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Mycopathogens for Biological Control of Mound Building Termites in an Agroforest Ecosystem

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ABSTRACT

Although five entomogenous fungi were pathogenic to the three mound building termites i.e. *Odontotermes wallonensis* (Wasmann), *O.obesus* (Rambur) and *O.brunneus* (Hagen), only *Beauveria bassiana* (Bals.) Vuill, and *Metarhizium anisopliae* (Metsch.) Sorokin var. *anisopliae* were highly virulent when compared to *M.flavoviride* Gams Rozypal var. *minus*, *Paecilomyces lilacinus* (Thom.) Samson and *P.fumosoroseus* (Wize) Brown and Smith. Among the three mound building termite species, *O.brunneus* was the most susceptible followed by *O.wallonensis* and *O.obesus*. This was confirmed through bioassay studies with the different isolates of *B.bassiana* and *M.anisopliae*. Bapatla isolate of *B.bassiana* with the lowest LC_{50} and LT_{50} values was the most effective against all the three termite species tested.

KEY WORDS : *Odontotermes wallonensis, O.obesus, O.brunneus,* susceptibility, *Beauveria bassiana, Metarhizium anisopliae, M.flavoviride, Paecilomyces lilacinus, P.fumosoroseus*

Termites are social insects of ancient lineage and their hidden mode of life provides a reliable defense against various unfavourable factors and thereby makes any control of this dangerous pest of wood quite a difficult task. As termites do not resist desiccation, at least part of the nest is maintained at RH near saturation, which is conducive to infection by entomopathogenic fungi. Hence, an investigation was undertaken to study the efficacy of these mycopathogens against the common species of mound building termites encountered frequently in agroforest ecosystem around Coimbatore.

MATERIALS AND METHODS

Pathogenicity tests were conducted with a uniform dose of 10^7 conidia ml^{-1}, with different fungal isolates (Table 1). The termites of the respective species were taken in a Petri dish (9 cm) lined by a filter paper (Whatman 100) and directly sprayed with 3 ml of conidial suspension using a hand atomizer. Control insects were sprayed with only 0.02 per cent Tween 80^R in sterile distilled water. The treated insects were slowly let into Petri dishes (9 cm) containing a thin layer of fine sterilized soil with wood pieces and fresh fungal comb pieces which served as food for these insects. The Petri dishes with treated insects were maintained at 25 $\pm$ 2°C. Hundred insects were used per treatment and there were three replications.

Bioassay tests were carried out with five isolates of *Beauveria bassiana* (Bals.) Vuill. obtained from five different geographical locations namely Bapatla-Andhra Pradesh (BPT), Philippines (PHP), Bangalore- Karnataka (BNG), Coimbatore-Tamil Nadu (CBE) and IARI-New Delhi (NDL), *Metarhizium anisopliae* (Metsch.) Sorokin Coim-

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Table 1. Pathogenicity of certain fungal pathogens against agroforestry termites

Fungus @	Per cent corrected mortality of workers major caste*		
	O. wallonensis	*O. obesus*	*O. brunneus*
Metarhizium anisopliae (Ma)	57.33[cd]	43.67[d]	57.67[d]
M. flavoviride	10.67[e]	8.00[e]	14.67[f]
Paecilomyces lilacinus	6.00[ef]	6.33[e]	9.33[g]
P. fumosoroseus	4.00[f]	2.00[f]	6.33[h]
Beauveria bassiana (BNG)	68.67[b]	54.33[c]	68.33[c]
B. bassiana (NDL)	51.33[d]	37.33[d]	52.33[e]
B. bassiana (BPT)	84.33[a]	76.67[a]	84.00[a]
B. bassiana (CBE)	60.67[bc]	45.00[d]	60.00[d]
B. bassiana (PHP)	79.67[a]	68.67[b]	79.67[b]

@ at 10^7 conidia ml^{-1}
*Mean separation by DMRT at 5% level

batore (Ma). *M.flavoviride, Paecilomyces lilacinus,* (Thom.) Samson and *P.fumosoroseus* (Wize) Brown and Smith. Different concentrations ranging from 10^4 through 10^8 conidia ml^{-1} of each of the above isolates were prepared by using sterile distilled water containing 0.02 per cent Tween 80^R (Roberts and Yendol, 1971). Standardisation of different concentrations was done using Neubauer heamocytometer. Observations on mortality were recorded at 6 h interval upto seven days.

The mortality data were converted to angles and after analysis of variance, the means were separated by Duncan's Multiple Range Test (DMRT). Dosage and time - mortality responses were subjected to probit analysis (Finney, 1964).

RESULTS AND DISCUSSION

Among the mycopathogens tested against the three most common mound building termite species i.e. *Odontotermes wallonensis* (Wasmann), *O.obesus* (Rambur) and *O.brunneus* (Hagen), *B.bassiana* and *M.anisopliae* were the most effective causing significantly higher mortalities than *M.flavoviride, P.lilacinus* and *P.fumosoroseus*. The latter three species proved to be weak pathogens causing considerably insignificant mortalities in all the three species of termites (Table 1). *B.bassiana* was the most effective mycopathogen. However, the different isolates behaved differently as far as the effectiveness was concerned. Among them, the Bapatla isolate caused the highest mortality of all the three species of termites. This was

Table 2. Relative susceptibility of workers major caste of agroforestry termites to different fungal isolates

Fungus @	*O. wallonensis*		*O. obesus*		*O. brunneus*	
	$Chi^{2*}(3)$	LC_{50}	$Chi^{2*}(3)$	LC_{50}	$Chi^{2*}(3)$	LC_{50}
B. bassiana (BNG)	0.02	24.02	2.09	52.89	4.10	17.92
B. bassiana (NDL)	1.37	179.08	1.75	330.63	2.08	79.58
B. bassiana (BPT)	0.03	5.14	0.50	9.98	1.32	2.64
B. bassiana (CBE)	0.11	74.03	4.14	148.79	0.06	30.02
B. bassiana (PHP)	0.31	19.72	1.28	36.46	0.03	5.79
M.anisopliae (Ma)	1.71	100.91	1.05	225.32	0.04	34.24

@ at 10^4 through 10^8 conidia ml^{-1}
* All lines are significantly a good fit ($P < 0.05$)

Table 3. Probit analysis of time-mortality response of workers major caste of agroforestry termites to different fungal isolates at a dose of $4x10^7$ conidia ml^{-1}

Fungus	*O. wallonensis*		*O. obesus*		*O. brunneus*	
	Chi^{2*}(3)	LT_{50}(h)	Chi^{2*}(3)	LT_{50}(h)	Chi^{2*}(3)	LT_{50}(h)
B. bassiana (BNG)	0.69	88.37	1.16	92.62	1.29	85.35
B. bassiana (NDL)	2.08	105.39	1.62	110.79	1.81	99.85
B. bassiana (BPT)	1.80	81.25	1.58	83.66	1.20	80.21
B. bassiana (CBE)	1.74	96.83	1.66	101.45	0.90	90.88
B. bassiana (PHP)	0.52	85.02	1.27	91.93	0.84	82.69
M.anisopliae (Ma)	1.15	102.95	2.13	107.78	1.61	93.06

* All lines are significantly a good fit ($P < 0.05$)

followed by PHP, BNG, CBE and NDL isolates in the order mentioned. Probit analyses of the dosage- mortality and time-mortality responses further confirmed the effectiveness of Bapatla isolate. This was followed by PHP, BNG, CBE and NDL isolate (Tables 2 and 3).

In the present study, the slopes (regression co-efficient) in general, were very low in all the bioassays as far as the dosage- mortalities were concerned. On the other hand, the slopes were higher in case of time-mortalities indicating that the time- dependent responses were more markedly pronounced than the dose- dependent responses. Hall (1980) found that even a 100 - fold increase in dose of *Verticillium lecanii* Zimm., did not influence the mortalities in aphids significantly. Ignoffo *et al.* (1982) have reported that the slopes of the dose response lines for entomogenous fungi, in general, have been less steep than those for other entomopathogenic microbes such as bacteria, viruses and protozoans. Shallow dose-mortality responses seem to be typical for fungus-insect interactions according to various workers (Rombach and Gillespie, 1988).

The variation in virulence among the different isolates within *B.bassiana* may be due to heterokaryosis, somatic recombination and saprobic growth the fungus has undergone in the environment prior to its interaction with the insects as reported by Roberts and Yendol (1971). Sikura and Bevzenko (1972) found variation in toxin production in different strains of *B. bassiana* which could be correlated with variation in virulence. Similarly, variation in susceptibility of noctuid larvae to different geographical isolates of *Nomuraea rileyi* (Farlow) Samson were observed by Ignoffo *et al.* (1976). In nature, living organisms particularly microbes undergo selection, recombination and mutation depending upon ecological situation which influences their genetic make up which in turn reflect on the virulence ultimately (Ignoffo and Garcia, 1985).

Gottwald and Tedders (1983) consider that *B. bassiana* is superior to *M. anisopliae* because of its higher pathogenicity, the production and release of 10 to 200 times more conidia per cadaver and its ability to spread saprophytically through the soil. A similar trend was observed in the present study with most isolates of *B. bassiana* against termites.

Bioassay tests have further shown that, among the different agroforestry termite species, *O. brunneus* was the most susceptible to the entomopathogenic fungi followed by *O. wallonensis* and *O. obesus*. A mycopathogen could infect more than one species, but the relative susceptibility among species commonly differs. This difference might be due to the presence of different pathotypes with different host preference or the inherent variation in the susceptibility of the host insect to a particular fungal pathogen. Obviously, the biochemical interactions in the infection process which might be specific to a host-pathogen interaction, would explain the reasons for differential susceptibility (Fargues, 1976; Maniania and Fargues, 1984; Ignoffo and Garcia, 1985; Keller and Zimmermann, 1989).

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