Effect of Silicon, Sulfates, and Bacterial Isolates on Protease Enzyme Activity and Gray Mold Resistance of Eggplant Plants

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Abstract

Gray mold disease caused by *Botrytis cinerea* is an important fungal disease that can negatively affect the growth and productivity of eggplant plants. In the present study the efficacy of potassium silicate, potassium sulfate and three isolates of beneficial bacteria in individual, and their combination, was tested on the effect on gray mold disease, protease enzyme activity and growth parameters of eggplant plants. The experiment was carried out in the greenhouse with eggplant cultivar (P.K.111) and 17 treatments such as individual treatments, combined treatments, fungicide treatment and positive and negative control. The incidence and severity of disease were determined during three consecutive weeks after inoculation with *B. cinerea* and protease activity and root growth characteristics were also investigated.The results indicated a progressive increase in disease incidence for the positive control (65% for first week, 92% for second week, and 98% for third week) and disease severity (40% to 67.33% for second and third weeks, respectively). Of the single bacterial treatments, Bacterial *Pantoea agglomerans* as the most effective in reducing disease development. The combined treatment of Potassium sulfate + Potassium silicate was the most effective non-chemical treatment, as it suppressed disease incidence and severity to 18% and 8% respectively in the first week, 40% and 25% respectively in the second week and 45% and 30% respectively in the third week. In the third week, the fungicide treatment recorded the lowest disease incidence and severity with 40% and 25%, respectively, of the infected treatments.

There were also significant differences between treatments in protease enzyme activity. The latter resulted in the highest activity (1.483) followed by the same treatments with Bacterial isolates 2 and 3 with activities 1.410 and 1.387, respectively while the negative control recorded the lowest (0.637). Potassium silicate alone gave the highest root dry weight (39.366 g) and potassium sulfate + potassium silicate + Bacterial isolate 2 gave the highest root fresh weight (45.922 g).

Overall, the findings indicate that the integration of silicon, sulfate, and beneficial bacterial isolates, particularly Bacterial isolate 2, has potential as a component of an integrated management strategy for gray mold disease in eggplant. The combined treatments reduced disease development and, in some cases, improved root growth and protease activity, supporting their potential as sustainable alternatives or complementary approaches to chemical disease control.

Keywords: Eggplant; Gray mold; Botrytis cinerea; Bacterial isolates; Biological control; Vegetative growth.

Introduction

Eggplant (***Solanum melongena*** L.) is a highly valuable vegetable crop with a number of fungal diseases. Of these, Botrytis cinerea is responsible for gray mold disease which may affect plant growth, fruit quality and yield. So it is crucial to find effective and sustainable ways in which to manage diseases [1, 2].

Silicon is a beneficial element which can be used to enhance plant resistance to biotic and abiotic stresses. It also enhances physiological and biochemical defense mechanisms, depositions of silica, and strengthening of structural barriers which increases the resistance of plants against fungal pathogens [3, 4]. In addition, silicon might improve plant defense responses and decrease pathogen development inside the plant tissues [5, 6].

Beneficial bacterial isolates, especially plant growth promoting rhizobacteria (PGPR) play significant role in biological disease control. They can suppress plant pathogens by producing antimicrobial compounds, competing with the pathogens, and stimulating plant defense mechanisms. Bacillus spp. Have been found to be effective against B. Cinerea [7, 8]. Trichoderma spp. Has also been shown to have potential in the control of grey mold and shelf life of infected fruits [9].

Promising is the use of the mixture of silicon and beneficial microorganisms as a strategy for sustainable plant disease management. They could improve plant defences and lower disease severity, but could also lower the amount of chemical pesticides required [10, 11]. To effectively manage Botrytis disease, it is necessary to combine several biological, nutritional and chemical strategies [12].Protease is an essential enzyme in plant defense response and protein metabolism. Its activity may vary as a result of physiological and biochemical reactions of plants to pathogen infection and treatments that induce resistance. Among the different treatments, the Sulphate + Silica + Bacteria 1 recorded the highest protease activity (1.483), followed by Sulphate + Silica + Bacteria 2 (1.410) and Sulphate + Silica + Bacteria 3 (1.387) while the negative control showed the lowest protease activity (0.637).

The enhanced plant physiological and defence reactions induced by the bacterial isolates, silicon and sulphate could be linked to the increases in protease activity seen in the combined treatments. Hence, the present study is designed to determine the activity of the protease enzyme and resistance of eggplant against gray mold disease due to different concentrations of silica, sulphate and bacterial isolates, and to assess their sustainability as disease management tools in eggplant.

Material and Methods

Study Location

The study was carried out in the laboratories and greenhouse of the Department of Plant Protection, College of Agriculture, University of Tikrit during the agricultural season used for the experiment. In this study, the preparation of the fungal isolate and the bacterial isolates, the treatments and their evaluation in the greenhouse were all carried out.

Plant Material

The seeds of eggplant cultivar PK-111 were used. The seeds were planted in peat moss and at the four leaf stage transplanted to plastic pots (7 kg capacity) containing the experimental soil. Irrigation and other agricultural activities were standardized as much as possible and the period for acclimatization of plants was sufficient before the treatments were applied.

Pathogenic Fungal Isolate

Botrytis cinerea fungal isolate procured from the Department of Plant Protection, College of Agriculture, University of Basra was used. The isolate was also molecularly identified with the region called ITS and is deposited in GenBank with the accession number PZ520500.1. Fungal isolate was first re-activated on the appropriate culture medium prior PDA to its use for inoculation.

Bacterial Isolates

Three molecularly identified bacterial isolates were used:

1. *Pseudomonas fluorescens*
2. *Pantoea agglomerans*
3. *Bacillus cereus*

The bacterial isolates were reactivated before preparing the suspensions required for treatment application, and their purity was confirmed before use.

` Experimental Treatments

17 treatments (T1–T17) were used in thefield experiment. The negative control (T1) was distilled water and the T2 and T3 treatments were potassium silicate at 5 mL/250 mL water and potassium sulfate at 3 g/250 mL water respectively. The treatments (T4–T6) were bacterial isolate *Pseudomonas fluorescens Bacillus cereus* respectively atThe bacterial suspensions were prepared by transferring the bacterial growth from the culture plates into sterile distilled water. The prepared bacterial suspensions were used in the field experiment at a rate of 10 mL per 250 mL of water.

The bacterial isolates 1, 2, and 3 were used in the treatments T7, T8, and T9, which were *Solanum melongena* L treated with potassium silicate and bacterial isolate *Pseudomonas fluorescens,pantoea agglomerans ,Bacillus* cereus respectively, and T10, T11, and T12, which were potato plants treated with potassium sulfate and bacterial isolate *Pseudomonas fluorescens,pantoea agglomerans ,Bacillus* cereus respectively. The combined application of potassium silicate and potassium sulfate along with bacterial isolate *Pseudomonas fluorescens,pantoea agglomerans ,Bacillus cereus* were treated as T13, T14 and T15 respectively as per their concentration in the experiment. T16 was the fungicide treated with 0.25 mL/250 mL water of Ortiva Top 325 SC, while T17 was the positive control, in which the plants were inoculated with the pathogen without any treatment.

Inoculation with the Pathogen

Botryti cinerea was artificially inoculated into eggplant plants at the four-to five-true-leaf stage appropriate age for infection. Small superficial wound was created with a sterile scalpel on the plant stem and a 5 mm diameter fungal disc cut from the growing margin of a 7 – 10 days old fungal colony was introduced onto the wounded position of the plant stem. The disc was glued with sterile Parafilm so that it was in direct contact with the plant tissue. Transparent polyethylene bags then were placed over the plants for 48 hours to keep the high humidity necessary for successful infection. The plant covers were then taken off and the plants were left growing in the greenhouse until disease symptoms appeared. The assessment of the disease was then started based on the evaluation dates as indicated in the experiment.

Assessment of Disease Incidence

Disease incidence was calculated using the following equation:

Disease incidence (%) = (Number of infected plant units ÷ Total number of examined plant units) × 100Disease incidence was evaluated over three consecutive weeks after inoculation.

Assessment of Disease Severity

Disease severity was assessed using a disease rating scale. The scores were then converted into percentages using the McKinney equation:

The disease rating scale actually used in the experiment should be included in the final version submitted to the journal.x"Number of infected plant xDisease rating " /(Total number of plant x \maximum disease rating) x 100 % Disease Severity (%)

This method allows quantitative measurement of infection intensity, providing a standardized approach for comparison among different treatments.

The following describes the disease severity rating scale adopted for this purpose :

Disease Severity Disease Rating

x

$$\frac{\textbf{Number of infected plant xDisease rating}}{\text{Total number of plant x \maximum disease rating}} \text{ x } \textbf{100 \%} \text{ Disease Severity (\%)}$$

This method allows quantitative measurement of infection intensity, providing a standardized approach for comparison among different treatments.

The following describes the disease severity rating scale adopted for this purpose :

Disease Rating	Disease Severity
0	No infection
1	Infection ranging from 1–10%
2	Infection ranging from 11–25%
3	Infection ranging from 26–50%
4	Infection ranging from 51–75%
5	Infection ranging from 76–100%
6	Plant death

Assessment of Vegetative Growth Traits

A. Protease Enzyme Activity

The protease enzyme activity of the eggplant plant tissues was measured to assess the plant's resistance to the plant growth and development to different experimental treatments. The obtained values of enzyme activity was followed to record the resultsProtease activity was determined using the azocasein method. Briefly, 0.1 mL of crude enzyme extract was mixed with 0.2 mL of 1% azocasein and incubated at 30°C for 30 min. The reaction was stopped by adding 0.4 mL of 10% trichloroacetic acid (TCA). After 10 min, the mixture was centrifuged at 4000 rpm for 5 min. The supernatant was then mixed with an equal volume of 1 M NaOH, and the absorbance was measured at 440 nm using a spectrophotometer. Enzyme activity was expressed as U/g fresh weight (FW), according to Krasuska et al. (2016).

B.The fresh weight of B. Root.

Root system of eggplant plants was brought up and carefully separated from soil. The root fresh weight was determined by removing the soil from the root and weighing the roots immediately. The results were noted in grams (g).

C. Root Dry Weight

Root samples were first weighed for root fresh weight then dried under the experimental conditions to a constant weight. The dried roots were then weighed to determine the root dry weight. The data presented in grams (g)

Statistical Analysis

The data were statistically analyzed according to the Randomized Complete Block Design (RCBD). Analysis of variance (ANOVA) was used to detect differences among treatments, and the treatment means were compared using the Least Significant Difference (LSD) test at a probability level of 0.05.

Results and Discussion

Disease Incidence and Severity during the First Week

The results presented in the table indicated that the positive control (Positive Control) had the highest disease incidence (65%) and disease severity (40%), while the negative control (Negative Control) had no disease incidence and disease severity. This indicates that the infection has been established and that the gray mold disease is still developing in the untreated plants.

When applied individually, the best performance was recorded by Bacteria 2 that resulted in 35% disease incidence and 20% disease severity, whereas Bacteria 1 recorded 38% disease incidence and 22% disease severity, and Bacteria 3 had 42% and 25% data points, respectively.

The overall response to the combined treatments was more pronounced in terms of disease incidence and severity. The ج treatment Potassium sulfate + Potassium silicate + Bacteria 2 was the most effective treatment; 18% of the plants had disease incidence and 8% of plants had disease severity. The disease incidence and severity were 12% and 5% respectively after fungicide treatment, which was the lowest of treated plants.

LSD for the disease incidence at 5% probability level was 3.34 and for disease severity was 1.75, which can be used to establish whether the differences between the means of the various treatments are significant.

The higher disease incidence and severity in the positive control confirm the

successful establishment of gray mold, while the lower values in bacterial treatments indicate their potential to suppress Botrytis cinerea. Bacteria 2 showed the highest effectiveness, which may be related to its stronger antagonistic activity. The improved performance of Potassium sulfate + Potassium silicate + Bacteria 2 may result from a complementary effect that enhances plant defense. This agrees with Nieto-Angel et al. [11] and recent findings [12], which reported that potassium silicate can reduce B. cinerea infection and enhance disease resistance. The fungicide remained the most effective treatment during the first week

Table 1. Effect of the Treatments on Disease Incidence and Severity of Gray Mold Disease during the First Week

Disease Severity (%)	Disease Incidence (%)	**Treatment**
28	**45**	**Silica**
30	**50**	**Sulphate**
22	**38**	**Bacteria 1**
20	**35**	**Bacteria 2**
25	**42**	**Bacteria 3**
15	**30**	**Silica + Bacteria 1**
12	**25**	**Silica + Bacteria 2**

20	**35**	**Silica + Bacteria 3**
20	**35**	**Sulphate + Bacteria 1**
18	**32**	**Sulphate + Bacteria 2**
28	**48**	**Sulphate + Bacteria 3**
10	**22**	**Sulphate + Silica + Bacteria 1**
8	**18**	**Sulphate + Silica + Bacteria 2**
15	**28**	**Sulphate + Silica + Bacteria 3**
5	**12**	**With Pesticide**
0	**0**	**Negative Control**
40	**65**	**Positive Control**
1.75	**3.34**	LSD 5%

Disease Incidence and Severity during the Second Week

There were distinct differences among treatments in disease development during the second week as seen in the disease incidence and severity results presented in the table. The incidence of the disease in the positive control was the highest (92%) and the disease severity was also the highest (67.33%), showing that the disease was severe in the untreated plants. A negative control which had no disease incidence was found and the disease incidence and severity were at 0% in this case.Sulphate + Silica + Bacteria had the lowest disease incidence (40%) and disease severity (25%), followed by the Sulphate + Silica + Bacteria. *Pseudomonas fluorescens* with 45% disease incidence and 28% disease severity. This also resulted in a significant decrease in disease incidence (45%) and severity (30%) for the Silica + Bacteria *Bacillus cereus* treatment.The fungicide was effective in reducing disease incidence and severity as in the With Pesticide treatment, which had the lowest values of 35% and 22% respectively of the treatments which were exposed to infection.The individual treatments with Silica had 68% disease incidence and 50% disease severity, and Sulphate had the highest disease incidence among the individual treatments (72%) and 52% disease severity. With respect to the bacterial treatments, the disease incidence was in the range of 55–68% and the disease severity ranged from 35–50%. The lowest incidence of disease and severity (55% and 35%, respectively) were found for the bacterial isolate of bacteria 2.The LSD at the 5% probability level for disease incidence was 3.22 and for disease severity was 3.35, which means that means of disease incidence and disease severity levels showing values above the LSD are statistically different. However, accurate determination of all the pairs should take into account the original means and replicates. The increased disease incidence and severity during the second week indicate continued development of Botrytis cinerea, while the superior performance of Sulphate + Silica + Bacteria *Bacillus cereus* suggests a complementary effect that enhanced disease suppression. Similar effects of beneficial bacteria and potassium silicate against gray mold were reported previously [13,14].

Table 2. Effect of the Treatments on Disease Incidence and Severity during the Second Week

Disease Severity (%)	Disease Incidence (%)	**Treatment**
50	**68**	**Silica**
52	**72**	**Sulphate**
40	**60**	**Bacteria Pseudomonas**
35	**55**	**Bacteria*Pantoea agglomerans***
50	**68**	**Bacteria Bacillus cereus**
35	**50**	**Silica + Bacteria Pseudomonas**
30	**45**	**Silica + Bacteria *Pantoea agglomerans***
40	**60**	**Silica + Bacteria Bacillus cereus**
40	**60**	**Sulphate + Bacteria Pseudomonas**
35	**55**	**Sulphate + Bacteria *Pantoea agglomerans***
55	**72**	**Sulphate + Bacteria *Bacillus cereus***
28	**45**	**Sulphate + Silica + Bacteria 1**
25	**40**	**Sulphate + Silica + Bacteria 2**
35	**55**	**Sulphate + Silica + Bacteria 3**
22	**35**	**With Pesticide**
0	**0**	**Negative Control**
67.33	**92**	**Positive Control**
3.35	**3.22**	**LSD 5%**

DiseaseIncidenceandSeverityduringtheThirdWeek

Clear differences were detected among the treatments with regard to disease incidence and severity. The disease incidence (98%) and disease severity (82.67%) of the positive control (Positive Control) were the highest while that of the negative control (Negative Control) was 0%.The With Pesticide treatment treatment showed the lowest disease incidence (40%) and the lowest disease severity (25%) among the disease control treatments. This was followed by Sulphate + Silica + Bacteria 2 with 45% disease incidence and 30 % disease severity and then by Sulphate + Silica + Bacteria 1 with 50 % disease incidence and 35 % disease severity. Overall these results suggest that the treatment of bacterial isolates with silica and sulfate was the most effective treatment for reducing disease incidence and severity compared to most individual and binary treatments.The Sulphate + Silica + Bacteria 3 treatment was 60% disease incidence and 42% disease severity and the Silica + Bacteria 2 treatment was 52% disease incidence and 38% disease severity. The individual treatments had a greater amount of disease development. Sulphate had 82% disease incidence and 65% disease severity while Silica had 78%

disease incidence and 62% disease severity.

Bacteria 2 showed the lowest disease incidence (62%) and disease severity (45%) when compared with the other two bacteria, Bacteria 1 (68% disease incidence and 50% disease severity) and Bacteria 3 (80% disease incidence and 63% disease severity). The incidence and severity of disease was also reduced in the binary treatments when compared with the individual treatments, especially Silica + Bacteria 2.The LSD for 5% probability level was 3.12% for disease incidence and 3.13% for disease severity which means that means exceeding these values were significantly different at the 5% level. Overall, the results showed that the fungicide treatment and the Sulphate + Silica + Bacteria treatments, especially the treatments that include Bacteria 2, are the most effective in inhibiting the incidence and severity of the disease among other treatments. The increase in disease incidence and severity indicates continued progression of Botrytis cinerea, while the fungicide and Sulphate + Silica + Bacteria 2 treatments showed the highest effectiveness. The superior performance of Bacteria 2 in combination with silica and sulfate suggests a complementary effect in suppressing disease development, consistent with previous studies on bacterial biocontrol and potassium silicate against gray mold [15,16] .

Table 3. Effect of the Treatments on Disease Incidence and Severity during the Third Week

Disease Severity (%)	Disease Incidence (%)	Treatment
62	**78**	**Silica**
65	**82**	**Sulphate**
50	**68**	**Bacteria 1**
45	**62**	**Bacteria 2**
63	**80**	**Bacteria 3**
42	**58**	**Silica + Bacteria 1**
38	**52**	**Silica + Bacteria 2**
50	**68**	**Silica + Bacteria 3**
50	**68**	**Sulphate + Bacteria 1**
45	**62**	**Sulphate + Bacteria 2**
68	**82**	**Sulphate + Bacteria 3**
35	**50**	**Sulphate + Silica + Bacteria 1**
30	**45**	**Sulphate + Silica + Bacteria 2**
42	**60**	**Sulphate + Silica + Bacteria 3**
25	**40**	**With Pesticide**

0	**0**	**Negative Control**
82.67	**98**	**Positive Control**
3.13	**3.12**	**LSD 5%**

Effect of Different Treatments on Protease Enzyme Activity in Eggplant Plants

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The results presented in Table 4 indicated that the eggplant plants showed significant differences among the various treatments in terms of protease enzyme activity. Treatments Sulphate + Silica + Bacteria 1, Sulphate + Silica + Bacteria 2 and Sulphate + Silica + Bacteria 3 showed the highest protease activity, being 1.483, 1.410 and 1.387 respectively. Protease activity of Silica + Bacteria 1, Silica + Bacteria 2 and Silica + Bacteria 3 were found to be 1.357, 1.313 and 1.287 respectively.

The results for the individual treatments of Silica, Sulphate, Bacteria 1, Bacteria 2, and Bacteria 3 were 1.187, 0.980, 0.957, 0.927 and 0.913 respectively. The lowest protease activity was observed for the Without All (Negative Control) treatment with 0.637 as compared to the With Pesticide treatment (0.677). The value for the With Disease Only (Positive Control) treatment was 0.830. The LSD value was 0.014, which is significant, meaning that the difference between the treatment means is significant.The higher protease activity in the combined Sulphate + Silica + Bacteria treatments, particularly Bacteria 1, suggests that these treatments stimulated plant defense responses against Botrytis cinerea. The increased activity of defense-related enzymes following biotic and mineral treatments agrees with previous studies showing that beneficial bacteria and silicon can enhance enzymatic defense mechanisms in plants [17,18].

Table (4) Effect of Different Treatments on Protease Enzyme Activity in Eggplant Plants

Protease Activity	Treatment
1.187	Silica
0.980	Sulphate
0.957	Bacteria 1
0.927	Bacteria 2
0.913	Bacteria 3
1.357	Silica + Bacteria 1
1.313	Silica + Bacteria 2

1.287	Silica + Bacteria 3
1.267	Sulphate + Bacteria 1
1.243	Sulphate + Bacteria 2
1.227	Sulphate + Bacteria 3
1.483	Sulphate + Silica + Bacteria 1
1.410	Sulphate + Silica + Bacteria 2
1.387	Sulphate + Silica + Bacteria 3
0.677	With Pesticide
0.637	Without All (Negative Control)
0.830	With Disease Only (Positive Control)
0.014	LSD

Root Dry Weight (g)

Table (5) indicated that there were differences in root system of eggplant plants dry weight between the different treatments. The Least Significant Difference (LSD) value was 7.702 g. The Silica treatment produced the highest mean root dry weight of 39.366 g which was significantly higher than all the other treatments as the differences were greater than the LSD value, thus showing its significant superiority in increasing the root dry weight.The next one was the Silica + Bacteria 3 treatment with a mean of 21.605 g followed by Sulphate + Silica + Bacteria 2 with a mean of 19.047 g and Silica + Bacteria 2 with a mean of 17.901 g. The treatments Sulphate + Silica + Bacteria 3, Bacteria 1 and Sulphate + Bacteria 2 had mean values of 17.852g, 17.773g and 16.942g respectively.With Disease Only (Positive Control), the lowest root dry weight was observed with an average of 10.647 g while Sulphate + Bacteria 1 showed 11.782 g. The Pesticide and Negative Control (Without All) treatments were relatively similar with 12.760 and 12.713 g, respectively.The highest root dry weight was recorded with Silica (39.366 g), indicating that silicon strongly promoted root development, while the lowest value in the diseased control (10.647 g) suggests that Botrytis cinerea negatively affected root growth. Similar studies have reported that silicon application can enhance root growth and biomass accumulation under biotic stress [19,20].

The results suggested that the Silica treatment alone was most effective in enhancing root dry weight compared to other treatments, while disease infection alone resulted in the least root dry weight.

Table (5): Effect of Different Treatments on the Root Dry Weight of Eggplant Plants (g)

Root Dry Weight (g)	Treatment
39.366	Silica
15.938	Sulphate
17.773	Bacteria 1
16.547	Bacteria 2
13.786	Bacteria 3
13.648	Silica + Bacteria 1
17.901	Silica + Bacteria 2
21.605	Silica + Bacteria 3
11.782	Sulphate + Bacteria 1
16.942	Sulphate + Bacteria 2
16.019	Sulphate + Bacteria 3
15.615	Sulphate + Silica + Bacteria 1
19.047	Sulphate + Silica + Bacteria 2
17.852	Sulphate + Silica + Bacteria 3
12.760	With Pesticide
12.713	Without All (Negative Control)
10.647	With Disease Only (Positive Control)
7.702	LSD

Root Fresh Weight (g)

The results of the different treatment in the eggplant root fresh weight presented in Table (4-8) revealed that there was a significant difference among these treatments. The value of the least significant difference (LSD) at the 0.05 probability level was 7.318 g. The highest root RFW (45.922 g) was obtained from Sulphate + Silica + Bacteria 2 while the lowest root RFW (39.232 g) was obtained from Sulphate + Silica + Bacteria 3, followed by Silica + Bacteria 3 with 44.153 g.

The Bacteria 1 treatment had a root fresh weight of 34.447 g, while the Bacteria 2 treatment had a root fresh weight of 33.111 g, and the Silica treatment had a root fresh weight of 33.069 g. However, the lowest root fresh weight was obtained with the With Disease Only (Positive Control) which yielded 16.780 g, whereas, With Disease and All (Negative Control) yielded 21.550 g. The root fresh weight of With Pesticide treatment was 25.348 g.The highest root fresh weight was recorded with Sulphate + Silica + Bacteria 2 (45.922 g), indicating that the combined treatment

promoted root growth, whereas the lowest value in the diseased control (16.780 g) suggests that Botrytis cinerea negatively affected root development. Similar findings have shown that silicon and beneficial bacteria can improve root growth and plant biomass under pathogen stress [21,22].

Table 6 The remaining treatments recorded root fresh weight values ranging from 25.116 to 32.464 g, as shown in the table.

Root fresh weight (g)	Treatment
33.069	Silica
27.720	Sulphate
34.447	Bacteria 1
33.111	Bacteria 2
31.487	Bacteria 3
25.116	Silica + Bacteria 1
26.871	Silica + Bacteria 2
44.153	Silica + Bacteria 3
32.464	Sulphate + Bacteria 1
28.115	Sulphate + Bacteria 2
31.074	Sulphate + Bacteria 3
31.027	Sulphate + Silica + Bacteria 1
45.922	Sulphate + Silica + Bacteria 2
39.232	Sulphate + Silica + Bacteria 3
25.348	With Pesticide
21.550	Without All (Negative Control)
16.780	With Disease Only (Positive Control)
7.318	LSD (0.05)

Conclusion

- The effectiveness in reducing the severity and incidence of gray mold Botrytis cinerea disease in eggplant plants was different across the tested treatments
- The disease incidence and severity of positive control were found to be increasing with the passage of time and reached up to 65% and 40% in the first week, 92% and 67.33% in the second week and 98% and 82.67% in the third week, respectively.
- Of the individual bacterial treatments, Bacterial isolate 2 was most effective in reducing the

incidence and severity of disease over the three assessment periods.

- The combined treatment of potassium sulfate+potassium silicate+Bacterial isolate 2 was also the most effective non-chemical treatment with disease incidence and severity of 18% and 8% in the first week, 40% and 25% in second week and 45% and 30% in third week, respectively
- The fungicide treatment had the lowest incidence and severity of diseases recorded in the 3rd week (40% and 25% respectively) of the infected treatments.
- The 6th treatment showed significant differences in protease enzyme activity. The bacterial isolate 1 showed the highest activity (1.483) followed by bacterial isolate 2 (1.410); and negative control showed the lowest activity (0.637).
- Potassium silicate alone resulted in the highest root dry weight (39.366 g) and treatment of potassium sulfate + potassium silicate + Bacterial isolate 2 resulted the highest root fresh weight (45.922 g)
- Overall, the findings of this study indicate that silicon, sulfate and the bacterial isolates especially Bacterial isolate 2, could be integrated in an eggplant management program for gray mold disease.
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