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Mycopathogens for Biological Control of *Odontotermes brunneus* (Hagen)

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ABSTRACT

Among the entomopathogenic fungi tested against the termite, *Odontotermes brunneus* (Hagen), *Beauveria bassiana* (Bals.) Vuill, *Metarhizium anisopliae* (Metsch.) Sorokin var. *anisopliae, M. flavoviride* Gams Rozsypal var. *minus, Paecilomyces lilacinus* (Thom.) Samson and *P. fumosoroseus* (Wize) Brown & Smith, were pathogenic to termites, while the other three mycopathogens *viz., Verticillium lecanii* Zimm, *Paecilomyces farinosus* (Holm. ex Gray) and *Nomuraea rileyi* (Farlow) were not pathogenic. *B. bassiana* was the most effective against termites followed by *M. anisopliae, M. flavoviride, P. lilacinus* and *P. fumosoroseus*. Of the three morphogenetic forms of *O. brunneus*, workers minor were the most susceptible followed by workers major and soldier caste.

Further bioassay with the different fungal isolates of the two most virulent mycopathogens namely *B. bassiana* and *M. anisopliae* revealed that Bapatla isolate of *B. bassiana* was the most effective recording the lowest LC_{50} (2.64×10^4 conidia ml^{-1}) and LT_{50} (80.21 h)

Key Words : *Odontotermes brunneus,* mycopathogens, bioassay

Termites are highly organised social insects. Their hidden way of life, inaccessible sub-soil nests, and existence of several destructive subterranean species make chemical control extremely difficult. There has been no attempt in India so far to tackle termite problem through biological means, although a few attempts have been made in other countries particularly Australia.

MATERIALS AND METHODS

Infectivity tests with different fungal isolates were conducted with a uniform dose of 10^7 conidia ml^{-1}. The termites were taken in a Petri dish (9 cm) lined by a filter paper (Whatman 100) and were directly sprayed with 3 ml conidial suspension using a hand atomizer. Control insects were sprayed with only 0.02 per cent Tween 80^R in sterile distilled water. The Petri dishes with treated insects were maintained at 25 ± 2°C. Soft wood and fresh fungal comb pieces were provided as feed. Hundred insects were used per treatment and there were three replications.

Bioassay tests were carried out with five isolates of *B. bassiana* obtained from five locations *viz.,* Bapatla, Andhra Pradesh (BPT), Phillippines (PHP), Bangalore, Karnataka (BNG), Coimbatore, Tamil Nadu (CBE) and New Delhi (NDL) and *M. anisopliae* (Ma). Different conidial 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 haemocytometer. Observations on the mortality were recorded at 6 h interval upto seven days.

RESULTS AND DISCUSSION

Among the mycopathogens tried against *O. brunneus,* all the isolates of *B. bassiana* and *M.*

Table 1. Pathogenicity of certain fungal pathogens against *O. brunneus*

Treatments	Per cent corrected mortality*		
	Workers major	Workers minor	Soldiers
Metarhizium anisopliae (Ma)	57.67^{d}	75.67^{de}	47.00^{c}
M. flavoviride	14.67^{f}	20.33^{f}	9.33^{d}
Paecilomyces lilacinus	9.33^{g}	12.67^{g}	6.67^{de}
P. fumosoroseus	6.33^{h}	9.33^{g}	4.00^{e}
Beauveria bassiana (BNG)	68.33^{c}	82.67^{c}	59.67^{ab}
B. bassiana (NDL)	52.33^{e}	70.67^{e}	43.67^{c}
B. bassiana (BPT)	84.00^{a}	94.56a	65.33^{a}
B. bassiana (CBE)	60.00^{d}	77.33^{d}	54.00^{b}
B. bassiana (PHP)	79.67^{b}	88.00^{b}	63.00^{a}

* Mean separation by DMRT at 5% level

anisopliae were found to be virulent effecting significantly higher mortalities, while, *M. flavoviride, P. lilacinus* and *P. fumosoroseus* were weak pathogens. Among the five isolates of *B. bassiana viz.*, CBE, NDL, PHP, BPT and BNG, the BPT isolate caused the highest mortality among all the three forms of termites, *viz.*, workers major, workers minor and soldiers. Workers minor invariably suffered higher mortality followed by workers major and the soldiers were the least affected by mycopathogens (Table 1).

The probit analysis of the dosage-mortality and time-mortality responses of the three morphogenetic forms of *O. brunneus* with five isolates of *B. bassiana* and one isolate of *M. anisopliae* indicated that BPT isolate was the most effective, recording the lowest LC_{50} and LT_{50} values followed by PHP, BNG, CBE, Ma and NDL isolates and Ma. It further confirmed the higher susceptibility of workers minor followed by workers major and soldier caste of termites (Table 2,3).

The variation in virulence among the different isolates within the single species of the fungus 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*

Table 2. Susceptibility of workers major of *O. brunneus* to different fungal isolates

Fungus	Chi^2 * (3)	Regression equation	LC_{50} (Conidia ml^{-1}) x 10^4	Fiducial limits (95%) x 10^4
B. bassiana (BNG)	4.10	Y = 2.56708 + 0.46311x	17.92	12.34 — 26.01
B. bassiana (NDL)	2.08	Y = 1.97778 + 0.51216x	79.58	58.08 —109.03
B. bassiana (BPT)	1.32	Y = 1.71556 + 0.74264	2.64	1.93 — 3.61
B. bassiana (CBE)	0.06	Y = 1.76104 + 0.59132x	30.02	22.47 — 40.10
B. bassiana (PHP)	0.03	Y = 2.59760 + 0.50434x	5.79	3.90 — 8.61
M. anisopliae (Ma)	0.04	Y = 2.79901 + 0.39767x	34.24	22.81 — 51.41

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

Table 3. Probit analysis of time-mortality response of workers major of *O. brunneus* to different fungal isolates

Fungus	Chi^2 (3)	Regression equation	LC_{50} (Conidia ml^{-1}) x 10^4	Fiducial limits (95%) x 10^4
B. bassiana (BNG)	1.29	Y = 2.72181x - 8.42182	85.35	80.34 — 90.67
B. bassiana (NDL)	1.81	Y = 4.48077x - 17.40110	99.85	96.25 —103.59
B. bassiana (BPT)	1.20	Y = 4.02544x + 14.74180	80.21	76.99 — 83.56
B. bassiana (CBE)	0.90	Y = 5.75989x - 23.56044	90.88	88.32 — 93.52
B. bassiana (PHP)	0.84	Y = 2.87074x - 9.11680	82.69	78.08 — 87.57
M. anisopliae (Ma)	1.61	Y = 4.99380x - 19.81323	93.06	90.04 — 96.18

* at 4 x 10^7 conidia ml^{-1}

which could be correlated with the variation in virulence. Variation in susceptibility of noctuid larvae to different geographical isolates of *Nomuraea rileyi* (Farlow) Samson was observed by Ignoffo *et al.* (1976). Ferron (1978) found obvious differences in virulence between numerous strains of *B. brongniartii* against *Melolantha melolantha* (L.) and *Acanthoscelides obtectus* (Say). In nature, living organisms particularly microbes undergo selection, recombination and mutation depending upon the ecological situation which influences their genetic make up which in turn reflect the virulence ultimately (Ignoffo and Garcia, 1985).

Variation in susceptibility of termites existed among different developmental stages of the same species and within the same stages at different periods of time. This phenomenon of varying susceptibility was well documented in the investigations with fungi such as *B. bassiana, N. rileyi* and *P. fumosoroseus* (Getzin, 1961; Gardner and Noblet, 1978; Ignoffo *et al.,* 1978; Fargues and Rodriguez-Rueda, 1980). Wood and Grula (1984) reported that the amino acid composition on the larval surface varied among instars and discussed the possible influence of amino acid combinations, certain amines and peptides on the infectivity of fungal pathogens.

Host pathogen interactions occurred not only at the host integument, but also in the haemocoel where many intrinsic factors operate. Incidentally, chemical constituents also vary as the age of the insect advances (Boman, 1981). In the light of these findings, the variation in susceptibility of the three forms of individuals of *O. brunneus* could be understood.

REFERENCES

BOMAN,H.G. 1981. Insect responses to microbial infections. In: *"Microbial control of pests and plant diseases 1970-1980"* (H.D.Burges ed.) pp. 769-784, Academic Press, London.

FARGUES,J. and RODRIGUEZ-RUEDA,D. 1980. Susceptibility of the larvae of *Spodoptera littoralis* (Lep:Noctuidae) to the entomopathogenic hyphomycetes *Nomuraea rileyi* and *Paecilomyces fumosoroseus. Entomophaga,* **25,** 43-45.

FERRON,P. 1978. Biological control of insect pests by entomogenous fungi. *Ann. Rev. Entomol.,* **23,** 409-442.

GARDNER,W.A. and NOBLET,R. 1978. Effects of host age, route of infection and quantity of inoculum on the susceptibility of *Heliothis virescens, Spodoptera eridania, S. frugiperda* to *B. bassiana. J. Georgia Ent. Soc.,* **13,** 214-222.

GETZIN,L.W. 1961. *Spicaria rileyi* (Farlow) Charles, an entomogenous fungus of *Trichoplusia ni* (Hubner). *J. Insect Pathol.,* **3,** 2-10.

IGNOFFO,C.M. and GARCIA,C. 1985. Host spectrum and relative virulence of an Ecuadoran and Mississippian biotype of *Nomuraea rileyi. J. Invertebr. Pathol.,* **45,** 346-352.

IGNOFFO,C.M., HOSTETTER,D.L., BIEVER, K.D. GARCIA, G., THOMAS, G.D., DICKERSON, W.A. and PINNELL,R. 1978. Evaluation of an entomopathogenic bacterium, fungus and virus for control of *Heliothis zea* on Soybeans. *J. Econ. Entomol.,* **71,** 165-168.

IGNOFFO,C.M., PUTTLER,B., HOSTETTER,D.L. and DICKERSON,W.A. 1976. Susceptibility of the cabbage looper, *Trichoplusia ni* and the velvet bean caterpillar, *Anticarsia gemmatalis* to several isolates of the entomopathogenic fungus *Nomuraea rileyi*. *J. Invertebr. Pathol.*, **28**, 259-262.

ROBERTS,D.W. and YENDOL,W.G. 1971. Use of fungi for microbial control of insects. In: *"Microbial control of insects and mites"* (H.D.Burges and Hussey,N.W. eds.), pp. 125-149, Academic Press, London.

SIKURA,A.I. and BEVZENKO,T.M. 1972. Toxic properties of *Beauveria bassiana* (Bals.) Vuill. Strains of insects. *Vopr. Zasch. Rast.*, **17**, 68-74.

WOOD,S.P. and GRULA,E.A. 1984. Utilizable surface nutrients on *Heliothis zea* available for growth of *Beauveria bassiana*. *J. Invertebr. Pathol.*, **43**, 259-269.