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# Study of bio-efficacy of entomopahogenic fungi for suppression of termite incidence in maiz

■ B.S. RANA* AND DINESH KACHHAWA

Department of Entomology, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, UDAIPUR (RAJASTHAN) INDIA

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*Corresponding author:

ABSTRACT

Extensive use of chemical insecticides for termite management has lead to hazardous residual impact on plant health. Moreover, they are very expensive and also toxic to human beings. Therefore, there is a demand to develop an alternative safe economic and eco-friendly bio agent to control the termite population under maize field condition. In the present investigation, the bio-agents *i.e. Beauveria bassiana, Metarrhizium anisopliae* and *Paecilomyces fumosoroseus* were used @ $5x10^{13}$ spore /ha and @ $5x10^{13}$ spore /ha FYM to enrich formulation and all the bio-agents have shown the promising results in *in vivo* in suppression of termite population in maize field. Similarly, the antagonistic fungi improved the germination as well as reduced the plant mortality caused by termite and improved the yield of maize as compared to untreated control. Result of entire study indicated a possibility of obtaining a powerful suppression of termite population by using plant beneficial bio-agents.

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## INTRODUCTION

Maize (*Zea mays* L.) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. Globally, maize is known as "queen of cereals" because it has the highest genetic yield potential among the cereals. It is cultivated on nearly 150 m ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36 per cent (782 mt) in the global grain production. The United States of America (USA) is the largest producer of maize contributes nearly 35 per cent of the total production in the world and maize is the driver of the US economy. In India, maize is the third most important food crop after rice and wheat. According to advance estimate, it is cultivated in 8.7 m ha (2010-11) mainly during *Kharif* season which covers 80 per cent area. Maize in India, contributes nearly 9 per cent in the National food basket and more than Rs. 100 billion to the agricultural GDP at current prices. Maize is attacked by several insects and pests among them termite is one of the important pests of the maize crop.

Termites belong to the insect order Isopteran and have long been recognized as important agricultural and domestic pests (Owusu *et al*., 2008). Termites are social insects that live together as a colony in a nest. Termites are the most troublesome pest of plants, trees and wooden structures. They severely damage agricultural crops and urban infrastructure. Termites build large epigial nests (mounds) from where they forage outwards to distance up to 50 m in galleries (Osipitan and Oseyemi, 2012). Termites are economically important

insect pests causing serious damage up to 100per cent loss to agricultural crops and various domestic products (Abdurahman, 1990; UNFAO, 2000; Sekamatte, 2001; Nyeko *et al*., 2010).

There are about 2,500 species of termites in the world and only 10per cent have pest status. Out of 300 species in India, about 35 have been reported as damaging agricultural crops and timbers in buildings. They cause over 3 billion dollars damage to wooden structures annually throughout the United States (Lewis, 1997). In India, they cause the yield loss of 15- 25 per cent of maize and about 1,478 million Rupees (IFAD-CIMMYT, 2001). Termites can attack plants at any stage of development from the seed to the mature plant.

Management of termites has largely relied on broad spectrum and persistent organo-chlorine insecticides in the world (Logen *et al*., 1990). Now-a-days, most of the persistent insecticides were banned or withdrawn from the market for human health and environmental reasons. Also, synthetic insecticides are not affordable by poor farmers. Thus, there are serious limitations and increasing legal restriction associated with application of persistent and deleterious insecticides, because of which the search for environmentally benign alternatives methods of termite's management has been intensified by entomologists. Among the diverse potential alternatives available for termite management, the use of entomopathogenic fungi is getting momentum (Michael, 2005).

Entomopathogenic fingi, *Metarhizium anisophilae* (Metchnikoff) and *Beauveria bassiana* (Basamo) are effective in the management of different species of termites (Milner *et al*., 1998; Milner, 2003) which may be used in different methods among which direct exposure, soil barrier and in baits system were able to achieve good control in termite colony. The genus *Metarhizium*, *Beauveria* and *Paecilomyces* are fungal pathogens of insect that have shown great promise in commercial development. *Metarhizium anisophilae*, with worldwide distributed has been isolated from more than 200 insect species across seven orders and has shown great potential as bio-control agents. Strains of *Metarhizium* differ in their host range, necessitating selection of the most virulent against a target insect (Zimmermann, 1993).

*Metarhizium anisopliae* has an advantage over *B. bassiana* in microbial management of termite due to its social behaviour and high production of fungal biomass (Sun *et al*., 2002). According to (David *et al.*, 2010), a positive relationship between virulence and repellency effect of different isolates of the fungus, *Metarhizium anisopliae* on *M. michaelseni* was determined. Further, they compared the volatile profile of two isolates of *Metarhizium anisopliae*, on the same species of termites and found that the volatiles of each isolate act synergistically.

The entomopathogenic fungus, *Metarhizium anisopliae*, has wide host-range and is widely used as biopesticides agents several types of insect pests which include onion thrips, white grub, cattle ticks and different species of termites such as *Reticulitermes* spp., *Rhinotermitidae*, *Coptotermes formosanus* and *Odontotermes formosanus* (Maniania *et al*.,2003; Sun *et al*., 2002 and 2003; Wang and Powell, 2004; Cherry *et al*., 2005; Samson *et al.*, 2005; Bahiense *et al*., 2006; Dong *et al*., 2009). Many strains of *Metarhizium anisopliae* have been isolated from termites and are reported as effective myco-incesticides (Sun and Hendersen, 2003; Wright *et al*., 2005) for the management of subterranean termites.

Biological control of different agricultural and domestic pests has been reported as promising option in the current and future state of pest management (Bittencourt, 2002; Jaramillo and Borgemeister, 2006). In *Metarhizium anisopliae*, pathogenicity has been studied and found to cause mortality on different stages of insect pests such as filth fly parasitoid, *Spalangia cameroni*, malaria mosquito, *Anopheles gambia* (Nielsen *et al*., 2004; Scholte *et al*., 2006). Thus, new management apporches in termites is deemed of prime necessity in india. However, the report on the use of entomopathogenic fungi for the management of termites in India is very meagre deposited the economic importance of termites as insect pest. Therefore, the current study is aimed to determine the efficacy of some available isolates of entomopathogenic fungi (*M. anisopliae*, *B.bassiana* and *P. fumosoroseus)* at different concentrations for the management of termites.

## MATERIAL AND METHODS

The trial was conducted at Agronomy research farm at Rajasthan College of Agriculture, Udaipur, during 2012 and 2013 in Randomized Block Design with three replications with eight treatments including control. The plot size $10\times10m^2$ maintained plant to plant spacing and row to row distance 60 cm × 30 cm. Before sowing, fungal pathogens (*M. anisopliae*, *B.bassiana* and *P.fumosoroseus)* were applied at $5\times10^{13}$ spores/ ha and FYM enriched were mixed thoroughly in the soil prior to sowing in the maize experiment field. Chlorpyriphos 20 EC @ 4ml/kg (seed treatment) was also taken as recommended check. The untreated control plot was maintained separately for comparison.

**FYM Enriched :**

100 kg decompose FYM was added 2-3 litre of water to moist it. Then 1 kg of *M. anisopliae*, *B.bassiana* and *P.fumosoroseus* was thoroughly mixed in FYM and covered with moist gunny begs and turned twice at one week interval, after 20 days FYM enriched fungus was ready to use.

**Treatments :**

- Soil application of following :
- *Beauveria bassiana* @5x10$^{13}$ spores/ha.
- *Beauveria bassiana* @5x10$^{13}$ spores/ha FYM enriched.
- *Metarrhizium anisopliae* @5x10$^{13}$ spores/ha.
- *Metarrhizium anisopliae* @5x10$^{13}$ spores/ha FYM enriched
- *Paecilomyces fumosoroseus* @5x10$^{13}$ spores/ha
- *Paecilomyces fumosoroseus* @5x10$^{13}$ spores/ha FYM enriched
- Seed treatments with chlorpyriphos 20Ec @ 4ml/kg seed (Reco. Check)
- Untreated control.

## RESULTS AND DISCUSSION

Experiment was conducted at RCA farm during 2012-13 in termite infested maize field. The results reveled that the treatments comprising soil application of FYM enriched *Metarrhizium anisopliae* @ 5×10$^{13}$ spores/ha, was found most effective among the entomopathogenic fungus, showed the highest germination percentage of maize 91per cent (2012) and 95 per cent (2013) and maximum yield 39.37 q/ha (2012) and 39.40 q/ha (2013) with minimum plant mortality at 90 days 3.63 per cent (2012) and 4.6per cent (2013) followed by *Metarrhizium anisopliae* @ 5x10$^{13}$ spores/ha, recorded germination percentage of maize 90 per cent (2012) and 93 per cent (2013) and yield 37.58 q/ha (2012) and 37.62 q/ha (2013) with minimum plant mortality at 90 days 4.6 per cent (2012) and 4.1 per cent (2013). Also insecticide, Chlorpyriphos 20Ec @ 4ml/kg seed treatment (Reco. Check) was found most effective with highest germination percentage of maize 94 per cent (2012) and 98 per cent (2013) and maximum yield 41.56 q/ha(2012) and 41.66 q/ha (2013) with minimum plant mortality at 90 days 1.7per cent (2012) and 2.8 per cent (2013) as compared to germination percentage of maize 71per cent (2012) and 76 per cent (2013) and yield 30.74 q/ha (2012) and 30.82 q/ha (2013) and maximum plant mortality at 90 days 19.3 per cent (2012) and 21.8 per cent ( 2013) in untreated control as shown in (Table 1 and Fig. 1).

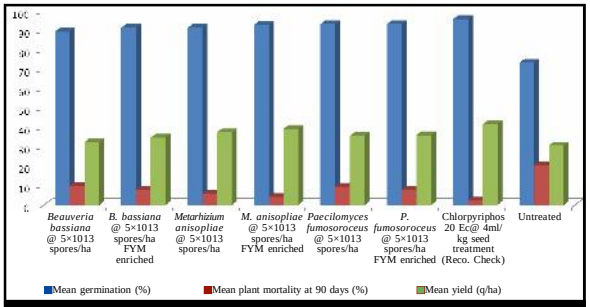


**Fig. 1 : Bio-efficacy of entomopathogenic fungi against termite population**

The present investigation revealed that FYM enriched *Metarrhizium anisopliae* @ 5×10$^{13}$ spores/ha, was found most effective among the entomopathogenic fungus and showed the highest germination percentage of maize 91 per cent (2012) and 95 per cent (2013) and maximum yield 39.37 q/

**Table 1 : Bio-efficacy of etomopahogenic fungi for suppression of termite population (*Odontotermes obesus*) and colonization in maize field**

| Sr. No. | Treatments | Germination (%) | | | Plant mortality at 90 days (%) | | | Yield (q/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2011-12 | 2012-13 | Mean | 2011-12 | 2012-13 | Mean | 2011-12 | 2012-13 | Mean |
| 1. | *Beauveria bassiana* @5x1013 spores/ha | 87 | 92 | 89.5 | 8.43 | 11.2 | 9.81 | 32.43 | 32.52 | 32.47 |
| 2. | *B. bassiana* @5x1013 spores/ha FYM enriched | 89 | 94 | 91.5 | 7.72 | 8.2 | 7.96 | 34.87 | 34.92 | 34.89 |
| 3. | *Metarhizium anisopliae* @5x1013 spores/ha | 90 | 93 | 91.5 | 5.26 | 6.2 | 5.73 | 37.58 | 37.62 | 37.6 |
| 4. | *M. anisopliae* @5x1013 spores/ha FYM Enriched | 91 | 95 | 93 | 3.63 | 4.6 | 4.1 | 39.37 | 39.40 | 39.38 |
| 5. | *Paecilomyces fumosoroseus* @5x1013 spores/ha | 93 | 94 | 93.5 | 8.85 | 10.2 | 9.52 | 35.77 | 35.80 | 35.78 |
| 6. | *P. fumosoroseus* @5x1013 spores/ha FYM enriched | 92 | 95 | 93.5 | 7.3 | 8.5 | 7.9 | 36.08 | 36.12 | 36.1 |
| 7. | Chlorpyriphos 20 Ec@ 4ml/kg seed treatment (Reco. Check) | 94 | 98 | 96 | 1.7 | 2.8 | 2.25 | 41.56 | 41.66 | 41.61 |
| 8. | Untreated control | 71 | 76 | 73.5 | 19.3 | 21.8 | 20.55 | 30.74 | 30.82 | 30.78 |
| | S.E. ± | 0.78 | 0.69 | | 0.737 | 0.778 | | 0.991 | 0.861 | |
| | C.D. (P=0.05) | 2.418 | 2.139 | | 2.285 | 2.412 | | 2.825 | 2.670 | |

ha (2012) and 39.40 q/ha (2013) with minimum plant mortality at 90 days 3.63 per cent (2012) and 4.6 per cent (2013).

The results of the present experiments broadly support previous work on the efficacy of *M. anisopliae* in the control of termites, and perhaps for the first time, demonstrate the effectiveness of an entomo-pathogenic fungus in the control of termites in a maize agroecosystem Trials carried out in Keneya against termites, have also demonstrated significantly reduced maize lodging and increased grain yield in both seasons (Maniania *et al.*,2002). These findings are in conformity with earlier reports (Singha *et al*., 2006; Ahmed *et al.*, 2009; Dong *et al*., 2009) who had shown a similar pattern of activity with isolates of these two entomopathogenic fungi against subterranean termite, *Coptotermes curvingnathus*. Both the fungal species were reported to produce an enzyme, exoprotease which has insecticidal activity. The highest concentration ($1\times10^9$ conidia $ml^{-1}$) of fungal isolates, *Metarrhizium anisopliae* (PPRC-2 and MM) had shown nearly 100 per cent mortality. A high level of mortality has been observed ranging from 25 to 75 per cent (9609) and 45 to 95 per cent (PPRC-56) for the isolates of *B. bassiana* while 60 to 100 per cent (MM) and 75 to 100 per cent (PPRC) for *M. anisopliae* isolates when compared to 0.21 per cent Diazinon with 100 per cent mortality over time. Fernandes and Alves (1991) achieved 100 per cent mortality of *Cornitermes cumulans* Kollar colonies within 10 days of application of 5 g of dust of either *M.anisopliae* or *Beauveria bassiana* (Bals.) Vuill. Milner and Staples (1996) reported that several hundred colonies of five different species of termites with nest in mounds or trees were destroyed when dry conidia of *M. anisopliae* were blown directly into the nursery region. Nkunika (1999) reported suppression of building activity of *Macrotermes falciger* Gerstacker following treatment with *B. bassiana* as bait in mounds in Zambia.

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