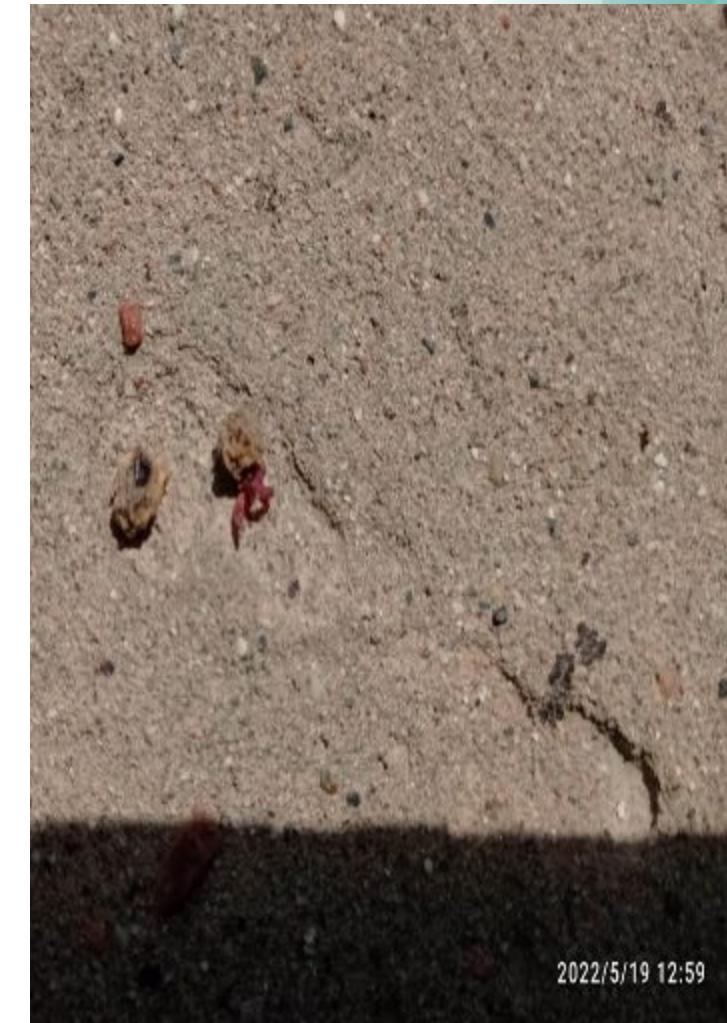
Experience variant with soil  
(fertile soil + bioproduct) wheat samples



# 20 days after sowing, control variant with soil addition



# 20 days after sowing, control version highly pesticide contaminated soil



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**Experience variant with control soil (heavy pollution, plants don't grow)**



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**Table 1. Pesticide content in underground and aboveground plant parts on the germination phase**

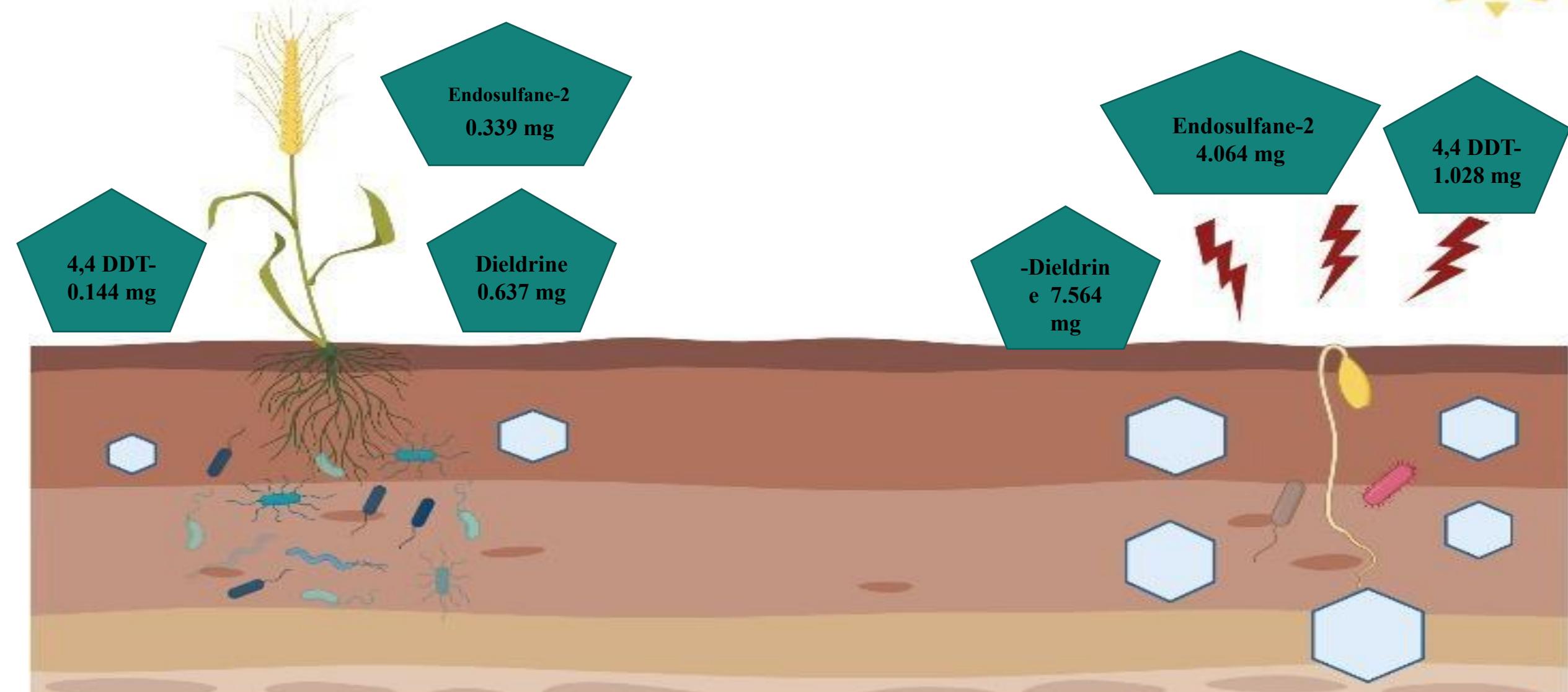
№	Pesticide	Concentration in control soil (fertile soil + no bioproduct) (mg/kg ± SD)	Concentration in experimental soil (fertile soil + bioproduct) (mg/kg ± SD)	Concentration in control soil (fertile soil + no bioproduct) (mg/kg ± SD)	Concentration in experimental soil (fertile soil + bioproduct) (mg/kg ± SD)	Concentration in control soil (fertile soil + no bioproduct) (mg/kg ± SD)	Concentration in experimental soil (fertile soil + bioproduct) (mg/kg ± SD)						
		<i>Zea mays</i>				<i>Triticum aestivum</i>				<i>Beta vulgaris</i>			
		underground part	above-ground part	underground part	above-ground part	underground part	above-ground part	underground part	above-ground part	underground part	above-ground part		
1	A-BHC	0.022± 0,04	0.004± 0,09	0.034± 0,17	0.004± 0,13	0.023± 0,05	0.024± 0,07	0.053± 0,05	0.049± 0,03	0.010± 0,07	0.022± 0,07	0.026± 0,17	0.013± 0,08
2	G -BHC	0.014± 0,08	-	0.074± 0,23	0.004± 0,01	0.022± 0,01	0.037± 0,06	0.053± 0,06	0.041± 0,08	0.070± 0,16	0.010± 0,27	0.044± 0,17	0.026± 0,08
3	B -BHC	0.092± 0,05	0.024± 0,02	<b>0.272± 0,06</b>	0.021± 0,13	<b>0.109± 0,04</b>	0.036± 0,05	<b>0.110± 0,08</b>	<b>0.112± 0,07</b>	<b>0.133± 0,07</b>	<b>0.129± 0,07</b>	<b>0.167± 0,13</b>	0.071± 0,12
4	D-BHC	0.036± 0,12	0.003± 0,07	-	0.059± 0,10	0.046± 0,03	0.010± 0,06	0.007± 0,02	0.061± 0,06	0.037± 0,21	0.083± 0,03	0.015± 0,07	0.028± 0,11
5	Heptachlor	0.029± 0,07	0.004± 0,01	0.056± 0,11	0.018± 0,09	0.009± 0,01	0.015± 0,07	0.073± 0,09	0.043± 0,06	0.061± 0,04	0.045± 0,04	0.034± 0,11	0.018± 0,17
6	Aldrin	0.096± 0,08	0.005± 0,02	<b>0.131± 0,05</b>	0.017± 0,11	0.029± 0,02	0.016± 0,04	<b>0.337± 0,08</b>	<b>0.112± 0,05</b>	<b>0.293± 0,04</b>	0.069± 0,05	0.086± 0,03	0.024± 0,16
7	Heptachlor-epox	0.085± 0,08	0.011± 0,02	<b>0.120± 0,02</b>	0.009± 0,01	0.034± 0,03	0.004± 0,05	<b>0.283± 0,04</b>	<b>0.384± 0,03</b>	<b>0.152± 0,03</b>	0.056± 0,06	0.006± 0,02	0.086± 0,17
8	Trans-Chlordan	0.008± 0,05	0.006± 0,18	0.013± 0,06	0.013± 0,06	0.003± 0,06	0.003± 0,04	<b>0.121± 0,05</b>	0.097± 0,05	0.090± 0,04	0.065± 0,04	0.021± 0,07	0.018± 0,14
9	G-Chlordan Endosul-1-A-Chlordan	0.052± 0,02	0.010± 0,05	<b>0.128± 0,08</b>	0.011± 0,02	0.056± 0,04	0.018± 0,04	0.045± 0,06	0.092± 0,04	<b>0.104± 0,04</b>	0.036± 0,05	<b>0.143± 0,11</b>	0.056± 0,11
10	4,4 DDE	0.086± 0,17	-	<b>0.172± 0,05</b>	0.013± 0,08	0.021± 0,05		0.033± 0,02	0.065± 0,05	0.055± 0,05	0.025± 0,03	0.033± 0,12	0.022± 0,08
11	Dieldrine	<b>0.285± 0,02</b>	0.016± 0,08	<b>0.107± 0,06</b>	0.067± 0,15	0.045± 0,07	0.045± 0,11	<b>0.537± 0,06</b>	<b>0.761± 0,04</b>	<b>0.807± 0,09</b>	0.099± 0,03	<b>0.695± 0,14</b>	0.021± 0,09
12	Endrine	0.012± 0,19	0.002± 0,11	0.024± 0,07	0.003± 0,06	0.019± 0,04	0.009± 0,06	0.053± 0,04	<b>0.128± 0,05</b>	0.041± 0,02	0.023± 0,02	0.052± 0,14	0.024± 0,12
13	4,4 DDD	0.018± 0,13	0.004± 0,04	<b>0.185± 0,05</b>	0.003± 0,15	<b>0.100± 0,05</b>	0.004± 0,05	<b>0.190± 0,06</b>	<b>0.373± 0,01</b>	<b>0.205± 0,07</b>	0.079± 0,14	<b>0.159± 0,15</b>	0.077± 0,12
14	Endosulfane-2	<b>0.202± 0,07</b>	0.007± 0,07	<b>0.208± 0,06</b>	0.032± 0,16	<b>0.150± 0,06</b>	0.026± 0,04	<b>0.183± 0,05</b>	<b>0.368± 0,03</b>	<b>0.271± 0,09</b>	<b>0.107± 0,14</b>	<b>0.211± 0,11</b>	0.093± 0,02
15	Endrine-Aldehid	<b>0.133± 0,23</b>	0.003± 0,03	<b>0.106± 0,05</b>	0.013± 0,03	0.092± 0,09	0.019± 0,05	<b>0.235± 0,03</b>	<b>0.219± 0,06</b>	<b>0.209± 0,02</b>	0.049± 0,11	<b>0.241± 0,11</b>	0.062± 0,11
16	4,4 DDT	-	-	<b>0.107± 0,02</b>	0.026± 0,04	0.094± 0,12	0.030± 0,06	<b>0.123± 0,01</b>	<b>0.206± 0,04</b>	<b>0.261± 0,02</b>	0.026± 0,15	0.097± 0,13	0.020± 0,04
17	Endosulfan-sulfat	0.021± 0,14	0.019± 0,02	0.047± 0,03	0.024± 0,13	0.015± 0,04	0.015± 0,05	0.057± 0,09	0.079± 0,03	0.056± 0,03	0.018± 0,17	0.062± 0,13	0.012± 0,03
18	Metoxichlor	0.007± 0,28	0.015± 0,08	0.035± 0,08	0.014± 0,18	0.011± 0,03		<b>0.214± 0,01</b>	0.056± 0,02	0.065± 0,05	0.006± 0,02	0.050± 0,11	0.007± 0,07
19	Endrine-ketone	0.024± 0,06	0.012± 0,11	0.019± 0,18	0.010± 0,14	0.023± 0,7	0.011± 0,07	<b>0.195± 0,06</b>	<b>0.154± 0,07</b>	<b>0.161± 0,02</b>	0.027± 0,02	<b>0.153± 0,12</b>	0.012± 0,07

**Table 2. Pesticide content in underground and aboveground plant parts on the maturation phase**

№	Pesticide	Concentration in control soil (fertile soil + no biopродuct) (mg/kg ± SD)		Concentration in experimental soil (fertile soil + biopродuct) (mg/kg ± SD)		Concentration in control soil (fertile soil + no biопродuct) (mg/kg ± SD)		Concentration in experimental soil (fertile soil + biопродuct) (mg/kg ± SD)		Concentration in control soil (fertile soil + no biопroduct) (mg/kg ± SD)		Concentration in experimental soil (fertile soil + biопродuct) (mg/kg ± SD)	
		<i>Zea mays</i>				<i>Triticum aestivum</i>				<i>Beta vulgaris</i>			
		underground part	above-ground part	underground part	above-ground part	underground part	above-ground part	underground part	above-ground part	underground part	above-ground part	underground part	above-ground part
1	A-BHC	0,002±0,02	-	0,004±0,01	0,002±0,01	0,028±0,01	0,001±0,01	0,005±0,01	-	0,012±0,01	0,002±0,01	-	0,004±0,01
2	G -BHC	0,006±0,01	0,054±0,01	0,127±0,03	0,006±0,01	0,022±0,02	0,005±0,01	0,002±0,01	0,025±0,01	0,018±0,01	0,032±0,01	-	0,013±0,01
3	B -BHC	-	-	-	0,002±0,01	0,016±0,01	0,003±0,01	0,007±0,01	-	-	0,018±0,02	-	0,001±0,01
4	D-BHC	0,005±0,02	-	0,018±0,02	-	0,017±0,01	0,004±0,01	0,004±0,01	-	0,005±0,01	0,002±0,01	-	-
5	Heptachlor	0,002±0,01	-	0,009±0,01	0,007±0,02	0,020±0,01	0,003±0,01	0,004±0,01	0,001±0,01	0,008±0,01	0,003±0,01	0,006±0,01	0,003±0,02
6	Aldrin	0,004±0,01	-	0,004±0,01	-	0,010±0,01	0,014±0,01	0,042±0,02	0,004±0,01	0,008±0,01	0,006±0,01	0,002±0,02	0,003±0,01
7	Heptachlor-epox	0,009±0,02	-	0,014±0,01	0,001±0,01	0,038±0,02	0,004±0,01	0,099±0,01	0,005±0,01	0,011±0,01	0,022±0,02	0,002±0,01	0,007±0,01
8	Trans-Chlordane	0,002±0,01	-	0,003±0,01	-	0,005±0,01	0,007±0,01	0,012±0,01	0,001±0,01	0,008±0,01	0,011±0,01	-	0,001±0,01
9	G-Chlordane Endosul-1-A-Chlordane	0,005±0,01	-	0,005±0,01	-	0,004±0,01	0,008±0,01	0,069±0,02	0,003±0,01	0,003±0,01	0,013±0,04	0,006±0,01	0,001±0,01
10	4,4 DDE	0,003±0,01	-	0,013±0,01	-	-	0,004±0,01	0,021±0,01	0,001±0,01	-	0,005±0,01	-	0,005±0,01
11	Dieldrine	0,002±0,01	-	0,029±0,03	-	0,044±0,02	0,050±0,01	0,029±0,01	0,012±0,01	0,057±0,02	0,022±0,01	0,026±0,02	0,030±0,01
12	Endrine	0,003±0,03	-	0,002±0,01	-	-	0,007±0,01	0,028±0,01	0,002±0,01	0,005±0,01	0,005±0,01	-	0,006±0,01
13	4,4 DDD	0,011±0,01	-	0,007±0,01	-	0,005±0,01	0,021±0,01	0,114±0,03	0,007±0,01	0,012±0,01	0,016±0,01	0,004±0,01	0,012±0,01
14	Endosulfane-2	0,005±0,01	-	0,020±0,01	0,002±0,01	0,012±0,01	0,012±0,01	0,100±0,03	0,007±0,01	0,017±0,01	0,015±0,01	0,006±0,01	0,014±0,02
15	Endrine-Aldehid	0,009±0,01	-	0,006±0,01	-	-	0,015±0,01	0,063±0,01	0,007±0,01	0,012±0,01	0,013±0,01	0,012±0,01	0,011±0,01
16	4,4 DDT	0,010±0,02	-	0,012±0,01	-	-	0,019±0,01	0,032±0,01	-	0,011±0,01	0,004±0,01	0,019±0,01	0,003±0,01
17	Endosulfan-sulfat	0,002±0,01	-	-	-	-	0,004±0,01	0,017±0,01	-	-	0,003±0,01	-	0,002±0,02
18	Metoxichlor	-	-	-	-	-	-	0,008±0,01	-	-	-	-	-
19	Endrine-ketone	-	-	-	-	-	-	0,013±0,01	-	-	0,007±0,01	-	-

# Comparison of the content of pesticides in the soil by options, before and after application of plants (after 8 months, before sowing and after harvesting)

№	Name	Concentration in control soil (fertile soil + no bioprodut) (mg/kg ± SD)		Concentration in experimental soil (fertile soil + bioprodut) (mg/kg ± SD)		Concentration in control soil (heavy pollution, mg/kg ± SD) (plants don't grow)	
		March 2022	October 2022	March 2022	October 2022	March 2022	October 2022
1	A-BHC	0,077±0,01	0,011±0,01	0,032±0,02	0,001±0,01	0,240±0,01	0,070±0,02
2	B-BHC	0,080±0,02	0,022±0,01	0,061±0,01	0,006±0,02	0,445±0,01	0,341±0,01
3	G-BHC	0,061±0,02	0,004±0,03	0,042±0,01	0,001±0,01	0,276±0,01	0,160±0,01
4	D-BHC	0,044±0,01	0,022±0,01	0,035±0,02	0,006±0,02	0,243±0,01	0,486±0,02
5	Heptachlor	0,032±0,01	0,020±0,02	0,028±0,01	0,004±0,01	0,112±0,01	0,363±0,01
6	Aldrine	0,142±0,02	0,019±0,01	0,130±0,03	0,007±0,01	1,056±0,01	0,995±0,01
7	Heptachlor-epox	0,406±0,03	0,033±0,02	0,354±0,02	0,015±0,01	2,700±0,02	1,030±0,01
8	Trans-Chlordane	0,052±0,02	0,011±0,01	0,078±0,02	0,006±0,01	0,428±0,01	1,046±0,02
9	G-Chlordane-Endosulfan-1	0,419±0,03	0,017±0,03	0,177±0,01	0,021±0,03	1,611±0,02	0,743±0,01
10	4,4 DDE	0,153±0,01	0,021±0,01	0,105±0,01	0,008±0,01	0,435±0,01	1,036±0,01
11	Dieldrine	<b>1,492±0,02</b>	0,218±0,01	<b>0,637±0,03</b>	0,040±0,02	<b>7,564±0,03</b>	<b>3,254±0,02</b>
12	Endrine	0,122±0,03	0,012±0,02	0,092±0,02	0,006±0,01	0,596±0,01	0,606±0,01
13	4,4 DDD	0,665±0,02	0,034±0,02	0,324±0,01	0,018±0,01	<b>3,097±0,02</b>	1,348±0,02
14	Endosulfane-2	<b>1,053±0,03</b>	0,042±0,01	0,339±0,04	0,029±0,03	<b>4,064±0,03</b>	2,051±0,01
15	Endrine-Aldehid	0,332±0,02	0,022±0,03	0,292±0,02	0,020±0,01	<b>2,070±0,02</b>	1,847±0,01
16	4,4 DDT	0,194±0,01	0,015±0,01	0,144±0,01	0,009±0,02	<b>1,028±0,01</b>	1,260±0,03
17	Endosulfan-sulfat	0,100±0,01	0,004±0,02	0,071±0,03	0,004±0,01	0,582±0,01	0,472±0,01
18	Metoxichlor	0,344±0,02	0,001±0,01	0,125±0,02	0,003±0,01	1,020±0,03	0,334±0,01
19	Endrine-ketone	0,422±0,02	0,002±0,01	0,192±0,01	0,002±0,01	1,534±0,02	0,455±0,01



Near this experimental site,  
livestock are grazed year-round



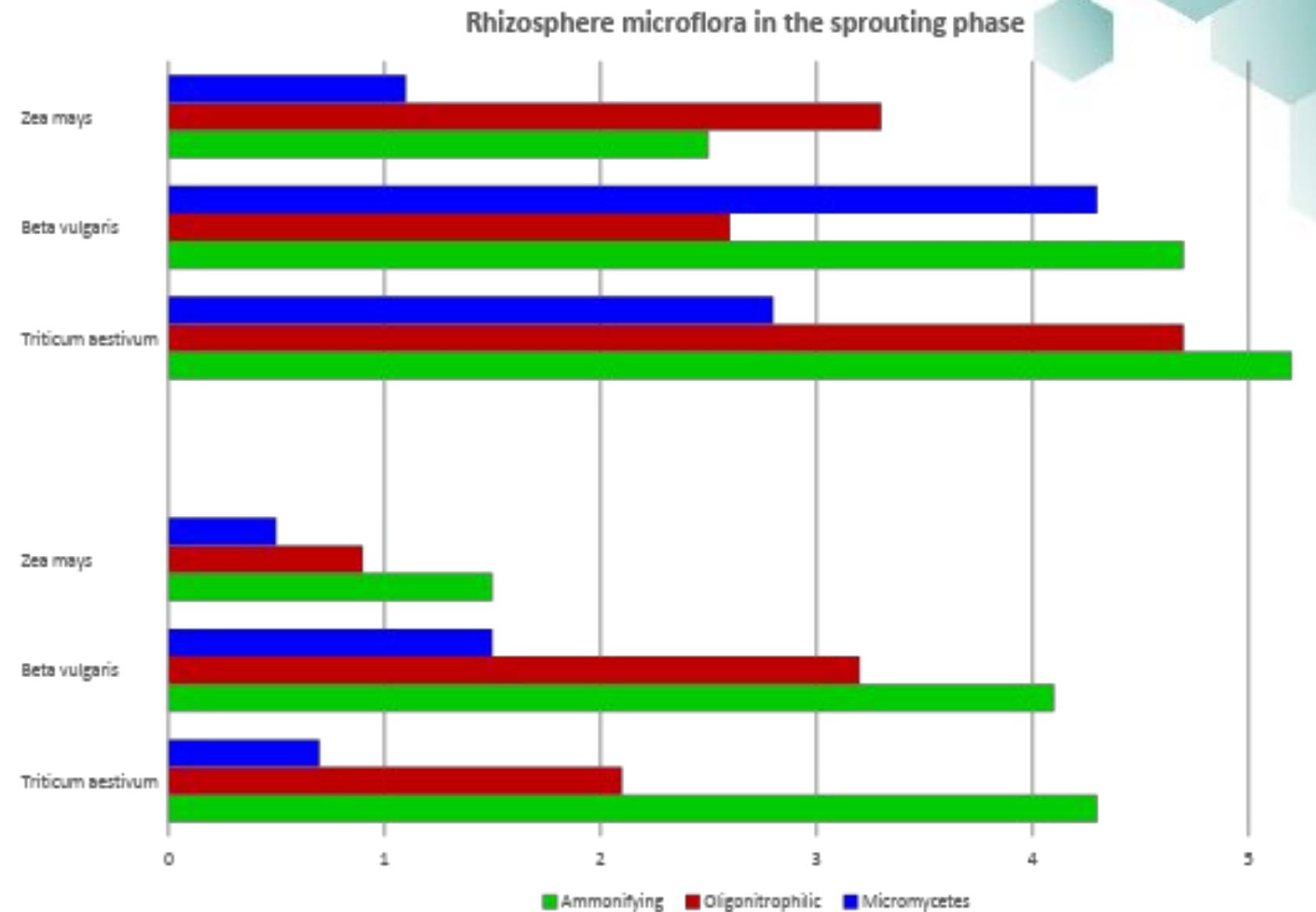
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# Microbiological characteristics of the rhizosphere microflora of agricultural plants on the germination phase

№	Name of crops	Experience variant with control soil (fertile soil + no bioprotectant)			Experience variant with soil (fertile soil + bioprotectant)		
		CFU Ammonifying Bacteria MPA $10^6$ c/g	CFU Oligonitrophilic group, KAA $10^6$ c/g	CFU Micromycetes, Capeka $10^3$ c/g	CFU Ammonifying Bacteria MPA $10^6$ c/g	CFU Oligonitrophilic group, KAA $10^6$ c/g	CFU Micromycetes, Capeka $10^3$ c/g
1.	<i>Triticum aestivum</i>	4,3 ± 0,18	2,1 ± 0,11	0,7 ± 0,43	5,2 ± 0,22	4,7 ± 0,54	2,8 ± 0,19
4.	<i>Zea mays</i>	1,5 ± 0,51	0,9 ± 0,22	0,5 ± 0,18	2,5 ± 0,15	3,3 ± 0,33	1,1 ± 0,23
5.	<i>Beta vulgaris</i>	4,1 ± 0,34	3,2 ± 0,16	0,3 ± 0,14	4,7 ± 0,45	2,6 ± 0,13	4,3 ± 0,29

**Experience variant with  
soil  
(fertile soil + bioprodut)  
rhizosphere microflora of  
wheat**

**Experience variant  
with control soil  
(fertile soil + no  
bioprodut)  
rhizosphere microflora  
of wheat**



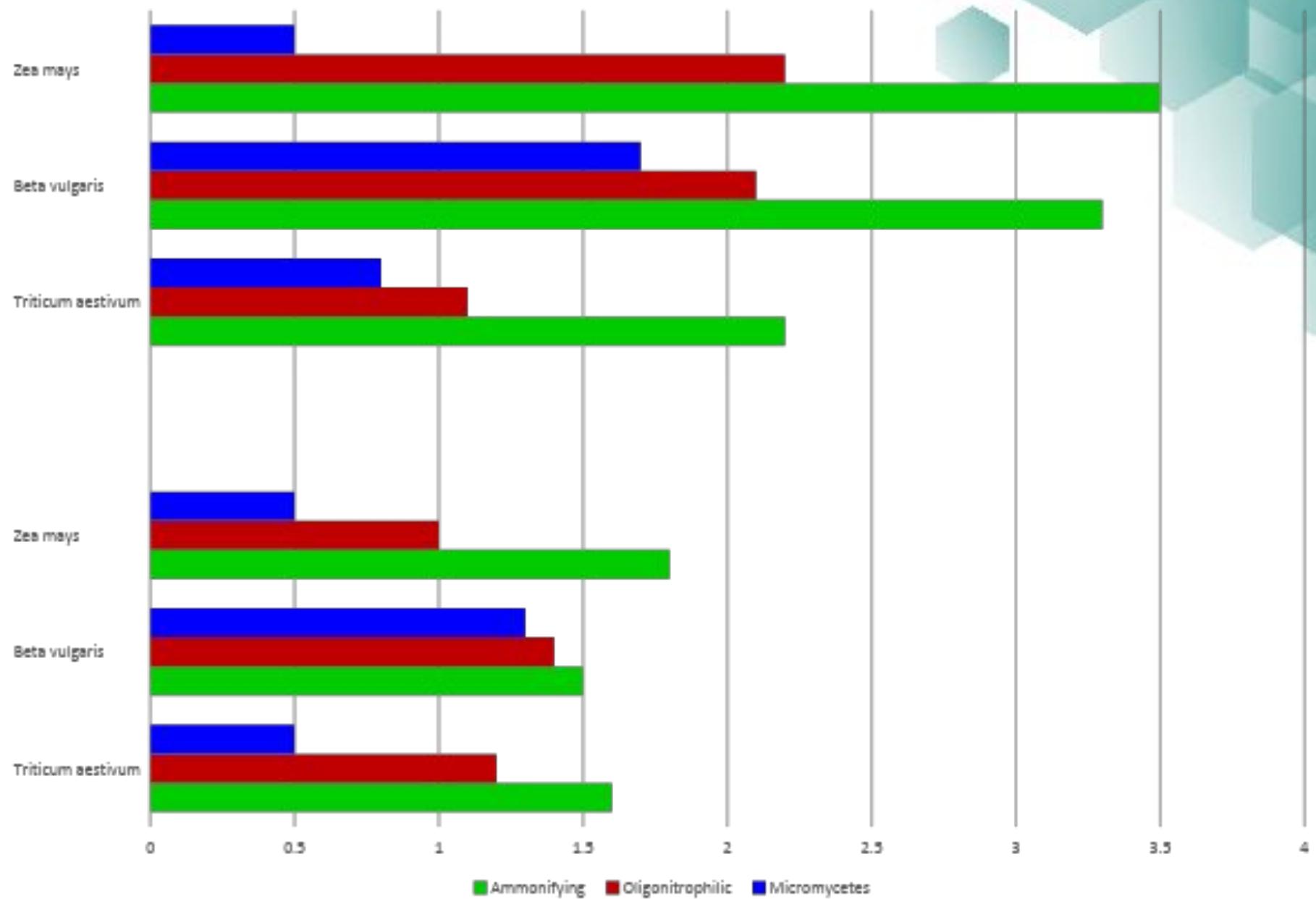
# Microbiological characteristics of the rhizosphere microflora of agricultural plants on the maturation phase

№	Name of crops	Experience variant with control soil (fertile soil + no bioprotectant)			Experience variant with soil (fertile soil + bioprotectant)		
		CFU Ammonifying Bacteria MPA $10^6$ c/g	CFU Oligonitrophilic group, KAA $10^6$ c/g	CFU Micromycetes, Capeka $10^3$ c/g	CFU Ammonifying Bacteria MPA $10^6$ c/g	CFU Oligonitrophilic group, KAA $10^6$ c/g	CFU Micromycetes, Capeka $10^3$ c/g
1.	<i>Triticum aestivum</i>	1,6 ± 0,17	1,2 ± 0,17	0,5 ± 0,32	2,2 ± 0,43	1,1 ± 0,42	0,8 ± 0,23
4.	<i>Zea mays</i>	1,5 ± 0,35	1,4 ± 0,23	1,3 ± 0,19	3,3 ± 0,27	2,1 ± 0,33	1,7 ± 0,38
5.	<i>Beta vulgaris</i>	1,8 ± 0,62	1,0 ± 0,51	0,5 ± 0,18	3,5 ± 0,21	2,2 ± 0,28	0,5 ± 0,57

**Experience variant with  
soil  
(fertile soil + bioprodut)  
rhizosphere microflora of  
wheat**

**Experience variant  
with control soil  
(fertile soil + no  
bioprodut)  
rhizosphere microflora  
of wheat**

Rhizosphere microflora in the maturation phase

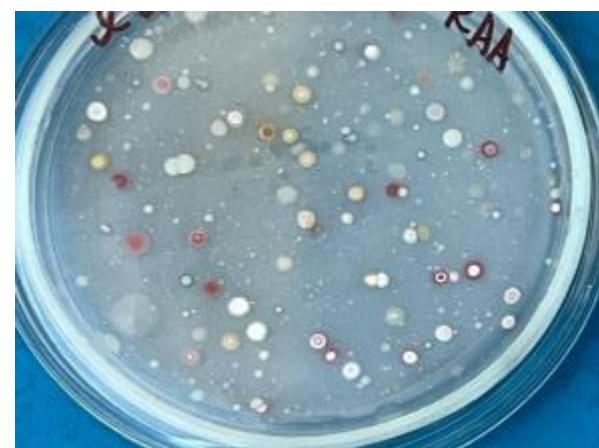


# Oligotrophic group

Experience variant with control soil  
(fertile soil + no bioproduct)  
rhizosphere microflora of wheat



Experience variant with soil  
(fertile soil + bioproduct) rhizosphere  
microflora of wheat

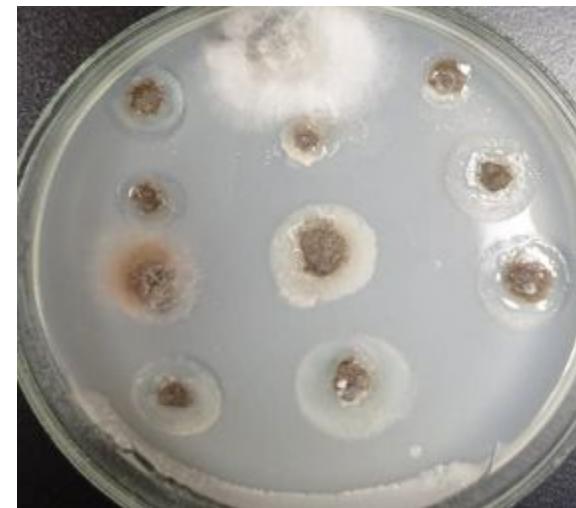


# Nitrogen-fixing group

Experience variant with control soil  
(fertile soil + no bioproduct)  
rhizosphere microflora of wheat



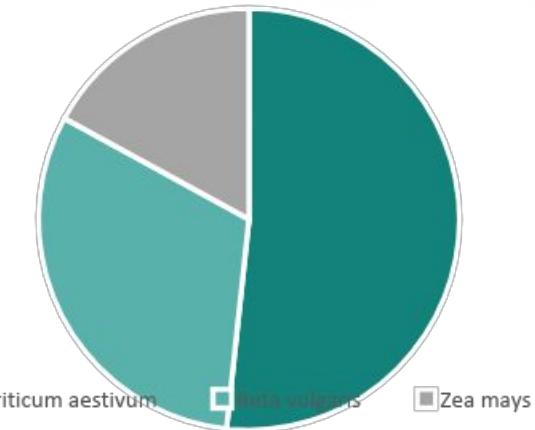
Experience variant with soil  
(fertile soil + bioproduct) rhizosphere  
microflora of wheat



# Nitrogen-fixing group

Nitrogen-fixing group

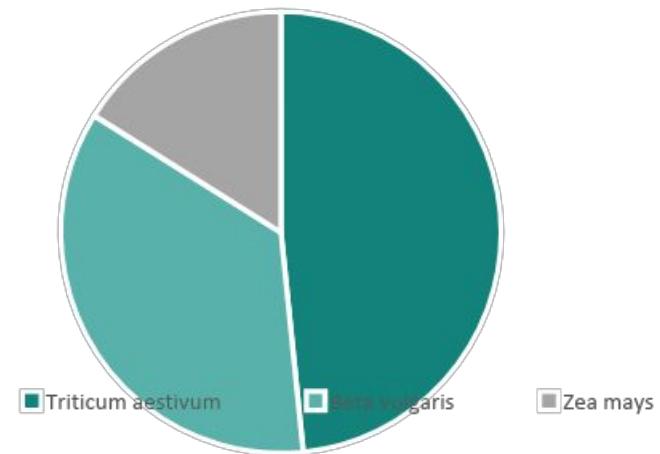
Experience variant with control soil  
(fertile soil + no bioproduct)  
rhizosphere microflora of wheat



Experience variant with soil  
(fertile soil + bioproduct) rhizosphere  
microflora of wheat



Nitrogen-fixing group



- ✓ Among ammonifying bacteria species diversity was represented only by 2-3 species, mainly bacillary species such as *Bacillus subtilis*, *Bacillus cereus*, *Bacillus megaterium*, *Bacillus mesentericus*, also single colonies of *Pseudomonas fluorescens*, *Micrococcus sp.*
- ✓ It is interesting to note, the oligonitrophic group of microorganisms, if earlier in the soil, when the content of organochlorine compounds exceeded more than, in hundreds times, they were not detected, their growth was completely absent. Now, with the growth of plants their quantitative ratio increased, especially in the variant in the soil treated with biopreparation on rhizospheric microflora of beans, the most numerous colony-forming unit was  $14.6 \times 10^6$  cells/g. The least abundant CFU in the variant with the control, in the roots with fescue, where was  $1.6 \times 10^6$  cells/g. Also, it should be noted that the species diversity is represented by species from sections such as *Albus*, *Cinereus*, *Chromogenes*.
- ✓ The group of micromycetes was represented, by species such as *Fusarium sp.*, *Alternaria sp.*, *Botrytis sp.*, *Penicillium sp.*, *Mucor sp.*, all these species, are often common in agricultural lands. Therefore, may have been present in the seed coat of plant seeds. As, previously, in these soils, there was also no growth of micromycetes, and, now, their abundance, is explained, only, by the growth of plants in these soils.

# The maturation phase of wheat



REDMI NOTE 8T  
48MP QUAD CAMERA



REDMI NOTE 8T  
48MP QUAD CAMERA

# The ripening phase of beets



The beet feels very well on this soil, in the upper part and in the control plot and in the plot treated with a biological product, the germination is excellent.



**16 months after using of bioremediation and phytoremediation technology**

# Conclusions

1. When applying phytoremediation technology, when growing plants on the experimental site, we can conclude that the viability of this soil is established, it indicates the abundant growth of these plants and the reduction of phytotoxicity of the soil.
2. The microbiological characteristic of the given soil also shows the increase of microorganisms in all variants, and especially in the variant of soils where both bio-product and fertilized soil were applied, the content of colony forming unit of ammonifying microorganisms increased to  $7.3 \times 10^6$  cells/ml.
3. During the experiment, areas of soils where there is still a high concentration of pesticides were discovered and plant growth is impossible on these soils, seeds can germinate perfectly, but they cannot sprout.
4. Another distinctive feature was to process these seeds with a biological preparation from our laboratory collection Biopreparation "ROSTIN", developed by us at the Department of Plant Protection, Faculty of Agriculture KTMU in 2010, which received a patent. Has been effectively tested and used on cereals, vegetables, and fruit crops. The basis of the bio preparation is a culture of live soil streptomycetes (*Streptomyces fumanus*).
5. Chromatographic analysis of the soil revealed 19 species of obsolete pesticides, the concentration of which was different depending on the variants of the experimental site. Thus, if dieldrin in March was 0.637 mg/kg of soil in the variant with fertilized soil and bioproduct, in October its concentration decreased to 0.040 mg/kg, whereas in the site with no plants in March 2022 was - 7.564 mg/kg of soil, and in October 2022 was - 3.254 mg/kg of soil
6. Thus, the experimental work lasts for 18 months, if earlier these soils were bare without plants, then at the given period plants abundantly grow and fruit, except for some sites where it is required to carry out still additional actions.



Thank you to the organizers of the forum for their support in participating in this event.

Thank you for your support in funding the project «Technical assistance in implementation of trials on bioremediation of POPs contaminated soils»



# THANK YOU FOR YOUR ATTENTION

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