Research Article

Ecotoxicological Effects of Sevin10% and Chlorofet on Soil Fungal Community Dynamics

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Abstract | Fungi play an essential role in nutrient cycling and soil health, but they are adversely affected by pesticide application in the soil. This study evaluates pesticide effects on agricultural soil fungi growth in Abu Al-Khaseeb to understanding ecological risks and maintaining soil fertility. Two commonly used pesticides: Sevin 10% (Carbaryl), a carbamate insecticide, and Chlorofet (Chlorpyrifos), an organophosphate insecticide, were tested at concentrations of 1, 5, 10, 25, 50, and 75 ppm to evaluate their effects on six fungal species isolated from the soil of Abu Al-Khaseeb farms. The tested fungi included *Aspergillus candidus*, *A. flavus*, *A. terreus*, *Fusarium* sp., *Penicillium* sp., and *Scytalidium lignicola*. The study assessed both the radial mycelial growth of these fungi and the overall fungal density in soil samples treated with the pesticides. Statistical analysis displays that Sevin 10% significantly inhibited fungal growth, particularly at concentrations ranging from 5 to 25 ppm. *Scytalidium lignicola* showed the highest resistance to Sevin, whereas *Aspergillus candidus*, *A. flavus*, and *Penicillium* sp. were the most sensitive. In contrast, Chlorofet exhibited a strong inhibitory effect at all concentrations from 1-75 ppm, significantly reducing radial growth across all fungal isolates. Additionally, the number of fungal colonies in pesticide-treated soil showed a marked decline even at the low concentration 1 ppm compared to untreated controls. Both tested pesticides exhibited significant percentage inhibition effects on all six fungal species at all tested concentrations.

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Introduction

In recent years, Chemical pesticides are among the most important tools humans depend on in modern agriculture, as they are used to protect crops from pests and improve agricultural production (Damalas, 2009). Despite the clear economic benefits of using these compounds through increased productivity by killing harmful pests, their excessive or uncontrolled use in recent years has raised growing concerns about their environmental impacts. These compounds affect not only target organisms, such as harmful insects, but also non-target microorganisms, such as fungi and beneficial bacteria in the soil,

disrupting the ecological balance (Ayansina, 2009; Aktar *et al*., 2009; Arora and Sahni, 2016).

Pesticides easily penetrate into groundwater and soil, natural environments habitat for sensitive microbial communities, including numerous fungi that play a vital role in decomposing organic matter and recycling nutrients. As these compounds accumulate in the environment, these ecosystems become polluted and uninhabitable. The effects of pollution may also gradually spread through the food chain in a phenomenon known as bioaccumulation (Staley *et al*., 2015; Syafrudin *et al*., 2021; Pradhan *et al*., 2022). Hence, it is important to studying the effects of pesticides on fungi and organisms that inhabit agricultural soils, given their essential role in protecting soil fertility and the sustainability of agricultural systems. Pesticides and other organic pollutants, can adversely affect non- target organisms such as fungi and bacteria community in soil and water (Dijksterhuis *et al*., 2011; Srinivasulu and Ortiz, 2017; Chtioui *et al*., 2022; Wan *et al*., 2025).

The toxicity of pesticides on fungi depends mainly on the type and concentration of the pesticide as well as fungal species exposed to the pesticide (Forim *et al*., 2010; Diniz *et al*., 2020; Puspitarini *et al*., 2021). Several studies reported the effects of pesticides on microorganism, Mycorrhizal fungi are sensitive to some pesticides when used into the soil; while other pesticide can increase mycorrhizal growth (Arora and Sahni, 2016; Pagano *et al*., 2023) also studies found that the growth, sporulation and pathogenicity of entomopathogenic fungi can be greatly affected by pesticides (Rashid *et al*., 2010; Hernandez *et al*., 2012; Tkaczuk *et al*., 2015; Pelizza *et al*., 2015; Celar and Kos, 2016; Ramos *et al*., 2022).

Field studies indicate that Whenever fungicides or insecticides are used at recommended rates, they may not affect or have only temporary effects on the soil microbial diversity (Ahtiainen *et al*., 2003; Griffiths *et al*., 2006; Vig *et al*., 2008). A study by Steiner *et al*. (2024) demonstrated that pesticides can negatively affect the diversity and composition of soil microbial communities, particularly fungi and protists, and reduce vital soil functions such as respiration and microbial biomass. These compounds may also improve some grape quality indicators, revealing a variation between environmental and production impacts.

Some herbicides stimulate fungal growth, such as Glyphosates which stimulates the growth of some fungi species and actinomycetes while inhibiting the growth of other species (Means *et al*., 2007; Araujo *et al*., 2003).

Virag *et al*. (2007) reported that pesticides such as carbendazim, acetochlor, simazine, EPTC, and chlorpyrifos affect the growth of soil fungi species including *Fusarium oxysporum*, *Penicillium expansum*, and *Trichoderma harzianum*.

While Neghamish *et al*. (2011) found that the insecticide Carbaryl 10D did not affect fungi and bacteria numbers in just one treatment out of six during the first 3 days of experiment, and in the end of the test, the numbers increased slightly.

Fungus like *Trichoderma harzianum* was impacted by the application of Nogos insecticide, and *Fusarium solani* was more affected at the same concentration. Other fungi, such as *Rhizopus stolonifer* and *Aspergillus niger*, were not affected according to Al-Jawhary (2013).

Several studies indicate that the ability of fungi to grow in media or environments containing pesticides may indicate either the ability of these fungi to tolerate pesticide toxicity or utilize pesticides as a nutritional source for growth (da Silva *et al*., 2013; Allobawi *et al*., 2024). Additionally, pesticide metabolism in fungi is an important mechanism for eliminating xenobiotic compounds.

Other studies have shown that sporulation of entomopathogenic fungi (*Metarhizium anisopliae*, *Beauveria bassiana*, and *Acremonium spp*.) is stimulated by the presence of some insecticides and fungicides (Fiedler and Sosinska, 2017).

According to Henn *et al*. (2020), some fungi are inhibited by atrazine concentrations, although they are tolerant to high concentrations of this compound. It was observed that the inhibition rate increases as atrazine concentrations rise. *Pluteus cubensis*, *Gloelophyllum striatum*, and *Agaricales* isolates also showed the ability to degrade atrazine at different rates, and this degradation is enhanced under nitrogen-limited conditions.

Microorganisms also play an important part in the

pesticides biodegradation through a process known as mycodegradation (Dinakarkumar *et al.*, 2024). Bacteria and fungi break down pesticides and convert them into simple compounds and nutrient (carbon and organic phosphorus) to support growth, *Aspergillus niger* for example, has been shown to be highly effective in this process (Al-Jawhary, 2013; Thabit and El-Naggar, 2014; Abd El-Ghany and Masmali, 2016; Henn *et al.*, 2020).

Insecticides are classified into several categories, including the Carbamates and organophosphates , Sevin 10% (carbaryl) belongs to carbamate , affects insects through contact and exhibits systemic activity, while Chlorofet (Tc 48% chlorpyrifos) belongs to organophosphate group and is chemically known as O,O-Diethyl-O-(3,5,6-trichloro-2-pyridylphosphorothionate acts on the nervous system in pests , some studies suggest that chlorpyrifos may influence fungal metabolism or enzyme production processes. Figure 1 shows the chemical structures of both pesticides (Beatty and Sohn, 1986; Shaaban and Al-Mallah, 1993; Wali *et al.*, 2020).

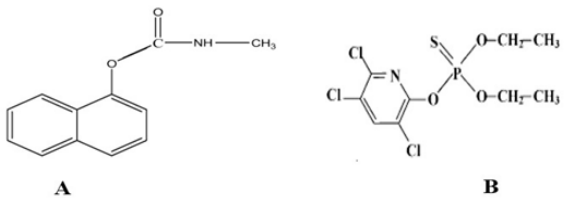

Figure 1: *The synthetic formula of A- Sevin10%(carbaryl) (*Mdeni *et al.*,2022*) and B- Chlorofet (Chlorpyrifos) (*Duirk *et al.*, 2009*)*

We conducted this study to investigate the effects of two commonly used pesticides, Sevin 10% (Carbaryl), a carbamate insecticide, and Chlorofet (Chlorpyrifos), an organophosphate insecticide, on the radial growth and fungal density (counting the number of fungal colonies per gram of soil) of certain fungal species found in agricultural soils, and compared these results to untreated control samples.

Materials and Methods

Fungal isolates

Agricultural soil was collected from a farm in (Abu Al-Khaseeb – Basrah Governorate), air-dried, milled, and distributed into sterile glass containers.

Six fungal isolates from this soil were selected: *Aspergillus candidus*; *A. flavus*; *A. terreus*; *Fusarium sp.*, *Penicillium sp.*, and *Scytalidium lignicola*, the isolates were purified using Potato Dextrose Agar (PDA) and incubated for 5 days, the pure isolates stored in the refrigerator at a temperature of 4˚ C.

Pesticides

Sevin10% and Chlorofet pesticides, were chosen for this study due to their widespread use in the region. Sevin10% belongs to the group of carbamate insecticides, while Chlorofet (Tc 48% = 480 g/L chlorpyrifos (is from the group of organophosphate pesticides supplied by the Jordanian VAPCO company. The study focus on the test of the effect of these pesticides on the radial growth of the fungi selected for the study, as well as their effect on the density of fungi in treated soil.

To prepare the standard stock solution for each pesticide, 1 g of Sevin 10% was dissolved in 20 ml of acetone then diluted to a final volume of 1000 ml with sterile distilled water to obtain a concentration of 1000 parts per million (ppm) . For Chlorofet, 0.25 ml was dissolved in 20 ml of acetone and then diluted to 300 ml with sterile distilled water to obtain a concentration of 400 parts per million (ppm). Six concentrations 1, 5, 10, 25, 50 and 75 ppm were prepared for each pesticide according to the dilution formula ($N_1V_1 = N_2V_2$). The PDA culture medium was used to evaluate the effect of the different concentrations on the radial growth of fungi, while sterile distilled water was used as control treatment in soil samples.

Test the effect of pesticides on the radial growth of fungi

Prepare PDA culture medium by dissolving 39 g in one liter of distilled water and adding 250 mg/l of the antibiotic Chloramphenicol. Sterilize the medium in an autoclave at 121˚C and 15 (psi) pressure for 15 minutes, then cool it to 45˚C. Next, take specific sizes of the standard solution of pesticides Sevin 10% and Chlorofet according to the dilution formulation and mix each volume with 500 ml of PDA medium in 750 ml glass bottles.

Shake the bottles gently to ensure proper mixing of the pesticide with the culture medium, resulting in concentrations of 1, 5, 10, 25, 50, and 75 parts per million (ppm) of each pesticide. Place these bottles in a water bath at a temperature of 70˚C for three

minutes to remove any solvent (acetone) that could affect fungal growth. Pour the culture media into sterile Petri dishes (9 cm), with 25 ml in each plate, including a control group without any pesticide treatment. Allow the medium to solidify, then take a 5 mm disk from each fungal growing colony at five days of age using a sterile corn borer and place one disk onto the center of each plate. Use two replicates per fungal isolate for each concentration of pesticide and for the control treatment.

Incubate the plates at a temperature of 25 ± 2˚C for 5-7 days depending on the fungal growth rate. Measure two perpendicular diameters of each fungal colony using a ruler, calculate the mean diameter, and compare the colony diameter with those of growing colonies in control plate prepared and measured in the same way.

The effect of pesticides on the density of fungi present in treated soil

To measure fungal density, the previously prepared concentrations were used; 50 ml of each concentration were added to each container containing agricultural soil samples,with two replicates for each concentration. The contents of each container were mixed using a sterile glass rod . Two control treatments were used: the first included sterilized soil in an autoclave at 121˚C and a pressure of 15 psi for 20 minutes, and then treated with sterile distilled water to determine the effect of pesticide contamination. The second control treatment included soil from the same orchards from which the pesticide-treated soils were taken, but not sterilized. It was treated with sterile distilled water only to compare fungal density with that in the pesticide-treated soils. The mouths of the containers were closed with sterile glass covers and left at room temperature for a week.

The effects of pesticides on the density of fungi evaluated using the dilution method described by (Cooke, 1969), 1 g was taken from each container of soil and dissolved in 9 ml of sterile distilled water to obtain a dilution 10:1. From this dilution, 1:100 and 1:1000 dilutions were made. The last two dilutions were filtered through 0.45 µm Millipore filters (provided by Albet, Germany), using a vacuum filtration device. The filter papers were transferred onto PDA culture medium and the plates were incubated at 25 ± 2 ˚C for 3-4 days. The number of growing colonies in each plate was counted, and the number of fungal colonies per 1g of soil treated with the two pesticide was calculated and compared with the number in untreated soil.

Percentage of fungal growth inhibition

The inhibition percentage of mycelial growth is calculated according to the following formula

$I\% = [(Dc - Dt)/Dc] \times 100$

I (%): inhibition percentage; Dc: average of control colonies diameter; Dt: average of the treated colonies diameter. (Ouoba *et al*., 2018**)**

Statistical analysis

The results were analyzed statistically using the fully randomized global trials method (Al-Rawi and Khalfallah 2000). The statistical processor SPSS program was used to analyze the results at a probability level of $P \leq 0.05$. Differences were considered significant if the calculated F value was equal to or greater than its tabular value. The lowest significant difference (LSD) rate was then tested among the averages to compare them.

Results and Discussion

Pesticides are chemicals divided into (insecticides, fungicides, and herbicides) according to the pest in agriculture, it has a significant impact on non-target organisms. Most them causing long -term toxic effects involving a fungal growth and sporulation impact (Mensin *et al*., 2013).

The fungal sensitivity to different concentrations of insecticides varies. Therefore, several concentrations of insecticides against each fungus were used in this study, considering the concentrations used by farmers. The results show a distinct variation in the effective concentrations of pesticides among the tested fungi. The statistical analysis revealed that the pesticide Sevin10% had a significant effect at $P \leq 0.05$ on the radial growth of the fungi under study, the most significantly effecting concentrations were 5,10 and 25 ppm. *Scytalidium lignicola* was the most resistant among fungal species, that show significant inhibition of its radial growth at a concentration of 25 ppm. While the *Aspergillus candidus*, *A. flavus*, and *Penicillium sp.* were reduced significantly at a concentration of 5 ppm. The fungi *A. terreus* and *Fusarium sp.* showing inhibition at a concentration of 10 ppm (Table 1 and Table 4).

Table 1: *Radial growth rate of the studied fungi exposed to the effect of the pesticide Sevin10%*

Fungal colonies diameters (in centimeters)	Fungal species	Pesticide concentration (ppm) **							The average*	LSD
		0	1	5	10	25	50	**75**		
	Aspergillus candidus	3.75^{a}	3.8 ^{ba}	3.2^{c}	2.75^{d}	2.75^{ed}	2.3^{f}	2.0 ^{gf}	2.94	0.050
	A. flavus	5.25^{a}	5.25^{ba}	4.5^{cab}	4.8^{dabc}	4.05^{ecd}	4.5^{fabcde}	3.0^{g}	4.48	0.076
	A. terreus	4.35 ^{a}	4.2 ^{ba}	4.2 ^{cab}	3.75 ^{dabc}	3.45 ^{ed}	3.45 ^{fde}	3.01 ^{gef}	3.77	0.0067
	Fusarium sp.	4.5^{a}	4.4^{ba}	4.5^{cab}	4.1^{db}	3.75^{ed}	3.75^{fde}	3.01^{g}	4.01	0.0033
	Penicillium sp.	8.1^{a}	8.0^{ba}	7.8^{ca}	7.5^{dc}	7.2^{ed}	7.1^{fde}	6.4^{g}	7.44	0.0156
	Scytalidium lignicola	6.75 ^{a}	6.70^{ba}	6.70^{cab}	6.61^{dabc}	6.5^{eabc}	6.3^{fde}	6.0^{gf}	6.51	0.003
Mean***		5.45	5.39	5.15	4.91	4.62	4.57	3.90		

**Different letters indicate significant differences between groups (P≤0.05).*

Table 2: *Radial growth rate of the studied fungi exposed to the effect of the pesticide Chlorofet*

Fungal colonies diameters (in centimeters)	Fungal species	Pesticide concentration (ppm)**							The average *	LSD
		0	1	**5**	10	25	50	**75**		
	Aspergillus candidus	3.75 ^{a}	3.3^{ba}	3.0^{cb}	2.55^{dc}	2.40^{ed}	2.25^{fde}	2.25^{gdef}	2.79	0.0066
	A. flavus	5.25 ^{a}	5.1^{ba}	4.5^{c}	3.75^{d}	2.85^{e}	2.25^{f}	1.65^{g}	3.62	0.1367
	A. terreus	4.35^{a}	3.25^{b}	2.95^{cb}	2.65^{dbc}	2.65 ^{ebcd}	2.5 ^{fde}	2.5 ^{gdef}	2.98	0.0067
	Fusarium sp.	4.5^{a}	4.0^{ba}	3.4^{c}	2.1^{d}	1.6 ^{ed}	1.3^{fe}	0.9^{gf}	2.54	0.2933
	Penicillium sp.	8.1^{a}	5.05^{b}	4.75^{cb}	4.60^{dbc}	4.15^{ecd}	3.70^{fe}	3.70^{gef}	4.86	0.003
	Scytalidium lignicola	6.75^{a}	5.0^{b}	4.4^{cb}	4.1^{dbc}	3.5^{ecd}	3.5^{fcde}	3.2^{gdef}	4.35	0.0033
Mean***		5.45	4.29	3.83	3.29	2.86	2.58	2.37		

**Different letters indicate significant differences between groups (P≤0.05).*

Table 3: *The effect of the pesticide Sevin10% and Chlorofet on the density of fungi present in the soil treated with them*

ت	Pesticide	Number of fungal colonies per 1 gm of soil*							The average
		0	1	5	10	25	50	75	
1	Sevin10%	25000	22000	21000	19000	17000	16000	14000	19142.85
2	Chlorofet	25000	20000	18000	16000	14000	12000	8000	16142.85
Mean		25000	21000	19500	17500	15500	14000	11000	

It is worth noting that the number of fungal colonies were calculated at a 1:1000 dilution due to their density in the 1:100 dilution, the resulting number was then multiplied by the dilution factor.

Table 4: *The minimum concentrations that significantly affect the pesticides Sevin10% and Chlorofet on the growth and density of fungi present in the treated soil with them.*

Pesticides	Concentrations of pesticides affect fungal species and their density in soil (ppm)						
	Aspergillus candidus	*A. flavus*	*A. terreus*	*Fusarium* sp.	*Pencillium* sp.	*Scytalidium lignicola*	Number of soil fungi
Sevin10%	5	5	10	10	5	25	1
Chlorofet	1	1	1	1	1	1	1

As for the fungal tolerance test for Chlorofet pesticide, it was found that all of these fungi showed a significant reduction at P≤0.05 in radial growth at a concentration of 1 ppm (Table 2 and Table 4).

Furthermore, both pesticides caused a significant reduction in the number of fungal colonies present in all treated soils with different concentrations (Table 3).

Both tested pesticides exhibited statistically significant percentage inhibition effects on all six fungal species at all tested concentrations. The highest percentage inhibition for both pesticides against

all species was observed at 75 ppm (Figures 2 and Figure 3). However, *Aspergillus candidus* displayed an atypical response; it showed stimulated growth at 1 ppm of Sevin 10% but also the highest percentage inhibition among all fungi at 75 ppm for the same pesticide. For the chlorofet pesticide, *Fusarium sp.* exhibited the highest percentage inhibition among all fungal species, again at 75 ppm concentration. Exposure to high concentrations of pesticides can negatively affect fungal growth, this leads to damage to soil fertility and the biological cycling of organic matter (Zhou *et al.*, 2025). This observation consistent with previous studies; for example, Cowley and Lichtenstein, (1970) reported that Carbaryl affected most of the 17 fungal species tested at high concentrations, while low concentrations had minimal or no impact. Similarly, Mohammadi and Amini, (2015) found that increasing concentrations of insecticides and herbicides including Ethalfluralin, Phosalone, Amitraz, Malathion, Holoxyfop-R-methyl, Chlorpyrifos, Binapacryl, Fenpropathrin, and Thiodicarb promote inhibition of fungal growth and spore germination.

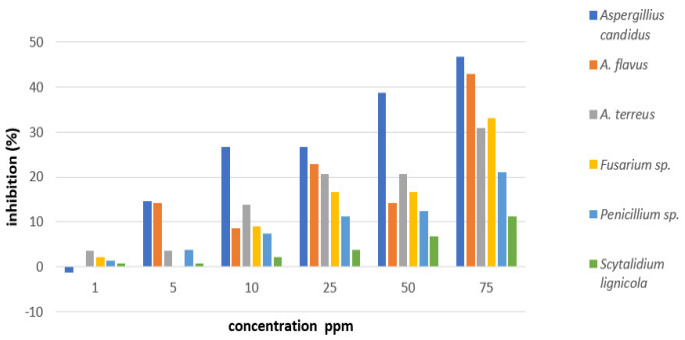

Figure 2: *Percentage of fungal growth inhibition by Sevin10% pesticide*

Numerous studies have confirmed pesticide effects on fungal populations. Das *et al.* (1995) showed that fenvalerate and phorate altered soil fungal community composition by stimulating *Penicillium sp.* and inhibiting *Rhizopus sp.*, whereas *Fusarium sp.* was affected only by fenvalerate. Badan and Diwan (1999) demonstrated that benomyl, dichlorvos, and glyphosate reduced fungal density, with dichlorvos being the most affective. Dazomet, carbaryl, and chlorpyrifos were also reported to inhibit fungal growth and spore formation (Mensin *et al.*, 2013). Additionally, high concentrations of chlorpyrifos and cypermethrin have been shown to be either toxic to fungi and bacteria or there is no affect (Srinivasulu and Ortiz, 2017). similarly, high-dose or extended glyphosate application reduced the fungal abundance (Vazquez *et al.*, 2021).

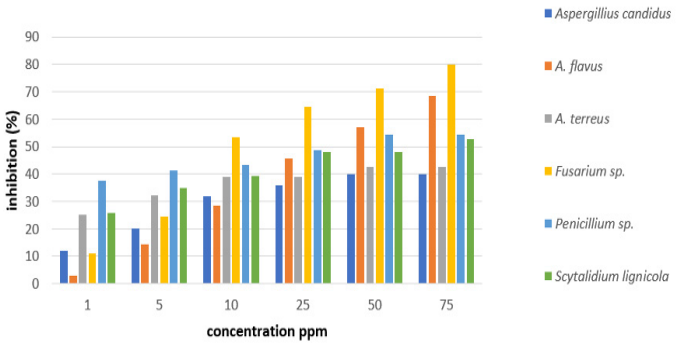

Figure 3: *Percentage of fungal growth inhibition by Chlorofet pesticide*

Changes in soil microbial community structure, including both fungal and bacterial species, have been used as indicators of pesticide contamination (Streletskii *et al.*, 2022). Observed alterations in species such as *Terabacterus*, *Kitasatospora*, *Streptomyces*, *Sphingomonas*, *Apitrichum*, *Solichosema*, *Gamsea*, and *Humicola* provide evidence of pesticide exposure. Overall, pesticides negatively impact soil microflora by inhibiting growth, enzymatic activity, and metabolic functions, thereby reducing soil fertility and nutrient cycling. Chlorpyrifos and carbaryl, in particular, significantly damage fungal populations, sporulation, enzymatic activity, and soil metabolic pathways (Meena *et al.*, 2020; Patel *et al.*, 2023; Raj *et al.*, 2024). The pesticide Sevin10% has both contact and simple systemic effects on organisms exposed to it (Shaaban and Al-Mallah, 1993). Faraj *et al.*, (2024) reported that carbaryl half-life range from 4 to 72 days in soil and have low solubility and attach to soil, chlorpyrifos is a non-selective insecticide and is toxic to various non-target organisms (Maggio *et al.*, 2021) and absorbed strongly by soil and since it has low water solubility, it is difficult to drain away from soil. also, it has half-life 20-120 days in soil (Singh *et al.*, 2003; Ajaz *et al.*, 2005; Jaiswal *et al.*, 2017), so in this study these pesticides effect significantly in all treatment on all fungi in soil and PDA culture medium after 5 days of experimentation. but the effect of Sevin10% is less than that of chlorofet pesticide. The difference in the effect of pesticide concentrations on fungal growth in culture medium versus soil may be due to longer survival of pesticides in laboratory conditions compared to field conditions, where they are subject to leaching, evaporation, and photodegradation (Hsu and Bartha, 1979). Fungi typically have thick cell walls, particularly in their reproductive units, to

withstand changes in environmental conditions such as heat, drought, and other factors (Beauvais and Latgé, 2018). The pesticide's action on the cell walls through contact may sufficiently affect fungal growth and reproduction (Yang *et al.*, 2011), potentially explaining why this pesticide affects fungal growth at relatively high concentrations of up to 25 parts per million compared to other pesticides. (Dela Cruz *et al.*, 2022) establish that soil fungi grown in the laboratory have varying sensitivity and tolerant to prothioconazole and isopyrazam through direct contact among the fungus species studied. the variety and sensitivity of Sevin10% and chlorofet pesticide in this study toward the fungi and in another studies, may be due to several factors are contribute to the fate of pesticides in the field, such as soil type, other microorganisms, and the physical and chemical properties of contaminants and soil (Hage-Ahmed *et al.*, 2018**)**.

A previous study by Bansal (2011) confirmed that carbamate pesticides reduce fungi and actinomycetes populations in the treated soil, while Malhotra *et al.* (2021) indicated that carbamate pesticides, especially carbaryl, have varying effects on the different fungal species. Some fungi are negatively affected by this pesticide, while other fungi, such as *Phanerochaete chrysosporium*, *Trichoderma*, and *Aspergillus*, are not affected by the pesticide. Instead, they decomposed the pesticide and utilizing it as carbon and energy source due to the degradative enzymes, which help decompose the aromatic chain of the pesticides.

Beatty and Sohn (1986) found that the tested fungi showed a high tolerance towards Carbafuran pesticide, at the high concentrations 75 and 106 ppm specially *Aspergillus giganteus*, and they also mentioned that some types of soil fungi are capable of consuming and metabolizing this pesticide, as well as the pesticide Lindane at their low concentrations. While it was noted that Chlorofet inhibited the growth of soil fungi at low concentrations, 1 ppm, and inhibited the growth of all other tested fungi at a concentration of 43 ppm, that's the same result in this study which shows a decrease in the number of fungi and colony diameter, even at low concentrations. Carbaryl had little to no effect on Arbuscular Mycorrhizal fungi (AMF) in organic soils due to the organic matter, which enhanced adsorption of carbaryl to the soil (Freidenreich *et al.*, 2022).

Other studies indicated that some fungi metabolize and convert pesticides into other compounds less toxic and use them as sources of carbon, phosphorus, and energy (Deshmukh *et al.*, 2016; Wang *et al.*, 2022; Dinakarkumar *et al.*, 2024; Chepyala *et al.*, 2024; Thirumalaivasan *et al.*, 2024), including *Penicillium sp.*, while the fungus *Fusarium sp.* does not have pesticide-degrading ability, so it was more sensitive to the impact of pesticides (Al-Jawhary, 1998 and 2001). However, the response and tolerances of fungal species to pesticides vary, with some showing weak resistance and others demonstrating medium to high resistance, since numerous fungal species can utilize pesticides as nutrient sources for growth, while several species may find it toxic (Al-Jawhary, 2013; Widyaningsih and Triasih, 2023).

The influence of chlorpyrifos and other pesticides on soil microbial communities has been widely documented, Yet the extent and duration of their influence seems variable. For example, Chu *et al.* (2008) observed noticeable reductions in both bacterial and fungal populations, particularly when chlorpyrifos was combined with chlorothalonil, although a gradual recovery of fungal numbers indicates potential adaptive strategies within certain species. Sabogal-Vargas *et al.* (2023) similarly reported that increasing chlorpyrifos concentrations significantly reduced colony diameters of *Trichoderma* strains, indicating a partial inhibitory effect on hyphal growth. In contrast, Huang *et al.* (2016) found more prolonged inhibition of fungal diversity, with Fusarium species being more sensitive, a variation that could result from differences in soil type, pesticide application rates, or experimental design. Huang also confirm that changes in soil pH may partly explain why some fungal groups were extremely affected. More recent studies by Wołejko *et al.* (2022) and Cheng *et al.* (2023) confirmed the inhibitory role of chlorpyrifos; however, it remains unclear whether such effects are temporal or persistent.

While inhibitory effects are widely reported, some pesticides have been shown to stimulate fungal growth under specific conditions. Magnoli *et al.* (2020) observed that chlorpyrifos stimulated the growth of *Aspergillus* strains in both laboratory and field experiments. Elzakey *et al.* (2023) found that *Aspergillus terreus* not only grew in the presence of chlorpyrifos but also degraded 75.59% of the pesticide, suggesting adaptive metabolic capacity.

Similarly, Allobawi *et al*. (2025) reported that Spartan pesticide enhanced growth of *Aspergillus terreus* and *Aspergillus clavatus*, whereas Sevin 10% and chlorofet inhibited their growth by reducing fungal numbers and increasing growth inhibition percentages in current study. These findings make clear that pesticide–fungal effects are not constant but depending on different conditions.

Excessive use of single or multiple pesticides can negatively impact soil microbial communities, affecting both bacteria and fungi, and reducing populations of beneficial and pathogenic fungi. This can also facilitate the emergence of plant-pathogenic or pesticide-resistant strains, particularly with the use of modern fungicides (Shah *et al*., 2023; Allobawi *et al*., 2024; Islam *et al*., 2024; Akhtar *et al*., 2024; Pan *et al*., 2025).

This study showed that pesticides such as chlorpyrifos can significantly inhibit fungal growth, although the range of inhibition varies with concentration. However, other reports indicate that some pesticides may stimulate fungal growth or alter microbial communities in crop roots (Islam *et al*., 2024). For instance, difenoconazole has been associated with increased fungal diversity, whereas imidacloprid was found to reduce it (Feng *et al*., 2025). Even though we do not yet know if these changes will continue or fade over time, the results clearly indicate the damaging effects of Sevin 10% and Chlorofet. At the same time, the results show that their effects depend heavily on the surrounding conditions such as influenced by chemical type, fungal species, soil properties, and environmental conditions. This suggests that future research should go further by investigating the mechanisms that enable microbial communities to adapt, recover, and sustain resilience.

Conclusions and Recommendations

Chlorofet and Sevin 10% are two types of pesticides were regularly used by farmers were used in this study to determine whether they affect the 6 soil fungi growth. It was observed that these pesticides affect the radial growth of fungi, as they inhibit growth depending on the concentrations and type of these pesticides, and Chlorofet was the most effective.

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Novelty Statement

This study reveals the different effects of Sevin 10% and Chlorofet on soil fungi, shows that low doses of Chlorofet significantly inhibit fungal growth, highlights species-specific resistance patterns, especially in *Scytalidium lignicola*, and provides new insights into pesticide-fungal interactions.

Author's Contribution

Balqees S. Al-Ali: Conceptualization, Writing – original draft
Dh. Dh. Al-Khion: Writing – review & editing, Data curation
Fadel Jabbar Farhan: Investigation, Laboratory work
Salah N. Aziz: Sampling, Fieldwork.
Ameer A. Mohammed: Formal analysis, Data analysis.

Generative AI or AI assisted technology statement
The authors declare that no generative AI was used in the creation of this manuscript.

Conflict of interest
The authors have no conflict of interest.

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