Efficacy of fungal entomopathogens against red cotton stainer, *Dysdercus cingulatus* Fabricius (Hemiptera: Pyrrhocoridae)

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ABSTRACT

The efficacy of entomopathogenic fungi [*Beavueria bassiana* (Bb08, Bb10) and *Isaria fumosorosea* (*Ifr*)] isolated from different regions of Southern Tamil Nadu, India was assessed against red cotton stainer, *Dysdercus cingulatus.* All the tested isolates showed 100% mortality. The *B. bassiana* isolates such as Bb08, Bb10 and an *I. fumosorosea* isolates exemplified the significant mortality among the isolates tested. LC_{50}, LC_{90} and correlation coefficient were calculated for mortality. Bb08, Bb10 and *Ifr* isolates unveiled the lowest LC_{50} (5.9×10^5, 6.6×10^5 and 2.6×10^5) and LC_{90} (1×10^9, 7.3×10^8 and 3.9×10^8) value compared to the isolates tested. Highly significant correlation co-efficient was observed in the isolates Bb08, Bb10 and *Ifr*

Key words: *Beauveria bassiana*, *Isaria fumosorosea*, native isolates, mortality.

INTRODUTION

Cotton, *Gossypium hirsutum* (Linn.) is the most economically important natural fiber material in the world. It is widely known as "The King of Fibers". The economy of many countries depends up on cotton production. Nearly 24% of the total cotton production in the world is cultured from India. In recent years, cotton production is declining due to the infestation of insect pests and diseases. Of these sucking pests are deleterious during the early stage of cotton growth. Pests such as stainer, jassids, aphids, whiteflies and thrips are constituted as important pests of cotton (Uthamasamy *et al*., 2004). One of the dreadful pests of cotton in southeast Asian countries is *Dysdercus cingulatus* (Fab.) (Hemiptera:Pyrrhocoridae) (Kohno and Bui Thi, 2004). It is distributed in all the cotton growing regions of India (Sahayaraj and Ilayaraja, 2008). It is commonly known as red cotton bug and is an important pest of lady's finger, sambhal, hollyhock etc. If not managed properly, both nymph and adult insects damage the cotton bolls and leaves severely. Although it has been controlled by many synthetic insecticides because of the high residual effect of chemical insecticides, the immediate need for sustainable eco-friendly pest management has been felt very strongly providing an impetus to research and development of microbial pesticides.

Entomopathogenic fungi are widely available biological control agents (BCAs) for controlling agricultural pests (Wraight *et al.,* 2001). Nowadays, hundreds of fungi have been identified and are being developed as biological control agents for various insects. Species from the genera *Beauveria, Metarhizium, Isaria* and *Lecanicillium* and others have been registered and commercialized in the United States. (Environmental Protection Agency, 2009). *Isaria fumosorosea* (Wize) (=*Paecilomyces fumosoroseus*) is a fungal biocontrol agent with the potential for controlling several insect pests (Dunlap *et al*., 2005). The species *Isaria fumosorosea* and *Isaria farinosa* are well-known entomopathogenic fungi with a worldwide distribution in temporate and tropical zones and there is a relatively wide host range which makes them interesting agents for the development of biocontrol methods. Hence, the present study aims to evaluate the potential biocontrol agent *I. fumosorosea* against *D. cingulatus.*

MATERIALS AND METHODS

Entomopathogenic fungi, *Beauveria bassiana* [*Bb08* (Accession No. HQ848783) and *Bb10* (Accession.No. HQ416713)] and *Isaria fumosorosea* isolates used in this investigation were isolated from rhizosphere soil of different

regions of Madurai and Dindigul District, Tamil Nadu and were routinely grown on potato dextrose agar (PDA). The plates were incubated at 26°C for 10-14 days and stored in a refrigerator. All the fungal isolates were sub-cultured once in three weeks. To maintain the virulence, after sub-culturing all the three fungal isolates were passed through host insect and re-isolated for further studies.

Preparation of fungal spore concentrations

Three fungal isolates were cultured in potato dextrose agar (PDA) and were incubated at 26 °C for 10 days. After sporulation, aerial conidia were harvested by flooding the plate with sterile deionized water (dH2O) containing 0.02% Tween-80. Conidial spore suspensions were prepared and conidial count determined using a haemocytometer. All the suspensions were adjusted to a concentration of 1.5 x 10^8 conidia mL^{-1} from which lower concentrations were prepared by serial dilution technique for bioassay studies.

Laboratory bioassay

Bioassays were conducted with different isolates of *B. bassiana* and *I. fumosorosea* against *D. cingulatus* adult in the laboratory with conidial suspensions containing 1.5 x 10^8 conidia mL^{-1}. Twenty adult *D. cingulatus* were released on the cotton bolls sprayed with the fungal suspension and transferred into a glass jar and covered with a muslin cloth. *D. cingulatus* larvae sprayed with 0.02 % of Tween-80 were maintained as control in separate glass jars. Three replications each with 20 adults were maintained for each treatment. Mortality counts were taken at every 24 hrs after inoculation.

Statistical Analysis

Mortality data were subjected to Probit Analysis using SPSS (version 10.0) for LC_{50} and LC_{90} prediction and Chi-Square values were calculated using Microsoft Excel.

RESULTS AND DISCUSSION

As chemical control programmes were in practice for the management of *D. cingulatus* very few studies representing the biological control of *D. cingulatus* have been under taken so far.

Table 1. LC_{50}, LC_{90} Chi-square value and percentage of mortality caused by *Beauveria bassiana* (Bb08) against *Dysdercus cingulatus*

Time (Days)	LC_{50} (Spore mL^{-1})	LC_{90} (Spore mL^{-1})	Chi Square	Mortality (%)
2DAT	5.4 x 10^{11}	2.3 x 10^{15}	3.94* (p=0.268)	24±0.47
4DAT	3.1 x 10^{10}	1.9 x 10^{14}	2.976* (p=0.395)	44±0.47
6DAT	3.3 x 10^{8}	1.5 x 10^{12}	8.349* (p=0.039)	68±0.47
8DAT	1.6 x 10^{7}	3.3 x 10^{10}	2.768* (p=0.429)	88±0.47
10DAT	5.9 x 10^{5}	1 x 10^{9}	7.048* (p=0.070)	100±0.92

*Significant at P<0.05%

In the present investigation, entomopathogenic fungi isolated from rhizosphere soils were found highly virulent when tested against red cotton stainer, *D. cingulatus.* The percent mortality of the tested isolates against *D. cingulatus* was 100% at 1 x 10^8 spore mL^{-1} after 10 days of post treatment accordingly. The LC_{50} and LC_{90} of the Bb08 isolate range were between 5.9 x 10^5 to 5.4 x 10^{11} spore mL^{-1} and 1.9 x 10^9 to 2.3 x 10^{15} spore mL^{-1} whereas in Bb10 and *Ifr*, it was 6.6 x 10^5 to 1.2 x 10^{15} spore mL^{-1} and 7.3 x 10^8 to 3.7 x 10^{23} spore mL^{-1} as well as 2.6 x 10^5 to 3.8 x 10^{15} spore mL^{-1} and 3.9 x 10^8 to 1.2 x 10^{32} spore mL^{-1} respectively (Table 1 and 2).

Table 2. LC_{50}, LC_{90} Chi-square value and percentage of mortality caused by *Beauveria bassiana* (Bb10) *against Dysdercus cingulatus*

Time (Days)	LC_{50} (Spore mL^{-1})	LC_{90} (Spore mL^{-1})	Chi Square	Mortality (%)
2DAT	1.2X10^{15}	3.7X10^{23}	0.119* (p=0.989)	22±0.47
4DAT	2.5X10^{10}	8.4X10^{14}	0.827* (p=0.843)	48±0.47
6DAT	2.9X10^{9}	9.9X10^{13}	1.492* (p=0.684)	55±0.47
8DAT	2.1X10^{7}	2.3X10^{10}	1.603* (p=0.659)	88±0.74
10DAT	6.6x10^{5}	7.3X10^{8}	4.247* (p=0.236)	100±0.92

*Significant at P<0.05%

Among the isolates tested, *Ifr* had lowest LC_{50} (2.6 x 10^5 spore mL^{-1}) and LC_{90} (3.9 x 10^8 spore mL^{-1}) against *D. cingulatus* compared to Bb08 and Bb10 isolates, which was having LC_{50} and LC_{90}value of

5.9 x 10^5, 6.6 x 10^5 spore mL^{-1} and 1.9 x 10^9, 7.3 x 10^8 spore mL^{-1} respectively (Table 3). The chi-square values often represented the significant insecticidal efficiency of the tested isolates against *D. cingulatus.* Similar to the present investigation, Sahayaraj and Borgio (2010) observed 92.30% mortality of the *D. cingulatus* treated with green muscardine fungus, *Metarhizium anisopliae*. Similarly, Sahayaraj and Borgio (2010) used *M. anisopliae* for the control of *D. cingulatus* and found 75% mortality after 96 hrs of exposure. The LC_{50} of the present investigation was in accordance with the study reported by Sahayaraj and Borgio (2010) who observed LC_{50} value of 2.25 x 10^5 spore mL^{-1}. Similarly, Sahayaraj and Majesh Tomson (2010) reported the efficiency of the crude metabolites of the *M. anisopliae* capable of causing 45% mortality against *D. cingulatus*. Much in the same way, higher susceptibility of the *D. cingulatus* towards benzene extract of *Padina pavonica* having LC_{50} of 0.004% was observed by Sahayaraj and Kalidas (2011). Besides, the entomopathogen is highly virulent against the caterpillar of *S. litura* (Gayathri *et al.,* 2010; Joseph *et al.,* 2010; Malarvannan *et al.,* 2010; Sanehdeep *et al.,* 2011; Suganya, and Selvanarayanan, 2010). Thus the present study exemplifies the excellent biocontrol potential of the soil isolate, *Ifr* towards red cotton stainer, *D. cingulatus*. Therefore it is recommended that isolates *Ifr* can be used as biopesticide for the control of the red cotton bug, *D. cingulatus* and other insect pests.

Table 3. LC_{50}, LC_{90} Chi-square value and percentage of mortality caused by *Isaria fumosorosea* against *Dysdercus cingulatus.*

Time (Days)	LC_{50} (Spore mL^{-1})	LC_{90} (Spore mL^{-1})	Chi Square	Mortality (%)
2DAT	3.8 x 10^{15}	1.2 x 10^{32}	0.539* (p=0.910)	18±0.47
4DAT	4.8 x 10^{11}	9.5 x 10^{16}	0.678* (p=0.878)	32±0.47
6DAT	3.4 x 10^9	3.4 x 10^{13}	2.600* (p=0.457)	52±0.92
8DAT	1.3 x 10^7	5 x 10^{10}	8.210* (p=.042)	80±0.92
10DAT	2.6 x 10^5	3.9 x 10^8	3.502* (p=0.321)	100±0.47

*Significant at P<0.05%

REFERENCES

Dunlap, C., Biresaw, G. and Jackson, M. 2005. Hydrophobic and electrostatic cell surface properties of blastospores of the entomopathogenic fungus *Paecilomyces fumosoroseus. Colloids and Surface B: Interfaces*, **46**: 261–266.

Environmental Protection Agency, 2009. Biopesticide Active Ingredient Fact Sheets.http://www.epa.gov/pesticides/ biopesticides/ingredients/.

Gayathri, G., Balasubramanian, C., Vinayaga Moorthi, P. and Kubendran, T. 2010. Larvicidal potential of *Beauveria bassiana* (Balsamo) Vuillemin and *Paecilomyces fumosoroseus* (Wize,) Brown and Smith on *Culex quinquefasciatus* (Say). *Journal of Biopesticides*, **3**(1): 147-151.

Joseph, I., Edwin Chellaiah, D. and Ranjith Singh, A.J.A. 2010. Studies on the influence of *Beaueria bassiana* on survival and gut-flora of groundnut caterpillar *Spodoptera litura* Fab. *Journal of Biopesticides*, **3**(3): 553–555.

Kohno, K. and Bui Thi, N. 2004. Effects of host plant species on the development of *Dysdercus cingulatus* (Heteroptera: Pyrrhocoridae). *Applied Entomology and Zoology,* **39**: 183-187.

Malarvannan, S., Murali, P. D., Shanthakumar, S.P., Prabavathy, V.R. and Sudha Nair. 2010. Laboratory evaluation of the entomopathogenic fungi, *Beauveria bassiana* against the tobacco caterpillar, *Spodoptera litura* Fabricius (Noctuidae: Lepidoptera). *Journal of Biopesticides*, **3**(1): 126-131.

Sahayaraj, K. and Ilayaraja, R. 2008. Ecology of *Dysdercus cingulatus* (Fab.). *Egyptian Journal of Biology*, **10**: 122–125.

Sahayaraj, K and Borgio, J. F. 2010. Virulence of entomopathogenic fungus *Metarhizium anisopliae* (Metsch.) Sorokin on seven insect pests. *Indian Journal of Agricultural Research*. **44**(3): 195–200.

Sahayaraj, K. and Majesh Tomson. 2010. Impact of two pathogenic fungal crude metabolites on mortality, biology and enzymes of *Dysdercus cingulatus* (Fab.) (Hemiptera: Pyrrhocoridae). *Journal of Biopesticides*, **3** (1):163–167.

Sahayaraj. K. and Kalidas, S. 2011. Evaluation of nymphicidal and ovicidal effect of seaweed, *Padina pavonica* (Linn.) (Phaeophyceae) on cotton pest, *Dysdercus cingulatus* (Fab.). *Indian Journal of Geo-Marine Science*, **40**(1): 125-129.

Sanehdeep Kaur, Harminder Preet Kaur, Kirandeep Kaur and Amarjeet Kaur. 2011. Effect of different concentrations of *Beauveria bassiana* on development and reproductive potential of *Spodoptera litura* (Fabricius). *Journal of Biopesticides*, **4**(2): 161-168.

Shifa Vanmathi, J., Padma Latha, C. and Ranjit Singh, A. J. A. 2011. Impact of entomopathogenic fungi *Beauveria bassiana* on stored grains pest, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae). *Journal of Biopesticides*, **4**(2): 194-193.

Suganya, T. and Selvanarayanan, V. 2010. *In vitro* study on the effect of bhendi varieties on the infectivity of *Beauveria bassiana* (Bals.) Vuill to *Spodoptera litura* Fab. *Journal of Biopesticides*, **3**(1): 369-372.

Uthamasamy, S., Kannan, M. and Mohan, S. 2004. Impact of insecticides on sucking pests and natural enemy complex of transgenic cotton in India. *Current Science*, **86**: 726-729.

Wraight, S.P., Jackson, M.A. and de Kock, S.L. 2001. Production, stabilization and formulation of fungal biological agents. **In**: *Fungi as Biocontrol Agents* (Butt TM, Jackson C, Magan N eds.), CABI, Wallingford. 253–287 **PP**.

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