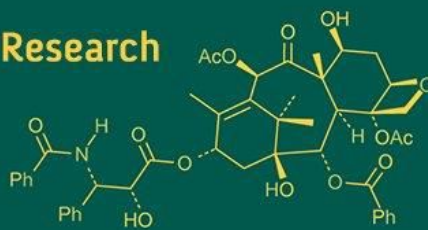


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Field assessment of Biopesticides against Bondar's nesting whitefly (*Paraleyrodes bondari* peracchi) in coconut ecosystem

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Abstract

Coconut (*Cocos nucifera* L.) cultivation in India is increasingly threatened by the exotic whitefly, Bondar's nesting whitefly (*Paraleyrodes bondari* Peracchi) necessitating the development of sustainable and eco-friendly management strategies. A field experiment was conducted during 2021-22 at HRS, Ambajipeta, to evaluate the efficacy of different biopesticides against whitefly populations under coconut ecosystem. The experiment was laid out in a randomized block design with seven treatments, including four entomopathogenic fungi, one botanical (azadirachtin 10,000 ppm), jet water spray, and an untreated control, with five replications. Observations on nymphs and adults were recorded at 7, 14 and 21 day intervals following spraying. Among the treatments, *Isaria fumosorosea* (NBAIR pfu-5 @ 5 ml L⁻¹) was most effective, significantly reducing whitefly populations and recording the highest reduction over pre-treatment counts with 58.42% reduction of nymphs and 80.10% reduction of adults. Azadirachtin 10,000 ppm ranked next in efficacy, followed by *Lecanicillium lecanii*, *Beauveria bassiana*, whereas *Metarhizium anisopliae* showed comparatively lower effectiveness. Jet water spray provided only marginal control, whereas the untreated control recorded a progressive increase in pest population. The superior performance of *I. fumosorosea* may be attributed to its ability to produce cuticle-degrading enzymes, facilitating rapid infection and mortality of whitefly stages. The study clearly demonstrates the potential of entomopathogenic fungi and botanicals as effective, environmentally safe components of integrated pest management (IPM) strategies for sustainable management of exotic whitefly complex in coconut.

Keywords: Biopesticides, evaluation, *Paraleyrodes bondari*, coconut

Introduction

Coconut (*Cocos nucifera* L.), belonging to the family Palmae (Arecaceae), is popularly known as the "Kalpavriksha" or divine tree due to its multifaceted utility in nutrition, medicine, cosmetics, and industry. Almost every part of the palm is economically useful, particularly in coconut-growing regions, with major by-products such as tender coconut water, copra, coconut oil, and coir pith contributing substantially to rural livelihoods and the agro-economy.

India is the third-largest producer of coconut globally, with an annual production exceeding 21 billion nuts from 2.16 million hectares, recording an average productivity of 21,274 nuts ha⁻¹ (APCC, 2024) [3]. Coconut cultivation is predominantly concentrated in southern India, and Andhra Pradesh alone accounts for 1, 07,370 ha with a productivity of 10,894 nuts ha⁻¹ (CDB, 2024) [4].

With the expansion of global trade, the inadvertent introduction of invasive pests has become a serious challenge to coconut cultivation. Among these, the rugose spiralling whitefly (*Aleurodicus rugioperculatus* Martin) has emerged as a major invasive pest, first reported from Tamil Nadu and Andhra Pradesh (Sundararaj & Selvaraj, 2016; Chalapathirao *et al.*, 2018) [15, 7]. Subsequently, the pest has spread rapidly, causing substantial yield and quality losses. In addition, other whitefly species such as *Paraleyrodes* spp. have also been reported infesting coconut in Kerala and Karnataka (Josephraj Kumar *et al.*, 2019; Vidya *et al.*, 2019) [12, 18]. The increasing incidence of whitefly infestations in coconut and the associated risks of yield loss, environmental contamination, and disruption of natural enemy complexes

necessitate the evaluation of biopesticides as sustainable management options. Indiscriminate use of chemical insecticides has led to issues such as pesticide resistance, residue concerns, and adverse effects on non-target organisms, highlighting the need for eco-friendly alternatives. Biopesticides, including entomopathogenic fungi and botanicals, offer target-specific action, compatibility with biological control agents, and reduced environmental footprint. Therefore, systematic evaluation of biopesticides is essential to identify effective, economically viable, and environmentally safe strategies for managing whitefly populations and strengthening integrated pest management (IPM) programs in coconut ecosystems.

Methods of Observation

Evaluation of various biopesticides against the exotic whitefly complex in coconut was undertaken to assess the feasibility of managing the pest using conventional biopesticides. The field experiment was conducted during 2021-22 at HRS, Ambajipeta, following a randomized block design with nine treatments, including an untreated control, and three replications. Each palm constituted one replication. The experiment was carried out on dwarf 'Gauthami Ganga' coconut palms aged 15-20 years. Among the treatments, five were biopesticides, one botanical (azadiractin 10,000 ppm), one jet water spray, and an untreated control. The required quantity of spray solution was prepared freshly at the time of application. Jet water spray was applied using a high-jet sprayer (Honda four-stroke petrol sprayer).

Table 2: Efficacy of different biopesticides against BNW nymphs under medium grade

Treatment	PTC	7 DAS	14 DAS	21 DAS	28 DAS	Reduction% Over PTC
<i>I. fumosorosea</i> NBAIR pfu- 5 @ 5 ml/L	8.56 (3.07)	6.52 (2.73)	5.59 (2.55)	4.19 (2.27)	3.56 (2.12)	58.42
<i>Azadiractin</i> 10000 ppm @ 1ml/L	8.12 (3.00)	6.48 (2.72)	5.70 (2.57)	4.47 (2.32)	3.87 (2.19)	52.37
<i>L. lecanii</i> Commercial @ 5 ml/L	8.45 (3.05)	7.38 (2.88)	6.67 (2.75)	5.78 (2.59)	5.17 (2.47)	38.82
<i>B. bassiana</i> Commercial @ 5 ml/L	6.76 (2.77)	6.07 (2.64)	5.57 (2.55)	4.93 (2.42)	4.47 (2.33)	33.83
<i>M. anisopliae</i> Commercial @ 5 ml/L	7.12 (2.83)	6.48 (2.72)	6.04 (2.64)	5.42 (2.52)	4.99 (2.43)	29.91
Water spray	8.09 (3.00)	7.96 (2.97)	7.84 (2.95)	7.69 (2.93)	7.53 (2.90)	6.88
Control (untreated)	7.33 (3.70)	9.21 (3.17)	13.74 (3.81)	15.47 (4.03)	19.21 (4.47)	-
SE (m) ±	-	0.02	0.04	0.04	0.06	-
C.D at 5%	NS	0.04	0.014	0.14	0.19	-

Table 3: Efficacy of different biopesticides against BNW adults under medium grade

Treatment	PTC	7 DAS	14 DAS	21 DAS	28 DAS	Reduction% Over PTC
<i>I. fumosorosea</i> NBAIR pfu- 5 @ 5 ml/L	12.12 (3.60)	7.70 (2.93)	5.53 (2.54)	3.40 (2.09)	2.41 (1.84)	80.10
<i>Azadiractin</i> 10000 ppm @ 1ml/L	13.23 (3.75)	8.59 (3.08)	6.60 (2.74)	4.22 (2.27)	3.24 (2.05)	78.71
<i>L. lecanii</i> Commercial @ 5 ml/L	12.15 (3.60)	8.39 (3.04)	6.83 (2.78)	4.68 (2.37)	3.72 (2.16)	69.41
<i>B. bassiana</i> Commercial @ 5 ml/L	12.06 (3.59)	8.36 (3.05)	6.93 (2.80)	4.95 (2.42)	4.05 (2.23)	66.38
<i>M. anisopliae</i> Commercial @ 5 ml/L	11.59 (3.52)	8.33 (3.03)	7.15 (2.84)	5.50 (2.53)	4.65 (2.36)	59.91
Water spray	13.26 (3.75)	12.84 (3.70)	12.56 (3.66)	12.29 (3.62)	12.04 (3.59)	9.20
Control (untreated)	11.24 (3.48)	14.15 (3.87)	16.52 (4.16)	22.74 (4.84)	28.78 (5.42)	-
SE (m) ±	-	0.03	0.04	0.08	0.10	-
C.D at 5%	NS	0.09	0.14	0.24	0.31	-

DAS: Days after spraying, PTC: Pre treatment data, Figures in the parenthesis are $\sqrt{x} + 0.5$ transformed values.

BNW Nymphs

As per the data in the table 2, At 7 DAS, *Isaria fumosorosea* (NBAIR pfu-5 @ 5 ml/L) reduced BNW nymphal population to 6.52 nymphs/leaflet, followed closely by azadiractin 10000 ppm @ 1 ml/L (6.48/ leaflet). Higher populations were recorded in *Lecanicillium lecanii* (7.38/ leaflet), *Beauveria bassiana* (6.07/ leaflet), and *Metarhizium anisopliae* (6.48/ leaflet), while water spray (7.96/ leaflet) and untreated control (9.21/ leaflet) recorded maximum counts.

Table 1: List of various bio-pesticides evaluated against Bondars nesting whitefly

	Treatments	Concentration	Dosage
T ₁	<i>Isaria fumosorosea</i>	1 X 10 ⁸ cfu	5 ml/L
T ₂	Azadiractin	10000 ppm	1 ml/L
T ₃	<i>Lecanicillium lecanii</i>	1 X 10 ⁸ cfu	5 ml/L
T ₄	<i>Beauveria bassiana</i>	1 X 10 ⁸ cfu	5 ml/L
T ₅	<i>Metarhizium anisopliae</i>	1 X 10 ⁸ cfu	5 ml/L
T ₆	Jet water spray	-	-
T ₇	Control (no spraying)	-	-

Sprays were applied at 15-day intervals. Following the pre-treatment count, observations on whitefly population were recorded at 7-day intervals. For population assessment, five palms per treatment were selected randomly. Counts of nymphs, pupae, and adults were recorded from four infested leaflets per leaf taken from four leaves per palm (top, middle, and lower whorls) representing four directions, total of 16 leaflets per palm, and expressed as mean per leaflet/palm. Nymphs and pupae were counted under a Nikon SMZ18 stereomicroscope, while adult populations were recorded visually.

$$\text{Pest population reduction \%} = \frac{\text{Pretreatment count} - \text{treatment count}}{\text{Treatment count}} \times 100$$

Results and Discussion

At 14 DAS, the lowest nymphal population per leaflet was observed in *I. fumosorosea* (5.59/ leaflet), followed by azadiractin (5.70/ leaflet). Moderate suppression was noted with *B. bassiana* (5.57/ leaflet), *M. anisopliae* (6.04/ leaflet), and *L. lecanii* (6.67/ leaflet). In contrast, water spray (7.84/ leaflet) and untreated control (13.74/ leaflet) showed higher infestation.

At 21 DAS, *I. fumosorosea* and azadiractin remained significantly superior with 4.19 and 4.47 nymphal population/ leaflet, respectively. Other biopesticides

recorded comparatively higher populations, viz., *B. bassiana* (4.93/ leaflet), *M. anisopliae* (5.42/ leaflet), and *L. lecanii* (5.78/ leaflet), whereas water spray (7.69/ leaflet) and control (15.47/ leaflet) continued to show increased nymphal density.

By 28 DAS, *I. fumosorosea* recorded the minimum nymphal population (3.56/ leaflet) with the highest reduction over PTC (58.42%), followed by azadiractin (3.87/ leaflet, 52.37%). Moderate control was achieved with *L. lecanii* (5.17/ leaflet), *B. bassiana* (4.47/ leaflet), and *M. anisopliae* (4.99/ leaflet). Water spray (7.53/ leaflet) was least effective, while the untreated control recorded the highest population (19.21/ leaflet), indicating severe pest buildup.

BNW Adults

At 7 DAS, *Isaria fumosorosea* (NBAIR pfu-5 @ 5 ml/L) recorded the lowest BNW adult population (7.70 adults/ leaflet), followed by azadiractin 10000 ppm @ 1 ml/L (8.59 adults/ leaflet). Comparable adult counts were observed with *Lecanicillium lecanii* (8.39 adults/ leaflet), *Beauveria bassiana* (8.36 adults/ leaflet), and *Metarhizium anisopliae* (8.33 adults/ leaflet). In contrast, water spray (12.84 adults/ leaflet) and untreated control (14.15 adults/ leaflet) recorded significantly higher adult populations as per the data in table 3.

At 14 DAS, *I. fumosorosea* remained most effective with 5.53 adults/ leaflet, followed by azadiractin (6.60 adults/ leaflet). Other biopesticides showed moderate suppression, viz., *L. lecanii* (6.83 adults/ leaflet), *B. bassiana* (6.93 adults/ leaflet), and *M. anisopliae* (7.15 adults/ leaflet). Water spray (12.56 adults/ leaflet) and untreated control (16.52 adults/ leaflet) continued to show higher adult incidence.

At 21 DAS, a pronounced decline in adult population was observed in *I. fumosorosea* (3.40 adults/ leaflet) and azadiractin (4.22 adults/ leaflet), which were significantly superior to other treatments. *L. lecanii* (4.68 adults/ leaflet), *B. bassiana* (4.95 adults/ leaflet), and *M. anisopliae* (5.50 adults/ leaflet) recorded comparatively higher adult numbers, while water spray (12.29 adults/ leaflet) and control (22.74 adults/ leaflet) showed severe infestation.

By 28 DAS, *I. fumosorosea* resulted in the minimum adult population (2.41 adults/ leaflet) with the highest reduction over PTC (80.10%), closely followed by azadiractin (3.24 adults/ leaflet, 78.71% reduction over PTC). *L. lecanii* (3.72 adults/ leaflet), *B. bassiana* (4.05 adults/ leaflet), and *M. anisopliae* (4.65 adults/ leaflet) provided moderate control. Water spray (12.04 adults/ leaflet) was least effective, whereas the untreated control recorded the maximum adult population (28.78), indicating unchecked pest multiplication.

Entomopathogenic fungi (EPF) significantly reduced whitefly populations by infecting insect hosts through enzymatic degradation of the cuticle via the production of proteases, chitinases, and lipases, which facilitate conidial attachment and penetration. Among the treatments evaluated, *Isaria fumosorosea* proved most effective in suppressing whitefly populations compared with *Beauveria bassiana*, *Metarhizium anisopliae* and *Lecanicillium lecanii*, likely due to its superior production of cuticle-degrading enzymes that disrupt host physiological regulation (Ali *et al.*, 2010) [2]. These findings corroborate earlier reports of significant reduction in rugose spiralling whitefly nymphal stages by *I. fumosorosea* (NBAIR pfu-5) under field

conditions (Boopathi *et al.*, 2013) [5]. Chalapathirao *et al.*, 2020; Selvaraj *et al.*, 2020) [8, 14]. Azadiractin 10,000 ppm was the next most effective treatment, suppressing all developmental stages of BNW by acting as a growth regulator, antifeedant, and repellent through inhibition of moulting hormone synthesis (Copping and Duke, 2007) [10], in agreement with earlier reports of reduced RSW adult intensity following azadiractin application (Chandrika *et al.*, 2017; Alagar *et al.*, 2021) [9, 1]. *Metarhizium anisopliae* was comparatively less effective, possibly due to lower conidial density and poor field persistence, as also reported by Boopathi *et al.* (2013) [5].

Conclusion

Among the treatments evaluated, *Isaria fumosorosea* proved most effective in suppressing BNW nymphal and adult stages compared with other treatments evaluated.

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