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# Research Article
# Virulence of Three Entomopathogenic Fungi Against Whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) in Tomato Crop

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## Abstract
**Background and Objective:** *Bemisia tabaci* (*B. tabaci*) is the most widespread insect pest of broad range of greenhouse and field crops. It is a serious threat to crop production due to direct damage. The aim of this study was to study the virulence of three entomopathogenic fungi against Whitefly, *Bemisia tabaci*. **Materials and Methods:** This study was carried out during 2 successive seasons (2015 and 2016). In this study trading compounds of entomopathogenic fungi, Bio magic (*Metarhizium anisopliae*), Bio power (*Beauveria bassiana*) and Bio catch (*Verticillium lecanii*) were used. Three concentrations were used ($1\times10^7$, $1\times10^8$ and $1\times10^9$ spores $mL^{-1}$). Data were analyzed by one-way analysis of variance and followed by a least significant difference (LSD at 5%, $p>0.05$). **Results:** Under laboratory conditions *V. lecanii*, *B. bassiana* and *M. anisopliae* mortalities were happened after 3 days from treatment. The maximum percent of mortality (100%) was occurred after the 6th day from treatment with the 3rd concentration in all isolates. The 3rd concentration ($1\times10^9$ spores $mL^{-1}$) was the highly toxic in *V. lecanii*, *B. bassiana* and *M. anisopliae* to the adult of *B. tabaci* compared with the other two concentrations. Under field conditions the 3rd concentration ($1\times10^9$) also was the best concentration against whitefly after the third application in *V. lecanii*, *B. bassiana* and *M. anisopliae.* The percent of reduction was ranged between 52 and 100% in all concentrations. *V. lecanii* was more virulence than *B. bassiana* and *M. anisopliae* against *B. tabaci*. **Conclusion:** These results confirmed that *V. lecanii*, *B. bassiana* and *M. anisopliae* isolates are promising agents for whitefly control in the field.

Key words: *Metarhizium anisopliae*, *Beauveria bassiana*, *Verticillium lecanii*, *Bemisia tabaci*, *Solanum lycopersicum*

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

*Whitefly, Bemisia tabaci* is the greatest spread insect pest in greenhouse and field crops. It is the most dangerous to crop production due to direct damage[1]. *Bemisia tabaci* is split into 11 groups encompassing 24 species[2]. It can cause economic losses estimated in crops such as tomatoes, soybean, beans, cotton and leafy vegetables[3,4].

Entomopathogenic fungi possess the unique ability to infect their host directly through the integument[5].

The most promising fungi include *V. lecanii*, *M. anisopliae* and *B. bassiana* [6-17].

The *V. lecanii*, *M. anisopliae* and *B. bassiana* species have been used to control whiteflies and related insects in greenhouses in Europe, Canada and Egypt[18-23].

The virulence of isolates of 3 entomopathogenic fungi (*V. lecanii*, *M. anisopliae* and *B. bassiana*) was determined on eggs, nymphs and adults of *B. tabaci*.

The cause of this increase is unknown but it may be due to the extended use of synthetic organic insecticides and subsequent augmented resistance to pesticides, changing climatic conditions[24].

The entomopathogenic fungi *B. bassiana* has high activity against whitefly[25]. Blastospores and conidia can infect the host directly but mycelium needs to grow and from infectious propagates first[26,27]. The aim of this study was to study the virulence of 3 entomopathogenic fungi against whitefly, *Bemisia tabaci*.

## MATERIALS AND METHODS

This study was carried out in greenhouse in El-Behira Governorate during season 2015-2016.

**Entomopathogenic fungi:** Bio magic (*Metarhizium anisopliae*), Bio power (*Beauveria bassiana*) and Bio catch (*Verticillium lecanii*).

**Preparing of the concentrations:** Three concentrations were used ($1\times10^7$, $1\times10^8$ and $1\times10^9$ spores $mL^{-1}$) and add 0.5% tween 80. The spores were counted in the suspension using a haemocytometer (Swastik Scientific Company, India) blood cell counting chambers (Hirscmann $0.1\times0.0025$ $mm^{-2}$).

A haemocytometer is essentially a microscope slide bearing a small well of known depth. The base of which is marked with squares of known dimensions. During use the well is covered with a special coverslip (usually 0.4 mm thick).

**Laboratory inoculation:** Adults whitefly, *B. tabaci* were transferred to the laboratory from the greenhouse and put in Petri dishes with tomato leaf disk and incubated in $22\pm2°C$ and $85\pm5\%$ RH. (Five adults/replicate) were used in all treatments. The entomopathogenic fungi were sprayed using a manual sprayer in a suspension containing (C1):$1\times10^7$, (C2):$1\times10^8$ and (C3):$1\times10^9$ spores $mL^{-1}$, while sterilized water was sprayed to the leaves disks as blank control. The mortality of whitefly was observed daily for 7 day.

**Greenhouse application:** An area 30 m$\times$10 m (= 300 $m^2$) was divided into 4 parts each part was divided into 3 plots were treated with 3 concentrations from *V. lecanii*, *M. anisopliae* and *B. bassiana* and the other one as control treated by water. Every plot divided into three replicates. The suspensions were sprayed early in the morning and three times a day (one week interval). The live insects of *B. tabaci* per leaf/replicate were counted after all treatment.

The percent of reduction were calculated according to Henderson and Tilton[28] as follows:

$$\text{Reduction percentages} = 1 - \frac{\text{Tb Ca}}{\text{Tb Ca}} \times 100$$

Where:

Tb and Ta are pre- and after-treatment counts, respectively.

Cb and Ca are untreated checks before and after treatment.

**Statistical analysis:** Data were analyzed by analysis of variance (one-ways classification ANOVA) and followed by a least significant difference (LSD at 5%, p>0.05)[29].

## RESULTS

Three concentrations of three isolates *V. lecanii*, *M. anisopliae* and *B. bassiana* were evaluated against *B. tabaci* under laboratory and greenhouse conditions.

**Effect of *V. lecanii*, *M. anisopliae* and *B. bassiana* on *B. tabaci* under laboratory conditions:** As mentioned in Table 1 there is no effect for *V. lecanii*, *M. anisopliae* and *B. bassiana* to *B. tabaci* after 3 days from treatment.

Mortalities are occurred in the 4th day. The percent of mortalities were increased gradually and reached to the maximum in the 7th day from treatment. With the all

Table 1: Effect of *V. lecanii*, *M. anisopliae* and *B. bassiana* on *B. tabaci* under laboratory conditions at 22±2°C and 85±5% RH

| | | Percentage of mortalities | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Verticillium lecanii* | | | *Metarhizium anisopliae* | | | *Beauveria bassiana* | | | |
| Days after application | Control | C1 | C2 | C3 | C1 | C2 | C3 | C1 | C2 | C3 | LSD |
| 2nd | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3rd | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4th | 0.0 | 24.2±2.5$^{b*}$ | 28.5±2.3$^{b}$ | 46.2±3.5$^{c}$ | 20.1±1.5$^{b}$ | 21.5±1.3$^{b}$ | 35.2±2.3$^{c}$ | 21.5±2. 3$^{b}$ | 27. 7±2.3$^{b}$ | 45.2±3.5$^{c}$ | 6.5 |
| 5th | 0.0 | 48.52±3.3$^{c}$ | 57.5±3.7$^{d}$ | 71.8±4.3$^{e}$ | 30.2±3.2$^{b}$ | 45.22±3.5$^{d}$ | 55. 5±2.2$^{e}$ | 34.5±3.3$^{b}$ | 57.5±3.5$^{d}$ | 65.5±2.2$^{e}$ | 7.3 |
| 6th | 0.0 | 58.2±2.2$^{b}$ | 80.51±2.2$^{c}$ | 96.5±4.3$^{e}$ | 45. 3±4.3$^{b}$ | 62.3±2.2$^{b}$ | 75.6±2.3$^{e}$ | 50. 6±5.5$^{b}$ | 73.3±2.5$^{b}$ | 87.5±1.6$^{e}$ | 8.9 |
| 7th | 0.0 | 68.3±3.2$^{b}$ | 90.4±4.5$^{c}$ | 100±4.9$^{d}$ | 56.2±2.2$^{b}$ | 80.5±4.2$^{c}$ | 90.5±2.2$^{d}$ | 67.8±3.3$^{b}$ | 90.5±4.3$^{c}$ | 97.3±4.7$^{d}$ | 9.8 |

C1: $1\times10^7$, C2: $1\times10^8$ and C3: $1\times10^9$ spores $mL^{-1}$, a-e Degree of significant from low to high, Mean±SD

Table 2: Effect of *V. lecanii*, *M. anisopliae* and *B. bassiana* on *B. tabaci* in greenhouse during season 2015

| | | Percent of infestation by *B. tabaci*/leave | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Verticillium lecanii* | | | *Metarhizium anisopliae* | | | *Beauveria bassiana* | | | |
| Applications | Control | C1 | C2 | C3 | C1 | C2 | C3 | C1 | C2 | C3 | LSD |
| 1st | 8±1.2$^{a*}$ | 7±2.5$^{a}$ | 9±1.2$^{a}$ | 9±2$^{a}$ | 8±1.5$^{a}$ | 10±2.2$^{a}$ | 10±3.2$^{a}$ | 8±1$^{a}$ | 9±1.5$^{a}$ | 10±2.3$^{a}$ | 3.2 |
| 2nd | 10±1.5$^{a}$ | 6±2$^{bc}$ | 2±2$^{bc}$ | 2±2$^{c}$ | 7±2$^{bc}$ | 6±2$^{bc}$ | 5±1.5$^{bc}$ | 6±1$^{b}$ | 4±1.7 | 3±2$^{bc}$ | 2.6 |
| 3rd | 9±2$^{a}$ | 4±1.2$^{bc}$ | 1$^{bc}$ | 0.0$^{c}$ | 5±2$^{bc}$ | 4±1.2$^{bc}$ | 3±1.5$^{bc}$ | 4±1$^{b}$ | 2±1.7$^{bc}$ | 1$^{bc}$ | 2.3 |
| Percent of reduction | ------ | 57.3 | 90.4 | 100 | 50.2 | 70.0 | 75.5 | 55.5 | 79.5 | 90 | ---- |

a-c Degree of significant from low to high (±SD)

Table 3: Effect of *V. lecanii*, *M. anisopliae* and *B. bassiana* on *B. tabaci* in greenhouse during season 2016

| | | Percent of infestation by *B. tabaci*/leave | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Verticillium lecanii* | | | *Metarhizium anisopliae* | | | *Beauveria bassiana* | | | |
| Applications | Control | C1 | C2 | C3 | C1 | C2 | C3 | C1 | C2 | C3 | LSD |
| 1st | 9±2.2$^{a*}$ | 8±2.3$^{a}$ | 10±2$^{a}$ | 9±2$^{a}$ | 9±2.5$^{a}$ | 10±2.2$^{a}$ | 10±3.2$^{a}$ | 9±2$^{a}$ | 9±1.5$^{a}$ | 10±2.3$^{a}$ | 3.3 |
| 2nd | 10±2.5$^{a}$ | 7±2$^{bc}$ | 5±2$^{bc}$ | 4±1$^{c}$ | 8±2$^{bc}$ | 7±2$^{bc}$ | 4±1.2$^{bc}$ | 6±2$^{b}$ | 4±1.7 | 3±2$^{bc}$ | 2.7 |
| 3rd | 10±2$^{a}$ | 5±2.2$^{bc}$ | 2±1$^{bc}$ | 0.0$^{c}$ | 6±2$^{bc}$ | 5±2.2$^{bc}$ | 3±2$^{bc}$ | 4±5$^{b}$ | 2±1.7$^{bc}$ | 1$^{bc}$ | 2.2 |
| Percent of reduction | ------ | 55.2 | 85.2 | 100 | 50.0 | 71.0 | 76.2 | 56.2 | 78.3 | 92 | ---- |

a-c Degree of significant from low to high (±SD)

concentrations, the percent of mortalities were increased with increase of concentrations. The percent of mortalities ranged between 68.3-100, 56.2-90.5 and 62.7-97.3% with *V. lecanii*, *M. anisopliae* and *B. bassiana*, respectively, in the 7th day after treatment. Table 1 shows that there are slight differences between effect of V*. lecanii*, *M. anisopliae* and *B. bassiana* isolation to *B. tabaci.* This mean that *V. lecanii* isolation is more effective than *M. anisopliae* and *B. bassiana*. The percent of mortalities with all concentrations ($C_1$, $C_2$ and $C_3$) of *V. lecanii* isolation were 68.3, 90.4 and 100%, respectively. The corresponding results with *M. anisopliae* and B*. bassiana* isolation were 56.2, 80.5 & 90.5, 67.8, 90.5 and 97.3, respectively.

**Effect of *V. lecanii, M. anisopliae* and *B. bassiana* on *B. tabaci* in green house during season 2015:** Table 2 obtained that the number of *B. tabaci* per leave was decreased compared with control after the second application. That the percent of reduction by *V. lecanii M. anisopliae* and *B. bassiana* after the third application were 57.3, 90.4 and 100, 50.2, 70.0 and 75.5 and 55.5, 79.5 and 90% with $C_1$, $C_2$ and $C_3$, respectively.

The statistical analysis showed that there were no significant differences between the concentrations and control after the first application of all plots. After the 2nd application there were significant differences ($p>0.05$) between all concentrations and control. After the third application there were highly significant differences among all concentrations. The LSD was two, three after the third application. The statistical analysis confirmed that the third concentration ($1\times10^9$) was the highly toxic compared the first and the second concentrations in all treatment.

**Effect of *V. lecanii, M. anisopliae* and *B. bassiana* on *B. tabaci* in green house during season 2016:** Table 3 show that after the second application the number *B. tabaci* leave were decreased compared with control. That the percent of reduction by *V. lecanii M. anisopliae* and *B. bassiana* after the third application were 55.2, 85.2 and 100, 50.0, 71.0 and 76.2 and 56.2, 78.3 and 92% with $C_1$, $C_2$ and $C_3$, respectively.

## DISCUSSION

The obtained data inferred that the entomopathogenic fungi *V. lecanii*, *M. anisopliae* and *B. bassiana* can be used as a promising agent in pest control and integrated pest management programs.

The effect of *V. lecanii*, *M. anisopliae* and *B. bassiana* may be depending on the type of host plant. While, the percent of mortality after 7th day by *V. lecanii*, *M. anisopliae* and *B. bassiana* ranged between 100, 72.2 and 92%, respectively[28]. This result compatible with Wraight *et al.*[30], who found that both of *B. bassiana* and *V. lecanii* caused mortalities of up to 97 and 100% in *Chilo partellus*, respectively. Maniania[31] reported that *B. bassiana* as an entomopathogenic fungi showed high effects on the aphid *Aphis craccivora* and the whitefly *B. tabaci* infesting cucumber. Zaki[32] reported that *V. lecanii* caused higher virulence in the early stages of whitefly and reduced with older instars. Gindin *et al.*[33], Abdel-Baky *et al.*[34], Abdel-Raheem *et al.*[35], Abdel-Raheem[36], Abdel-Raheem *et al.*[37], Abdel-Raheem *et al.*[14] and Abdel-Raheem[38] mentioned that entomopathogenic fungi caused good mortality to whitefly.

On the other hand, Sabbour and Abdel-Raheem[39] described the control of the silver leaf whitefly *Bemisia argentifolii* on several plants (including cucurbits, broccoli, tomatoes and cotton) using *B. bassiana*; they observed only a few fungus-killed adults on the plants did not exceed 1%.

## CONCLUSION

The results obtained that using of entomopathogenic fungi, *V. lecanii*, *B. bassiana* and *M. anisopliae* against *B. tabaci* as biological control agent are promising in the future. This study concludes that farmers have to use *V. lecanii* against *B. tabaci* in IPM program when first insect appear.

## SIGNIFICANCE STATEMENTS

This study discovered the effect of Entomopathogenic fungi as biological control agents for insects. *Verticillium lecanii*, shows higher effect against *Bemisia tabaci* than *Metarhizium anisopliae* and *Beauveria bassiana*. *Beauveria bassiana* shows higher effect than *Metarhizium anisopliae* against *Bemisia tabaci.*

## REFERENCES

1. Oliveira, M.R.V., T.J. Henneberry and P. Anderson, 2001. History, current status and collaborative research projects for *Bemisia tabaci*. Crop Prot., 20: 709-723.
2. De Barro, P.J., S.S. Liu, L.M. Boykin and A.B. Dinsdale, 2011. *Bemisia tabaci*: A statement of species status. Annu. Rev. Entomol., 56: 1-19.
3. Fontes, F.V.H.M., C.A. Colombo and A.L. Lourencao, 2012. Structure of genetic diversity of *Bemisia tabaci* (Genn.) (Hemiptera: Aleyrodidae) populations in Brazilian crops and locations. Sci. Agric., 69: 47-53.
4. Oliveira, C.M., A.M. Auad, S.M. Mendes and M.R. Frizzas, 2013. Economic impact of exotic insect pests in Brazilian agriculture. J. Applied Entomol., 137: 1-15.
5. Lacey, L.A., J.J. Fransen and R. Carruthers, 1996. Global Distribution of Naturally Occurring Fungi of *Bemisia*, their Biologies and Use as Biological Control Agents. In: Bemisia 1995: Taxonomy, Biology, Damage and Management, Gerling, D. and R. Mayer (Eds.). Intercept Andover Publishers, UK., pp: 401-433.
6. Faria, M. and S.P. Wraight, 2001. Biological control of *Bemisia tabaci* with fungi. Crop Prot., 20: 767-778.
7. Wraight, S.P., G.D. Inglis and M.S. Goettel, 2007. Fungi. In: Field Manual of Techniques in Invertebrate Pathology: Application and Evaluation of Pathogens for Control of Insects and other Invertebrate Pests, Lacey, L.A. and H.K. Kaya (Eds.). Springer, Dordrecht, The Netherlands, ISBN: 978-1-4020-5931-5, pp: 223-248.
8. Lacey, L.A., S.P. Wraight and A.A. Kirk, 2008. Entomopathogenic Fungi for Control of *Bemisia tabaci* Biotype B: Foreign Exploration, Research and Implementation. In: Classical Biological Control of *Bemisia tabaci* in the United States-A Review of Interagency Research and Implementation, Gould, J., K. Hoelmer and J. Goolsby (Eds.). Chapter 3, Springer, Dordrecht, The Netherlands, ISBN: 978-1-4020-6739-6, pp: 33-69.
9. Zaki, F.N. and M.A. Abdel-Raheem, 2010. Use of entomopathogenic fungi and insecticide against some insect pests attacking peanuts and sugarbeet in Egypt. Arch. Phytopathol. Plant Prot., 43: 1819-1828.
10. Sabry, K.H., M.A. Abdel-Raheem and M.M. El-Fatih, 2011. Efficacy evaluation of *Beauverai bassiana* and *Metarhizium anisopliae* on some insect pests under laboratory conditions. Egypt. J. Biol. Pest Control, 21: 28-33.
11. Soliman, M.M.M., A.S.H. Abdel-Moniem and M.A. Abdel-Raheem, 2014. Impact of some insecticides and their mixtures on the population of tomato borers, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) and *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) in tomato crop at Upper Egypt. Arch. Phytopathol. Plant Prot., 47: 1764-1776.
12. Abdel-Raheem, A.M., K.H. Sabry and Z.A. Ragab, 2009. Effect of different fertilization rates on control of *Bemisia tabaci* (Genn.) by *Verticillium lecanii* and *Beauveria bassiana* in potato crop. Egypt. J. Biol. Pest Control, 19: 129-133.

13. Abdel-Raheem, M.A., I.A. Ismail, R.S. Abdel-Rahman, I.E. Abdel-Rhman and F.R. Naglaa, 2015. Efficacy of three entomopathogenic fungi on tomato leaf miner, *Tuta absoluta* in tomato crop in Egypt. Swift J. Agric. Res., 1: 15-20.
14. Abdel-Raheem, M.A., N.F. Reyad, I.E. Abdel-Rahman and L. Al-Shuraym, 2016. Evaluation of some isolates of *Entomopathogenic fungi* on some insect pests infesting potato crop in Egypt. Int. J. ChemTech Res., 9: 479-485.
15. Ismail, I.A., R.S. Abdel-Rahman and M.A. Abdel-Raheem, 2016. Utilization of certain plant extracts and entomopathogenic fungi for controlling the black fig fly, *Lonchaea aristella* on fig trees. Int. J. ChemTech Res., 9: 35-42.
16. Ismail, I.A., R.S. Abdel-Rahman and M.A. Abdel-Raheem, 2016. Economical evaluation of different methods for controlling fig longihorne beetle, *Hesperophanes griseus* (Coleoptera: Cerambycidae) on fig trees. Int. J. ChemTech Res., 9: 122-125.
17. Saleh, M.M.E., M.A. Abdel-Raheem, I.M. Ebadah and H.E. Huda, 2016. Natural abundance of entomopathogenic fungi in fruit orchards and their virulence against *Galleria mellonella* larvae. Egypt. J. Biol. Pest Control, 26: 203-207.
18. Fransen, J.J., K. Winkelma and C. Lanteren, 1987. The differential mortality at various life stages of the greenhouse whitefly, *Trialeurodes vaporariorum* (Homoptera: Aleyrodidae), by infection with the fungus *Aschersonia aleyrodis* (Deuteromycotina: Coelomycetes). J. Invertebr. Pathol., 50: 158-165.
19. Chandler, D., J.B. Heale and A.T. Gillespie, 1994. Effect of osmotic potential on the germination of conidia and colony growth of *Verticillium lecanii*. Mycol. Res., 98: 384-388.
20. Abdel-Raheem, M.A., 2005. Possibility of using the entomopathogenic fungi *Beauveria bassiana* and *Metarhizium anisopliae* for controlling the sugar-beet insects *Cassida vittata* Vill. and *Scrobipalpa ocellatella* Boh. Egypt. Ph.D. Thesis, Faculty of Agriculture, Cairo University, Egypt.
21. Shah, F.A., C.S. Wang and T.M. Butt, 2005. Nutrition influences growth and virulence of the insect-pathogenic fungus *Metarhizium anisopliae*. FEMS Microbiol., 251: 259-266.
22. Shah, F.A., N. Allen, C.J. Wright and T.M. Butt, 2007. Repeated *in vitro* subculturing alters spore surface properties and virulence of *Metarhizium anisopliae*. FEMS Microbiol. Lett., 276: 60-66.
23. Jackson, M.A., C.A. Dunlap and S.T. Jaronski, 2010. Ecological considerations in producing and formulating fungal entomopathogens for use in insect biocontrol. BioControl, 55: 129-145.
24. Wang, L., J. Huang, M. You, X. Guan and B. Liu, 2007. Toxicity and feeding deterrence of crude toxin extracts of *Lecanicillium* (*Verticillium*) *lecanii* (Hyphomycetes) against sweet potato whitefly, *Bemisia tabaci* (Homoptera: Aleyrodidae). Pest Manage. Sci., 63: 381-387.
25. Al-Deghairi, M.A., 2008. Bioassay evaluation of the entomopathogenic fungi, *Beauveria bassaina* Vuellemin against eggs and nymphs of *Bemisia tabaci* Gennadius (Homoptera: Aleyrodidae). Pak. J. Biol. Sci., 11: 1551-1560.
26. Del Prado, E.N., J. Iannacone and H. Gomez, 2008. Effect of two entomopathogenic fungi in controlling *Aleurodicus cocois* (Curtis, 1846) (Hemiptera: Aleyrodidae). Chilean J. Agric. Res., 68: 21-30.
27. Scorsetti, A.C., R.A. Humber, C. de Gregorio and C.C.L. Lastra, 2008. New records of entomopathogenic fungi infecting *Bemisia tabaci* and *Trialeurodes vaporariorum*, pests of horticultural crops, in Argentina. BioControl, 53: 787-796.
28. Henderson, C.F. and E.W. Tilton, 1955. Tests with acaricides against the brown wheat mite. J. Econ. Entomol., 48: 157-161.
29. SAS., 2003. SAS/STAT User's Guide. Version 8.2, SAS Institute Inc., Cary, NC., USA.
30. Wraight, S.P., R.I. Carruthers, S.T. Jaronski, C.A. Bradely, J.C. Garza and S. Galaini-Whraight, 2000. Evaluation of the entomopathogenic fungi *Beauveria bassiana* and *Paecilomyces fumosoroseus* for microbial control of the silverleaf whitefly, *Bemisia argentifolii*. Biol. Control, 17: 203-217.
31. Maniania, N.K., 1991. Susceptibility of *Chilo partellus* Swinhoe (Lep., Pyralidae) eggs to entomopathogenic hyphomycetes. J. Applied Entomol., 112: 53-58.
32. Zaki, F.N., 1998. Efficiency of the entomopathogenic fungus, *Beauveria bassiana* (Bals), against *Aphis crassivora* Koch and *Bemesia tabaci*, Gennandius. J. Applied Entomol., 122: 397-399.
33. Gindin, G., N.U. Geschtovt, B. Raccah and I. Barash, 2000. Pathogencity of *Verticillium lecanii* to different developmental stages of the silverleaf whitefly, *Bemisia argentifolii*. Phytoparasitica, 28: 229-239.
34. Abdel-Baky, N.F., H.A. El-Fadaly, M.E. El-Nagar, N.S. Arafat and R.R.H. Abd-Allah, 2005. Virulence and enzymatic activities of some entomopathogenic fungi against whiteflies and aphids. J. Agric. Sci., Mansoura Univ., 30: 1153-1167.
35. Abdel-Raheem, M., I.E.S. Abd El-Rahman and N.F. Reyad, 2016. Entomopathogenic Fungi. Lambert Academic Publishing, Germany, ISBN: 978-3-659-91451-5, Pages: 120.
36. Abdel-Raheem, M., 2016. Control of Potted Ornamental Insect Pests. Lambert Academic Publishing, Germany, ISBN-13: 978-3-659-82600-9, Pages: 72.
37. Abdel-Raheem, M.A., N.F. Reyad, L.A. Al-Shuraym and I.E. Abdel-Rahman, 2016. Nano entomopathogenic fungi as biological control agents on cabbage worm, *Pieris rapae* L. (Lepidoptera: Pieridae). Der Pharm. Chem., 8: 93-97.
38. Abdel-Raheem, M., 2015. Insect Control by Entomopathogenic Fungi and Chemical Compounds. Lambert Academic Publishing, Germany, ISBN-13: 978-3-659-81638-3, Pages: 76.
39. Sabbour, M. and M. Abdel-Raheem, 2015. Toxicity of the fungus *Beauveria bassiana* and three oils extract against *Sitophilus granaries* under laboratory and store condition. Am. J. Innov. Res. Applied Sci., 1: 251-256.