Tikrit Journal for Agricultural Sciences (2023) 23 (2): 25-41
DOI: https://doi.org/10.25130/tjas.23.2.3

IRAQI Academic Scientific Journals
المجلات الأكاديمية العلمية العراقية
ISSN:1813-1646 (Print); 2664-0597 (Online)
Tikrit Journal for Agricultural Sciences
Journal Homepage: http://www.tjas.org
E-mail: tjas@tu.edu.iq

TJAS
Tikrit Journal for Agricultural Sciences

Evaluation of the local isolate *Streptomyces kanamyceticus* strain Tikrit-5 in control of gray rot disease on eggplant caused by *Botrytis cinerea*

Abdullah Fadhil Mahmoud[1] and Abdullah Abdul Karim Hassan[2]
[1]*Ministry of Agriculture, Salah al-Din Agriculture Directorate, Tikrit, Iraq*
[2]*Department of Plant Protection, College of Agriculture, Tikrit University, Iraq*

[*] *Corresponding author: E-mail*: drabdullah.has67@tu.edu.iq

KEY WORDS:
Streptomyces kanamyceticus, *Botrytis cinerea*, eggplant cultivars

Received: 01/08/2022
Accepted: 05/09/2022
Available online: 30/06/2023

ABSTRACT

The study was carried to know the effect of local strain, *Streptomyces kanamyceticus* on the growth and production of three varieties of eggplant plants and its control gray rot disease. The results showed that the *S. kanamyceticus* with the fungicide Prado in the presence of the pathogenic fungus *B. cinerea* achieved the highest plant, shoot and root system of dry weight and leaf area in all eggplant cultivars compared with the lowest these parameters in the pathogenic fungus treatment. The results also showed the lowest infection severity with the pathogen *B. cinerea* was recorded in Barcelona cultivar treated with (*S. kanamyceticus*+ Prado) which reached to 21.23% compared with the highest infection severity of 80.06% in the Norita cultivar infected with the pathogenic fungus. *S. kanamyceticus* with the fungicide Prado in the presence of the pathogenic fungus *Botrytis cinerea* achieved the highest resistance induction agents such as chitinase, β–glucanase, peroxidase and polyphenol oxidase in all eggplant cultivars compared other treatments. The effect *S. kanamyceticus* was reflected by resistance induction, reducing the infection severity and improving the vegetative characteristics to a higher plant productivity. The highest fruit weight was recorded under the conditions of infection with the pathogenic fungus *B. cinerea* in Barcelona cultivar treated with *S. kanamyceticus* with the fungicide Prado reached to 588.82 gm compared with the lowest fruit weight of 301.41 gm in Norita cultivar in the treatment of pathogenic fungi only. In terms of fruit hardness, the treatment of *S. kanamyceticus* with the Prado in the presence of the pathogenic fungus *B. cinerea* achieved the highest fruit hardness reached 3.8 kg/cm^2 in Barcelona cultivar compared with the lowest fruit hardness of 2.8 kg/cm^2 in both cultivar Norita and Al-Nasr in the treatment of pathogenic fungus only.

تقييم العزلة المحلية *Streptomyces kanamyceticus* strain Tikrit-5 في السيطرة على مرض التعفن الرمادي على الباذنجان المتسبب عن الفطر *Botrytis cinerea*

عبدالله فاضل محمود [1] و عبدالله عبدالكريم حسن [2]
[1]وزارة الزراعة ، مديرية زراعة صلاح الدين ، تكريت ، العراق
[2]قسم وقاية النبات ، كلية الزراعة، جامعة تكريت ، العراق

الخلاصة

اجريت الدراسة لمعرفة تأثير السلالة المحلية *Streptomyces kanamyceticus* على نمو وإنتاج ثلاث أصناف من نبات الباذنجان وتأثيرها في السيطرة على مرض التعفن الرمادي. أظهرت النتائج أن *S. kanamyceticus* مع المبيد برادو وبوجود الفطر الممرض *B. cinerea* حققت أعلى ارتفاع للنبات ووزن جاف للمجموع الخضري والمجموع الجذري والمساحة الورقية في جميع أصناف الباذنجان مقارنة مع أقل المعايير في معاملة الفطر الممرض فقط. كما أظهرت النتائج أن أقل شدة إصابة بالفطر *B. cinerea* سجلت في صنف برشلونة المعاملة بـ (*S. kanamyceticus* + Prado) اذ بلغت 21.23٪ مقارنة بأعلى شدة إصابة بلغت 80.06٪ في صنف نوريتا في معاملة الفطر الممرض فقط. حققت معاملة *S. kanamyceticus* مع المبيد برادو وبوجود الفطر الممرض *B. cinerea* أعلى عوامل استحداث المقاومة مثل الكايتينز ، بيتا - كلوكانيز ، بيروكسيديز وبولي فينول أوكسيديز في جميع أصناف الباذنجان مقارنة مع المعاملات الأخرى. وقد انعكس تأثير *S. kanamyceticus* من خلال استحداث المقاومة وتقليل شدة الإصابة وتحسين الصفات الخضرية مما ادى إلى إنتاجية نباتية أعلى. اذ تم تسجيل أعلى وزن للثمار تحت ظروف الإصابة بالفطر الممرض *B. cinerea*. اذ بلغ 588.82 غم مقارنة باقل وزن للثمار بلغ 301.41 غم في معاملة الفطر الممرض فقط للصنف نوريتا، اما من حيث صلابة الثمار فقد حققت معاملة *S. kanamyceticus* مع المبيد برادو وبوجود الفطر الممرض *B. cinerea* أعلى صلابة للثمار بلغت 3.8 كغم/سم^2 في صنف برشلونة مقارنة بأقل صلابة للثمار بلغت 2.8 كغم/سم^2 في كلا الصنفين نوريتا والنصر في معاملة الفطر الممرض فقط.

الكلمات المفتاحية: *Streptomyces kanamyceticus* ، *Botrytis cinerea* ، أصناف الباذنجان.

INTRODUCTION

The eggplant and its scientific name (*Solanum melongena* L.) is a summer vegetable crop and it is one of the crops of the *Solanaceae* family (Hussein and Muhammed, 2017). Which is one of the most important plant families from an economic point of view, especially in the hot and temperate regions of the world, as the eggplant plant was known in the past that it was growing in the wild, and its original home is China and India (HG and Osman, 2014; Suganiya and Kumuthini, 2014). The importance of eggplant is the use of its fruits as food in most countries of the world, including Iraq, as well as some medical uses. It has a high nutritional value. Eggplant fruits contain 14.34% protein, 2.82% fat, 12.85% fiber, 63.87% carbohydrates, in addition to some nutrients such as potassium, Phosphorous, magnesium, calcium, iron and zinc (Gopalan *et al*., 2007; Hussain *et al*., 2010). Eggplant fruits are also distinguished by containing some vitamins such as vitamin A, B1, B2, B5, C (Cardoso *et al*., 2009). The areas planted with this crop increased in Iraq in 2020, as the cultivated area reached (13.617.26 Hectors), with a total production estimated at (51.800) tons, and a yield of (3804) kg/Hectors (Central Statistics Organization, 2020). Eggplant is also grown in many countries of the world due to its high content of biologically active compounds including phenolic compounds and micronutrients (Luthria, 2007). The eggplant crop is exposed to many diseases that reduce the yield in quantity and quality, and one of the important fungal diseases is gray rot.

Gray rot disease caused by the fungus *Botrytis cinerea* is one of the common diseases of the eggplant crop. This disease affects the eggplant crop from the beginning of its cultivation until the time of its maturity and marketing. exposed or in protected cultivation or after harvest during storage (Mosbach *et al*., 2011) .The fungus *B. cinerea* causes great economic losses in many countries of the world annually. The rate of loss ranges from $10 billion to $100 billion annually worldwide (Boddy, 2016). The fungus *B. cinerea* produces large quantities of conidia, which are scattered in the air and can be transmitted through the air easily and for long distances. These fungi also form stone bodies called sclerotia, which enable the fungus to survive in the absence of its hosts or when suitable conditions are not available for its growth (Mouekouba *et al*., 2013).

There are multiple methods used to control gray rot disease caused by *B. cinerea*, including chemical methods, mainly the use of chemical pesticides such as Switch, Topsin-M, Rovral, Elevate, and other chemical pesticides (Shishido, 2011). The use of chemical pesticides has led to the emergence of many problems, including environmental pollution, the high cost of chemical pesticides and the emergence of resistant strains as a result of the repeated use of pesticides, as well as its harmful effect on beneficial microorganisms as well as being toxic to humans and animals (Decognet *et al*., 2009). In view of the many problems that have emerged from the use of chemical control, the world has begun to resort to alternatives to chemical control, and among these alternatives is the use of biological control, which is one of the safe methods for the environment, humans and plants themselves (Compant *et al*., 2005). Biological control has proven to be one of the most environmentally friendly methods due to its ability to use natural antibiotics (Qessaoui *et al*., 2019). Bio-fungicide is the general name given to microorganisms and natural compounds that have the ability to control plant diseases (Francis and Keinath, 2010).

Actinomycetes and especially the genus *Streptomyces* spp. are often used as Biocontrol agents because they can produce a wide range of secondary metabolites (Bubici, 2018). Abbey *et al*. (2019) reported the production of biocides to combat *Botrytis* diseases from some strains of Actinomycetes, where the strain (*Streptomyces griseoviridis* k61) produces the biocide (Mycostop) from Vedera registered in North America (Canada & US) & Europe, and also the strain (*Streptomyces lydicus* WYEC108) Biocide (Actinovate SP) from Monsanto, registered in Canada, Turkey, US. Yuan and Crawford (1995) used at the applied level two strains of Actinomycetes, *Streptomyces lydicus* and *Streptomyces griseoviridis*, as good bio-resistance agents against various plant pathogens. Actinomycetes of all kinds are the most productive source of bioactive secondary metabolites, including antifungals, and are considered natural sources of bioactive compounds (Aksoy *et al*., 2016). Another biological control method against gray rot is the use of the biological fungus *Trichoderma* spp. Which is characterized by ease of isolation and propagation, as this fungus was used to resist many plant pathogenic fungi, including the fungus *B. cinerea*, which infects different parts of the plant such as the stem, flowers and fruits, as well as infecting different crops such as grapes, strawberries, prepare vegetable eggplant and various vegetables (Freeman *et al*., 2004). The current study aimed to apply some aspects of integration in resisting pathogenic fungi by chemical and biological methods represented by Actinomycetes and to evaluate the sensitivity of some eggplant cultivars to disease and their response to experimental treatments.

MATERIALS AND METHODS

Pathogenic fungus *Botrytis cinerea*

The pathogenic fungus *B. cinerea* was obtained from the Plant Diseases Laboratory - College of Agriculture - Tikrit University (Hassan and Mahmoud, 2022).

Preparation of *Streptomyces kanamyceticus* filtrate

S. kanamyceticus strain Tikrit-5 isolate (highly antagonistic isolate against the pathogenic fungus *B. cinerea*) was used. This isolate was characterized morphologically and molecularly and registered in the National Center for Biotechnology Information (NCBI) under the accession number (OM432024.1). (Hassan and Mahmoud, 2022).

S. kanamyceticus was grown in the Starch Peptone Yeast Extract Medium (SPYEM) consisting of 10 g of Starch, 4 g of Yeast extract, and 1g of K_2HPO_4 in 1000 ml of distilled water (Collins *et al*., 1995). After the incubation at 30C for 15 days, the medium was filtered using a paper filter paper (Whatman No.1) then centrifuged at 5000 rpm for 10 min. Finally, the sediment was discarded, and the filtrate was used in subsequent experiments.

Preparation of *B. cinerea* spore suspension

Spores of the pathogenic fungus *B. cinerea* grown in PDA medium were collected by adding 10 ml of distilled water to the plate using a sterile fine brush. The spores were carefully harvested to avoid scratching the PDA. Spore suspension was prepared at a concentration of 10^{10} spore/ ml using a counting slide.

Field experience

The field experiment was carried out in the greenhouse at the Research Station of the Plant Protection Department - Tikrit University on 7/11/2021.

After sterilizing the soil with formalin at a concentration of 5% for 7 days, the plastic house was ventilated to fumigate formalin. Three cultivars of eggplant were planted, including Norita (Germany), Barcelona (Spanish) and Nasr (local).

The experiment included the following treatments for each cultivar, with 10 plants per treatment:

The pathogenic fungus *B. cinerea*

B. cinerea+ *S. kanamyceticus*

B. cinerea + fungicide Brado

B. cinerea + *S. kanamyceticus* + Brado

S. kanamyceticus

For the pathogenic fungus treatments, the suspension of pathogenic fungus spores was sprayed at a rate of 50 ml per plant two weeks after planting the seedlings using hand spryer, then repeated spraying after a month of planting to ensure the occurrence of infection. The filtrate of *S. kanamyceticus* was sprayed at a rate of 50 ml / plant. The fungicide, Prado (0.1%) treatment was also sprayed with 50 ml/plant, while the Prado + *S. kanamyceticus* filtrate was sprayed with 50 ml (1:1 V:V), all plant service operations were carried out including fertilization, irrigation and weeding.

Studied traits

Vegetative traits

Estimation of plant height

The height of the plants was estimated by taking three plants at random from each treatment and from each replicate, and the root system was separated from the vegetative total.

Estimation of shoot and root dry weights

The shoot system was separated from the root system, then the plant roots were washed with water well to get rid of the soil stuck in them. The root and vegetative parts were dried using an electric oven at 60C until their weight was stable. The average weights of both shoot system and root system were calculated using a sensitive scale.

Estimation of leaf area

The leaf area of the plant was measured according to the method (Wallace and Munger, 1965).

Preparation of the crude enzymes

The roots of three plants (from each replicate) were washed with water to get rid of the mud, then the roots were cut into small pieces and 1 g of roots was taken and placed in a mortar and 5 ml of acetate buffer solution pH 5.6 was added, then completely crushed and Centrifuged at 5000 rpm for 5 minutes, the sediment was discarded, and the filtrate which represents the crude enzymes was sterilized via millipore membrane Filter. 22 µm.

Estimation of the chitinase and β-glucanase activities

Chitinase and β-glucanase activities were estimated according to Tweddell *et al*. (1994). Briefly, 1 ml of substrate solution (1%) (chitine and β-glucan for chitinase and β- glucanas estimation, respectively) was added to 1 ml of the crude enzymatic filtrate, the mixture was incubated in a water bath at a temperature of 30° C for two hours, centrifuged at 2000 rpm for 5 minutes, then mixe 1 ml of the supernatant with 1 ml of DNS solution. The mixture was boiled in a 100 °C water bath for 5 minutes, then cooled and the absorbance at 540 nm was measured using spectrophotometer. enzmetic unit was defined as the amount of enzyme required for liberate a micromole of the substance (chitin) per ml / minute.

Determination Peroxidase and Poly Phenol oxidase activities

It was estimated according to Mahadevan and Sridhar (1986). 2.5 ml of the guaicol solution (1%) for Peroxidase , catechol (1%) for Poly Phenol oxidase at a temperature of 25°C, was mixed with 0.1 ml of the crude enzyme, after five minutes the absorbance is measured at a wavelength of 470 nm, then the laccase activity was estimated according to the following equation:

One unit= ΔA_{470} of 0.01/ min

Estimation of the severity of infection with the pathogen *Botrytis cinerea*

The severity of infection of the pathogenic fungus *Botrytis cinerea* was estimated according to the pathological index mentioned by Gao *et al*. (1995) which shown in Table (1), and the severity of infection was estimated according to McKinney's equation for all treatments (Mckinney, 1923).

Infection severity =

$$\frac{Sum(\text{The number of infected plants at degree } 0*0 + ...+ \text{ the number of infected plants at degree } 6*6)}{\text{Total number of plants} * \text{highest score in the medical evidence}} \mathbf{100} \times$$

Table (1) the pathological index

Degree	Pathogenic symptoms
0	healthy plant (control)
1	Yellowing and wilting of leaves from 1-20% of the plant
2	Yellowing and wilting of leaves from 21-40% of the plant
3	Yellowing and wilting of leaves from 41-60% of the plant and rotting of stems from 1-10%
4	Yellowing and wilting of leaves from 61-80% of the plant and rotting of stems and flowers from 11-30% of the stem
5	plant death

Fruit weight: The fruits of three plants (from each replicator and from each treatment) were weighed at three times harvest. The weight was calculated in (g) using a sensitive scale and the general average was calculated for each treatment.

Fruit hardness: Fruit hardness was measured for three fruits (from each replicate and from each treatment) using Fruit Hardness Tester. Fruit hardness was measured immediately after fruits harvesting.

Statistical analysis

The field experiment was carried out by Randomized Complete Blocks Design, Statistical analysis of the resulted data were carried out by analysis of variance was using the program (SPSS). The means were compared according to the Least Significant Deference (L.S.D.) test at the level of probability 0.05.

RESULTS and DISCUSSION

Table (2) showed that the highest rate of plant height was recorded in the treatment of *S. kanamyceticus*, which was 58.58 cm, with a significant superiority compared to the untreated plants, as the average plant height reached 43.46 cm. In terms of infection with pathogenic fungi, the highest rate of plant height was 54.28 cm in the *S. kanamyceticus* with the fungicide Prado compared to the lowest height of 38.26 cm in the treatment of pathogenic fungi only.

Barcelona eggplant cultivar showed the highest rate of plant height of 50.61 cm with significant superiority over the other cultivars. As for the interaction of the uninfected treatments, the highest height was reached for the cultivar Barcelona treated with *S. kanamyceticus*, which reached 60.32 cm compared to 41.21 cm in the control treatment of the variety Norita. As for the interaction level of the treatments and in the presence of the pathogenic fungus *B. cinerea*, the cultivar Barcelona treated showed with *S. kanamyceticus* with the pesticide Prado, the highest height reached 56.16 cm compared to the lowest recorded height in Norita cultivar, which reached 36.07 cm. The interaction between treatments and cultivars in presence of the pathogenic fungus *B. cinerea* showed the highest height of 56.16 cm in the Barcelona cultivar treated with *S. kanamyceticus* and Prado compared to the lowest height (36.07 cm) in Norita cultivar treated with pathogenic fungus.

Table (2) Effect of *S. kanamyceticus* strain Tikrit-5 on the plant height (cm) of three cultivars of eggplant under conditions of infection with the pathogenic fungus *B. cinerea*

Treatments	Eggplant cultivars			Average of treatments
	Norita	Barcelona	Nasir	
Control (healthy plants)	41.21	45.83	43.33	43.46
Pathogenic fungus *B. cinerea*	36.07	40.02	38.69	38.26
B. cinerea +*S. kanamyceticus*	50.16	51.98	51.81	51.32
B. cinerea + fungicide Brado	44.16	49.33	47.04	46.84
B. cinerea +*S. kanamyceticus* +Brado	52.13	56.16	54.55	54.28
S. kanamyceticus	57.09	60.32	58.32	58.58
Average of cultivars	46.80	50.61	48.97	
L.S.D ($P_{0.05}$)	Treatments = 2.33 Cultivars =2.06 Treatments × Cultivars =3.11			

Through the results listed in Table (3), it was found that the highest average dry weight of the shoot system was recorded in the treatment *S. kanamyceticus*, which reached to 55.17 g, with significant superiority compared with the untreated plants, where the average dry weight was 52.47 g. At the level of infection with pathogenic fungi *B cinerea*, the highest dry weight rate was reached to 52.39 g in the treatment of *S. kanamyceticus* with the fungicide Prado, compared to the lowest dry weight rate of 24.77 g in the treatment of pathogenic fungus only.

In terms of cultivars, Barcelona cultivar showed the highest dry weight rate of 50.18 g, with significant superiority compared to other cultivars. The interaction between treatments and cultivars in the presence of the pathogenic fungus *B. cinerea* showed the highest dry weight of 56.33 g in the Barcelona cultivar treated with *S. kanamyceticus* with the Prado compared with the lowest dry weight of 23.64 g in Norita cultivar treated with pathogenic fungus.

Table (3) Effect of *S. kanamyceticus* strain Tikrit-5 on the dry weight of shoots (g) of three cultivars of eggplant under conditions of infection with the pathogenic fungus *B. cinerea*

Treatments	Eggplant cultivars			Average of treatments
	Norita	Barcelona	Nasir	
Control (healthy plants)	48.26	56.43	52.72	52.47
Pathogenic fungus *B. cinerea*	23.64	25.68	25.0	24.77
B. cinerea +*S. kanamyceticus*	45.33	50.90	45.73	47.32
B. cinerea + fungicide Brado	46.17	53.42	48.84	49.48
B. cinerea +*S. kanamyceticus* +Brado	48.19	56.33	52.66	52.39
S. kanamyceticus	51.26	58.34	55.91	55.17
Average of cultivars	43.81	50.18	46.81	
L.S.D ($P_{0.05}$)	Treatments = 1.87 Cultivars= 1.93 Treatments × Cultivars =2.26			

Table (4) shows that the highest dry weight of the root system was recorded in the treatment *S. kanamyceticus*, which was 4.06 g, with a significant superiority compared to the untreated plants, as the average weight was 3.76 g. In the presence of infection with the pathogenic fungus *B. cinerea*, *S. kanamyceticus* with the fungicide Prado achieved significant superiority over all treatments infected with the pathogenic fungus, as the weight reached 3.8 g, while the lowest dry weight at the level of treatments infected with pathogenic fungi was 3.28 g . At the level of cultivars, Barcelona cultivar significantly outperformed the rest of the cultivars, as its average weight was 4.19 g. The interaction between treatments and cultivars in the presence of the pathogenic fungus *B. cinerea* showed the highest dry weight of 4.35 g in the Barcelona cultivar treated with *S. kanamyceticus* with the Prado compared with the lowest dry weight of 2.76 g in Norita cultivar treated with pathogenic fungus.

Table (4) Effect of *S. kanamyceticus* strain Tikrit-5 on the dry weight of root system (g) of three cultivars of eggplant under conditions of infection with the pathogenic fungus *B. cinerea*

Treatments	Eggplant cultivars			Average of treatments
	Norita	Barcelona	Nasir	
Control (healthy plants)	3.26	4.31	3.70	3.76
Pathogenic fungus *B. cinerea*	2.76	3.75	3.32	3.28
B. cinerea +*S. kanamyceticus*	2.97	3.87	3.45	3.43
B. cinerea + fungicide Brado	3.11	4.14	3.61	3.62
B. cinerea +*S. kanamyceticus* +Brado	3.28	4.35	3.77	3.8
S. kanamyceticus	3.62	4.69	3.86	4.06
Average of cultivars	3.17	4.19	3.62	
L.S.D ($P_{0.05}$)	Treatments = 0.17 Cultivars = 0.22 Treatments × Cultivars = 0.46			

The results in Table (5) showed that the highest leaf area was 3107.19 cm^2 in the treatment *S. kanamyceticus*, with a significant difference compared with 3003.01 cm^2 in the control, at the level of infection with the pathogenic fungus *B. cinerea*, *S. kanamyceticus* with the Prado showed the highest average leaf area which reached 3017.12 cm^2 compared with the lowest leaf area of 1020.62 cm^2 in the treatment of pathogenic fungus only. Among the eggplants cultivars, Barcelona variety recorded the highest leaf area of 2661.17 cm^2 compared to other varieties, while the interaction between treatments and cultivars in the presence of the pathogenic fungus *B. cinerea* showed the highest leaf area of 3022.9 cm^2 in the Barcelona cultivar treated with *S. kanamyceticus* with the Prado compared with the lowest leaf area of 1011.14 cm^2 in Norita cultivar treated with pathogenic fungus.

Table (5) Effect of *S. kanamyceticus* strain Tikrit-5 on the leaf area (cm^2) of three cultivars of eggplant under conditions of infection with the pathogenic fungus *B. cinerea*

Treatments	Eggplant cultivars			Average of treatments
	Norita	Barcelona	Nasir	
Control (healthy plants)	2996.22	3010.0	3002.81	3003.01
Pathogenic fungus *B. cinerea*	1011.14	1033.2	1017.52	1020.62
B. cinerea +*S. kanamyceticus*	2866.80	2891.7	2883.33	2880.61
B. cinerea + fungicide Brado	2869.44	2880.5	2873.70	2874.55
B. cinerea +*S. kanamyceticus* +Brado	3017.06	3022.9	3011.41	3017.12
S. kanamyceticus	3088.61	3128.7	3104.26	3107.19
Average of cultivars	2641.55	2661.17	2648.84	
L.S.D ($P_{0.05}$)	Treatments = 63.81 Cultivars = 55.09 Treatments × Cultivars = 73.60			

The results listed in Table (6) indicate the effectiveness of Streptomyces *kanamyceticus* strain Tikrit-5 on chitinase enzyme (units/ml) for three cultivars of eggplant. *S. kanamyceticus* with the Prado showed the highest activity of chitinase, which was 0.86 units/ml, with significant superiority compared to the plants of the control treatment, in which the activity of chitinase reached 0.03 units/ml. In terms of infection with the pathogenic fungus *B. cinerea*, the highest activity of chitinase was recorded in the *S. kanamyceticus* with fungicide Prado, which was 0.86 units / ml, followed by 0.79 units / ml in the *S. kanamyceticus* with the pathogenic fungi, then 0.45 units/ml in the treatment of pathogenic fungi only, compared to the lowest chitinase activity (0.22 units/ml) recorded in the pathogenic fungus with the fungicide Prado.

Among eggplant cultivars, the highest chitinase activity was 0.55 units / ml in Barcelona cultivar, while the interaction between the non-infected treatments with the pathogenic fungus, the Barcelona cultivar treated with *S. kanamyceticus* achieved the highest chitinase activity of 0.81 units/ml compared with the lowest activity 0.02 Unit/ml in Barcelona cultivar. On the other hand, interaction of treatments infected with the pathogenic fungus *B. cinerea*, it showed the highest chitinase acitivity was 0.96 units/ml in Barcelona cultivar treated with(*S. kanamyceticus* + Prado), compared with the lowest activity of 0.21 units/ml in Norita cultivar treated with pathogenic fungus and the fungicides prado.

Table (6) Effect of *S. kanamyceticus* strain Tikrit-5 on chitinase activity (u/ml) of three cultivars of eggplant under conditions of infection with the pathogenic fungus *B. cinerea*

Treatments	Eggplant cultivars			Average of treatments
	Norita	Barcelona	Nasir	
Control (healthy plants)	0.03	0.02	0.03	0.03
Pathogenic fungus *B. cinerea*	0.44	0.41	0.50	0.45
B. cinerea +*S. kanamyceticus*	0.69	0.87	0.82	0.79
B. cinerea + fungicide Brado	0.21	0.23	0.23	0.22
B. cinerea +*S. kanamyceticus* +Brado	0.73	0.96	0.88	0.86
S. kanamyceticus	0.65	0.81	0.77	0.74
Average of cultivars	0.46	0.55	0.54	
L.S.D ($P_{0.05}$)	Treatments = 0.12 Cultivars = 0.08 Treatments × Cultivars = 0.15			

Table (7) showed that the highest activity of Polyphenol oxidase (PPO) recorded in *S. kanamyceticus* with the fungicide Prado was 1.71 units/ml with a significant difference compared with 0.13 units/ml in the untreated plants. At the level of infection with the pathogenic fungus *B. cinerea*, *S. kanamyceticus* with the Prado achieved the highest activity of PPO, which reached 1.71 units/ml, compared with the lowest activity of 0.30 units/ml in pathogenic fungus with the fungicide Prado. Among the cultivars, the Barcelona showed the highest enzyme activity as it reached 1.07 units/ml, superior to the other cultivars. The interaction between treatments infected with the pathogenic fungus *B. cinerea* showed that *S. kanamyceticus* with the Prado in the Norita cultivar had the highest PPO activity of 1.74 units/ml compared with the lowest activity of 0.28 units/ml in Norita cultivar treated with the (pathogenic fungus + with the fungicide Prado).

Table (6) Effect of *S. kanamyceticus* strain Tikrit-5 on Polyphenol oxidase activity (u/ml) of three cultivars of eggplant under conditions of infection with the pathogenic fungus *B. cinerea*

Treatments	Eggplant cultivars			Average of treatments
	Norita	Barcelona	Nasir	
Control (healthy plants)	0.12	0.14	0.14	0.13
Pathogenic fungus *B. cinerea*	0.94	0.96	0.93	0.94
B. cinerea +*S. kanamyceticus*	1.63	1.66	1.58	1.62
B. cinerea + fungicide Brado	0.28	0.31	0.30	0.30
B. cinerea +*S. kanamyceticus* +Brado	1.74	1.73	1.66	1.71
S. kanamyceticus	1.22	1.30	1.27	1.26
Average of cultivars	0.99	1.07	0.98	
L.S.D ($P_{0.05}$)	Treatments = 0.11 Cultivars = 0.031 Treatments × Cultivars = 0.18			

Table (8) shows the effect of treatment with *Streptomyces kanamyceticus* strain Tikrit-5 on the activity of peroxidase (PO) for three eggplant cultivars. In the level of infection with the pathogenic fungus *B. cinerea*, *S. kanamyceticus* with the Prado showed the highest PO activity, which was 1.83 units/ml, compared with the lowest PO activity 0.34 units/ml in presence of pathogenic fungi with the fungicide Prado only, while at the level of cultivars, Barcelona cultivar showed higher PO activity as it reached 0.89 units/ml compared with other cultivars. In terms of interaction of treatments infected with the pathogenic fungus *B. cinerea*, the highest PO activity was 1.86 units/ml in Barcelona cultivar treated with *S. kanamyceticus* with Prado, compared with the lowest PO activity 0.31 units/ml recorded in the interaction of Norita cultivar treated with the pathogenic fungus and the fungicide Prado.

Table (8) Effect of *S. kanamyceticus* strain Tikrit-5 on Peroxiase activity (u/ml) of three cultivars of eggplant under conditions of infection with the pathogenic fungus *B. cinerea*

Treatments	Eggplant cultivars			Average of treatments
	Norita	Barcelona	Nasir	
Control (healthy plants)	0.10	0.11	0.11	0.11
Pathogenic fungus *B. cinerea*	0.56	0.58	0.58	0.57
B. cinerea +*S. kanamyceticus*	1.65	1.77	1.65	1.69
B. cinerea + fungicide Brado	0.31	0.37	0.33	0.34
B. cinerea +*S. kanamyceticus* +Brado	1.81	1.86	1.81	1.83
S. kanamyceticus	0.60	0.67	0.63	0.63
Average of cultivars	0.84	0.89	0.85	
L.S.D ($P_{0.05}$)	Treatments = 0.14 Cultivars = 0.02 Treatments × Cultivars = 0.18			

Table (9) showed that the highest activity of β-glucanase was recorded in plants treated with *S. kanamyceticus* with the Prado, as the activity was 0.93 units/ml with a significant superiority compared to the non-treated plants (control), which reached to 0.01 units / ml, At the level of infection with the pathogenic fungus *B.cinerea*, *S. kanamyceticus* with the Prado achieved the highest β-glucanase activity, which reached 0.93 units/ml, followed by 0.87 units/ml in the *S. kanamyceticus* with the pathogenic fungus only, compared with the lowest β-glucanase activity of 0.15 units/ml in the pathogenic fungus with the fungicide. Among the cultivars, Barcelona cultivar showed the highest

β-glucanase activity of 0.56 units/ml compared to the other cultivars. The interaction between the treatments infected with the pathogenic fungus and its cultivars showed that Barcelona cultivar treated with (*S. kanamyceticus* + Prado) had the highest enzyme activity of 1 unit/ml compared with the lowest activity of 0.13 units/ml in Norita cultivar treated with the (pathogenic fungus + Prado).
Table (10) shows the plant's reaction to the infection severity with the pathogenic fungus *B. cinerea*. All treatments with S. *kanamyceticus* showed significant superiority in lowering of infection severity compared to the pathogenic fungus treatment only. The lowest infection severity was 21.23 in Barcelona cultivar treated with *S. kanamyceticus* with the Prado in presence of the pathogenic fungus, compared with the 80.06% in Norita cultivar treated with pathogenic fungus only.

Table (9) Effect of *S. kanamyceticus* strain Tikrit-5 on β-glucanase activity (u/ml) of three cultivars of eggplant under conditions of infection with the pathogenic fungus *B. cinerea*

Treatments	Eggplant cultivars			Average of treatments
	Norita	Barcelona	Nasir	
Control (healthy plants)	0.01	0.01	0.01	0.01
Pathogenic fungus *B. cinerea*	0.53	0.53	0.52	0.53
B. cinerea +*S. kanamyceticus*	0.89	0.88	0.84	0.87
B. cinerea + fungicide Brado	0.13	0.16	0.17	0.15
B. cinerea +*S. kanamyceticus* +Brado	0.92	1	0.87	0.93
S. kanamyceticus	0.78	0.78	0.74	0.77
Average of cultivars	0.54	0.56	0.53	
L.S.D ($P_{0.05}$)	Treatments = 0.07 Cultivars = 0.05 Treatments × Cultivars = 0.10			

Table (10) Effect of *S. kanamyceticus* strain Tikrit-5 on the infection severity (%) of three cultivars of eggplant under conditions of infection with the pathogenic fungus *B. cinerea*

Treatments	Eggplant cultivars			Average of treatments
	Norita	Barcelona	Nasir	
Control (healthy plants)	0	0	0	0
Pathogenic fungus *B. cinerea*	80.06	74.13	77.72	77.30
B. cinerea +*S. kanamyceticus*	30.04	27.06	28.71	28.60
B. cinerea + fungicide Brado	29.50	26.34	28.33	28.06
B. cinerea +*S. kanamyceticus* +Brado	24.66	21.23	22.74	22.88
S. kanamyceticus	0	0	0	0
Average of cultivars	27.38	24.79	26.25	
L.S.D ($P_{0.05}$)	Treatments = 4.28 Cultivars = 1.21 Treatments × Cultivars = 4.55			

Through the results listed in Table (11), it is clear that the highest fruit production of eggplant was recorded in plants treated with *S. kanamyceticus*, where the production reached 601.28 g/plant, with significant superiority compared to non-treated plants, as the fruit production reached 586.94 g/plant. Under the conditions of infection with the pathogenic fungus *B.cinerea*, *S. kanamyceticus* with the fungicide Prado showed the highest yield of 582.94 g/plant with significant superiority compared to other treatments infected with the pathogenic fungus. At the level of eggplant cultivars, Barcelona cultivar significantly outperformed the other cultivars as the yield reached 536.81 gm/plant, while in terms of interaction of un-infected treatments with the pathogenic fungus *B. cinerea*, Barcelona cultivar treated with *S. kanamyceticus* achieved the highest yield of 607.21 gm/plant compared with the lowest production 580.16 g/plant in the control treatment of Norita cultivar. The interaction of treatments infected with the pathogenic fungus *B. cinerea,* Barcelona cultivar treated with (*S. kanamyceticus* + Prado), showed a higher yield of 588.80 g/plant compared with the lowest yield of 300.18 and 301.41 g/plant in the cultivars Nasr and Norita, treated with pathogenic fungi, respectively.

Table (11) Effect of *S. kanamyceticus* strain Tikrit-5 on the fruit weight (g/ plant) **of three cultivars of eggplant under conditions of infection with the pathogenic fungus *B. cinerea***

Treatments	Eggplant cultivars			Average of treatments
	Norita	Barcelona	Nasir	
Control (healthy plants)	580.16	593.11	587.54	586.94
Pathogenic fungus *B. cinerea*	301.41	307.22	300.18	302.94
B. cinerea +*S. kanamyceticus*	547.81	561.08	555.63	554.84
B. cinerea + fungicide Brado	550.76	563.44	558.90	557.7
B. cinerea +*S. kanamyceticus* +Brado	577.06	588.80	582.95	582.94
S. kanamyceticus	593.13	607.21	603.51	601.28
Average of cultivars	525.06	536.81	531.45	
L.S.D ($P_{0.05}$)	Treatments = 5.87 Cultivars = 4.15 Treatments × Cultivars = 6.34			

Table (12) showed the effect of *S. kanamyceticus* strain Tikrit-5 on the hardness of eggplant fruits. *S. Kanamyceticus* in the un-infected plants showed the highest hardness of 4.43 kg/cm^2 with significant superiority compared with the untreated plants. At the level of infection with the pathogenic fungus, (*S. kanamyceticus* + Prado) showed the highest hardiness of 3.6 kg / cm^2 compared with the lowest fruit hardness of 2.87 kg / cm^2 in the treatment of the pathogenic fungus only. Among the cultivars, Barcelona achieved the highest rate of fruit hardness, reaching 3.75 kg/cm^2 compared to other cultivars. The interaction of treatments infected with the *B.cinerea* showed that (*S. kanamyceticus* + Prado) showed the highest hardness value of 3.8 kg / cm^2 compared with the lowest hardness 2.8 kg / cm^2 in both Norita and Nasr cultivars treated with pathogenic fungus only.

The results of increase plant height by *S. kanamyceticus* strain Tikrit-5 agree with EL-Shatoury *et al*. (2020), when they indicated that bean plants treated with *Streptomyces* isolates (St 1 Met, St 2 Met) increased plant height, as the highest height in plants treated with St 2 Met was 111.6 cm. compared with the control treatment, which had an average height of 86 cm. our results also confirmed by Djebaili *et al*. (2021), who indicated the shoot length of tomato plants increased when treated with *Streptomyces albidoflavus* H12 and *Nocardiopsis aegyptica* H14 at a rate of 10.71 cm compared with 7.71 cm in the control . The results of increase dry weight of the eggplant by *S. kanamyceticus* strain Tikrit-5 agreed with EL-Shatoury *et al*. (2020), as they noticed an increase in the dry weight of bean plants infected with gray rot disease caused by the pathogenic fungus *B. cinerea* when using *Streptomyces* isolates (St 1 Met, St 2 Met) by 12.3 g for St 1 Met strain and 18.9

g for St 2 Met strain compared with plants treated with water only, as the dry weight was 10.5 g. The same study confirmed that the secondary metabolites resulting from the isolate of *Streptomyces* (St 2 Met) considered as factors promoting plant growth, the dry weight of the plant was 80% higher after St 2 Met spray treatment, compared to healthy plants (not infected with the pathogenic fungus *B. cinerea*). At the level of increasing leaf area, our results showed that the strain *S. kanamyceticus* strain Tikrit-5 with the fungicide Prado achieved the highest rate of leaf area in eggplant. These results agree with study of Djebaili *et al*. (2021) which showed the highest leaf area in tomato plants treated with *Streptomyces albidoflavus* H12 and *Nocardiopsis aegyptica* H14.

Table (12) Effect of *S. kanamyceticus* strain Tikrit-5 on the fruit hardness (kg/cm^2) of three cultivars of eggplant under conditions of infection with the pathogenic fungus *B. cinerea*

Treatments	Eggplant cultivars			Average of treatments
	Norita	Barcelona	Nasir	
Control (healthy plants)	3.8	4.2	4.0	4
Pathogenic fungus *B. cinerea*	2.8	3.0	2.8	2.87
B. cinerea +*S. kanamyceticus*	3.1	3.6	3.3	3.33
B. cinerea + fungicide Brado	3.0	3.4	3.2	3.2
B. cinerea +*S. kanamyceticus* +Brado	3.4	3.8	3.6	3.6
S. kanamyceticus	4.3	4.5	4.5	4.43
Average of cultivars	3.4	3.75	3.57	
L.S.D ($P_{0.05}$)	Treatments = 0.33 Cultivars = 0.31 Treatments × Cultivars = 0.37			

On the level of plant stimulation to develop resistance, treatment of *S. kanamyceticus* with the fungicide Prado showed the highest rate of chitinase and beta-glucanase activities. These results agreed with study of Medina and Martinze, (2011) that indicated the strain (H7602) of *Streptomyces griseus* has a biological effect against pathogenic fungus *Phytophthora capsici*, (caused of pepper blight), by inducing systemic resistance in the plant and reduced infection by 47%. This vital activity is due to an increase in chitinase activity. These results agreed with Shekhar *et al*. (2006) who noticed that the *Streptomyces violaceusniger* has a high antagonistic activity against the fungi *Phanerochaete chrysosporium*, *Postia placenta*, *Coriolus versicolor* and *Gloeophyllum trabeum*, this activity is due to the increase in the chitinase activity secreted by *Streptomyces violaceusniger*. These results are consistent with Lahmyed *et al*. (2021) who stated that Actinomycetes strains have the ability to produce the enzyme β-glucanase ranged between 1.4--17 units/ml. Gonzalez *et al*. (2003) indicated that β-glucanase produced by Actinomycetes which often used in biological control processes and in the manufacture of biocides. It was also noted that there are indirect mechanisms of *Streptomyces* sp. that stimulate systemic resistance in plants against plant pathogens. *Streptomyces* spp. improved the plant's defense mechanisms (Schrey and Tarkk, 2008).

İn severity of infection, the treatment of *S. kanamyceticus* with the fungicide Prado showed the highest effect on the pathogenic fungus *B. cinerea*, this result agreed with Yang *et al*., (2021), as they noticed that rice plants infected with blight caused by the pathogenic fungus *Rhizoctonia solani* when treated with the *Streptomyces padanus* PMS-702 reduced disease severity to 20% compared to 65% in untreated plants. Fan *et al*. (2019) reported that the severity of infection with the pathogenic fungus *Pseudoperonospora cubensis* that causes downy mildew in cucumber plant is inversely proportional to the antibiotic fungichromin, as the infection severity decreases with the increase in the concentration of the antibiotic fungichromin produced by *Streptomyces padanus* PMS-702 used against the pathogenic fungus, in 5 g/mlµ of fungichromin, infection severity was 100%, then decreased to 0% when used at 10 g/mlµ of fungichromin. The most important role of the antibiotic Fungichromin produced by *Streptomyces* spp. affects the membrane-bound ergosterol present in phytopathogenic fungi, which leads to its breakdown, leaching of the contents of the cell and death (Baginski, Czub *et al*. 2006). Zhang, Yang *et al*. (2020) confirmed that antifungalmycin N2 produced by *Streptomyces* sp. N2 plays an important role in inducing the rice plant to activate catalase and peroxidase to combat the disease of rice colostrum blight caused by the pathogenic fungus *Rhizoctonia solani*, due to this antibiotic, the infection rate in plants decreased from 65.21% to 26.02%. *S. kanamyceticus* with the fungicide Prado achieved the highest rate of productivity (fruit weight), these results are consistent with study of Qi *et al*., (2019) that showed most of the *Streptomyces* strains produce secondary metabolites such as antibiotics, antioxidants, or plant growth promoters. In addition, the field test conducted on the strawberry inoculated with the pathogen *B. cinerea* showed that the volatile organic compounds (VOCs) produced by *Streptomyces* S97 prevented the symptoms of gray rot disease on strawberry by more than 87% compared to control, at the same time *Streptomyces* S97 led to increase in plant productivity (Ayed, Kalai-Grami *et al*. 2021).

CONCLUSION

The Iraqi local isolate, *S. kanamyceticus* strain Tikrit-5 , proved its role in control of the gray rot disease on eggplant caused by the fungus *Botrytis cinerea*. This isolate improved the plant's vegetative characteristics and productivity, as well as reducing the severity of infection with the pathogenic fungus by inducing systemic plant resistance and production of the antibiotic fungichromin.

CONFLICT OF INTEREST

The authors declare no conflicts of interest associated with this manuscript.

REFERENCES

Abbey, J. A., Percival, D., Abbey, L., Asiedu, S. K., Prithiviraj, B., and Schilder, A. (2019). Biofungicides as alternative to synthetic fungicide control of grey mould (*Botrytis cinerea*)–prospects and challenges. Biocontrol science and technology, 29(3), 207-228.

Aksoy, S. Ç., Uzel, A., and Bedir, E. (2016). Cytosine-type nucleosides from marine-derived *Streptomyces rochei* 06CM016. The Journal of Antibiotics, 69(1), 51-56.

Ayed, A., Kalai-Grami, L., Ben Slimene, I., Chaouachi, M., Mankai, H., Karkouch, I., & Limam, F. (2021). Antifungal activity of volatile organic compounds from *Streptomyces* sp. strain S97 against *Botrytis cinerea*. Biocontrol Science and Technology, 31(12), 1330-1348.

Baginski, M., Czub, J., & Sternal, K. (2006). Interaction of amphotericin B and its selected derivatives with membranes: molecular modeling studies. The Chemical Record, 6(6), 320-332.

Boddy, L. (2016). Pathogens of autotrophs. In The fungi (pp. 245-292). Academic Press.

Bubici, G. (2018). *Streptomyces* spp. as biocontrol agents against *Fusarium* species. CAB Rev, 13, 050.

Cardoso, M. O., de Oliveira, A. P., Pereira, W. E., and de Souza, A. P. (2009). Growth, nutrition and yield of eggplant as affected by doses of cattle manure and magnesium thermophosphate plus cow urine. Horticultura Brasileira, 27(3), 307-313.

Central Agency for Statistics and Information Technology.2020. Production of secondary crops and vegetables. Periodical Bulletin. Iraqi Statistics Directorate. Ministry of Planning and Development Cooperation. The Republic of Iraq.

Collins, C. H., Lyne, P. M., and Granje J M (1995) Microbiological methods pp 129–31.

Compant, S., Duffy, B., Nowak, J., Clément, C., and Barka, E. A. (2005). Use of plant growth-promoting bacteria for biocontrol of plant diseases: principles, mechanisms of action, and future prospects. Applied and environmental microbiology, 71(9), 4951-4959.

Decognet, V., Bardin, M., Trottin-Caudal, Y., and Nicot, P. C. (2009). Rapid change in the genetic diversity of *Botrytis cinerea* populations after the introduction of strains in a tomato glasshouse. Phytopathology, 99(2), 185-193.

Djebaili, R., Pellegrini, M., Ercole, C., Farda, B., Kitouni, M., and Del Gallo, M. (2021). Biocontrol of Soil-Borne Pathogens of *Solanum lycopersicum* L. and *Daucus carota* L. by Plant Growth-Promoting Actinomycetes: In Vitro and In Planta Antagonistic Activity. Pathogens, 10(10), 1305.

El-Shatoury, S. A., Ameen, F., Moussa, H., Wahid, O. A., Dewedar, A., and AlNadhari, S. (2020). Biocontrol of chocolate spot disease (*Botrytis cinerea*) in faba bean using endophytic Actinomycetes *Streptomyces*: a field study to compare application techniques. PeerJ, 8, e8582.

Fan, Y. T., Chung, K. R., and Huang, J. W. (2019). Fungichromin production by *Streptomyces padanus* PMS-702 for controlling cucumber downy mildew. The plant pathology journal, 35(4), 341.

Francis, R., and Keinath, A. (2010). Biofungicides and chemicals for managing diseases in organic vegetable production. CLEMSON Cooperative extension. Information leaflet, 88.

Freeman, S., Minz, D., Kolesnik, I., Barbul, O., Zveibil, A., Maymon, M., and Elad, Y. (2004). *Trichoderma* biocontrol of *Colletotrichum acutatum* and *Botrytis cinerea* and survival in strawberry. European Journal of Plant Pathology, 110(4), 361-370.

Gao, H., Beckman, C. H., and Mueller, W. C. (1995). The rate of vascular colonization as a measure of the genotypic interaction between various cultivars of tomato and various formae or races of *Fusarium oxysporum*. Physiological and Molecular Plant Pathology, 46(1), 29-43.

Gopalan, C., Sastri, B. R., and Balasubramanian, S. (2007). Nutritive Value of Indian Foods of brinjal. *Solanum melongena*.

Gonzalez-Franco, A. C., Deobald, L. A., Spivak, A., and Crawford, D. L. (2003). Actino lates. Canadian Journal of Microbiology, 49(11), 683-698.bacterial chitinase-like enzymes: profiles of rhizosphere versus non-rhizosphere iso

Hassan, A. A., and Mahmoud, A. F. (2022). Isolation, Phenotypic and Molecular Identification of Actinomycetes from Soil and Evaluation of Their Efficiency in Control of the Pathogen *Botrytis cinerea* Caused Gray Rot Disease on Eggplant. Third International Scientific Conference of Agriculture, Environment and Sustainable Development. IOP Conference; Earth and Environmental Science. 1060 (2022) 012108. doi:10.1088/1755-1315/1060/1/012108.

HG, A. E. G., and Osman, H. S. (2014). Effect of exogenous application of boric acid and seaweed extract on growth, biochemical content and yield of eggplant. Journal of Horticultural Science & Ornamental Plants.

Hussein, W. A., and Muhammed, M. M. (2017). The response of white eggplant plants to foliar application with boron and potassium silicate. Assiut J. Agric. Sci, 48(1), 394-401.

Hussain, J., Rehman, N. U., Khan, A. L., Hamayun, M., Hussain, S. M., and Shinwari, Z. K. (2010). Proximate and essential nutrients evaluation of selected vegetables species from Kohat region, Pakistan. Pak. J. bot, 42(4), 2847-2855.

Lahmyed, H., Bouharroud, R., Qessaoui, R., Ajerrar, A., Amarraque, A., Aboulhassan, M. A., and Chebli, B. (2021). Actinomycete as biocontrol agents against tomato gray mold disease caused by *Botrytis cinerea*. Kuwait Journal of Science, 48(3), 1-8.

Luthria, D. L. (2007). Phenolic compounds analysis in foods and dietary supplements is not the same using different sample preparation procedures. In *II* International Symposium on Human Health Effects of Fruits and Vegetables: Favhealth. 841: 381-388.

Mahadevan, A. and Sridhar, R. (1986). Methods in physiological plant pathology. Sivakami publications, lndira nagar, India.

McKinney, H. H. (1923). Influence of soil temperature and moisture on infestation of wheat seedlings by helmin. Journal of agricultural research, 26, 195.

Medina Cuevas, H. M., and Martínez, Z. E. (2011). Aislamiento y búsqueda de actinobacterias Del suelo productoras de enzimas extracelulares y compuestos con actividad antimicrobiana. UNACAR tecnociencia, (1), 72-94.

Mosbach, A., Leroch, M., Mendgen, K. W., and Hahn, M. (2011). Lack of evidence for a role of hydrophobins in conferring surface hydrophobicity to conidia and hyphae of *Botrytis cinerea*. BMC microbiology, 11(1), 1-14.

Mouekouba, L. D. O., Zhang, Z., Olajide, E. K., Wang, A., and Wang, A. (2013). Biological control of *Botrytis cinerea* in tomato leaves. International Proceedings of Chemical, Biological and Environmental Engineering (IPCBEE), 60, 64-68.

Qessaoui, R., Bouharroud, R., Furze, J. N., El Aalaoui, M., Akroud, H., Amarraque, A., and Chebli, B. (2019). Applications of new rhizobacteria *Pseudomonas* isolates in agroecology via fundamental processes complementing plant growth. Scientific reports, 9(1), 1-10.

Qi, D., Zou, L., Zhou, D., Chen, Y., GAO, Z., Feng, R., and Wang, W. (2019). Taxonomy and broad-spectrum antifungal activity of *Streptomyces* sp. SCA3-4 isolated from rhizosphere soil of Opuntia stricta. Frontiers in microbiology, 1390.

Schrey, S. D., and Tarkka, M. T. (2008). *streptomycetes* as modulators of plant disease and symbiosis. Antonie Van Leeuwenhoek, 94(1), 11-19.

Shekhar, N., Bhattacharya, D., Kumar, D., and Gupta, R. K. (2006). Biocontrol of wood-rotting fungi with *Streptomyces violaceusniger* XL-2. Canadian journal of microbiology, 52(9), 805-808.

Shishido, M. (2011). Plant disease management in protected horticulture. Horticulture Research, 65, 7-18.

Suganiya, S., and Kumuthini, D. H. (2014). Effect of Boron on flower and fruit setting, and yield of ratoon Brinjal crop.

Tweddell, R. J., Jabaji-Hare, S. H., and Charest, P. M. (1994). Production of chitinases and β-1, 3-glucanases by Stachybotrys elegans, a mycoparasite of *Rhizoctonia solani*. Applied and Environmental Microbiology, 60(2), 489-495.

Wallace, D. H., and Munger, H. M. (1965). Studies of the physiological basis for yield differences. I. Growth analysis of six dry bean varieties 1. Crop Science, 5(4), 343-348.

Yang, C. J., Huang, T. P., and Huang, J. W. (2021). Field Sanitation and Foliar Application of *Streptomyces padanus* PMS-702 for the Control of Rice Sheath Blight. The plant pathology journal, 37(1), 57.

Yuan, W. M., and Crawford, D. L. (1995). Characterization of *Streptomyces lydicus* WYEC108 as a potential biocontrol agent against fungal root and seed rots. Applied and Environmental Microbiology, 61(8), 3119-3128.

Zhang, S. W., Yang, Y., Wu, Z. M., & Li, K. T. (2020). Induced defense responses against *Rhizoctonia solani* in rice seedling by a novel antifungalmycin N2 from *Streptomyces* sp. N2. Australasian Plant Pathology, 49(3), 267-276.