Efficacy of oil based formulation of *Beauveria bassiana* (Bals.) Vuill. against chilli mite, *Polyphagotarsonemus latus* Banks delivered through different delivery equipments

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ABSTRACT

The use of conventional synthetic insecticides to manage mites population poses great difficulties owing to their cryptic nature and has, therefore led to growing interest in novel and effective alternatives like microbial bio-control agents. Successful usage of entomopathogenic fungi for pest control under field conditions includes delivery techniques, infectivity and persistence of their inoculum in the environment. Microplot experiment on chilli mite, *Polyphagotarsonemus latus* Banks revealed that the oil based formulation of *B. bassiana* (Bb 112) was significantly superior to all other treatments and recorded the highest cumulative mean population reduction of 39.80 per cent. Two field experiments conducted against chilli mite, the cumulative mean per cent reduction in the first field trial at Kumarapalayam and the second one at Ambilikkai showed that oil based formulation of *B. bassiana*, Bb 112 @ 10^8 spores mL^{-1} sprayed with CDA sprayer was significantly superior to other treatments with 39.27 and 45.86 per cent reduction respectively.

Keywords: Oil based formulation, *Polyphagotarsonemus latus, Beauveria bassiana*, Delivery methods

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INTRODUCTION

India is the world's largest producer and exporter of chilli. Its production level is around 1.49 million tonnes which accounts for 26 per cent of global production with an area of 7.75 lakh hectares (Saxena and Gandhi, 2014). Yellow mite or broad mite, *Polyphagotorsonemus latus* Banks is a serious pest on chilli in Andhra Pradesh, Karnataka, Tamil Nadu, Madhya Pradesh and Maharashtra. Both nymphs and adults suck cell sap and devitalize the plant and as a result twisting and downward curling of leaves, petiole elongations of older leaves occur. Severely infested plants show deserted leaves with brownish patches leading to drying up of entire foliage. It is difficult to control mites with insecticides because of their small size and cryptic habits (Lewis, 1997). During the last two decades control of chilli pests especially in irrigated crop has been characterised by high pesticide usage and associated residues in the fruits (Joia *et al.*, 2001). Besides pest resurgence, resistance, destruction of natural enemies (Rao and Ahmed, 1986), both domestic consumption and export of chilli necessitates production of quality chillies devoid of pesticide residues.

Use of conventional synthetic insecticides to manage thrips and mites population poses great difficulties owing to their cryptic nature and hence has led to growing interest in novel and effective alternatives like microbial bio-control agents. Microbial control is recognized as the most sought after technology due to many positive attributes it possesses such as broad spectrum effectiveness, amenability for mass production and long term storage etc., Of these different microbial agents, entomopathogenic fungi (EPF) are gaining importance in pest control, because of their pathogenic potential to insects especially sucking pests (Rabindra and Ramanujam, 2007). Biopesticides based on entomopathogenic fungi are highly effective, safe and ecologically acceptable against many pests. Among entomopathogenic fungi, *Beauveria bassiana* (Bals.) Vuill. (Hypocreales: Cordycipitaceae) is an attractive bio-pesticide for use in integrated pest management, it has have host specificity with proven safety (Bateman *et al.,* 1993). In this context, microplot and field trials were carried out to evaluate the efficacy of the oil based fungal biopesticide against chilli mites and to identify an effective delivery method for the oil formulation.

MATERIALS AND METHODS

Preparation of Oil based formulation of *B. basssiana* (Bb 112)

Oil based formulation of *B. bassiana* (Bb 112) was prepared as per the protocol developed by Sangamithra (2015). Oil based formulation was prepared by dissolving 1 g of pure conidia (10^{10} conidia g^{-1}) of Bb 112 in 100 mL of paraffin oil, along with adjuvants to enhance the efficacy of the formulation.

Microplot and field evaluation against chilli mite

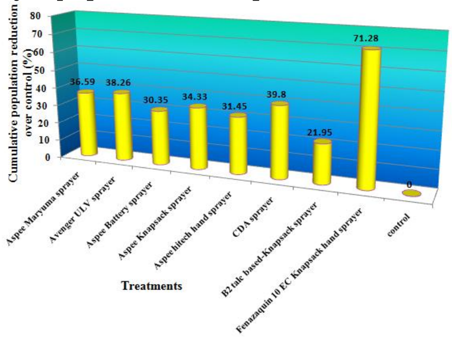
One Microplot experiment (at Insectary, Department of Agricultural Entomology, TNAU, Hyb. Bullet) and two field experiments (at Kumarapalayam- Hyb. Bullet, Ambilikkai- Var. K2) were conducted to evaluate the performance of oil based formulation of *B. bassiana* (Bb 112) delivered through different delivery equipments *viz.*, ASPEE Maruyama Engine sprayer (T1), Avenger ULV sprayer (T2) , ASPEE Battery sprayer (T3), ASPEE Knapsack hand sprayer (T4), ASPEE Hitech hand sprayer (T5) and CDA (Controlled Droplet Applicator) sprayer (T6) against chilli mites in comparison with the talc based formulation of *B. bassiana* (B2) (T7) available at the Department of Plant Pathology, TNAU and with acaricide check (Fenazaquin) (T8). The experiments were carried out during 2016 in a randomized block design with the plot size of 2.5 m × 2.5 m for microplots and 4 m × 5 m for field trials. Each treatment was replicated three times. Two rounds of treatments were imposed at fortnightly interval. The pre and post treatment counts on live mites population were made on 3, 7, 10 and 14 days after application from five plants selected randomly in each plot. The yellow mite population was counted from three fully opened terminal leaves and expressed as number of mites per leaf. Yield data was also recorded during each pickings and analysed after pooling in field trial. The mites population and per cent reduction in population over control observed from both micro plot and field experiments were subjected to square root (X+0.5) and *arc sine transformation* and the analysis of variance. Different experiments were carried out in AGRES and the means were separated by least significant difference (LSD) available in the package. The yield data were analyzed statistically after pooling the yield data from all the pickings in chilli.

RESULTS AND DISCUSSION

Microplot experiments on chilli mite, *P. latus*

In chilli, *P. latus* population before imposing treatments ranged from 13.89 to 14.68 mites per leaf. The mean data on post treatment population of the mite is presented in

Figure 1. Efficacy of oil based formulation of *B. Bassiana* (Bb 112) against *P. Latus* using different delivery equipment- micro plot



After the first round of spraying, the oil formulation of *B. bassiana* (Bb 112) @ 10^8 spores mL^{-1} sprayed with CDA sprayer was found to be significantly superior to all other treatments and recorded the highest per cent reduction of 32.06 per cent.

The acaricide check, fenazaquin 10 EC @ 1.5 mL lit^{-1} was significantly superior to all other treatments and recorded the highest population reduction of 65.90 per cent.

After the second round of spraying, the oil formulation of *B. bassiana* (Bb 112) sprayed with CDA sprayer was found to be significantly superior to all other treatments and recorded the highest per cent reduction of 46.03 per cent. The acaricide check, fenazaquin 10 EC @ 1.5 mL lit^{-1} was significantly superior to all other treatments and recorded the highest population reduction of 75.48 per cent. The cumulative mean per cent reduction of *P. latus* after two rounds of spraying indicated that the Bb 112 @ 10^8 spores mL^{-1} as oil based formulation sprayed with CDA sprayer was significantly superior to all other treatments by recording a population reduction of 39.80 per cent. The next in the order of efficacy was Bb 112 @ 10^8 spores mL^{-1} in oil based formulation sprayed with Avenger ULV sprayer (38.26 %) and Aspee Maruyama Engine sprayer (36.59 %).

Field evaluation against chilli mite, *P. latus*

Trial I- Location: Kumarapalayam

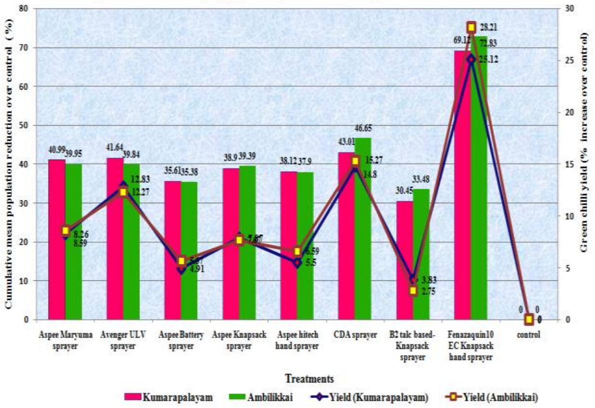
In this field trial, the efficacy of oil based formulation of *B. bassiana* (Bb 112) was also assessed against the mite population that co-occurred along with thrips on the same plants. The results of the field trial after first round of spraying are presented in Figure 2. After the first round of spraying, Bb 112 @ 10^8 spores mL^{-1} in oil based formulation sprayed with CDA sprayer was significantly superior to all other treatments and recorded the lowest mites population of 14.15, 13.88, 12.97 and 13.01 on 3, 7, 10 and 14 days after treatment, respectively and recorded 31.64 per cent reduction in mites population. Bb 112 @ 10^8 spores mL^{-1} in oil based formulation sprayed with Avenger ULV sprayer was the next best treatment with 29.43 per cent mean reduction in mites population. The acaricide check, fenazaquin 10 EC at 1.5 mL lit^{-1} was significantly superior to all other treatments and recorded 66.39 per cent reduction in thrips population. Similar trend was also observed after second round of spraying.

The cumulative mean per cent reduction in mites population showed that Bb 112 @ 10^8 spores mL^{-1} in oil based formulation sprayed with CDA sprayer and Aspee Maruyama engine sprayer were significantly superior to other treatments with 39.27 and 37.72 per cent reduction, respectively. However, the acaricide check, fenazaquin 10 EC @ 1.5 mL lit^{-1} recorded the lowest mite population and effected a cumulative mean reduction of 71.60 per cent after two sprays.

Trial II - Location: Ambilikkai

Field trial at Ambilikkai also revealed that the Bb 112 @ 10^8 spores mL^{-1} in oil based formulation sprayed with CDA sprayer and Avenger ULV sprayer were on par with the highest per cent reduction in mite population after first round of spraying. A similar trend was also observed after second round of spraying. After second round of spraying, Bb 112 @ 10^8 spores ml^{-1} in oil based formulation sprayed with CDA sprayer was effective in reducing the mite's population to the extent of 49.98 per cent

Figure 2. Pooled efficacy of oil formulation of B. Bassiana (Bb 112) against P. Latus on chilli using different delivery equipment (Field trail I & II)



The cumulative mean reduction over control showed that, among the different treatments, Bb 112 @ 10^8 spores mL^{-1} in oil based formulation sprayed with CDA sprayer was significantly superior in reducing the mite population by registering the highest reduction of 45.86 per cent. The standard check, fenazaquin 10 EC @ 1.5 mL lit^{-1}was significantly superior to all other treatments and recorded higher reduction in the mites population.

Higher efficacy of oil formulations of *B. bassiana* (Bb 112) in the present investigation might be due to the fact that the oil could coat the dry, dusty type of conidia allowing them to suspend easily in oil and spread rapidly over the surface of leaves which helps better contact of conidia with insect cuticle. The variation in virulence may be attributed to the number of conidia received by the individual pest (Bateman *et al.*, 1993). Sangeetha (2013) reported that the corn oil based formulation of *B. bassiana* (Bb 101) sprayed with ULV sprayer was most effective against *P. latus* on chilli with 57.51 per cent reduction after two rounds of spraying. The present findings are also in accordance with Nugroho and Ibrahim (2007) who reported significant reduction in the population of *P. latus* sprayed with *B. bassiana* and *P. fumosoroseus*. The findings are in accordance with Bateman *et al.* (1993) who reported that the use of oil formulation of *M. anisopliae* in ULV was highly effective against locusts in Africa. Being non-evaporative, oil formulation of mycoinsecticides is readily compatible with ULV application techniques for spraying at low relative humidities (Bateman, 1997). According to Bateman and Alves (2000) CDA represents a very specialised delivery system for oil formulations which can only be used with specialised application equipments (often rotary atomisers).

In laboratory conditions, thrips acts as good host for fungal pathogens, since they are generally soft bodied and inhabit environments with humid microclimates which favours infection and disease transmission (Hajek and Ledger, 1994). Whereas the field performance of different fungal candidates was dependent on both virulence to target pests and adaptation to field condition (Luz and Fargues, 1997). Multiple applications of microbial pesticides may improve the ability of infectious inoculum, thereby providing efficient control of target pests. Nevertheless, in a single spray all the population may not be encountered by *B. bassiana* and is dependent on persistence of conidia on foliage, probably because of the limited ability of individual thrips to acquire secondary conidia from the treated surface (Gatarayiha *et al.*, 2011) and perhaps the effective control by fungus is largely attributed to the favourable environmental condition. Hence, the repeated applications of *B. bassiana* with the right formulation could directly target new emerging adults, thereby would provide a better control.

Trial I- Kumarapalayam

Bb 112 @ 10^8 spores mL^{-1} in oil based formulation sprayed with CDA sprayer and Avenger ULV sprayer registered the highest yield of 23.34 and 22.94 t ha^{-1} with an yield increase of 14.80 and 12.83 per cent over untreated check (Figure 1). The plots treated with fenazaquin 10 EC recorded the fruit yield of 24.83 t ha^{-1} with an increase of 22.13 per cent over untreated check.

Trial II - Ambilikkai

The higher green chilli yield was obtained in Bb 112 @ 10^8 spores mL^{-1} in oil based formulation sprayed with CDA sprayer (13.81 t ha^{-1}) followed by Avenger ULV sprayer. Bb 112 @ 10^8 spores mL^{-1} oil formulation sprayed with Aspee Maruyama engine sprayer and Aspee hitech hand sprayer were next in order with 13.01 and 12.77 per cent increase respectively in yield over control. fenazaquin 10 EC recorded the fruit yield of 15.02 t ha^{-1} with an increase of 25.37 per cent over untreated check. The potential entomopathogenic fungi promote plant growth and improve yield by providing effectual management against pests (Dara, 2013). Present findings were in confirmation with Mikunthan and Manjunatha (2008) who reported that oil formulation of *Fusarium semitectum* Berk. and Rav. recorded higher green chilli yield both at *Kharif* and summer seasons. Chinniah *et al.* (2016) obtained 9025 kg ha^{-1} of chilli yield when sprayed with *B. bassiana* 1 x 10^8 spores mL^{-1} against sucking pests of chilli.

In Integrated Pest Management (IPM), application of right plant protection methods through right appliance may check the pest population in an effective manner. This is proved through the present result with oil based formulation of Bb 112 against chilli mite. Hence, application of oil based formulation of Bb 112 through CDA sprayer can be very well integrated in the pest management programmes for chilli mites.

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