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The Effects of Biological and Chemical Agents on the Management of Main Pests in Tomato Plant

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Abstract : **This laboratory study aimed to evaluate the efficiency of two biological agents *Beauveria bassiana* (Bals) and *Bacillus thuringiensis* (Kursaki) and four chemical pesticides Levo 2.4 SL, Aster 20 SL, Difuse 450 SC, and Matrixine Plus EC on four important main pests that infect tomato plants. The pests studied were whitefly *Bemisia tabaci* (Hemiptera: Aleyrodidae), Meyrick *Tuta absoluta* (Lepidoptera: Gelechiidae), Sulzer *Myzus persicae* (Hemiptera: Aphididae) and Koch *Tetranychus urticae* (Acari: Tetraanychidae). The results show that the pesticide Matrixine Plus recorded the highest average of mortality of both larval and adult stages of all four pests. The average of mortality for adults and larvae of whitefly were 96.67% and 86.67% respectively. The average of mortality for adults and larvae of Meyrick was 93.33% for both stages, while the percentages for adults and larvae of Sulzer and Kotch were 96.67% respectively after seven days of exposure. The lowest averages of mortality were recorded for Antario on whitefly adults and for Difuse on whitefly (both (16.67%). Difuse caused the lowest average of mortality (26.67%) on Meyrick adults, whereas Antario caused the lowest average of mortality of 20% on Meyrick larvae. The results show also that Antario caused the lowest average of mortality of 23.33% on adults and 16.67% on larvae. Similarly, Difuse was recorded the lowest average of 20% on adults while Antario caused the lowest average of mortality of 26.67% on larvae after one day of treatment.**

***Keywords*: Lycopersicon esculentum; Beauveria bassiana; Antario; Matrixine Plus; Aster pest; mortality.**

I. Introduction

Tomato (*Lycopersicon esculentum* Mill.) belongs to the Solanaceae family. The species originated form the western coastal part of the South American continent. Tomato plant is one of the most economically important vegetable crops globally due to its high nutritional value [1]. In 2018, Iraq's production of tomato crop was around 467.600 thousand tons. The total production of Basra city was 239.800 thousand tons that put the city in the first place with 51.3% of the total production in Iraq [2]. Various agricultural pests infect the plant during their growing season such as the whitefly insect *Bemisia tabaci* (*B. tabaci*), the tomato leaf miner *Tuta absoluta* (*T. absoluta*), the green peach aphids *Myzus persicae* (*M. persicae*) and the red spider mite *Tetranychus urticae* (*T. urticae*) [3]. Chemical pesticides have been widely used to control these pests. However, it has been found that such control can cause undesirable consequences such as the rapid development of the resistance of large numbers of pesticide including organophosphates, carbamates and pyrethroid. Despite, the negative impact of pesticides on farming, it has a crucial role in controlling pests and increasing crop yields. Thus, it is necessary to develop mechanism within the environmental foundation and balance the used of pesticide with pest integrated management [4]. Many researchers have tended to find other alternatives to control the number of pests without causing environmental pollution such as biological control. The biological control agents *Bacillus thuringiensis* and *Beauveria bassiana* that are known for their efficacy in controlling many pests due to the ease of isolation and the rapid growth [5]. The present study has been conducted to evaluate the effectiveness of some chemical pesticides and biological control on compacting tomato crop pests.

II. Materials and methods

The study was carried out at the laboratory of Plant Protection Department, College of Agriculture / University of Basra. The insects kept in transparent plastic containers (18 x 12 x 9 cm) under controlled condition of temperature (26 C° ± 2 C°) and a relative humidity of (between 45 and 50%). The lids of the containers replaced with piece of cloth (Organza fabric) to prevent insects from escaping. A thin layer of medicinal cotton moistened with distilled water and filter papers were placed inside the plastic container to preserve moisture. Tomato leaves placed on the top of filter papers and insects were finally added after their treatment with chemical and biological agents as mentioned in Table (1).

Table 1. The name of used chemical agents used in this study

Name of pesticides	Active substance	Dose	Source
Levo 2.4 SL	2.4SL Oxymatrin	25 ml/ 100 liter of water	Sineria
Aster20 SL	Acetamiprid 20 SL	50-70 ml/ 100 liter of water	Agri-Chem
Difuse 450 SC	Diflubenzuron 48%	40-70 ml/ 100 liter of water	Agriphar
Matrixine Plus EC	2.4% Abamectine and Oxymatrin	50 ml / 100 liter of water	Russl IPM

A. The biological agents that have been used in this study includes:

Beauveria bassiana

The fungi *B. bassiana* was applied in a form of wettable powder where each gram contains 10 x 17 spores prepared by dissolving 5 g in one liter of water.

***Bacillus thuringiensis* (Antario)**

The commercial formulation (wettable powder) of *Bacillus thuringiensis* used as an insecticide containing (32000IU/ mg) + Abamectin at a percentage of 50-100 g / 100 l of water, produced by Russel IPM.

B. The effect of some chemical and biological pesticides on the ratio of destruction of some tomato crop pests: -

The whitefly (*Bemisia tabaci*)

The leaves of the tomato plant which contain the larvae of whitefly were collected in the early morning and placed in plastic bags. Three biological replicates per treatment were used, each replicate contains three plastic boxes. Control treatment was sprayed with distilled water. One leaf with ten larvae and ten adults was placed in each box.

C. The tomato leaf miner (*Tuta absoluta*)

The leaves of infected tomato plant were transferred to the laboratory to ensure the presence of the larvae within the leaves using optical microscopy. Ten leaves with ten larvae and ten adults (insects) were placed in each box. Each treatment contains three boxes in addition to a control treatment.

1. Green peach (*Myzus persicae*)

A tomato leaf infected with ten larvae and ten adults was placed in each plastic box and considered as one biological replicate. Three biological replicates were used as well as a control treatment.

2.* The red spider mite *(Tetranychus urticae)

Tomato leaves were collected and washed with distilled water and dried prior to use. One leaf placed in each box and ten larvae and ten adults were then transferred. Three biological replicates per treatment in addition to control treatment were used in this experiment.

Assessment of agent effectiveness. The death percentage of each of pest when exposed to the experimental agent, compared with the control treatment, was used as the measure of effectiveness of the agents. The death percentage (%) is defined as the number of deaths/total number of insects exposed to each agent. The death percnetage was calculated for both immature and adult forms of the pest after one, three and seven days of exposure to the agent.

The following equation was used to calculate the effectiveness of each agent.

$$\text{Effectiveness of agents} = \frac{\text{Death percentage per pesticide treatment - death percentage in control treatment}}{\text{100 - death percentage in control treatment}} \times 100\%$$

D. Statistical analysis

The laboratory experiment was conducted using the complete randomized design (CRD) as a two-factor experiment. The averages of mortality were compared according to the method of least significant difference (L.S.D) under the probability level 0.01 [5]. Statistical analysis was carried out using GenStat Discovery Edition 3.

III. Results and discussion

The effect of some chemical and biological agents on the mortality percentage of different phases of some tomato pests: -

1. **The effect of chemical and biological agents on the mortality percentage of the larvae of the whitefly (*B. tabaci*)**

The results in Table (2) summaries the effect of exposure of our chemical agents and two biological agents on the average of mortality percentage of larvae of the whitefly. The highest death percentage of 74.4% was caused by exposure to Aster; this did not differ significantly from the death percentage of 72.2% caused by Matrixine Plus. The bacterial agent Antario resulted in the lowest death percentage (26.7%) of the six agents tested. With respect to duration of exposure, the effectiveness of all agents increased with duration. The highest average of mortality percentage of 68.9 % occurred after seven days of exposure while the lowest average of 32.8% occurred after one day of treatment.

The results showed that there is interference a clear relationship of treatment effectiveness and the duration of exposure. The highest average of mortality percentage of nymphs (93.33%) occurred with Aster after seven days of treatment. Similarly, treatment with Matrixine Plus caused a high average of mortality percentage of 86.67% followed by the treatment with *B. bassiana* (biological) and Levo (chemical), both with death percentages of 67.76%. In contrast, the treatment with Antario was significantly lower at reduced the average of mortality percentage by 16.67% after one day of treatment. The superiority of the pesticide Aster can be attributed to the effect of the pesticide on the protein transporter Glutathione s-transferase. This transports enzymes which digest the protein in the insect's food, thus acting as a nutritional inhibitor. Our findings are consistent with those of [7-10], who also report on the efficacy of the active substance Acetamiprid in controlling whitefly. Similar effects of *B. bassiana* on the death percentage of whitefly nymphs (72.7%) after seven days of exposure have been reported by [11,12].

Table 2. Effect of some chemical and biological agents on the mortality percentage of the larvae of the whitefly *B. tabaci*.

Treatment	Mortality percentage post treatment /day			Average of treatment
	one day post treatment	Three days post treatment	seven days post treatment	
Levo	33.33	73.33	76.67	61.11
Aster	43.33	86.67	93.33	74.44
Difuse	23.33	33.33	43.33	33.33
Matrixine Plus	46.67	83.33	86.67	72.22
Antario	16.67	26.67	36.67	26.67
B. bassiana	33.33	63.33	76.67	57.78
Average of days	32.78	61.11	68.89	
L.S.D (0.01)	Pesticide: (9.06)	Days: 6.41	Interaction: 15.70	

2. **The effect of chemical and biological agents on the mortality percentage of the adults of whitefly (*B. tabaci*)**

The results in Table 3. showed the range of mortality percentages of adult whitefly (*B. tabaci*) of different treatments and durations of exposure. Treatment with Matrixine Plus achieved the highest average mortality percentage of 87.8%, followed by the pesticides Levo and Aster with a death percentage of 74.44%. The lowest percentage of 28.9% and 30.0% was recorded for by the Difuse and Antario treatments respectively. Similarly, the highest average of mortality percentage (71.1%) occurred after seven days of treatment, while the lowest average of mortality percentage (41.7%) was recorded after one day of treatment.

As for the immature forms, there is a link between the death percentage from the treatments and the period of exposure. The highest death percentage for the Matrixine Plus was 96.67%, which did not differ significantly from the Aster and Levo agents, with 93.33 and 86.67% loss respectively after seven days of exposure. Treatment with *B. bassiana* resulted in an average mortality percentage of 80.0% after seven days. Treatment with the pesticide Difuse resulted in the lowest average of death percentage of 16.7%, which did not differ significantly from the biological agent Antario (23.3%) after one day of treatment. This finding is consistent with those of [13], Mansor and Hashem [14] on the efficacy of Matrixine Plus on the half-wing and insect sheathed insects.[14] reporting on the efficacy of some chemical pesticides and *B. bassiana* in controlling whitefly infestation on pumpkins, found that the fungus achieved a death percentage of 90.33%. Similarly, a study conducted by [12], also recorded a death percentage of 94.52% after five days of the fungal treatment.

Table 3. Effect of some chemical and biological pesticides on the mortality percentage of the adults of the whitefly (*B. tabaci*).

Treatment	Mortality percentage post treatment /day			Average of treatment
	One day post treatment	Three days post treatment	Seven days post treatment	
Levo	56.67	80.00	86.67	74.44
Aster	43.33	86.67	93.33	74.44
Difuse	16.67	33.33	36.67	28.89
Matrixine Plus	73.33	93.33	96.67	87.78
Antario	23.33	33.33	33.33	30.00
B. bassiana	36.67	73.33	80.00	63.33
Average of days	41.67	66.67	71.11	
L.S.D (0.01)	Pesticide: 9.23	Days: 6.52	Interaction: 15.98	

3. The effect of chemical and biological agents on the mortality percentage of the adults of whitefly (*B. tabaci*)

The results in Table 4. also indicate a wide range of agent effectiveness, but a pattern, with regard to the mortality of the tomato leaf miner (*T. absoluta*). Treatment with Matrixine Plus again showed the highest average of mortality percentage (82.22%), followed by the Antario (72.22%). The lowest average (52.22%) was recorded for treatment with *B. bassiana*. The results also show that seven days of treatment cause the highest average mortality percentage (84.44%) while the lowest average (41.11%) was recorded after one day of treatment

The interaction between the treatment effectiveness and the duration of exposure is confirmed for individual agents. Treatment with Matrixine Plus resulted in highest average of mortality percentage at 93.33%; this did not differ significantly from Antario and *B. bassiana* with an average of 68.67% and 67.67% respectively. This is a positive finding for the biological treatments. These results are in agreement with the findings of [15,16] on the effect of the agent Abamectin on the larvae of *T. absoluta*. In regard to the treatment with Antario, many studies suggest that the bacteria *B. thuringiensis* produces toxins that cause rupture of the insect's intestinal wall; causing an imbalance in the organs where the insect stops feeding and death usually occurs in two to five days [17]. In addition, Hassan and Youssef [18], emphasized that the use of *B. thuringiensis* increased larvae mortality by 80-90% after seven days of treatment, compared to mortality of 13.30% among controls.

Table 4. The effect of some chemical and biological agents on the mortality percentage of the larvae of *T. absoluta.*

Treatment	Mortality percentage post treatment /day			Average of treatment
	One day post treatment	Three days post treatment	Seven days post treatment	
Levo	33.33	76.67	80.00	63.33
Aster	36.67	80.00	90.00	68.89
Difuse	36.67	70.00	80.00	62.22
Matrixine Plus	63.33	90.00	93.33	82.22
Antario	50.00	80.00	86.67	72.22

B. bassiana	26.67	53.33	76.67	52.22
Average of days	41.11	75.00	84.44	
L.S.D (0.01)	Pesticide: 11.03	Days: 7.80	Interaction: 19.11	

4. The effect of pesticides on the mortality percentage of the adults of the tomato leaf miner *T. absoluta*

Statistical analysis showed significant differences in the effect of chemical and biological agents on the average of mortality of adults of *T. absoluta*. Matrixine Plus resulted in the highest average of mortality percentage of 83.33%, while the lowest average (32.22%) was achieved by Difuse. The results again showed that the most effective of the three test periods was seven days of exposure, resulting in the highest average of death percentage of 56.65%, compared with the lowest average death percentage of 35.56% after one day of treatment. There was an interaction between the exposure to treatments and the period of exposure. Our results indicate that the most effective combination is seven days of exposure to Matrixine Plus, which caused the highest death percentage of the pest, at 93.33%. Treatments with Levo and the biological agent *B. bassiana* also resulted in high death percentages of 80.00% 76.67% respectively. A lower death percentage of 20.00% was recorded after one day of treatment with Difuse. These findings confirm those of [1], in showing the effectiveness of Matrixine Plus against adults of the tomato leaf miner. The primary cause of larval death from cotton and cabbage leaf worms is the consumption (from the treated eggshell) of a lethal dose of Alsystin synthesis inhibitor during the hatching period [20]. A study by Corbitt [21], found that the first larval phase was more sensitive to the pesticide Abamectin. This effect decreased with aging with the pesticide more toxic to first-phase larvae compared to the third and fourth phase of larvae [21].

Table 5. The effects of some chemical and biological pesticides on the mortality percentage of adults of tomato leaf miner (*T. absoluta*).

Treatment	Mortality percentage post treatment /day			Average of treatment
	One day post treatment	Three days post treatment	Seven days post treatment	
Levo	53.33	76.67	80.00	70.00
Aster	23.33	43.33	53.33	40.00
Difuse	20.00	36.67	40.00	32.22
Matrixine Plus	66.67	90.00	93.33	83.33
Antario	23.33	46.67	50.00	40.00
B. bassiana	26.67	56.67	76.67	53.33
Average of days	35.56	58.33	65.56	
L.S.D (0.01)	Pesticide: 10.17	Days: 7.19	Interaction: 17.62	

5. The effect of chemical and biological agents on the mortality percentage of larvae of green peach aphids (*M. persicae*)

The results in Table 5. also revealed significant differences in the mortality percentages of larvae of the green peach aphids (Myzus persicae), treated with the chemical and biological agents. The highest average of 87.78% was observed after treatment with Matrixine Plus. The treatments of Levo and Aster also increased the average of mortality percentage of the pest, reaching 84.44% and 78.89% respectively, followed by biological treatment with an average of mortality percentage of 64.44%. The lowest average was observed with treatment of Antario at 33.33%. Similarly, the best seven days treatment period resulted in the highest death percentage (78.89%), whereas the lowest death percentage of 47.78% occurred after only one day of treatment. As for the interaction of specific treatment with time of exposure, the results again showed that the seven days period was the most effective with Matrixine Plus causing the highest percentages of death of larvae (96. 67%). This did not differ significantly from the averages of mortality percentages of Aster by 33%, by 93.33% Levo and the *B. bassiana* 86.67%. The treatment of one day with the bio-drug Antario resulted in the lowest average of mortality percentage of 23.33%. These results agreed with many studies in the literature, in that most plant-based insecticides affect the first phases and immature phases, causing disruption in the developmental stages and preventing the insect from feeding, leading to death [22,23]. The active substance Abamectin was found to have a greater effect on the early stages (nymphs) of green peach aphids compared to the later stages. In biological treatment with *B. bassiana*, infection occurs through the spores of the primary fungus that germinate on the surface of the plant host, forming secondary sticky spores that attach to the body of insects during their movement to feed. These spores penetrate the cotyl of the insect and begin to proliferate through the insect blood, leading to the death of the insect [24]. Another independent study conducted by [25], have also reported the ability of *B. bassiana* to control green peach aphids. In this study the average of mortality percentage of insects exposed to *B. bassiana* reached 80.31% as compared to the control.

Table 6. The effects of chemical and biological agents on the mortality percentage of green peach larvae (*M. persicae*)

Treatment	Mortality percentage post treatment /day			Average of treatment
	One day post treatment	Three days post treatment	Seven days post treatment	
Levo	70.00	90.00	93.33	84.44
Aster	53.33	90.00	93.33	78.89
Difuse	30.00	50.00	63.33	47.78
Matrixine Plus	73.33	93.33	96.67	87.78
Antario	23.33	36.67	40.00	33.33
B. bassiana	36.67	70.00	86.67	64.44
Average of days	47.78	71.67	78.89	
L.S.D (0.01)	Pesticide: 9.39	Days: 6.64	Interaction: 16.27	

6. The effect of chemical and biological agents on the mortality percentage of adults of green peach aphids (*M. persicae*)

The study again showed significant differences in the average of mortality percentage of green peach (*M. persicae*), with the different agents. The highest average of mortality percentage of 88.89%.was observed after treatment with Matrixine Plus. Treatment with Levo and Aster pesticides resulted in similar mortality percentages of 84.44% and 78.89% respectively, followed by the treatment with *B. bassiana* with a death percentage of 64.44%. The lowest mortality percentage of 33.33% was achieved by treatment with Antario agent. The results again showed that the highest average of mortality percentage of 78.89 % occurred after seven days of treatment. A lower percentage of death was 47.78% occurred after one day of treatment.

The results in Table (7) showed that the best result was achieved from exposure to Matrixine Plus for seven days, with an average of mortality percentage for the larvae of 96.67%. This did not differ significantly from the percentages achieved with Aster and Levo pesticides, with an average of mortality percentages of 93.33and 86.67%, respectively. The application of the agent Antario caused an average of mortality percentage of 73.33% over the same period. The application of Antario for one day resulted in a lowest average of death percentage of 16.67%, which did not differ significantly from the average of mortality percentage at one day, for the agent Difuse, which was 23.33. Several studies have reported the positive effect of Matrixine Plus on the mortality of adult green peach aphids [4,26]. However, the positive effects of the biological control on the average of mortality percentage of insects could be related to the fungal feeding on host plants where large amounts of nutrient are present and to the increase in surface area of insects as compared to the egg stage [24].

Table 7. The effects of chemical and biological agents on the mortality percentage of adults of green peach aphids (*M. persicae*).

Treatment	Mortality percentage post treatment /day			Average of treatment
	One day post treatment	Three days post treatment	Seven days post treatment	
Levo	56.67	83.33	86.67	75.56
Aster	53.33	90.00	93.33	78.89
Difuse	23.33	40.00	46.67	36.67
Matrixine Plus	76.67	93.33	96.67	88.89
Antario	16.67	30.00	33.33	26.67
B. bassiana	26.67	56.67	73.33	52.22
Average of days	42.22	65.56	71.67	
L.S.D (0.01)	Pesticide: 8.54	Days: 6.04	Interaction: 14.80	

7. The effects of chemical and biological agents on the mortality percentage of red spider mite larvae (*T. urticae*)

The results in Table (7) revealed a significant difference in the death percentage of larvae of *T. urticae* when exposed to the selected agents. The highest death percentage of 92.22% was recorded at seven days by Matrixine Plus, followed by Levo and *B. bassiana* with percentages of 83.33 and 76.67%, respectively. In contrast, Antario recorded the lowest average mortality percentage of 30.00% after one day. This percentage did not differ significantly from the results for Difuse and Aster, with average of mortality percentages of 35.56% and 37.78%, respectively. The results were consistent with that of the three test periods, seven days of treatment causes the highest percentage of death (66.67%), and the one day of treatment has the least effect on death percentage, with the lowest percentage of death percentage of 49.44% after one day of treatment. Overall, treatment with Matrixine Plus over seven days resulted in the highest average of mortality percentage for larvae of 97.67%. Levo and *B. bassiana* had a similarly strong effect on the average of mortality percentage (both 93.33%) under the same period. The lowest average of percentage recorded was for one day of treatment with Antario at 26.67%, which was not significantly different from treatment with Difuse (30.00%) and Aster (33.33%) for the same period. The superiority of Matrixine Plus could be attributed to the active substance Matrixine, which is widely known for its highly toxic effects and for reducing female fertility. In addition, it inhibits growth and deters feeding in the red spider mite [27,28]. The longer period of exposure to biological control by *B. bassiana* at concentration of 10-5 spore/ml also led to a significant increase in average of mortality percentage of larvae at 82.81%. These effects can result from the ability of the fungus to penetrate the cotyle of the pest and proliferate, leading to its death [27]. Another factor could be the ability of the fungus to secrete secondary compounds such as beauvercin, brassianolids, oosporein and oxalic acid, that dissolve the cotyle of the insects [29].

Table 8. The effects of chemical and biological agents on the mortality percentage of the larvae of two spotted red spider mite (*T. urticae*).

Treatment	Mortality percentage post treatment /day			Average of treatment
	One day post treatment	Three days post treatment	Seven days post treatment	
Levo	66.67	90.00	93.33	83.33
Aster	33.33	36.67	43.33	37.78
Difuse	30.00	36.67	40.00	35.56
Matrixine Plus	86.67	93.33	96.67	92.22
Antario	26.67	30.00	33.33	30.00
B. bassiana	53.33	83.33	93.33	76.67
Average of days	49.44	61.67	66.67	
L.S.D (0.01)	Pesticide: 8.36	Days: 5.91	Interaction: 14.49	

8. The effects of chemical and biological agents on the mortality percentage of the adults of red spider mite (*T. urticae*)

The results indicated that there were significant differences in the exposure to the treatments and duration of exposure on the average of morality percentage in red spider mite (*T. urticae*). The application of Matrixine Plus was recorded the highest average of morality of 92.22%, followed by the biological agent *B. bassiana* and Levo with an average of mortality percentage of f 73.33% and 72.22%, respectively. On the other hand, the application of Difuse was recorded the lowest average of mortality of 25.56%, which did not differ significantly from Antario, which was recorded an average of death percentage of 28.89%. The results also showed that the best period in causing the highest average of death of 63.33% was after seven days of treatment, while the lowest average of death of 41.11% occurred after one day of treatment (Table 9).

There was a significant interaction between the treatments and duration of exposure on the average of mortality percentage. The results showed that the best interaction occurred after seven days of the treatment with Matrixine Plus which had the highest average of mortality of 96.67%, and this did not differ significantly from the treatment with the fungus *B. bassiana* and the pesticide Levo with an average of mortality of 3.33% and 86.67%, respectively. The application of Difuse was recorded the lowest average of morality of 20.00% occurred after one day of treatment, which did not differ significantly from the treatments of the two pesticides, Antario and Aster, with an average of death of 23.33% and 26.67% respectively. The reason behind the positive effect of Matrixine Plus could be due to the active ingredient Abamectin which attack the nervous system of the Two-spotted spider mites. These findings are consistent with [30], about the ability of the active substance Abamectin to attack the nervous system of the two-spotted red spider mites. In addition, the pesticide contains the active substance Oxymatrine which mainly affects the nervous system, specifically the acetylcholine esterase [31], and has repellent and deterrent effects against the mites [32]. The positive effects of the biological control of *B. bassiana* is due to its poisoning/toxic effects. There are four routes for the toxicant to enter the body of insects through the respiratory tract upon contact or accumulates on the surfaces of the plant and swallows during feeding process or upon contact with the body [33]. A study conducted by

[30], explained that the application of fungi *T. harazianum* and *B. bassiana* are recorded a death percentage of 90% against the adults of *T.urticae* in cucumber plant after 72 hours of applying the treatment.

Table 9.The effects of chemical and biological agents on the mortality percentage of the adults of two spotted red spider mite (*T. urticae*).

Treatment	Mortality percentage post treatment /day			Average of treatment
	One day post treatment	Three days post treatment	Seven days post treatment	
Levo	46.67	83.33	86.67	72.22
Aster	26.67	36.67	40.00	34.44
Difuse	20.00	26.67	30.00	25.56
Matrixine Plus	86.67	93.33	96.67	92.22
Antario	23.33	30.00	33.33	28.89
B. bassiana	43.33	83.33	93.33	73.33
Average of days	41.11	58.89	63.33	
L.S.D (0.01)	Pesticide:7.19	Days: 5.08	Interaction: 12.45	

Conclusion

The results show that the pesticide Matrixine Plus recorded the highest average of mortality of both larval and adult stages of all four pests. The lowest averages of mortality were recorded for Antario and Difuse. the highest average of death occurred after seven days of treatment, while the lowest average of death occurred after one day of treatment.

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