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Evaluation of synthetics and eco-friendly pesticides against yellow mite, Polyphagotarnemus latus (Banks) (Acari: Tarsonemidae)

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Research Article

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Abstract

The efficacy of synthetic and eco-friendly pesticides against the yellow mite, *Polyphagotarsonemus latus* (Banks) (Acari: Tarsonemidae), was evaluated during 2023–24 at the Department of Agricultural Entomology, College of Agriculture, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bengaluru. Two field experiments were conducted at Hittalahalli, Chikkaballapura district, using two foliar sprays at 15-day intervals. Mite populations [eggs and active stages (nymphs+adults)] were recorded from the three shoot tips per plant viz., first to fifth leaves at 3, 7, 10, and 15 days after treatment. In the first experiment, cyenopyrafen 30SC at 0.5 mL/L proved most effective, recording the lowest mean mite population (4.11 mites/leaf) after the first spray, followed by spiromesifen 22.9SC at 0.8 mL/L (8.39 mites/leaf) and pyridaben 20WP at 0.8 g/L (10.05 mites/leaf), with no significant differences among them. After the second spray, cyenopyrafen 30SC maintained the lowest pooled mean population (3.01 mites/leaf), corresponding to a 94.33% reduction over control. In second experiment, pyridaben 20WP, spiromesifen 22.9SC, and cyenopyrafen 30SC showed comparable efficacy, reducing mite populations to 16.23, 20.65, and 21.39 mites/leaf, respectively, after the first spray. The second spray resulted in significantly lower populations with pyridaben 20WP (12.17 mites/leaf), spiromesifen 22.9SC (12.40 mites/leaf), and cyenopyrafen 30SC (12.42 mites/leaf), corresponding to 80.12, 79.74, and 79.11% reduction over control, respectively. Overall, cyenopyrafen, spiromesifen, and pyridaben were the most effective pesticides for managing *P. latus* on mulberry under field conditions.

Introduction

Mulberry, a fast-growing deciduous tree, is extensively cultivated for sericulture. China leads in mulberry cultivation (626,000 ha) and silk production (50,000 MT), followed by India with 253,000 ha and 36,582 MT (Anonymous, 2023). Mulberry offers medicinal benefits, including reducing blood sugar, obesity, and antioxidant properties (Mahesh et al., 2017). Karnataka is the leading Indian state in mulberry cultivation (112,658 ha, 8,722 MT), followed by Andhra Pradesh and Tamil Nadu (Anonymous, 2023). Mulberry is affected by over 300 pests, including sucking insects, defoliators, root feeders, and stem borers (Mahadeva, 2018). Notable pests like pink mealybug, Bihar hairy caterpillar, and leaf webber can cause up to 40% crop loss (Kumari, 2014). Among these, mites are significant, with 15 species reported globally, 7 in India (Narayanaswamy *et al.*, 1996).

Polyphagotarsonemus latus (broad or yellow mite) is a major pest from the family Tarsonemidae, measuring 0.1–0.2 mm and inhabiting shoot tips (Mohan et al., 2024). First reported in India by Mann et al. (1920), and was linked to diseases in potato and chilli (Kulkarni, 1922). Found on jute in 1940, its presence on mulberry was confirmed in 2002 (Chauhan et al., 2002). *Polyphagotarsonemus latus* reduces leaf moisture by up to 62.99% (Arun *et al.*, 2022) and affects over 250 plant species (Rajlakshmi *et al.*, 2009). It attacks the lower surface of young leaves, later moving to the upper surface, causing deformation. Eggs are laid on leaf undersides, with males carrying deutonymph of females for mating (Jeppson et al., 1975). The life cycle completes in five days at 25°C, with feeding symptoms like leaf curling, brittleness, and stunted growth (Karmakar, 1995).

Polyphagotarsonemus latus has expanded its host range from chilli to mulberry, causing yield losses of 20–70% (Kumar and Varshney, 2020). Its high reproductive rate, rapid development, and exponential population growth make it difficult to control (Rashid et al., 2024). While biocontrol methods have shown limited success, pesticides remain effective in reducing mite damage and aiding plant recovery (Helle and Sabelis, 1985). A comprehensive evaluation of pesticides, encompassing both conventional and novel options, is crucial to determine their efficacy against yellow mite. With this intension, the research on evaluation of synthetic and eco-friendly pesticides against yellow mite was selected for investigation.

Material and methods

The study was conducted in the farmer's fields at Hittalahalli, Shidlagatta taluk of Chikkaballapura district, Karnataka, India. Experimental fields for the research were selected by extensive survey in Chikkaballpur district which is known for its mulberry cultivation. Where two fields were selected, which are located 500 m apart. Fifteen days old pruned mulberry gardens infested with *P. latus* were selected for the study, enabling the farmers to harvest leaves at the optimal time for silkworm rearing without the residues of pesticides in the leaf for silkworm feeding. The experiment was laid out in a randomized block design with 10 treatments and three replications including an untreated check using mulberry variety V-1 with the spacing of 90 x 30 cm with the paired row system planting during June 2024 to July 2024. Treatment details with dosage are presented in the Table 1 Two rounds of pesticide sprays were applied at 15-day intervals using a high-volume knapsack sprayer, ensuring no drift between plots by using barrier. Insecticide chlorfenapyr 10 SC recommended in the package of practice of the UAS, Bangalore was used as standard check. Each treatment involved 45 plants with 15 per replication and 5 plants were selected randomly for yellow mite observation from each replication, with a total of 15 plants per treatment. From each plant, three shoots were selected and five leaves from upper portion of the shoots were used for recording the mite populations *i.e.*, eggs and active stages one day prior to spray application Observations were made and at 3,7,10, and 15 days post-application using a stereo microscope. The reason for selecting the top five leaves for mite population count was based on the findings of Arun (2022) that the *P. latus* infestation was restricted to top five leaves of the young shoots. The shoots infested with yellow mites were collected in polythene cover containing tissue paper and fastened with an elastic rubber band with a label giving details of habitat, locality, date of collection and collector name. The collected mite infested shoots were brought to the laboratory and observed under the stereo 300m microscope (Nikon ECLIPSE E 200) for number of yellow mites. The mite counts (eggs and active stages) for the entire leaf on 1st, 2nd, 3rd, 4th and 5th leaf was recorded separately for each plant from three shoot tip in the observation book. Similar methodology was followed for recording mite population at different intervals after first and second spray. Mite counts were recorded for each leaf, pooled across 5 plants, and averaged for data were analyzed statistically following the analysis of variance technique (ANOVA) for Randomized block Design (RBD) for comparing treatments and the results were interpreted at 5 per cent level of significance by using WASP 2.0 software. The efficacy of treatments was determined by Henderson and Tilton formula (Henderson and Tilton, 1955),

Table 1
Treatment details of synthetic and eco-friendly products for the management of *P. latus* during 2023-24

Treatment details		Dosage
T1	*Metarhizium anisopliae* (Mechnikov) Sorokin (NAU strain)	4 g/L
T2	*Pseudomonas fluorescens* (Shatpada All Rounder)	4 g/L
T3	Azadirachtin 10000PPM	2 ml/L
T4	Wettable sulphur 80WP (Fungicide & Acaricide)	3 g/L
T5	Spiromesifen 22.9SC (Insecticide & Acaricide)	0.8 ml/L
T6	Hexythiazox 5.45EC (Acaricide)	0.6 ml/L
T7	Pyridaben 20WP (Insecticide & Acaricide)	0.8 g/L
T8	Cyenopyrafen 30SC (Acaricide)	0.5 ml/L
T9	Chlorfenapyr 10SC (Insecticide & Acaricide)	1.5 ml/L
T10	Control	-

% reduction in mite population = $[1-(T_a \times C_b) / (T_b \times C_a)] \times 100$

Where,

T_a = Population in the treated plot after spray

T_b= Population in the treated plot before spray

C_a = Population in the control plot after spray

C_b = Population in the control plot before spray

Result and discussion

In first experiment at Hittalahalli, before the treatment, the yellow mite population did not differ significantly among plots, confirming a uniform distribution (Table 2). The control consistently recorded the highest mean mite population, reaching 56.27 mites per leaf at 15 DAS.Three days after the first spray, cyenopyrafen 30 SC @ 0.5 ml/L recorded the lowest infestation (1.47 mites/leaf), comparable to spiromesifen 22.9 SC @ 0.8 ml/L (4.41 mites/leaf) and pyridaben 20 WP @ 0.8 g/L (4.63 mites/leaf). In contrast, azadirachtin 10000 ppm @ 2 ml/L showed the highest infestation (33.61 mites/leaf). The same trend followed at 7 DAS. Cyenopyrafen (4.57 mites/leaf) and spiromesifen (8.00 mites/leaf) remained most effective at 10 and 15 DAS. Following the first spray, the control plot had the highest mean mite population (49.60 mites/leaf), followed by azadirachtin (42.04 mites/leaf), *M. anisopliae* (36.87 mites/leaf), and NBAIR fungal product (31.93 mites/leaf). The lowest means were recorded in cyenopyrafen (4.11 mites/leaf), followed by spiromesifen (8.39 mites/leaf), which was statistically comparable to pyridaben (10.05 mites/leaf).

Table 2: Effect of synthetics and ecofriendly products on the population of yellow mite, *Polyphagotarsonemus latus* on mulberry during 2023-24 (Experiment-I).

Treatments		Pre-treatment count	Total mite population/leaf (Egg + Adult stage)					Total mite population/leaf (Egg + Adult stage)					Po Me
			First spray					Second spray					
			3DAS	7 DAS	10 DAS	15 DAS	Mean	3DAS	7 DAS	10 DAS	15 DAS	Mean	
T1	*Metarhizium anisopliae* @ 4g/L	57.34 (7.59)	20.92 (4.62)^{b}	26.73 (5.17)^{e}	52.10 (7.24)^{de}	47.74 (6.90)^{de}	36.87 (6.01)^{fg}	34.87 (5.90)^{d}	34.87 (5.96)^{d}	39.23 (6.30)^{h}	30.16 (5.48)^{fg}	34.78 (5.93)^{ef}	35. (6.(
T2	NBAIR fungal product @ 4g/L	44.94 (6.72)	19.18 (4.413)^{b}	22.01 (4.74)^{de}	41.81 (6.41)^{cd}	44.73 (6.72)^{cde}	31.93 (5.60)^{ef}	25.79 (5.12)^{cd}	23.06 (4.90)^{c}	25.64 (5.11)^{f}	25.91 (5.13)^{ef}	25.10 (5.06)^{de}	28. (5.3
T3	Azadirachtin 10000 ppm @ 2ml/L	47.10 (6.87)	33.61 (5.80)^{c}	41.57 (6.45)^{f}	44.62 (6.68)^{cd}	48.38 (6.96)^{de}	42.04 (6.50)^{gh}	51.93 (7.23)^{e}	39.23 (6.30)^{de}	27.76 (5.32)^{g}	40.32 (6.40)^{g}	39.81 (6.31)^{f}	40. (6.4
T4	Spiromesifen 22.9 SC @ 0.8ml/L	35.53 (5.96)	4.41 (2.17)^{a}	4.95 (2.45)^{ab}	8.00 (2.90)^{ab}	16.21 (4.02)^{ab}	8.39 (2.89)^{b}	0.57 (1.00)^{a}	6.80 (2.68)^{ab}	0.31 (0.90)^{ab}	6.40 (2.51)^{ab}	3.52 (1.82)^{ab}	5.9 (2.4
T5	Hexythiazox 5.45 EC @ 0.6ml/L	44.81 (6.68)	15.49 (3.99)^{b}	16.72 (4.15)^{cd}	34.80 (5.91)^{c}	32.92 (5.47)^{bcd}	24.98 (4.97)^{de}	18.98 (4.40)^{c}	22.27 (4.76)^{c}	16.22 (4.09)^{e}	16.77 (4.15)^{de}	18.56 (4.36)^{cd}	21. (4.7
T6	Pyridaben 20 WP @ 0.8g/L	38.39 (6.23)	4.63 (2.25)^{a}	3.24 (1.92)^{a}	9.13 (3.10)^{ab}	23.23 (4.83)^{b}	10.05 (3.04)^{b}	1.36 (1.35)^{a}	9.34 (2.91)^{b}	0.48 (0.99)^{b}	11.67 (3.44)^{bcd}	5.71 (2.24)^{ab}	7.8 (2.8
T7	Cyenopyrafen 30 SC @ 0.5 ml/L	52.16 (7.24)	1.47 (1.40)^{a}	1.88 (1.53)^{a}	4.57 (2.22)^{a}	8.53 (2.98)^{a}	4.11 (2.05)^{a}	0.42 (0.96)^{a}	2.54 (1.71)^{a}	0.17 (0.82)^{a}	4.48 (2.05)^{a}	1.90 (1.43)^{a}	3.0 (1.8
T8	Wettable sulphur 80 WP @ 3g/L	36.37 (6.04)	13.27 (3.57)^{b}	5.53 (2.45)^{ab}	16.59 (4.01)^{b}	27.89 (5.02)^{bc}	15.82 (3.91)^{f}	2.52 (1.71)^{a}	13.78 (3.76)^{bc}	1.29 (1.34)^{c}	6.89 (2.67)^{abc}	6.12 (2.39)^{b}	10. (3.3
T9	Chlorfenapyr 10 SC @ 1.5ml/L	36.38 (5.96)	14.17 (3.75)^{b}	14.24 (3.80)^{c}	32.60 (5.74)^{c}	27.89 (5.01)^{bc}	22.22 (4.69)^{d}	9.08 (3.10)^{b}	16.71 (4.15)^{c}	8.99 (3.08)^{d}	15.63 (3.81)^{cd}	12.60 (3.58)^{c}	17. (4.1
T10	Control	39.73 (6.24)	40.90 (6.43)^{c}	47.28 (6.89)^{f}	53.97 (7.98)^{e}	56.27 (7.51)^{e}	49.60 (7.06)^{h}	54.55 (7.42)^{e}	54.47 (7.41)^{e}	60.64 (7.82)^{i}	57.00 (7.74)^{h}	56.67 (7.55)^{g}	53. (7.3
F test		NS	*	*	*	*	*	*	*	*	*	*	*
SEM ±		0.49	0.37	0.30	0.44	0.61	0.24	0.27	0.39	0.03	0.42	0.31	0.2
CD @ 5 (%)			1.11	0.90	1.30	1.82	0.69	0.80	1.16	0.09	1.26	0.90	0.8

Note: Values in the parentheses are square-root transformed, DAS: days after spraying

Table 3: Effect of synthetics and ecofriendly products on the population of yellow mite, *Polyphagotarsonemus latus* on mulberry during 2023-24 (Trail-II).

Treatments		Pre-treatmentcount	Total mite population/leaf (Egg + Adult stage)					Total mite population/leaf (Egg + Adult stage)				
			First spray					Second spray				
			3DAS	7 DAS	10 DAS	15 DAS	Mean	3DAS	7 DAS	10 DAS	15 DAS	Mean
T1	*Metarhizium anisopliae* @ 4g/L	36.86 (6.06)	43.97 (6.66)^{ef}	44.04 (6.67)^{c}	51.32 (7.20)^{de}	27.48 (5.27)^{a}	41.70 (6.45)^{c}	36.28 (6.06)^{bc}	23.13 (4.73)^{de}	37.27 (5.90)^{cd}	40.96 (6.44)^{h}	34.41 (5.87)^{gf}
T2	NBAIR fungal product @4g/L	38.48 (6.18)	23.87 (4.930)^{d}	42.00 (6.49)^{c}	44.49 (6.71)^{cd}	39.34 (6.20)^{abc}	37.43 (6.11)^{bc}	30.41 (5.23)^{bc}	14.14 (3.81)^{cde}	30.47 (4.77)^{bc}	37.77 (6.19)^{g}	28.19 (5.28)^{f}
T3	Azadirachtin 10000PPM @ 2ml/L	34.01 (5.87)	35.87 (5.98)^{e}	55.43 (7.43)^{c}	47.63 (6.94)^{de}	58.88 (7.66)^{cde}	49.45 (7.03)^{c}	38.12 (5.94)^{bc}	23.78 (4.92)^{e}	43.32 (6.61)^{cd}	69.52 (8.37)^{i}	43.68 (6.53)^{g}
T4	Spiromesifen 22.9 SC @ 0.8ml/L	35.15 (5.97)	0.53 (1.01)^{a}	6.18 (2.58)^{ab}	40.70 (6.40)^{cd}	35.18 (5.96)^{ab}	20.65 (3.99)^{a}	5.08 (2.23)^{a}	0.98 (1.15)^{a}	1.00 (1.19)^{a}	9.59 (3.18)^{b}	4.16 (1.99)^{ab}
T6	Hexythiazox 5.45 EC @ 0.6ml/L	36.14 (6.05)	7.93 (2.90)^{c}	42.78 (6.50)^{c}	51.32 (7.20)^{de}	63.19 (7.98)^{de}	41.31 (6.16)^{bc}	25.38 (4.97)^{b}	12.58 (3.57)^{cd}	7.82 (2.88)^{ab}	29.83 (5.51)^{f}	18.90 (4.27)^{e}
T6	Pyridaben 20 WP @ 0.8g/L	37.19 (6.14)	2.66 (1.77)^{b}	3.83 (2.05)^{a}	29.12 (5.40)^{b}	29.29 (5.43)^{a}	16.23 (3.69)^{a}	14.14 (3.81)^{ab}	1.70 (1.45)^{a}	4.76 (2.21)^{a}	11.89 (3.52)^{c}	8.12 (2.78)^{bc}
T7	Cyenopyrafen 30 SC @ 0.5 ml/L	36.05 (96.05)	0.09 (0.76)^{a}	33.47 (5.46)^{c}	12.06 (3.53)^{a}	39.92 (6.35)^{abcd}	21.39 (4.12)^{a}	4.09 (2.14)^{a}	0.59 (1.01)^{a}	0.08 (0.76)^{a}	9.08 (3.09)^{a}	3.46 (1.76)^{a}
T8	Wettable sulphur 80 WP @ 3g/L	34.70 (5.86)	3.40 (1.90)^{b}	6.21 (2.54)^{ab}	33.31 (5.81)^{bc}	53.36 (7.31)^{bcde}	24.07 (4.43)^{ab}	16.81 (3.98)^{ab}	5.02 (2.08)^{ab}	6.21 (2.34)^{ab}	14.93 (3.92)^{d}	10.74 (3.25)^{cd}
T9	Chlorfenapyr 10 SC @ 1.5ml/L	36.08 (6.05)	5.81 (2.50)^{bc}	33.16 (5.04)^{bc}	39.79 (6.32)^{cd}	58.41 (7.63)^{cde}	34.29 (5.58)^{abc}	23.74 (4.92)^{b}	8.83 (3.00)^{bc}	6.54 (2.59)^{ab}	19.43 (4.46)^{e}	14.63 (3.77)^{de}
T_{10}	Control	44.43 (6.68)	51.82 (7.23)^{f}	58.10 (7.54)^{c}	60.22 (7.80)^{e}	53.78 (8.07)^{e}	55.98 (7.51)^{c}	53.25 (7.28)^{c}	63.08 (7.97)^{f}	61.57 (7.88)^{d}	88.28 (9.42)^{j}	66.54 (8.15)^{h}
F test		NS	*	*	*	*	*	*	*	*	*	*
SEM ±		0.34	0.25	0.96	0.31	0.55	0.67	0.76	0.39	0.83	0.89	0.30
CD @ 5 (%)			0.74	2.85	0.91	1.64	1.94	2.26	1.24	2.48	2.66	0.95

Note: Values in the parentheses are square-root transformed, DAS: days after spraying

The second spray was applied 15 days after the first, with the 15 DAS counts serving as precounts (Table 2). At 3 DAS, the lowest counts were observed in cyenopyrafen (0.42 mites/leaf), spiromesifen (0.57 mites/leaf), pyridaben (1.36 mites/leaf), and wettable sulphur 80 WP @ 3 g/L (2.52 mites/leaf). Hexythiazox 5.45 EC @ 0.6 ml/L recorded a moderate reduction (18.98 mites/leaf) and the same trend followed in 7, 10 and 15 DAS. Pooled data confirmed maximum populations in the control (53.14 mites/leaf), followed by azadirachtin (40.93 mites/leaf) and *M. anisopliae* (35.83 mites/leaf). Cyenopyrafen (3.01 mites/leaf) and spiromesifen (5.96 mites/leaf) consistently recorded the lowest means (Table 3, Fig. 1). Overall, cyenopyrafen exhibited the highest reduction in mite populations (94.33%), followed by spiromesifen (88.78%) and pyridaben (85.15%). Azadirachtin (22.98%) and *M. anisopliae* (32.57%) were least effective, while chlorfenapyr 10 SC @ 0.8 ml/L showed moderate efficacy (67.24%) (Fig. 2).

In experiment two, before the first spray, the yellow mite population did not differ significantly among treatments, indicating uniform distribution in the mulberry field, with counts ranging from 34.01 to 44.43 mites per leaf. Three days after the first spray, the highest mite population was recorded in the control plot (51.82 mites/leaf), followed by *M. anisopliae* (43.97 mites/leaf) and azadirachtin 10,000 ppm (35.87 mites/leaf). The lowest counts were observed in cyenopyrafen 30 SC (0.09 mites/leaf) and spiromesifen 22.9 SC (0.53 mites/leaf). At 7 DAS, pyridaben 20 WP recorded the lowest population (3.38 mites/leaf), while azadirachtin 10,000 ppm (55.43 mites/leaf) and the control (58.10 mites/leaf) had the highest. At 10 DAS, cyenopyrafen 30 SC remained most effective (12.06 mites/leaf), whereas the control had the highest population (60.22 mites/leaf). At 15 DAS, the control still recorded the highest infestation (53.78 mites/leaf), while *M. anisopliae* (27.48 mites/leaf) and pyridaben 20 WP (29.29 mites/leaf) showed significant reductions (Table 3). The mean mite population after the first spray was highest in azadirachtin 10,000 ppm (49.45 mites/leaf) and *M. anisopliae* (41.70 mites/leaf), comparable to the control (55.98 mites/leaf). The lowest mean populations were observed in pyridaben 20 WP (16.23 mites/leaf), spiromesifen 22.9 SC (20.65 mites/leaf), and cyenopyrafen 30 SC (21.39 mites/leaf) (Fig. 1).

The second spray was applied 15 days after the first, with the 15 DAS counts serving as precounts (Table 3). At 3 DAS, all treatments except *M. anisopliae* significantly reduced mite populations compared to the control (53.25 mites/leaf). The lowest counts were observed in cyenopyrafen (4.09 mites/leaf), spiromesifen (5.08 mites/leaf) and pyridaben (14.14 mites/leaf) and same trend followed in 7, 10 and 15DAS. Highest infestation was recorded in Azadiractin 10000 ppm (38.12 mites/leaf) and the same trend followed in 7, 10 and 15 DAS.

The overall mean mite population after the second spray was highest in the control (66.54 mites/leaf), followed by azadirachtin 10,000 ppm (43.68 mites/leaf), NBAIR fungal product (28.19 mites/leaf), and *M. anisopliae* (34.41 mites/leaf), with similar efficacy among the last two. The lowest mean populations were observed in cyenopyrafen (3.46 mites/leaf) and spiromesifen (4.16 mites/leaf), which were statistically comparable (Fig. 1). Pyridaben 20 WP (12.17 mites/leaf), spiromesifen 22.9 SC (12.40 mites/leaf), and cyenopyrafen 30 SC (12.42 mites/leaf) demonstrated the highest percent reduction in mite populations (80.12%, 79.74%, and 79.11%, respectively). In contrast, azadirachtin, *M. anisopliae*, and NBAIR fungal product were less effective (23.90%, 38.10%, and 46.30%). Chlorfenapyr and hexythiazox showed moderate reductions (60.03% and 50.82%, respectively) (Fig. 2).

Present investigation collectively suggests that, among the pesticides used for management of *P. latus*, cyenopyrafen 30 SC @ 0.5 ml/L, spiromesifen 22.9 SC at 0.8ml/L and pyridaben 20 WP @ 0.8g/L were most effective in controlling *P. latus*, showing significant reductions in mite populations over the observation period. Cyenopyrafen 30 SC @ 0.5 ml/L consistently demonstrated superior efficacy, achieving up to 94.33% reduction in mite populations across both spray schedules. This finding aligns with prior studies by Bajya and Ranjith (2016), who reported an 87.49% reduction, indicating that cyenopyrafen exhibits both rapid knockdown and residual activity against *P. latus*. The findings of Arun (2022) showed 89 per cent control of *P. latus* with spiromesifen 22.9 SC at 0.8 ml/L, which was on par with the results of the present study, *i.e.* 88.78 per cent. Effectiveness of pyridaben 20 WP in controlling mite aligns with the findings of Singh *et al.* (2023), where a reduction to 3.05 mites per leaf was recorded at 14 DAS. Efficiency of wettable sulfur (80 WP) at 3 g/L in controlling the yellow mite population of 71.57 to 79.35 per cent which is comparable to the results of Ahmed et al. (2011) where, they used sulfox 80 WDG @ 2.25 kg/ha-controlled mite population 81.57 per cent over control. Current study revealed that *M. anisopliae* had limited effectiveness (32.57–38.10%) against *P. latus* mites, similar to findings of Satpathi *et al* (2019) for *Isaria fumosorosea* (*Pf*) and *Beauveria bassiana* (*Bb*)

Conclusion

Based on the findings of field trials, cyenopyrafen 30 SC at 0.5 ml/L, spiromesifen 22.9 SC at 0.8 ml/L and pyridaben 20 WP at 0.8 g/L emerged as effective chemicals in managing the population of *P. latus* on mulberry. The mode of action of these chemicals is different hence; to avoid the resistance development in yellow mite, these chemicals can be used on rotational bases one after the other for the management of yellow mite.

Declarations

Competing interest

We wish to confirm that there are no known conflicts of interest associated with this publication.

Ethical approval

This article does not contain any studies with human participants or vertebrate animals. Experimental work was conducted on *Polyphagotarsonemus latus* (Banks), which is not subject to ethical approval under institutional or national guidelines.

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Author Contributions

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Data availability

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

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Figures

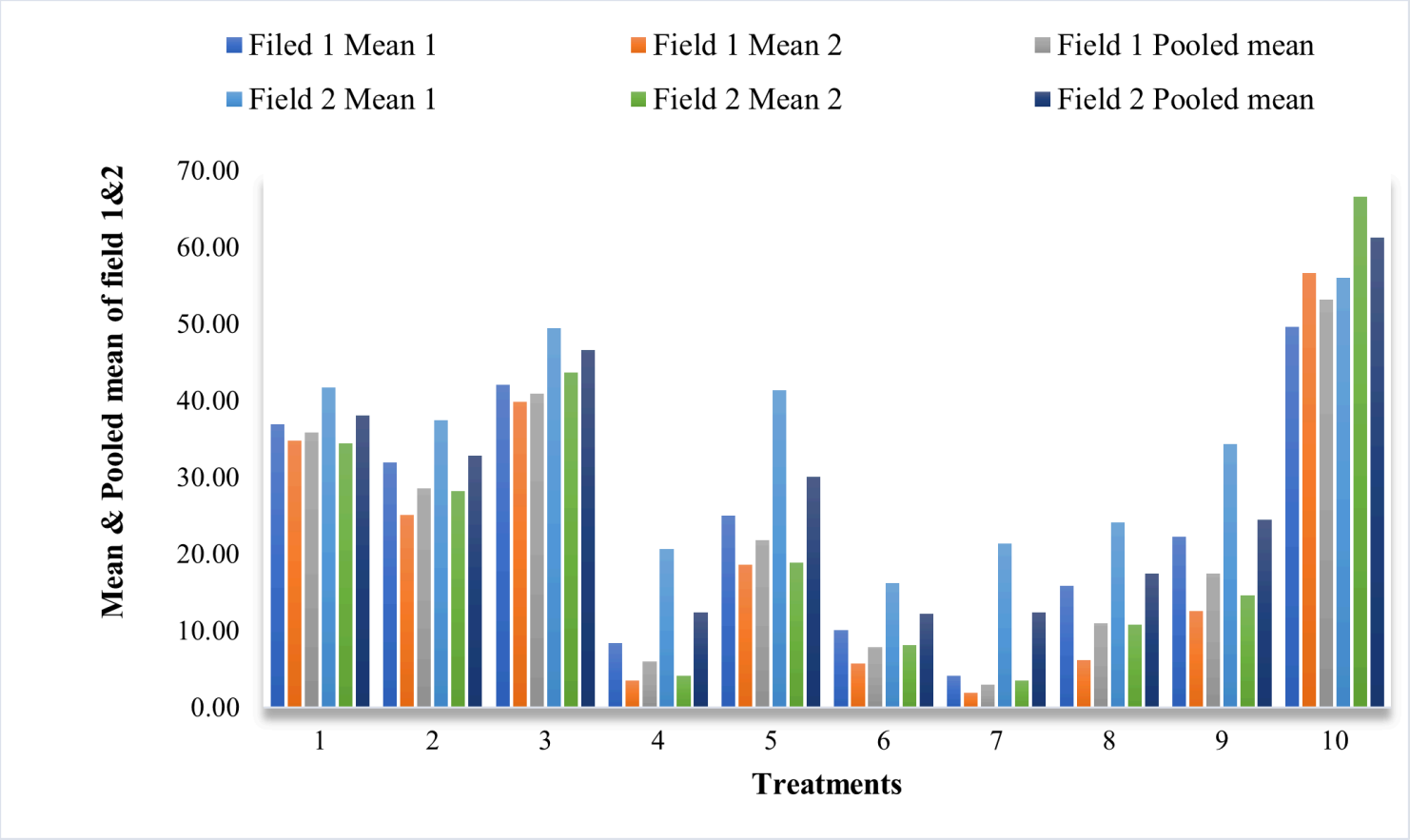


Figure 1

Mean mite population and pooled mean mite population of experiment 1and 2

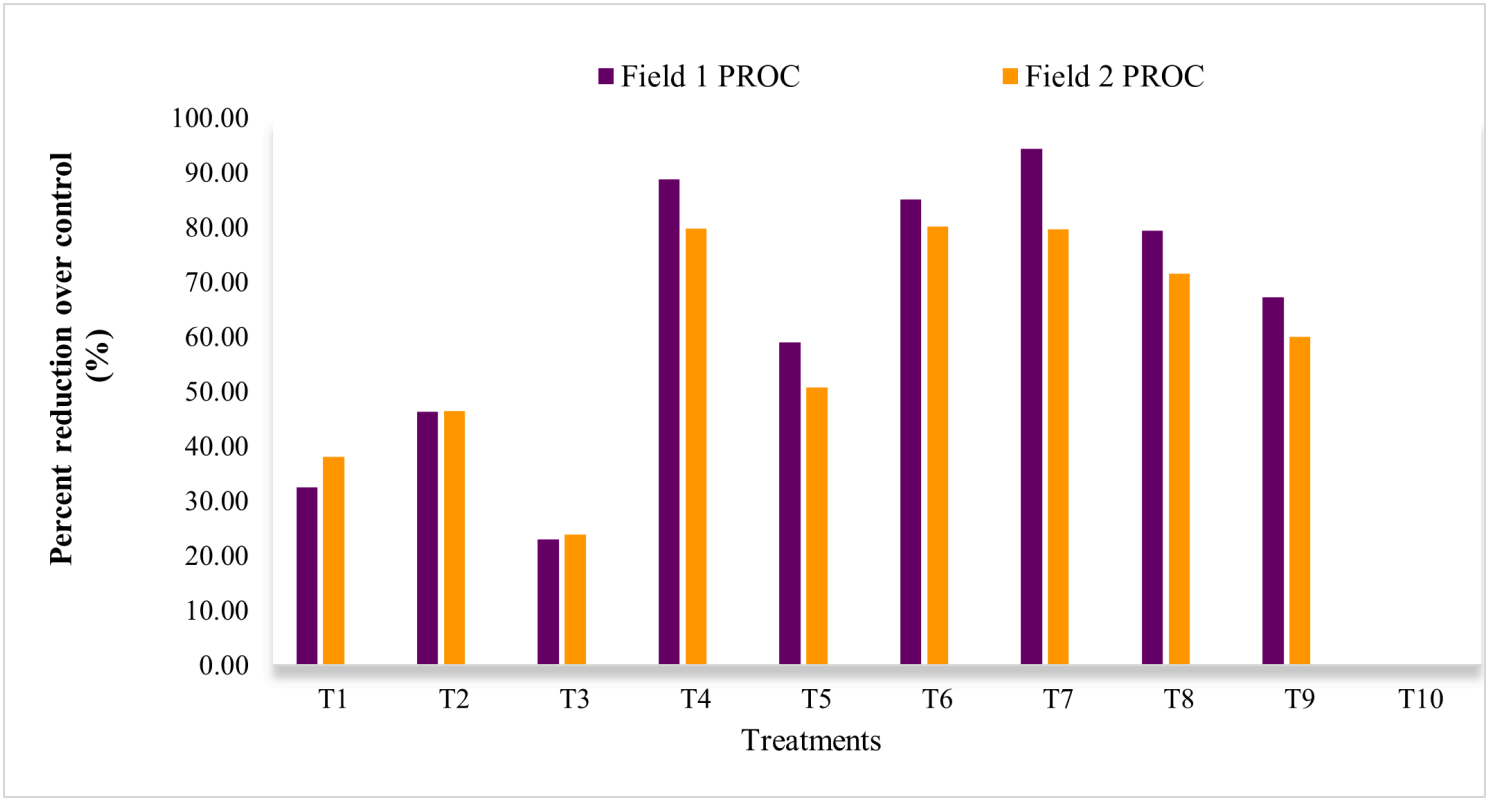


Figure 2

Effect of treatments on percent reduction of yellow mite population in mulberry