

SOIL BIOGENICITY OF WILT-INFECTED COTTON FIELDS DURING PLOWING OF VARIOUS PLANT RESIDUES

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Abstract: The model experiment results reveal that easily mobilized organic matter introduced into the soil is absorbed much faster by bacteria than by fungi during the initial decomposition phase. This study examines the influence of composting duration of various plant residues on soil biogenicity, microbiological activity, and *V. dahliae* development. Findings indicate that the composition of organic matter affects the quantity and type of microorganisms in soil as well as its biological activity. Increased bacterial and fungal populations correlate with available organic resources. Addition of plant residues enhances soil microbiological activity while reducing its fungistatic potential. In conclusion, heightened activity of antagonistic bacteria and fungi through plant residue enrichment augments soil fungistatic activity, inhibiting the growth of *Fusarium* sp. and *V. dahliae* pathogens..

Keywords: Soil microbiology, Plant residue composting, Fungal pathogens, Antagonistic bacteria.



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Introduction

Irrigated soils in Uzbekistan are characterized by high activity of biological processes that cause the decomposition of organic substances and their rapid mineralization. This leads to a decrease in humus reserves in the soil, loss of its structural state and deterioration of physical properties, a decrease in nitrification capacity and other negative phenomena.

All this affects the increase and spread of soil pathogens that cause wilt on cotton.

Continuous cultivation of cotton for many years in the same field and failure to use scientifically based crop rotation schemes led to a sharp increase in soil infection of *Verticillium dahliae* Klebahn and *Fusarium oxysporium* f. sp. *vasinfektum* (Atk.) Snyder et Hansen causing wilt on cotton.

As is known, under crop rotation conditions, the soil is enriched with easily mobilized organic matter from root and stubble residues of alfalfa and other forages, and therefore soil fertility increases and microbiological processes are stimulated. All this contributes to the improvement of the soil from wilt pests, increases the yield of cotton and improves its quality.

With the acquisition of independence of the republic, cotton-grain rotation of crops is widely used, and after harvesting the grain, the field is sown with repeated crops. Different crops accumulate

different amounts of root and crop residues in arable horizons (0-40 cm).

As Z. Tursunkhojaev and A. Bolkunov (1987) indicate, the accumulation of root and stubble residues of various crops, depending on their biological and morphological characteristics in the 0-40 cm horizon, ranges from 10.1 to 54.0 c/ha. After harvesting grain crops, no more than 1.2 tons of root and crop residues remain in the soil, which is clearly not enough to increase the biogenicity of the soil.

Among the measures aimed at combating wilt disease, the correct selection of cotton precursors is becoming increasingly important.

It is known that the development of wilt pathogens in the soil is determined by rather complex relationships that develop between the pathogen and soil saprophytic microflora; the latter depends on the quantity and quality of organic material entering the soil. The causative agent of cotton wilt can remain in the soil for a long time in a state of functional or forced dormancy in the form of microsclerotia (*V.dahliae*) and chlamydospores (*Fusarium*) resistant to external influences. Their germination and penetration into the underground organs of plants largely depends on the fungistatic potential of the soil, which means the ability to delay the germination of fungal diaspores.

There are numerous examples indicating the prospects for combating cotton wilt in the system of cotton-alfalfa crop rotation of intermediate and green manure crops that were cultivated in cotton fields during the non-growing season (Malitsky, Davlatov, 1967; Mirpulatova, 1973; Oripov, 1988; Muromtsev, Marupov, 1989; Marupov, 2003, 2013).

However, with the acquisition of independence of the republic, the widely used cotton-grain crop rotation does not contribute to the entry into the soil of a large amount of easily mobilized organic material, which is so necessary for microorganisms that contribute to an increase in the fungistatic activity of the soil.

Therefore, in recent years there has been an increase in the harmfulness of wilt pathogens in cotton fields, especially in the Bukhara and Navoi regions of the republic.

The purpose of the research was to study the biological activity of naturally infected wilt in cotton fields when plowing various plant residues

Methods

Model experiments to study the influence of various plant residues on the overall biogenicity of the soil were carried out in laboratory conditions on samples taken from the fields of old irrigated, heavily contaminated with the pathogen *Verticillium* wilt fungus *V.dahliae* meadow-saz soil of the Fergana region.

Production experiments were carried out on a plant heavily infected with the causative agent of *Fusarium* wilt by the fungus *Fusarium* sp. on meadow-alluvial soil of the Bukhara region. Soil samples for microbiological analysis were taken from a horizon of 0-40 cm before sowing, during the budding and flowering-fruitlet period of cotton. Soil analyzes were carried out using the generally accepted method of limiting dilutions according to S.F. Lazarev (1963).

The growth of bacteria was determined on MPA, actinomycetes on CAA, and fungi on Czapek's medium with pH 4.5 and 5. Acidification of Czapek's medium was carried out with 50% citric acid. Counts of isolated colonies of microorganisms were carried out on days 3-5-7.

Quantitative recording of the causative agent of verticillium wilt fungus *V. dahliae* in the soil was carried out according to the method of V.I. Popova and M.Yu. Stepanova (1975) as modified by I.I. Chernyaeva and G.A. Globus (1987).

The antibiotic activity of the *Trichoderma* antagonist against *V. dahliae* was determined by

the block method according to Yu.M. Voznyakovskaya (1969).

Results and Discussion

The results of the model experiment show that easily mobilized organic matter introduced into the soil is absorbed much faster by bacteria than by fungi in the initial period of decomposition. This is clearly visible in Fig. 1&2.

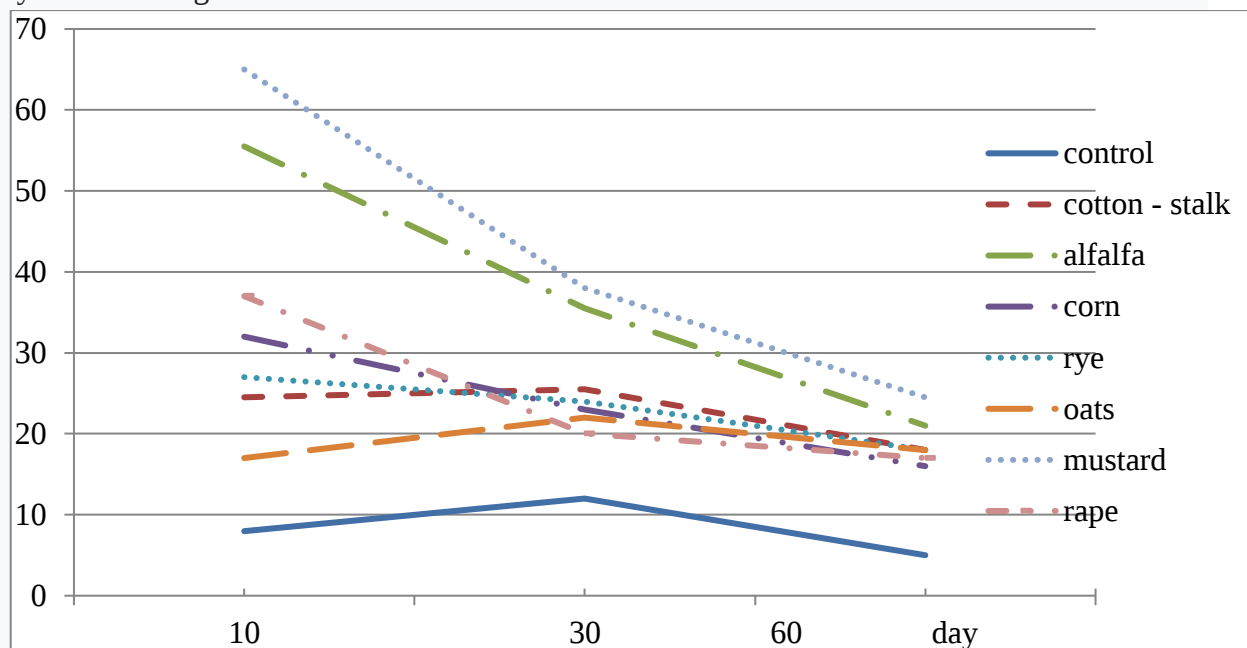


Fig 1. The influence of the timing of composting various plant residues on the overall biogenicity of the soil.

If on the 10th day the relative indicators of the total biogenicity of the soil in the variant without organic material were 13.5 million per 1 g abs. dry soil, then when plowing root and stubble residues of alfalfa, it amounted to 55.9 million. In options with plant residues of cotton (cotton stalk), rye, corn, oats and rapeseed, the total biogenicity ranged from 16.0 to 39.0 million..

The most active development of the total biogenicity of the soil was noted in the variant with plowing mustard green mass with green manure 66.6 million per 1 g abs. dry soil. Depending on the duration of composting of plant residues, a decrease in the development of bacterial flora was noted (on days 30 and 60).

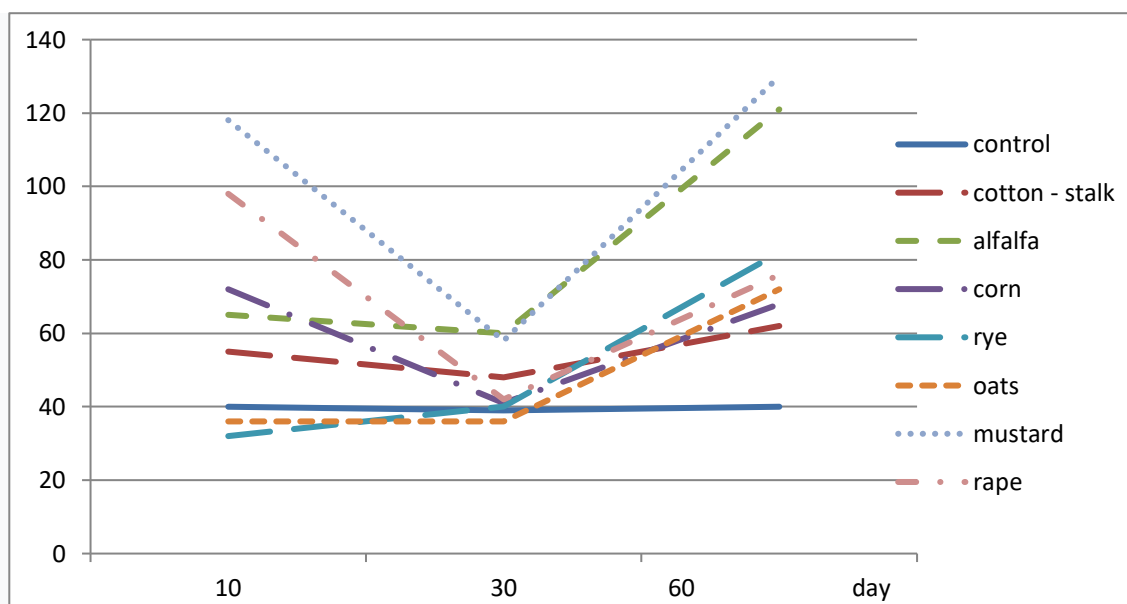


Fig.2. The influence of the timing of composting various plant residues on the number of soil micromycetes.

The opposite picture was observed in the development of fungi. If the number of fungus (Fig. 2) in the initial period of composting plant residues (10 days) is very large, then with the duration of composting they increase up to three times, depending on the option.

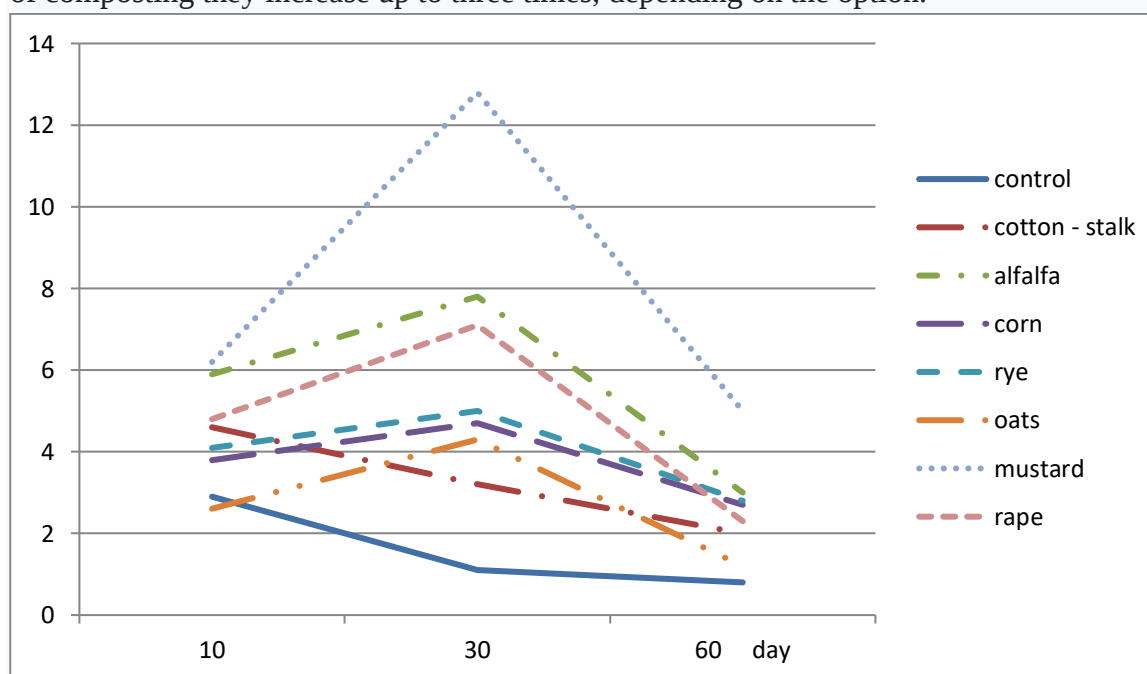


Fig. 3. Microbiological activity of soil.

The largest amount of CO_2 emission at all periods of analysis was observed (Fig. 3) where mustard was plowed into green manure, then in variants with plant residues plowed into alfalfa, rye and rapeseed. This indicates the intensity of microbiological processes occurring as a result of the decomposition of easily mobilized plant residues. An established fact of different rates of absorption by bacteria and fungi of what is present in the soil energy material suggests that this property largely explains the inherent state of fungistasis in the soil. This is also consistent with the fact that although

with an abundant supply of organic matter in the soil there is a simultaneous outbreak of reproduction of both bacterial and fungal flora, the number of the latter always remains lower.

We studied the dynamics of the development of *V. dahliae* depending on the duration of composting of plant residues and changes in the general biogenicity of the soil. The results obtained (Fig. 4) show that when the soil is enriched with easily mobilized organic substances in the initial period (the first 10 days), there is a noticeable increase in the number of *V. dahliae* due to abundant sporulation in the presence of nutrients.

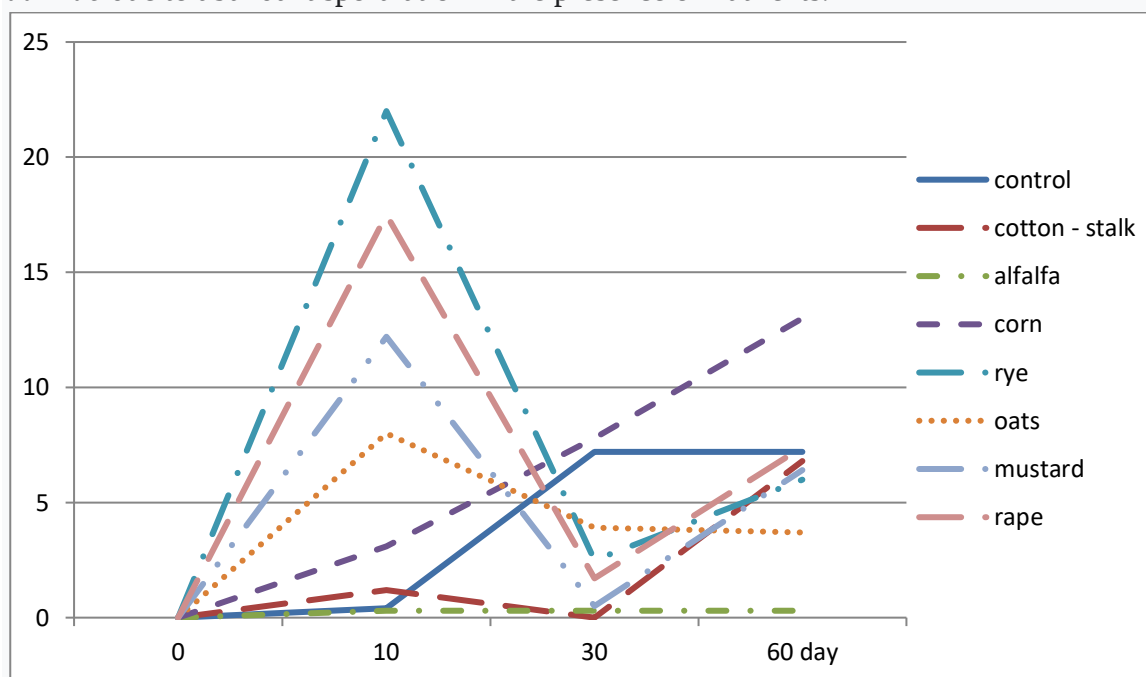


Fig.4. Dynamics of *V. dahliae* development in soil depending on the duration of composting of plant residues.

Thus, when composting plant residues of oats, mustard, rapeseed and rye, the number of *V. dahliae* propagules ranged from 10 to 21,5 pcs. in 1 g abs. dry soil, then, depending on the duration of composting, their number of pathogens decreased and ranged from 3.7 to 7,5 pcs., with control (variant without plant residues 7,5 pcs.).

It was noted that the influence of various plant residues of the studied crops on the number of *V. dahliae* in the soil was different. If in the variant with plowing of corn plant residues during the first 10 days, the number of *V. dahliae* was 3,2 pcs. then by 60 days – 13,3 pieces. In the variant with plowing of root and crop residues of alfalfa, the greatest germination of myrosclerotia of the pathogen was observed, and it amounted to less than 25 pcs. during all recording periods. 1 g abs. dry soil. Apparently, gaseous toxic emissions during the decomposition of alfalfa plant residues prevented the abundant sporulation of myrosclerotia of the pathogen.

G.N. Marshunova, N.K. Chernikova (1981), Yu.M. Voznyakovskaya (1983) argue that the processes of lysis and death of germinating conidia of the pathogen fungus may depend on the number of mycolytic bacteria.

The dynamics of the development of mycolytic bacteria with the addition of various plant residues (Fig. 5) shows that in all backgrounds and in all periods of observation with plowing of plant residues, the development of mycolytic bacteria occurs more intensively than in the background without them /control/. The most active development of mycolytic bacteria was noted at all periods of analysis in the variants with plowing of mustard plant residues, then where root and stubble

residues of alfalfa, rapeseed and rye were plowed.

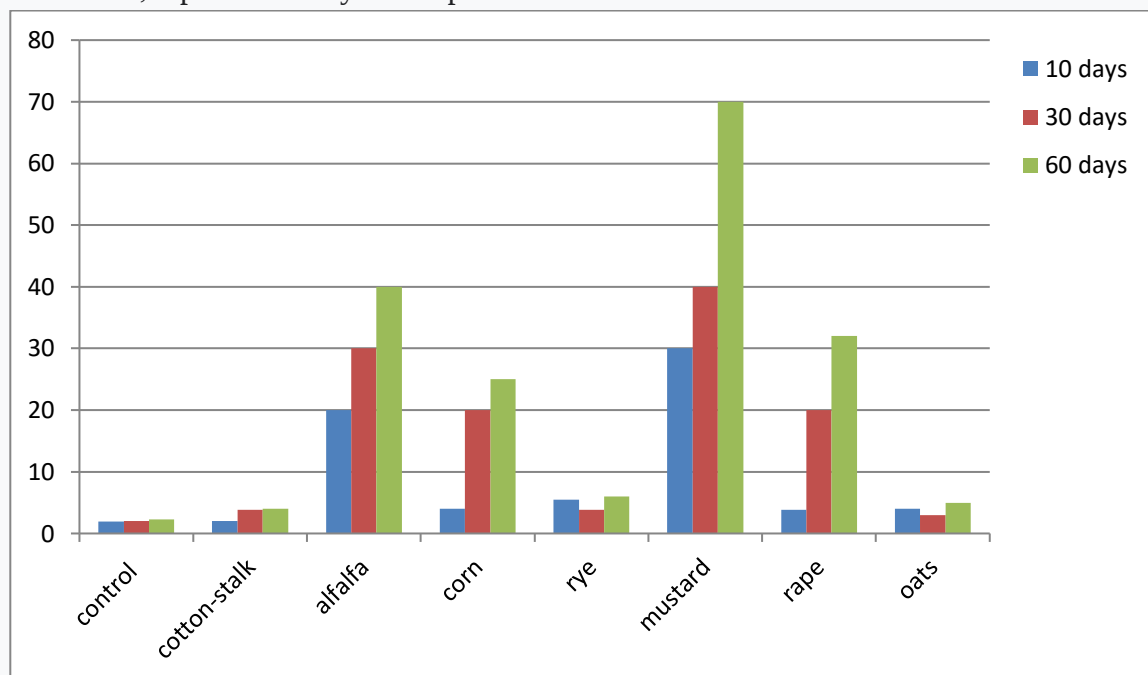


Fig. 5. Dynamics of *V. dahliae* development in soil depending on the duration of composting of plant residues.

Against the background of plowing cotton stems, the development of bacteria was much lower compared to other organic substances. Apparently, as N. Wolker /1979/ pointed out, the C:N ratio in plants was of great importance here.

More active absorption of organic matter introduced into the soil by bacterial flora compared to fungal flora shows the high specific ability of bacteria, which is one of the main conditions for soil fungistasis. The data show that the amount of *V. dahliae* in the soil depended on the quantity and quality of organic matter entering the soil - a source of nutrients for microorganisms.

Field experiments to study the effect of plant residues on the overall biogenicity of the soil were studied in a cotton field naturally heavily infected with the Fusarium wilt pathogen in the Bukhara region of the Republic of Uzbekistan.

Table 1

The total number of microorganisms in 1 g abs. dry soil.
Bukhara region, Karaulbazar district, farm "Amir Omon".
Production experience, variety Bukhara-10, 2023.

№ / №	Sequence of crop cultivation	Fungys on Czapek, thousand		Bacteria on MPA, thousand		Actinomycetes on KAA, million	
		Before sowing	In ripening	Before sowing	In ripening	Before sowing	In ripening
1.	Monoculture	7.87	9.3	79, 5	23.0	14.5	117
2.	Wheat + cotton	9.5	12,0	99.5	80.0	15.0	139.0

3.	Wheat, mustard for green manure + cotton	16,25	14,75	204,0	235.0	19,1	96,0

Data from microbiological analysis of soil on average for two years before sowing and during the period of cotton ripening are presented in **table 1**. From the data in Table 1 it is clear that in the monoculture of cotton (control) in the period before sowing cotton, the total number of fungi is 7.87 thousand. pcs and during the growing season of plants, increasing towards maturity, it reaches 9.3 thousand pcs per 1 gram. abs. dry soil. The number of bacteria was 79.5 and 23.0 thousand pieces per 1g abs., respectively. dry soil, and actinomycetes 14.5 and 117.0 million pieces in 1g abs. dry soil. In the wheat + cotton option, it was noted that there was a slight increase in the activity of microorganisms due to the entry into the soil of about 1 t/ha of root and crop residues of wheat. The most intensive development of fungi, bacteria and actinomycetes during all periods of soil analysis was observed precisely in the experimental variant where mustard phytomass was plowed in the fall of the previous year in an amount of more than 400.0 c/ha.

Table 2 presents average data for two years on the development of the main types of soil fungi after plowing of plant residues and mustard green manure. Tabular data show that in the period before sowing cotton in monoculture, the total number of mushrooms is 7.87 thousand pieces in 1 gram of absolutely dry soil. Among the isolated fungi, the dominant species were Aspergillus, Fusarium and Penicillium. Isolation of the fungus Trichoderma was not observed.

Table 2

Fungys in 1 g abs. dry soil, thousand

Bukhara region, Vobkent district, farm "Kulkhatib", Variety Bukhara-10, 2023

№	Sequence of crop cultivation	Всего грибов	из них					
			Aspergillus	Penicillium	Fusarium	Trichoderma	Mu-ëcor	Прочие
		Before sowing						
1.	Monoculture	8.0	4.0	1.5	2.0	0.0	0.0	0.5
2.	Wheat + cotton	9.0	7.0	0.0	2.0	0.0	0.0	0.0
3.	Wheat, mustard for green manure + cotton	12.0	6.0	3.0	0.0	*3.0	0.0	0.0
In ripening								
1.	Monoculture	7.5	5.0	0.5	2.0	0.0	0.0	0.0

2.	Wheat + cotton	9.5	6.5	1.0	1.0	1.0	0.0	0.0
3.	Wheat, mustard for green manure + cotton	13.0	5.0	3.0	0.0	*3.0	0.0	2.0

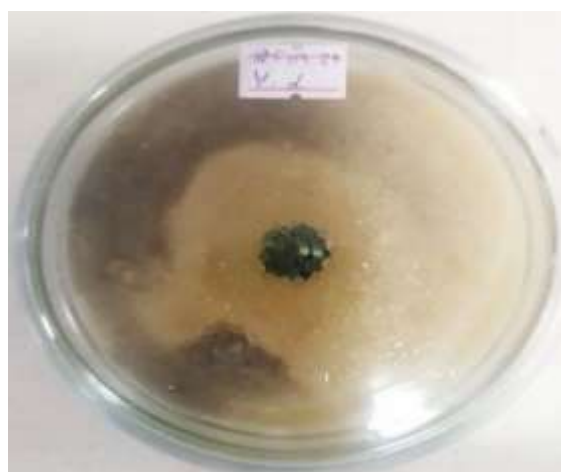
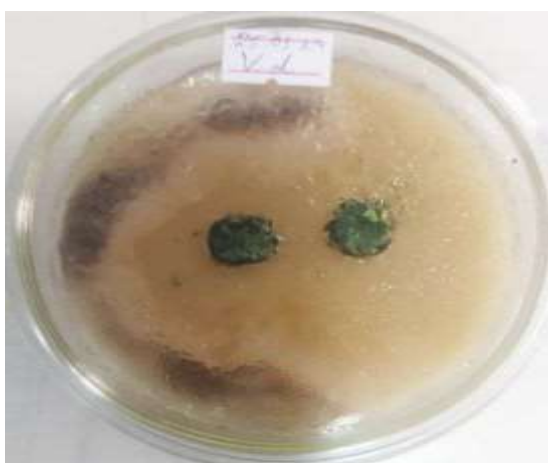
*** Note: copious fungal discharge *Trichoderma* sp.**

When the soil was enriched with root and crop residues of wheat, a slight increase in the activity of *Aspergillus* and *Fusarium* fungi was observed at both periods of soil analysis. . In the option of plowing mustard phytomass onto green manure, there was a significant increase in the activity of fungi and *Trichoderma*, are strains with properties, fungi of the genus



such as *Penicillium* among which there are antagonistic especially among *Trichoderma*.

Fig 1. Strains of fungi from the genus *Trichoderma* sp.



Against a background with the smell of mustard on green manure, three strains of the fungus are distinguished from the genus *Trichoderma*, different in cultural and morphological characteristics. Of these, one strain showed high antagonistic activity against *V. dahliae* and *Fusarium* sp. with a pathogen suppression zone with a diameter of 32-46 mm.

Fig 2. Antagonistic activity of the Bukhara population of the fungus *Trichoderma* sp.

The addition of organic mass of mustard green manure and plant residues of other crops reduced the fungistatic potential of the soil and stimulated the growth of *V. dahliae* microsclerotia, and the simultaneous proliferation of mycolytic bacteria and other antagonistic micromycetes led to their lysis.

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Conclusion

Enrichment of the soil with easily mobilized plant residues, especially mustard phytomass, followed by plowing under plowing, increased the fungistatic activity of the soil due to an increase in the number of mycolytic bacteria and natural forms of antagonistic fungi, especially from the genus *Trichoderma*, inhibiting the development of pathogenic wilt fungi *Fusarium* sp. and *V. dahliae*.

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