Journal of Biological Control, 33(2): 155-159,2019, DOI: 10.18311/jbc/2019/22605

Research Article

Evaluation of entomopathogenic fungi against sucking pests of *Bhut Jalakia*

RUDRA N. BORKAKATI[1*], D. K. SAIKIA[1] and B. RAMANUJAM[2]

[1]*Department of Entomology, Assam Agricultural University, Jorhat - 785013, Assam, India*

[2]*ICAR-National Bureau of Agricultural Insect Resources, H. A. Farm Post, Bellary Road, Hebbal, Bengaluru - 560024, Karnataka, India*

[*]*Corresponding author E-mail:* rnbk.agri@gmail.com

ABSTRACT: Experiment was conducted to evaluate the efficacy of six different strains of entomopathogenic fungi and one insecticide molecule against sucking pests of *Bhut Jalakia* during 2014-15 to 2016-17. *Bhut Jalakia* is one of the hottest chillis in the world, grown extensively in Assam, Nagaland and Manipur. *Aphis gossypii* Glover, *Scirtothrips dorsalis* Hood and *Bemisia tabaci* (Genn.) are the major sucking pests of *Bhut Jalakia* inflicting damage right from planting to fruiting stages of the crop. Three rounds of biopesticides @ 1×10^8 spores/gm and insecticide (imidacloprid 17.8 SL @ 20 gm a.i./ha) imposed at 3 weeks interval against the pests revealed that imidacloprid 17.8 SL could significantly reduce the mean population of *A. gossypii* (4.64); *S. dorsalis* (2.03) and *B. tabaci* (0.28), closely followed by *Beauveria bassiana* (NBAIR-Bb-5a) with 7.20, 3.07 and 0.64 per 10 leaves and both the treatments were on par in their efficacy after third spray. The rest of the entomopathogenic fungi were more or less effective in reducing the sucking pests and statistically at par with each other compared to untreated control plot. Highest yield of 52.64 q/ha recorded in imidacloprid treated plot followed by NBAIR strain of Bb-5a with 45.85 q/ha and had no any significant difference from each other. Minimum yield of 26.78 q/ha was obtained in untreated control plot.

KEY WORDS: *Bhut Jalakia*, biopesticides, entomopathogenic fungi, sucking pests

(Article chronicle: Received: 02-09-2018; Revised: 18-02-2019; Accepted: 25-02-2019)

INTRODUCTION

Bhut Jalakia, *Capsicum chinense* Jacq., is one of the hottest chillis in the world, and at the same time has a pleasant and palatable aroma. *Bhut Jalakia* is a inter specific hybrid between *Capsicum chinense* and *C. frutescens*. It is believed to have originated in North-east India. The heat value of *Bhut Jalakia* is 1,001,304 SHU, which is due to presence of a volatile phenolic amine Capsaicin and dihydrocapsaicin (Sanatombi and Sharma, 2008). In 2007, Guinness Records certified the *Bhut Jalakia* as the world's hottest chilli pepper, which was 400 times hotter than Tabasco sauce (Baruah *et al.,* 2014). The Assamese word '*Bhut*' refers to the typical, large pod size, with high hotness in the fruits (Bhagowati and Changkija, 2009).

The key reasons of drastic reduction of yield of chilli are due to heavy infestations of different types of sucking pests. At vegetative and flowering stage, the crop is the most vulnerable to sucking pests. However, *Bhut Jalakia* also attacked by almost same kinds of sucking pests of chilli, *viz*., aphids, *Myzus persicae* Sulzer, *Aphis gossypii* Glover; mites, *Polyphagotarsonemus latus* Banks; thrips, *Scirtothrips dorsalis* Hood, and jassid, *Amrasca biguttula biguttula* Ishida (Berke and Sheih, 2000; Begam *et. al.,* 2016; Buragohain *et. al.,* 2017). Indiscriminate and unplanned application of the pesticides by the growers has led to the development of many undesirable problems which become a threat to chilli ecosystem causing resurgence of pest, environmental problems, residues and destruction of natural enemy fauna, etc. The residue of ethion and chlorpyrifos was recorded in chillies even after one month of the first application to manage the sucking pests during the vegetative growth of the crop (Mahalingappa *et al.,* 2006). Besides health hazard and environmental pollution, hot quality of *Bhut Jalakia* is also gradually decreased due to the heavy use of synthetic chemicals including fertiliser and pesticides. Hence, this has promoted research to develop an alternative management strategy which would be safer, effective and economical. Moreover, biological control is now becoming very popular in insect pests control owing to its ecofriendly nature. Entomopathogenic fungi may play a pivotal role to manage the insect pests as safe alternatives to synthetic insecticides. Keeping all these points in view, an effort was made to study the efficacy of certain entomofungal pathogens for management of sucking pests of *Bhut Jalakia*.

MATERIALS AND METHODS

The Experiment was laid out at Randomised Block Design (RBD) in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2014-15, 2015-16 and 2016-17. *Bhut Jalakia* variety "Raja" (local) was raised in 10.5 m^2 plot containing 8 treatments including control and was replicated 4 times. To evaluate the effect of entomopathogenic fungi, *viz*., *Metarhizium anisopliae* (AAU-Biometa; MRC-0314), *M. anisopliae* (NBAIRMa-4; NCBI Acc. JF837157 and NBAIRMa-35, NCBI Acc. JQ518481), *Beauveria bassiana* (Biosona; MTCC- 25040) and *B. bassiana* (NBAIRBb-5a; NCBI Acc. JF837134 and NBAIRBb-23; NCBI Acc. JF837082) against sucking pests of *Bhut Jalakia* were used. Moreover, for comparison with chemical, imidacloprid 17.8 SL @ 20 gm a.i./ha was selected in addition to an untreated control check. control check. The entomopathogenic fungi belonged to the culture collection of Assam Agricultural University, Jorhat and National Bureau of Agricultural Insect Resources, Bengaluru. The powder based formulations of these fungi were prepared by Talc formulation was prepared by inoculating one loopful of culture in autoclaved potato dextrose broth (PDB) and incubated for 8 days at 26˚C, 150 RPM in incubator shaker. The culture was mixed in 1:1 ratio (sterilized Talc: culture) and dried for 2-3days. Moisture was checked for 8% and packed for further use. The talc formulation contains 1 x 108 cfu/gram where dose is recommended as 5 grams /liter (Ali Derakshan, 2008).

All the plants were subjected to three rounds of foliar sprays of insecticide and bio-pesticide and first were started in 0 (Zero) days of planting and subsequent sprays were imposed at 3 weeks intervals in morning hour without contaminating the adjacent plots. The untreated plots were sprayed with water only.

The population of aphids (*Aphis gossypii)*, thrips (*Scirtothripsdorsalis*), and white fly (*Bemisia tabaci*) was recorded from five randomly selected plants considering ten leaves from upper, middle and bottom, one day before and 3rd, 7th and 10th day after spraying. Picking of mature fruits was collected at 7-day interval and weight of the healthy fruits was recorded.

RESULTS AND DISCUSSION

Impact of various entomopathogenic fungi (1×10^8 spores/gm @ 5g/l) along with imidacloprid 17.8 SL @ 20 g. a.i./ha (0.4 ml/l) taken as standard check against sucking pests of *Bhut Jalakia* is presented in table 1, 2 and 3. Perusal of data revealed that the population of different sucking pests was at par during pre-spraying in different treatments. Among the various treatments evaluated against *Bhut Jalakia*, imidacloprid was the most effective and proved to be the best in reducing the population of aphid with 6.25, 4.67 and 3.00 during 2014-15, 2015-16 and 2016-2017, respectively, after third spray. However, it was closely followed by NBAIRBb-5a with 8.50 aphids per 10 leaves and showed no any significant difference between them in their efficacies after 3rd spray during 2014-15, during 2015-16 and 2016-17, NBAIRBb-5a was also, the next best treatment with 8.00 and 5.10 aphid per 10 leaves when compared with imidacloprid 17.8 SL. The rest of the entomopathogenic fungi were found to be more or less equally effective in reducing the aphid population of *Bhut Jalakia* compared to untreated control plot where the aphid population per 10 leaves were 32.00, 24.00 and 15.85 during all the crop seasons (Table 1). The effectiveness of imidacloprid 17.8 SL @ 20 g. a.i./ha (0.4 ml/l) against aphids of chilli had also been observed by Patil *et al.* (2002).

The same results in reducing *Aphis gossypii* by *Verticillium lecanii* and *Beauveria bassiana* was also reported by (Loueiro and Moino, 2006; Kim *et al.,* 2013; Jandricic *et al.,* 2014; Lee *et al.,* 2015; Eidy *et al.,* 2016). Highest mortality of chilli aphid was also achieved due to application of imidacloprid 17.8SL after three days of insecticide spray (Das, 2013).

The same trend of results was also obtained by imidacloprid 17.8SL in suppressing *Scirtothrips dorsalis* and *Bemisia tabaci* compared to different entomopathogenic fungi tested in the experiments during 2014-15 to 2016-17. The lowest number of S. *dorsalis* was recorded 1.25, 2.72 and 2.13 per 10 leaves during the different crop seasons in the imidacloprid 17.8SL treated plot. Similarly, the population of *B. tabaci* in imidacloprid 17.8SL treated plot was 0.78, 0.76 and 0.80 per 10 leaves after third spray. Amongst the different entomopathogenic fungi, the next best treatment was NBAIR strain Bb-5a, where the *S. dorsalis* and *B. tabaci* population per 10 leaves were 2.50, 3.58, 3.13 and 0.67, 0.63, 0.64, respectively, during different crop seasons. As regards to other entomopathogenic fungi, all the biopesticides showed a significant difference in reducing the population of *S. dorsalis* and *B. tabaci* over the untreated control plot, where the maximum population of *S. dorsalis* (15.50, 12.50 and 13.60) and *B. tabaci* (2.25, 2.30 and 2.27) per 10 leaves was recorded during 2014-15 to 2016-17 (Table 2 and 3).

The present findings were in conformity with Patil *et al.* (2002) who reported that imidacloprid 17.8 SL was highly effective against sucking pest complex in chilli. Similarly, Jagdish and Purnima (2011) reported that application of

Table 1. Effect of entomopathogenic fungi against *Aphis gossypi*

Treatments	2014-15				2015-16				2016-17				Pooled Mean		
	Pre treat-ment count	Post treatment count *			Pre treat-ment count	Post treatment count *			Pre treat-ment count	Post treatment count *			Post treatment count		
		Ist spray	IInd spray	IIIrd spray		Ist spray	IInd spray	IIIrd spray		Ist spray	IInd spray	IIIrd spray	Ist spray	IInd spray	IIIrd spray
Metarhizium anisopliae (AAU-Biometa)	25.00	20.25^{b}	15.25^{b}	12.00^{b}	21.56	14.83^{bc}	12.25^{cd}	10.75^{bc}	14.55	11.45^{b}	8.00^{bc}	7.00^{b}	15.51	11.83	9.92
B. bassiana (AAU-Biosona)	22.00	18.00^{bc}	14.75^{bc}	11.00^{bc}	19.75	13.67^{c}	12.25^{cd}	10.00^{c}	15.10	11.85^{b}	8.30^{b}	7.05^{b}	14.51	11.77	9.35
M. anisopliae (NBAIRMa-4)	21.00	16.75^{cd}	14.50^{bcd}	11.25^{bcd}	19.72	14.17^{c}	13.67^{b}	9.91^{c}	14.95	11.00^{bc}	7.45^{c}	7.00^{b}	13.97	11.87	9.39
M. anisopliae (NBAIRMa-4)	20.50	16.75^{cd}	12.75^{cd}	10.25^{bc}	22.59	16.17^{b}	15.42^{b}	11.08^{b}	14.30	10.95^{bc}	7.55^{c}	7.05^{b}	14.62	11.91	9.46
Beauveria bassiana (NBAIRBb-5a)	21.00	15.75^{cd}	12.00^{e}	8.50^{de}	21.42	11.50^{d}	11.17^{d}	8.00^{d}	14.00	7.95^{d}	6.45^{d}	5.10^{c}	11.73	9.87	7.20
B. bassiana (NBAIBb-23)	21.5	17.75^{bc}	12.50^{de}	9.00^{d}	20.17	11.33^{d}	9.84^{e}	8.75^{d}	14.65	10.25^{c}	7.55^{c}	7.30^{b}	13.11	9.96	8.35
Imidacloprid 17.8 SL	21.75	14.50^{d}	9.00^{f}	6.25^{e}	20.34	8.33^{e}	6.33^{f}	4.67^{e}	15.68	5.30^{e}	4.15^{e}	3.00^{d}	9.38	6.49	4.64
Untreated control	23.75	27.75^{a}	27.00^{a}	32.00^{a}	18.92	21.00^{a}	22.00^{a}	24.00^{a}	14.25	14.80^{a}	16.40^{a}	15.85^{a}	21.18	21.80	23.95
CD=0.05	NS	2.60	2.03	2.25	NS	1.99	1.21	1.11	NS	1.01	0.70	0.70	2.58	2.52	4.07
CV %		9.61	9.37	12.21		9.75	6.41	6.92		6.58	5.76	6.42	10.32	12.05	22.59

Means followed by the same letter in a column are not significantly different
*Count/10 leaves

Table 2. Effect of entomopathogenic fungi against *Scirtothrips dorsalis*

Treatments	2014-15				2015-16				2016-17				Pooled Mean		
	Pre treat-ment count	Post treatment count *			Pre treat-ment count	Post treatment count *			Pre treat-ment count	Post treatment count *			Post treatment count		
		Ist spray	IInd spray	IIIrd spray		Ist spray	IInd spray	IIIrd spray		Ist spray	IInd spray	IIIrd spray	Ist spray	IInd spray	IIIrd spray
Metarhizium anisopliae (AAU-Biometa)	10.25	7.00^{b}	6.00^{b}	4.50^{b}	11.92	8.33^{b}	8.75^{b}	7.00^{b}	11.10	7.65^{bc}	7.75^{b}	7.60^{b}	7.66	7.50	6.37
Beauveria bassiana (AAU-Biosona)	11.00	6.50^{bc}	5.25^{bc}	3.50^{bc}	10.58	7.00^{c}	7.33^{c}	5.83^{c}	11.90	7.80^{b}	7.75^{b}	6.40^{c}	7.10	6.78	5.24
M. anisopliae (NBAIRMa-4)	10.50	5.25^{cd}	4.75^{cd}	3.50^{bc}	13.0	8.83^{b}	6.33^{cde}	5.33d^{c}	11.65	6.78^{c}	6.45^{c}	6.08^{c}	6.95	5.84	4.97
M. anisopliae (NBAIRMa-35)	12.25	6.50^{bc}	5.00^{c}	3.25^{cd}	12.92	9.83^{b}	6.42^{cd}	4.75^{de}	12.55	8.10^{b}	6.75^{c}	5.23^{d}	8.14	6.06	4.41
B. bassiana (NBAIRBb-5a)	9.50	3.50^{ef}	3.00^{de}	2.50^{cd}	13.75	7.08^{c}	5.58d^{e}	3.58^{gf}	12.70	6.65^{c}	4.45^{d}	3.13^{e}	5.74	4.34	3.07
B. bassiana (NBAIRBb-23)	10.75	4.25^{de}	3.25^{d}	3.00^{cd}	11.08	5.42^{d}	4.75^{e}	4.50^{ef}	10.65	6.75^{c}	5.40^{d}	5.15^{d}	5.47	4.47	4.22
Imidacloprid 17.8 SL	12.25	2.75^{f}	2.00^{e}	1.25^{d}	12.25	4.67^{d}	3.33^{f}	2.72^{g}	11.65	4.43^{d}	3.20^{e}	2.13^{f}	3.95	2.84	2.03
Untreated control	12.25	15.75^{a}	17.25^{a}	15.50^{a}	10.67	11.75^{a}	13.17^{a}	12.50^{a}	10.85	11.98^{a}	13.10^{a}	13.60^{a}	13.16	14.51	13.87
CD=0.05	NS	1.34	1.17	1.27	NS	1.11	1.03	1.07	NS	0.99	0.97	0.80	2.47	2.23	1.77
CV %		14.13	13.73	18.72		9.61	10.06	12.54		8.93	9.64	8.7	19.42	19.47	18.27

Means followed by the same letter in a column are not significantly different
*Count/10 leaves

Table 3. Effect of entomopathogenic fungi against *Bemisia tabaci*

Treatments	2014-15				2015-16				2016-17				Pooled Mean		
	Pre treat-ment count	Post treatment count *			Pre treat-ment count	Post treatment count *			Pre treat-ment count	Post treatment count *			Post treatment count		
		Ist spray	IInd spray	IIIrd spray		Ist spray	IInd spray	IIIrd spray		Ist spray	IInd spray	IIIrd spray	Ist spray	IInd spray	IIIrd spray
Metarhizium anisopliae (AAU-Biometa)	2.19	1.16^{c}	1.12^{c}	1.10^{b}	2.28	1.17^{cd}	1.15^{c}	1.13^{b}	2.18	1.20^{b}	1.14^{c}	1.13^{b}	1.17^{de}	1.13^{b}	1.12^{b}
Beauveria bassiana (AAU-Biosona)	2.18	1.10^{c}	1.12^{c}	1.05^{b}	2.30	1.13^{cd}	1.00^{d}	0.96^{c}	2.17	1.16^{de}	1.12^{c}	1.05^{b}	1.13^{de}	1.08^{b}	0.98^{c}
M. anisopliae (NBAIRMa-4)	2.20	2.05^{b}	1.11^{c}	1.13^{b}	2.34	1.98^{b}	1.16^{c}	1.17^{b}	2.25	2.00^{c}	1.20^{c}	1.13^{b}	1.72^{c}	1.15^{b}	1.14^{b}
M. anisopliae (NBAIRMa-35)	2.18	1.98^{c}	1.20^{c}	1.11^{b}	2.50	1.69^{b}	1.32^{b}	1.06^{bc}	2.30	2.10^{bc}	1.40^{b}	1.10^{b}	1.92^{b}	1.30^{b}	1.10^{b}

B. bassiana (NBAIRBb-5a)	2.25	1.11 ^{c}	1.90^{b}	0.67 ^{c}	2.32	1.05 ^{cd}	0.98 ^{d}	0.63 ^{d}	2.28	1.12 ^{e}	0.87 ^{d}	0.64 ^{d}	1.14 ^{de}	0.95 ^{b}	0.64 ^{d}
B. bassiana (NBAIRBb-23)	2.30	1.20 ^{c}	1.16 ^{c}	1.11 ^{b}	2.35	1.35 ^{c}	1.16 ^{c}	1.10^{bc}	2.20	1.30 ^{d}	1.18 ^{c}	1.10 ^{b}	1.28 ^{d}	1.16 ^{b}	1.10 ^{b}
Imidacloprid 17.8 SL	2.25	1.10 ^{c}	0.97^{d}	0.78 ^{c}	2.30	0.98 ^{d}	1.10 ^{c}	0.76 ^{d}	2.10	1.05 ^{e}	0.87 ^{d}	0.80 ^{c}	1.04 ^{e}	0.98 ^{b}	0.28 ^{e}
Untreated control	2.30	2.32^{a}	2.40^{a}	2.25 ^{a}	2.25	2.45 ^{a}	2.38 ^{a}	2.30 ^{a}	2.45	2.40 ^{a}	2.32 ^{a}	2.27 ^{a}	2.33 ^{a}	2.25 ^{a}	2.10 ^{a}
CD=0.05	0.07	0.23	0.19	0.17	0.06	0.31	0.09	0.14	0.08	0.14	0.10	0.09	0.15	0.38	0.05
CV %	2.14	10.45	9.43	9.81	1.71	14.36	4.59	8.14	2.56	6.32	5.40	5.14	5.80	6.49	2.40

Means followed by the same letter in a column are not significantly different
*Count/10 leaves

NSKE 2% recorded 74.37% mortality to thrips. Arthurs *et. al.* (2013) observed the maximum efficacy of *B. bassiana* and *M. anisopliae* against *S. dorsalis* compared to other biopesticides. According to Prabhu *et. al.* (2014), imidacloprid 17.8SL was the best treatments against sucking pests of chillies and was significantly superior to other insecticide molecules.

In respect of yield of *Bhut Jalakia,* the pooled mean data of three years clearly showed that (Table 4), the highest yield of 52.64 q/ha was recorded in imidacloprid 17.8 SL treated plot, this was closely followed by NBAIR strain of Bb-5a and Bb-23 with 45.85 and 41.23 q/ha, respectively .The yield of imidacloprid 17.8 SL (52.64 q/ha) was significantly superior to the other plots treated with entomopathogenic fungi. However, no significant difference was observed in between yield parameter of Bb-5a and Bb-23. It could be concluded that all the treatments tested against sucking pests of chilli brought a significant reduction of number of population of sucking pests contributed significantly higher yield as against untreated control.

Table 4. Effect of local and NBAIR strains on yield of *Bhut Jalakia*

Treatments	2014-15 (q/ha)	2015-16 (q/ha)	2016-17 (q/ha)	Pooled mean
Metarhizium anisopliae (AAU strain) - Biometa	28.75^{d}	31.00^{de}	31.88 ^{e}	30.54
Beauveria bassiana (AAU strain) - Biosona	40.20^{c}	34.63^{cd}	32.48 ^{e}	35.77
M. anisopliae (Ma-4) NBAIR strain	29.75^{d}	29.50^{e}	34.70 ^{d}	31.32
M. anisopliae (Ma-35) NBAIR strain	30.38^{d}	30.38^{e}	38.20 ^{c}	32.99
B. bassiana (Bb-5a) NBAIR strain	51.20^{ab}	42.00^{b}	44.35 ^{b}	45.85
B. bassiana (Bb-23) NBAIR strain	46.00 ^{b}	37.88^{c}	39.80 ^{c}	41.23
Imidacloprid 17.8 SL	53.83 ^{a}	50.75^{a}	53.33 ^{a}	52.64
Untreated control	26.75 ^{d}	24.13^{f}	29.45 ^{f}	26.78
CD =0.05	5.92	3.78	1.83	5.59
CV %	10.49	7.34	4.62	8.60

Means followed by the same letter in a column are not significantly different

All the entomopathogenic fungi evaluated during the course of study exhibited equally more or less efficacies in suppressing the population of sucking pests of *Bhut Jalakia* compared to untreated control.

ACKNOWEDGEMENT

The authors are grateful to the Director, NBAIR, Bengaluru, Karnataka, India, for providing necessary entomopathogenic fungi to conduct the experiment. The authors also acknowledge the support received from Director of Research (Agri.) and Professor and Head, Department of Entomology, Assam Agricultural University, Jorhat, Assam, India.

REFFERENCES

Arthurs SP, Aristizábal LF, Avery PB. 2013. Evaluation of entomopathogenic fungi against chillithrips, *Scirtothrips dorsalis. J Insect Sci.* **13**: 1536-2442. https://doi.org/10.1673/031.013.3101 PMid:23895429 PMCid:PMC3735053

Baruah S, Zaman Md. K, Rajbongshi P, Das S. 2014. A Review on Recent researches on *Bhut Jalakia* and where the pharmacological activity of capsaicin. *Intl J Pharm Sci Rev Res*. **24**: 89-94.

Begam N, Saikia DK, Borkakati RN. 2016. Seasonal incidence of major insect-pests and their natural enemies of *Bhut Jalakia*. *Ann Pl Protec Sci*. **24**: 259-264.

Berke T, Sheih SC. 2000. Chilli peppers in Asia. *Capsicum Egg Pl Newslett.* **19**: 38-41.

Bhagowati RR, Chankija S. 2009. Genetic variability and traditional practices in Naga King chilli landraces of Nagaland. *Asian Agri History* **3**: 171-180.

Buragohain P, Saikia DK, Borkakati RN, Dutta BC, Thangjam R. 2017. Pest complex and the population dynamics of major pests of *Bhut Jalakia*. *Ecol Environ Conser*. **23**: 265-272.

Das G. 2013. Efficacy of imidacloprid 17.8SL, a nicotinoid group of insecticide against the infestation of chilli aphid, *Myzus persicae* (Hemiptera: Aphididae). *Int J Biol Sci.* **2**: 154-159.

Eidy M, Rafiee-Dastjerdi H, Zargarzadeh F, Golizadeh A and Mahdavi V. 2016. Pathogenicity of the entomopathogenic fungi *Beauveria bassiana* (Balsamo) and *Verticillium lecanii* (Zimmerman) against aphid *Macrosiphum rosae* Linnaeus (Hemiptera: Aphididae) under laboratory conditions. *Jordan J Biol Sci*. **9**: 25-28. https://doi.org/10.12816/0027004

Jagdish EJ, Purnima AP. 2011. Evaluation of selective botanicals and entomopathogens against *Scirtothrips dorsalis* Hood under poly house conditions on rose. *J Biopesticides* **4**: 81-85, 244.

Jandricic SE, Filotas M, Sanderson JP, Wraight SP. 2014. Pathogenicity of conidia-based preparations of entomopathogenic fungi against the greenhouse pest aphids *Myzus persicae, Aphis gossypii*, and *Aulacorthum solani* (Hemiptera: Aphididae). *J Invertebr Pathol.* **118**: 34–46. https://doi.org/10.1016/j.jip.2014.02.003 PMid:24583227

Kim JJ, Jeong G, Han JH, Lee S. 2013. Biological control of aphid using fungal culture and culture filtrates of *Beauveria bassiana. Mycobiology* **41**: 221-224. https://doi.org/10.5941/MYCO.2013.41.4.221 PMid:24493943 PMCid:PMC3905126

Lee WW, Shin TY, Bae SM, Woo SD. 2015. Screening and evaluation of entomopathogenic fungi against the green peach aphid, *Myzus persicae* using multiple tools. *J Asia-Pacific Entomol.* **18**: 607–615. https://doi.org/10.1016/j.aspen.2015.07.012

Loureiro ES, Moino JRA. 2006. Pathogenicity of hyphomycetes fungi to aphids *Aphis gossypii* Glover and *Myzus persicae* (Sulzer) (Hemiptera: Aphididae). *Neotrop Entomol*. **35**: 660-665. https://doi.org/10.1590/S1519-566X2006000500014

Mahalingappa PB, Reddy KD, Reddy KN, Subbaratnam GV. 2006. Dissipation of ethion and chlorpyriphos residues in/ on chilli (*Capsicum annuum*). *Pesticide Res J.* **18**: 72-73.

Patil AS, Patil PD, Patil RS. 2002. Efficacy of different schedule doses of imidacloprid against sucking pest complex of chilli (*Capsicum annum* L.). *Pestology* **26**: 31-33.

Prabhu ST, Nagraja MV, Ganapathi T. 2014. Evaluation of bio-efficacy of imidacloprid 17.8% S L against chilli insect pests. *Trends Biosci*. **7**: 3331-3334.

Sanatombi K, Sharma GJ. 2008 *In vitro* plant regeneration in six cultivars of *Capsicum* spp. using different explants. *Biol Plant.* **52**: 141-145. https://doi.org/10.1007/s10535-008-0029-0