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Evaluation of Indigenous Endophytic *Beauveria bassiana* UHSB-END1 against Grape Mealy Bug *Maconellicoccus hirsutus* (Green)

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ABSTRACT

Grapes (*Vitis vinifera*), a crop of immense global importance, are cultivated for various purposes, including fresh consumption and processed products. However, grape cultivation faces critical challenges from insect pests such as mealybugs (*Maconellicoccus hirsutus*), which cause severe yield and quality losses, increase pesticide dependence and contribute to environmental degradation. Sustainable pest management strategies, such as the use of entomopathogenic fungi, has emerged as promising alternative to chemical pesticides, addressing these challenges while supporting eco-friendly agricultural practices. This study assessed the efficacy of endophytic *Beauveria bassiana* UHSB-END1, as a biological control agent against mealybugs in Thompson Seedless grapevines. Field experiment employed soil drenching, foliar sprays and combination of both treatments. The combination treatment having the highest efficacy of 96.79% reduction compared to untreated controls, while foliar sprays and soil drenching individually showed notable pest suppression. The integration of biological controls into pest management programs not only minimizes environmental impacts but also supports biodiversity and long-term vineyard health. To further enhance its applicability, optimization of *B. bassiana* formulations and delivery methods is recommended to ensure consistent performance across varying climatic conditions.

Keywords: *Beauveria bassiana,* Biological Control, Endophyte,Grape, Mealy bugs.

INTRODUCTION

Grapes (*Vitis vinifera*) are among the most extensively cultivated and economically important fruit crops worldwide, with a history of cultivation spanning several millennia (Singh and Singh, 2024). Originating in the Near East, grapes are now grown across diverse climatic zones, from temperate to subtropical regions, serving as the cornerstone for wine production, fresh consumption and processed goods such as raisins, juices and jams (This *et al,* 2006). Beyond their commercial significance, grapes are highly valued for their phytochemical composition, which has become a focal point of research due to its health-promoting properties (Singh and Kaur, 2018). They are rich in bioactive compounds such as phenolic acids, flavonoids, tannins and stilbenes (e.g., resveratrol), which exhibit antioxidant, anti-inflammatory and cardioprotective effects (Kandylis, 2021). These compounds not only contribute to the sensory and nutritional quality of grape-based products but also support their role in addressing global health and wellness concerns.

Grapes have also emerged as a model system for studying plant physiology and stress responses due to their sensitivity to environmental stressors, including drought, salinity and temperature fluctuations. Advances in genomics and transcriptomics have facilitated significant progress in grapevine breeding programs, enabling the development of varieties with enhanced biotic and abiotic stress tolerance, higher yields and superior quality traits (Ollat *et al,* 2018). As the demand for sustainable agriculture and functional foods continues to rise, the multidisciplinary study of grapes offers insights into their biological, nutritional and ecological significance.

However, grape production faces substantial challenges from insect pests, which threaten both the quality and quantity of yields. Pests such as the Mealybugs (*Maconellicoccus hirsutus*), Thrips (*Frankliniella occidentalis*) Grapevine Moth (*Lobesia botrana*) and Grape Phylloxera (*Daktulosphaira vitifoliae*), cause extensive damage to vines by feeding on leaves, stems, flowers and fruit, thereby impairing

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photosynthesis, reducing fruit set and rendering produce unmarketable (Mani *et al,* 2008). In addition to direct economic losses, pest infestations increase production costs through higher pesticide usage, which often leads to pesticide resistance, environmental contamination and harm to beneficial organisms (Shabeer *et al,* 2022; Shabeer *et al,* 2024). Long-term effects of pest outbreaks, such as vineyard destruction by phylloxera or secondary infections like Botrytis bunch rot, further compound these issues (Granett *et al,* 2001). The socioeconomic implications are particularly acute for smallholder farmers lacking access to integrated pest management (IPM) or advanced pest control strategies. Yield reductions and quality deterioration can result in lower market prices, reduced income and financial instability. Effective pest management, emphasizing biological controls, resistant cultivars and precision agriculture technologies, is crucial for minimizing these impacts (Sinno *et al,* 2021).

Among biological control methods, entomopathogenic fungi such as *Beauveria bassiana* have garnered attention for their eco-friendly pest management capabilities. *B. bassiana* infects pests through spore contact, employing enzymes like chitinases and proteases to penetrate the host cuticle and proliferate internally, ultimately causing death (Vega, 2018). This fungus has demonstrated efficacy against various pests, including mealybugs, aphids and grapevine moths, making it a valuable tool in IPM strategies (Faria and Wraight, 2007). Studies indicate its effectiveness in managing mealybugs, which are vectors for grapevine leafroll-associated virus (GLRaV), thereby improving grapevine health and yield (Pietersen *et al,* 2017). Furthermore, *B. bassiana* formulations can be optimized for diverse climatic conditions, enhancing their application in varied agricultural systems (Inglis *et al,* 2001). Despite these advantages, environmental factors such as temperature, humidity and UV exposure can influence its field performance, necessitating improved delivery systems and formulation technologies (Jaronski, 2010; Yogananda *et al,* 2023). The adoption of *B. bassiana* offers economic and ecological benefits, including reduced pesticide residues, enhanced biodiversity and alignment with consumer demand for sustainable agricultural practices. The integration of biological controls like *B. bassiana* (UHSB-END1) into insect pest management programs represents a promising step toward sustainable grape production. By mitigating the negative impacts of pests while reducing dependence on chemical pesticides, these strategies hold potential for improving the resilience, productivity and environmental sustainability of viticulture systems globally.

MATERIALS AND METHODS

A study was conducted to evaluate the endophytic nature of *B. bassiana* and its efficacy against major insect pests of grape at Main Horticultural Research and Extension Centre, College of Horticulture, Bagalkot, University of Horticultural Sciences, Bagalkot, Karnataka (16.16°N, 75.61° E and 563 m above MSL) during October, 2023 to February, 2024. Grape variety Thompson Seedless was used for field level studies. The crop was maintained according to the package of practice of University of Horticultural Sciences, Bagalkot. The treatments were imposed after 10 days of forward pruning. Five treatments with four replications were laid out in a Randomized Block Design (RBD) (Table 1). The treatments were imposed after 10, 30, 60 and 90 days after forward pruning. Observations on mealy bug colonies (adults and nymphs) were recorded and expressed as number per vine. Three vines were selected randomly in each replication, in each vine top, middle and bottom leaves were selected for recording observation on pest population. For mealybugs pre-treatment counts was made a day before treatment and post treatment counts was made at 3, 7 and 10 days after application of treatments.

Further, the Henderson and Tilton (1955) formula was used to calculate the reduction in pest population over control.

$$\text{Reduction in pest population (\%)} = 100 \times \left[1 - \left(\frac{\text{Ta x Cb}}{\text{Tb x Ca}}\right)\right]$$

Where, Ta = Population in treatment plot after spray

Ca = Population in control plot after spray

Tb = Population in treatment plot before spray

Cb = Population in control plot before spray

Statistical analysis

The data on mealy bug colonies was subjected to square root transformation was analysed by ANOVA of the randomised complete block design and means were compared at p ≤0.05 CD using Duncan's multiple range test (DMRT). Web Based Agricultural Statistics Software Package (WASP v. 2.0) was used for all the statistical analysis.

RESULTS AND DISCUSSION

First and second application

There were no mealybug colonies during first and second application of treatments. The distribution of mealybug colonies among the different treatment a day before the imposition of treatment was uniform with non-significant difference. The application of *B. bassiana* treatments in early stages of plants as propellant method under the field level. In the present study, there was no mealybug colonies during bud initiation period after forward pruning (October 2023) might be due to lesser vegetative and reproductive growth of plants and also unfavorable environmental conditions like high rain fall, low temperature and high relative humidity which led to absence of insect pest population during first and second application of treatments. However, after panicle initiation and fruit setting the mealybugs infestation gradually increased. Application of *B. bassiana* UHSB-END1 treatments at regular interval during crop growth till harvesting led to the decline in mealy bug population in the early phase.

Third application

There was significant reduction in mealybug colonies with compared to untreated control in three days after treatment imposition. Among the different treatment the lowest mealybug colonies was noticed in combination treatment (5.00 per vine) which followed by foliar spray (5.25 mealybugs per vine), soil drenching (5.75 mealybugs per vine) and recommended package of practices with 5.75 per vine. The untreated control again recorded highest mealy bug colonies (7.50 per vine). Application of treatments (7 DAT) significantly reduced grape mealybug colonies was found in combination treatment (4.25 per vine). The soil drenching (5.00 per vine) and foliar spray (4.75 per vine) treatment both are on par with other. The recommended package of practices was recorded 5.50 mealybugs per vine. However, they were significantly superior over untreated control which registered 7.75 mealybugs per vine. The combination treatment consistently proved to be superior over other treatment recording 3.25 mealy bugs per vine (10 DAT) and followed by foliar spray with 4.25 per vine. The soil drenching (4.50 per vine) was on per with recommended package of practices by registering 5.25 mealybugs per vine, however found to be superior over untreated control which recorded 8.25 mealybugs per vine.

Fourth application

One day before the imposition of the treatment during fourth application, significantly highest mealybug colonies were observed untreated control (8.75 per vine) followed by recommended package of practices (5.50 per vine). The lowest thrips population was noticed in combination of treatments (2.75 mealybug colonies/vine). Three days after treatment, there was significant variation among different treatments. The combination treatment was on top by recording 1.75 mealy bug colonies per vine. The foliar spray with 2.50 mealy bug colonies per vine, soil drenching with 3.50 mealy bug colonies per vine and recommended package of practices with 5.00 mealy bug colonies per vine were significantly superior over untreated control (9.50 mealybug colonies/vine). After the imposition of treatments (7 DAT) significantly lowest mealybug colonies were noticed in combination treatment (1.00 per vine). Followed by, foliar spray (1.50 per vine), soil drenching (2.25 mealybug colonies/vine) and recommended package of practices (4.25 mealybug colonies/ vine) which differed statistically with each other and were significantly superior over untreated control (10.25 per vine). Ten days after fourth application of treatments, the combination treatment proved to be the best among other treatments with lowest mealybug colonies (0.25 per vine). The foliar spray and soil drenching were on per with other by recording 0.75 and 1.50 thrips per three leaves, respectively. Recommended package of practices was significantly inferior over other treatment by registering 3.50 mealybug colonies per vine. However, found to be superior over untreated control which recorded 10.75 mealybugs per vine.

Per cent population reduction over control

Overall reduction of the thrips population over the control was calculated and it was observed that, the highest population reduction was achieved in combination of treatments with 96.79 per cent. Whereas, foliar spray with 91.20 per cent followed by soil drenching 83.81 per cent. However, minimum of 62.23 per cent reduction was observed in recommended package of practices. The indigenous isolate *B. bassiana* UHSB-END1 effectively colonized various grape leaf tissues across different planting material. In this study, a strong symbiotic relationship was observed between the endophytic isolate and the grape plants during the active growth phase, regardless of the colonization method used (soil drenching, foliar spray or a combination). The highest colonization rates were recorded during the early stages of plant growth. (Jaber, 2015; Mantzoukas, 2021).

These results are in line with findings of Rondot and Reineke (2018) who reported the reduction in grape mealy bug infestation by Endophytic *B.*

Table 1: Treatment details for evaluation of *B. bassiana* UHSB-END1 against mealy bugs under field conditions.

Treatment	Detail	Dosage
T_1	Soil drenching	10g/le
T_2	Foliar Spray	5g/l
T_3	Combination of treatments	10+5g/l
T_4	Recommended package of practices of UHS, Bagalkot	_
T_5	Untreated control	_

Table 2: Bio-efficacy of *Beauveria bassiana* UHSB-END1 against grape mealy bug (*Maconellicoccus hirsutus*) during 2023-24 (third application)

Treatment	Dosage (g/ml)	Number of mealy bug population (per vine)				
		1 DBT	3 DAT	7 DAT	10 DAT	Mean
T_1- Soil drenching	10	6.25 (2.49)	5.75 (2.39) ^{b}	5.00 (2.23)^{bc}	4.50 (2.12)^{bc}	5.38
T_2- Foliar spray	5	5.75 (2.39)	5.25 (2.29) ^{b}	4.75 (2.18)^{bc}	4.25 (2.06) ^{c}	5.00
T_3- Combination of treatments (T_1+T_2)	10+5	5.25 (2.28)	5.00 (2.23) ^{b}	4.25 (2.06) ^{c}	3.25 (1.80) ^{d}	4.44
T_4- Recommended package of practice	-	6.25 (2.49)	5.75 (2.40) ^{b}	5.50 (2.34) ^{b}	5.25 (2.29) ^{b}	5.69
T_5- Untreated control	-	7.25 (2.69)	7.50 (2.73) ^{a}	7.75 (2.79) ^{a}	8.25 (2.87) ^{a}	7.69
S. Em ±	-	-	0.09	0.09	0.01	-
C. D. at 5%	-	-	0.24	0.24	0.20	-
CV (%)	-	-	6.45	6.70	5.74	-

Table 3: Bio-efficacy of *Beauveria bassiana* UHSB-END1 against grape mealy bug (*Maconellicoccus hirsutus*) during 2023-24 (fourth application)

Treatment	Dosage (g/ml)	Number of mealy bug population (per vine)				
		1 DBT	3 DAT	7 DAT	10 DAT	Mean
T_1- Soil drenching	10	4.25 (2.06) ^{c}	3.50 (1.87) ^{c}	2.25 (1.65) ^{c}	1.50 (1.40) ^{c}	2.88
T_2- Foliar spray	5	3.75 (1.93) ^{c}	2.50 (1.57) ^{cd}	1.50 (1.40) ^{cd}	0.75 (1.10) ^{cd}	2.13
T_3- Combination of treatments (T_1+T_2)	10+5	2.75 (1.65) ^{d}	1.75 (1.31) ^{d}	1.00 (1.18) ^{d}	0.25 (0.84) ^{d}	1.44
T_4- Recommended package of practice	-	5.50 (2.34) ^{b}	5.00 (2.23) ^{b}	4.25 (2.18) ^{b}	3.50 (2.00) ^{b}	4.56
T_5- Untreated control	-	8.75 (2.96) ^{a}	9.50 (3.08) ^{a}	10.25 (3.28) ^{a}	10.75 (3.35) ^{a}	9.81
S. Em ±	-	0.09	0.11	0.13	0.01	-
C. D. at 5%	-	0.24	0.29	0.35	0.20	-
CV (%)	-	7.10	9.49	11.85	5.74	-

bassiana. The *B. bassiana* was detected as an endophyte in mature grapevine plants up to five weeks after last application with significant reduction of infestation with grape leafhopper. Moloinyane and Nchu (2019) noticed the reduction of mealy bugs incidence in grape plant due the volatile compounds produced by endophytic *B. bassiana.* Kanitkar *et al* (2020) evaluated the bio-efficacy of Brigade-BL (*B. bassiana*) under field conditions as an entomopathogenic fungi mealy bugs (*M. hirsutus*) on Thompson Seedless grapes during 2014-15, wherein they found the drastic reduction in mealy bug population to the tune of 67.82 per cent in the foundation pruning compared to untreated control. Sayed *et al* (2020) highlighted the regional specificity of isolates and reported on the virulence of two EPF isolates, Bb-Taif1 and Bb-Taif2, when colonized endophytically in grapevine. Among the two, Bb-Taif1 was more effective and caused higher mortality in the aphid *A. illinoisensis* compared to Bb-Taif2. Similarly, Rasool *et al* (2021) demonstrated that colonization by *M. robertsii* and *B. bassiana* significantly reduced the population of the two-spotted spider mite 15 days after infestation.

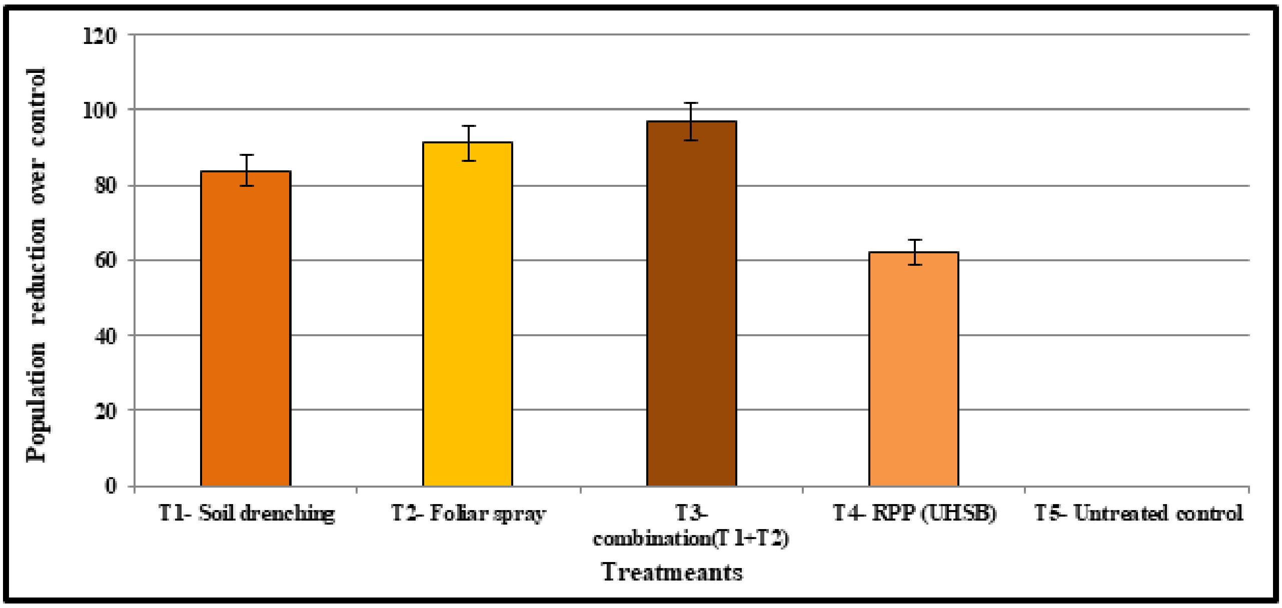

Fig. 1: Influence of endophytic *Beauveria bassiana* UHSB-END1 in reducing mealybug population over control

CONCLUSION

This study reinforced the critical role of entomopathogenic fungi in fostering resilience and sustainability in viticulture systems, providing a pathway for more environmentally conscious and economically viable grape production. The efficacy of *Beauveria bassiana* UHSB-END1 as a potential biological control agent against grape mealybug (*Maconellicoccus hirsutus*), achieving a reduction in pest population. The endophytic colonization of grapevine tissues by *B. bassiana* further enhanced plant resilience, aligning with sustainable agricultural practices. Environmental factors such as temperature and humidity influenced pest dynamics, suggesting the need for improved formulations for broader applicability. These findings support the integration of *B. bassiana* UHSB-END1 into Integrated Pest Management (IPM) strategies to enhance grapevine health, reduce environmental impacts and promote sustainable viticulture. Future research should explore its optimization under diverse climatic conditions for long-term viability.

REFERENCES

De Faria M R and Wraight S P (2007). Mycoinsecticides and mycoacaricides: a comprehensive list with worldwide coverage and international classification of formulation types. *Biocontrol* **43**(3): 237-256.

Granett J, Walker M A, Kocsis L and Omer A D (2001). Biology and management of grape phylloxera. *An Rev Entomol* **46**(1): 387-412.

Henderson C F and Tilton E W (1955). Test with acaricides against the brown wheat mite. *J Econ Ento* **48**: 157-161.

Inglis G D, Goettel M S, Butt T M and Strasser H (2001). Use of hyphomycetous fungi for managing insect pests. In *Fungi as biocontrol agents: progress, problems and potential* (23-69). Wallingford UK: CABI publishing.

Jaber L R (2015). Grape vine leaf tissue colonization by the fungal entomopathogen *Beauveria bassiana* and its effect against downy mildew. *Bio Control* **60**: 103-112.

Jaronski S T (2010). Ecological factors in the inundative use of fungal entomopathogens. *Bio Control* **55**: 159-185.

Kandylis P (2021). Grapes and their derivatives in functional foods. *Foods* **10**(3): 672.

Kanitkar S, Raut V M, Sawant S D, Yadav D S, Kulkarni M and Kadam M (2020). Field bio-efficacy of "Brigade-BL" (*Beauveria bassiana*) an Entomopathogenic fungi for the management of mealy bugs on Thompson Seedless Grapes. *Int J Res App Sci Biotech* **7**(5): 306-314.

Mani M, Kulkarni N S, Banerjee K and Adsule P G (2008). Pest management in grapes. National Research Centre on Grapes. *Ext Bulletin* **2**: 44.

Mantzoukas S, Lagogiannis I, Mpousia D, Ntoukas A, Karmakolia K, Eliopoulos P A and Poulas K

(2021). *Beauveria bassiana* endophytic strain as plant growth promoter: The case of the grape vine *Vitis vinifera*. *J Fungi* **7**(2): 142-146.

Moloinyane S and Nchu F (2019). The effects of endophytic *Beauveria bassiana* inoculation on infestation level of *Planococcus ficus*, growth and volatile constituents of potted greenhouse grapevine (*Vitis vinifera* L.). *Toxins* **11**(2): 72.

Ollat N, Cookson S J, Destrac-Irvine A, Lauvergeat V, Ouaked-Lecourieux F, Marguerit E, Barrieu F, Dai Z, Duchêne E, Gambetta G A and Gomès E (2018). Grapevine adaptation to abiotic stress: An overview. In *XII International Conference on Grapevine Breeding and Genetics* **1248**: 497-512.

Pietersen G, Bell V A and Krüger K (2017). Management of Grapevine Leafroll Disease and Associated Vectors in Vineyards. In: Meng, B., Martelli, G., Golino, D., Fuchs, M. (eds) Grapevine Viruses: Molecular Biology, Diagnostics and Management.

Rasool S, Cardenas P D, Pattison D I, Jensen B and Meyling N V (2021). Isolate- specific effect of entomopathogenic endophytic fungi on population growth of two-spotted spider mite (*Tetranychus urticae* Koch) and levels of steroidal glycoalkaloids in tomato. *J Chem Ecol* **47**(4): 476-488.

Rondot Y and Reineke A (2018). Endophytic *Beauveria bassiana* in grapevine *Vitis vinifera* (L.) reduces infestation with piercing-sucking insects. *Bio Control* **116**: 82-89.

Sayed S, El-Shehawi A, Al-Otaibi S, El-Shazly S, Al-Otaibi S, Ibrahim R, Alorabi M, Baazeem A and Elseehy M (2020). Isolation and efficacy of the endophytic fungus, *Beauveria bassiana* (Bals.) Vuillemin on grapevine aphid, *Aphis illinoisensis* Shimer (Hemiptera: Aphididae) under laboratory conditions. *Egypt J Biol Pest Control* **30**(1): 1-7.

Shabeer S, Asad S, Jamal A and Ali A (2022). Aflatoxin contamination, its impact and management strategies: an updated review. *Toxins* **14**(5): 307.

Shabeer T A, Hingmire S, Taynath B, Deshmukh U, Somkuwar R and Sharma A K (2024). Fate of multi-residue insecticides and their metabolites in the process of vinification: Analytical method validation, dissipation kinetics, processing factor and risk assessment. *Environ Pollut* **352**: 124-132.

Singh G and Singh N (2024). Effect of plant growth regulators effect on grape cutting (*Vitis vinifera* L.) cv. flame seedless. *J Krishi Vigyan* **12**(4): 827-830.

Singh N and Kaur G (2018). Study on time and method of grafting on the graft success in grape. *J Krishi Vigyan* **6**(2): 264-271.

Sinno M, Ranesi M, Di Lelio I, Lacomino G, Becchimanzi A, Barra E, Molisso D, Pennacchio F, Digilio M C, Vitale S and Turra D (2021). Selection of endophytic *Beauveria bassiana* as a dual biocontrol agent of tomato pathogens and pests. *Patho* **10**(10): 1242.

This P, Lacombe T and Thomas M R (2006). Historical origins and genetic diversity of wine grapes. *TiG* **22**(9): 511-519.

Vega F E (2018). The use of fungal entomopathogens as endophytes in biological control: a review. *Mycologia* **110**(1): 4-30.

Whalon M E, Mota-Sanchez D and Hollingworth R M (2008). Analysis of global pesticide resistance in arthropods. In *Global pesticide resistance in arthropods* (5-31). Wallingford UK: CABI.

Yogananda T, Ramanagouda S H, Venkateshalu B, Jamunarani G S, Rashmi S H, Awati M and Hadimani H P (2023). Colonization and endophytic effect of *Beauveria bassiana* (Bals.-Criv.) Vuill. UHSB-END1 against *Myzus persicae* (Sulzer) and *Plutella xylostella* (L.) in cabbage. *Egyptian J Biol Pest Control* **33**(1): 47.

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