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Evaluation of Plant-Based Products for the Management of Whitefly, Bemisia tabaci (Gennadius) on Kharif Mungbean

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Abstract

Field experiments were conducted at the Entomological Research Farm, Punjab Agricultural University (PAU), Ludhiana, during kharif seasons of 2022 and 2023 to evaluate eight plant-based products and one synthetic insecticide against whitefly, *Bemisia tabaci* (Gennadius), on mungbean variety ML 1808. Treatments included PAU homemade neem extract, homemade dharek extract, neem oil, Neem Seed Kernel Extract (NSKE 5%), castor oil, sesame oil, linseed oil, detergent powder at three dose levels each, and Actara 25WG (thiamethoxam) as a chemical check. Two sprays were applied and populations were recorded 3, 5, 7 and 10 days after each spray. Pooled analysis revealed that Actara 25WG @ 40 g/acre recorded the lowest population of *B. tabaci* (1.76 adults per trifoliate leaf) three days after the first spray, while PAU homemade neem extract @ 2000 ml/acre (2.87 adults per trifoliate leaf) was the most effective botanical, at par with neem oil @ 500 ml/acre and dharek extract @ 2000 ml/acre. Detergent powder @ 100 g/acre was least effective. The study establishes PAU homemade neem extract and dharek extract as promising eco-friendly alternatives for integrated management of sucking insect pests of mungbean.

1 Introduction

Mungbean (*Vigna radiata* L. Wilczek) is recognised as a staple protein source for economically disadvantaged populations across South and South-East Asia, supplying a substantial portion of daily dietary protein (Shafique et al. 2009). The crop thrives in semi-arid environments because of its drought tolerance, rapid maturation, and capacity to fix atmospheric nitrogen, thereby improving soil fertility (Sharar et al. 2001). India, China, Myanmar, Bangladesh, Thailand, the Philippines, and Pakistan collectively account for the bulk of global mungbean production.

Despite its agronomic importance, mungbean is susceptible to a wide spectrum of insect pests from sowing to post-harvest storage, leading to appreciable yield losses (Swaminathan et al. 2012). The whitefly *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) is among the most economically damaging sucking pests, causing direct phloem feeding injury and indirectly transmitting yellow mosaic virus. In addition to *B. tabaci*, stem fly, thrips, aphids, pod borers, pod bugs, and bruchids represent major biotic constraints to mungbean production (Sehgal and Ujagir 1988).

Bemisia tabaci is a multivolatine pest with a short generation time, and over-reliance on synthetic insecticides has led to resistance, residue accumulation, and secondary pest resurgence (Jayraj et al. 1986). Botanical and naturally derived products offer an ecologically safer, economically viable alternative that is compatible with integrated pest management (IPM) frameworks. Neem-based formulations have been demonstrated to reduce whitefly populations on various crops (Babu and Srinivasan 2001; Natarajan et al. 1986; Lal et al. 2024). Pongamia oil and azadirachtin have also shown efficacy against lepidopteran and homopteran pests on cruciferous vegetables (Cheema 2023).

The present study was therefore undertaken to evaluate eight plant-based products at three dose levels each, alongside a chemical standard (thiamethoxam), for the management of *B. tabaci* on kharif

mungbean under field conditions at Ludhiana, Punjab, India, during 2022 and 2023.

2 Materials and Methods

2.1 Experimental site and crop

Field experiments were conducted at the Entomological Research Farm, Punjab Agricultural University (PAU), Ludhiana (30.9°N, 75.8°E; altitude 247 m asl), during kharif seasons of 2022 and 2023. Mungbean variety ML 1808 was raised following PAU Package of Practices (Anonymous 2022, 2023). Seeds were treated with rhizobium culture prior to sowing. Plots measuring 3 m × 5 m were laid out in a Randomised Block Design (RBD) with three replications; inter-row spacing was 30 cm and intra-row plant spacing was 10 cm.

2.2 Treatments

Ten treatments were evaluated at three doses each where applicable (Table 1). Botanical treatments comprised: PAU homemade neem extract (1500, 1750, and 2000 ml/acre), homemade dharek extract (1500, 1750, and 2000 ml/acre), neem oil (300, 400, and 500 ml/acre), NSKE 5% (2.5, 5.0, and 7.5 kg/acre), castor oil (10, 20, and 30 ml/acre), sesame oil (600, 800, and 1000 ml/acre), linseed oil (100, 200, and 300 ml/acre), and detergent powder (100, 300, and 500 g/acre). Actara 25WG (thiamethoxam) @ 40 g/acre served as the chemical check; an untreated control was maintained.

2.3 Preparation of homemade botanical extracts

PAU homemade neem extract. Terminal shoots, leaves, green branches, and fruits of neem (*Azadirachta indica* A. Juss) (4 kg) were boiled in 10 litres of water for 30 min. The filtrate was cooled, filtered through muslin cloth, and applied at the recommended doses.

Homemade dharek extract. Terminal shoots, leaves, branches, and fruits of dharek (*Melia azedarach* L.) (4 kg) were similarly boiled in 10 litres of water for 30 min, filtered, and sprayed at doses of 1500, 1750, and 2000 ml/acre.

All oil formulations were emulsified by mixing with detergent powder @ 5 g per litre of water, agitated thoroughly, and filtered through muslin cloth before spraying to prevent nozzle blockage. Two sprays were applied at fortnightly intervals during crop growth.

2.4 Observation and data collection

Whitefly population was recorded on a per-trifoliate-leaf basis from five randomly selected plants per plot. Counts were made before each spray (pre-spray count) and at 3, 5, 7, and 10 days after spray (DAS). Phytotoxicity symptoms (leaf injury, wilting, necrosis, vein clearing) were also monitored.

2.5 Statistical analysis

Data were subjected to Analysis of Variance (ANOVA) for a Randomised Block Design following square-root transformation [√(n + 1)] to normalise counts. Treatment means were separated using Tukey's Honestly Significant Difference (HSD) test at p = 0.05. Pooled analysis was performed over both years.

3 Results and Discussion

3.1 Effect of plant products after the first spray

Pooled data on the efficacy of plant products against *B. tabaci* after the first spray are presented in Table 1 and Fig. 1. Three days after the first spray (3 DAS), the lowest adult population was recorded in Actara 25WG @ 40 g/acre (1.76 adults per trifoliate leaf), followed by PAU homemade neem extract @ 1750 ml/acre (2.85 adults per trifoliate leaf) which was at par with PAU homemade neem extract @ 2000 ml/acre (2.87), neem oil @ 500 ml/acre (3.00), and homemade dharek extract @ 2000 ml/acre (3.12). Detergent powder @ 100 g/acre was least effective (7.02 adults per trifoliate leaf).

Five DAS, the lowest population was recorded in PAU homemade neem extract @ 2000 ml/acre (3.15 adults per trifoliate leaf), at par with neem oil @ 500 ml/acre (3.27), PAU homemade neem extract @ 1750 ml/acre (3.30), and dharek extract @ 2000 ml/acre (3.53). Seven DAS, PAU homemade neem extract @ 2000 ml/acre (3.97) and dharek extract @ 2000 ml/acre (3.97) maintained the lowest population. This trend continued 10 DAS, with the lowest count in PAU homemade neem extract @ 2000 ml/acre (4.37) and the highest in detergent powder @ 100 g/acre (7.77).

3.2 Effect of plant products after the second spray

Pooled efficacy data after the second spray are presented in Table 2 and Fig. 2. Three DAS, Actara 25WG @ 40 g/acre (2.45 adults per trifoliate leaf) recorded the lowest population, at par with PAU homemade neem extract @ 2000 ml/acre (2.47), PAU homemade neem extract @ 1750 ml/acre (3.05), neem oil @ 500 ml/acre (3.17), and PAU homemade neem extract @ 1500 ml/acre (3.22).

Five DAS, PAU homemade neem extract @ 2000 ml/acre (3.03) produced the lowest count, at par with neem oil @ 500 ml/acre (3.60), dharek extract @ 2000 ml/acre (3.65), PAU homemade neem extract @ 1500 ml/acre (3.73), and PAU homemade neem extract @ 1750 ml/acre (3.82). Seven DAS, PAU homemade neem extract @ 2000 ml/acre (3.68) was most effective, at par with dharek extract @ 2000 ml/acre (3.72). Ten DAS, Actara 25WG @ 40 g/acre recorded the lowest count (1.90 adults per trifoliate leaf), while detergent powder @ 100 g/acre was highest (7.45).

3.3 Discussion

The superior performance of PAU homemade neem extract at higher doses is consistent with earlier reports. Babu and Srinivasan (2001) demonstrated that 2–3 applications of neem derivatives effectively managed *B. tabaci* on brinjal. The present findings corroborate results of Jayraj et al. (1986), who reported 93.7% and 90.3% nymphal mortality of *B. tabaci* with NSKE 5% and neem oil 5%, respectively, at

7 DAS. Lal et al. (2024) similarly observed that NSKE 5% (4.67 whitefly per six leaves) and neem oil 5% (4.88 whitefly per six leaves) were the most effective biopesticide treatments.

Natarajan et al. (1986) found that neem oil combined with monocrotophos provided better control than insecticide alone, suggesting a synergistic role for neem-based adjuvants. Cheema (2023) confirmed that azadirachtin 0.03%, NSKE powder, turmeric powder, and pongamia oil remained effective for up to 5 days against lepidopteran pests on brassicas. The effectiveness of dharek (*M. azedarach*) extract observed here adds to the growing body of evidence for limonoid-containing tree species as alternative pest management tools.

Detergent powder at low concentrations proved largely ineffective, supporting its limited utility as a standalone treatment. No phytotoxicity symptoms were observed for any botanical treatment across both seasons.

Table 1
Efficacy of various plant products against whitefly, Bemisia tabaci, on kharif mungbean after first spray (pooled data 2022–2023)

Sr. No.	Treatments	Dose/acre	Pre-spray count	*Adult population of B. tabaci per trifoliate leaf*			
				3 DAS	**5 DAS**	**7 DAS**	**10 DAS**
1	PAU homemade neem extract	1500 ml	8.10	3.75	4.30	5.27	6.00
2	PAU homemade neem extract	1750 ml	6.58	2.85*	3.30*	4.23	4.70
3	PAU homemade neem extract	2000 ml	8.03	2.87*	3.15*	3.97*	4.37*
4	Homemade Dharek extract	1500 ml	8.35	4.67	5.42	5.98	6.33
5	Homemade Dharek extract	1750 ml	7.17	3.52	4.17	4.52	4.83
6	Homemade Dharek extract	2000 ml	7.10	3.12	3.53	3.97*	4.52
7	Neem oil	300 ml	8.33	4.48	4.92	6.17	6.18
8	Neem oil	400 ml	8.43	4.12	4.55	5.75	6.05
9	Neem oil	500 ml	7.37	3.00*	3.27*	4.10	4.87
10	NSKE 5%	2.5 kg	7.92	4.55	5.30	5.55	5.45
11	NSKE 5%	5 kg	8.35	4.60	4.92	5.98	6.72
12	NSKE 5%	7.5 kg	8.63	4.42	4.87	5.73	6.67
13	Castor oil	10 ml	8.63	5.77	5.83	6.67	6.58
14	Castor oil	20 ml	8.25	5.10	5.00	6.40	5.88
15	Castor oil	30 ml	7.32	4.30	4.30	4.92	4.92
16	Sesame oil	600 ml	8.33	4.67	5.13	6.35	5.67
17	Sesame oil	800 ml	8.25	5.05	5.72	5.78	6.42
18	Sesame oil	1000 ml	8.58	4.38	5.17	5.58	5.60
19	Linseed oil	100 ml	8.18	5.58	6.42	7.22	7.07
20	Linseed oil	200 ml	7.58	4.63	5.17	5.88	6.12
21	Linseed oil	300 ml	7.17	3.92	4.37	5.32	5.33
22	Detergent powder	100 g	8.45	7.02	7.47	8.17	7.77

Sr. No.	Treatments	Dose/acre	Pre-spray count	*Adult population of B. tabaci per trifoliate leaf*			
				3 DAS	**5 DAS**	**7 DAS**	**10 DAS**
23	Detergent powder	300 g	9.48	6.23	6.87	7.28	6.87
24	Detergent powder	500 g	8.50	6.00	6.52	7.17	6.70
25	Actara 25WG (Thiamethoxam)	40 g	9.82	1.76**	2.00**	1.92**	2.25**
26	Untreated control	—	9.02	—	—	—	—
CD	CD (p = 0.05)		0.27	0.26	0.29	0.30	0.30

*Mean of 3 replications. DAS = days after spray. *At par with best treatment; **Positive standard (chemical check). Values are means of pooled 2022–2023 data.*

Table 2
Efficacy of various plant products against whitefly, Bemisia tabaci, on kharif mungbean after second spray (pooled data 2022–2023)

Sr. No.	Treatments	Dose/acre	Pre-spray count	*Adult population of B. tabaci per trifoliate leaf*			
				3 DAS	5 DAS	7 DAS	10 DAS
1	PAU homemade neem extract	1500 ml	8.08	3.22	3.73	5.87	4.10
2	PAU homemade neem extract	1750 ml	6.70	3.05	3.82	5.72	4.40
3	PAU homemade neem extract	2000 ml	7.98	2.47*	3.03*	3.68*	6.10
4	Homemade Dharek extract	1500 ml	8.32	3.80	4.58	4.23	4.58
5	Homemade Dharek extract	1750 ml	7.12	3.27	3.80	3.97	4.23
6	Homemade Dharek extract	2000 ml	7.37	3.27	3.65	3.72*	5.92
7	Neem oil	300 ml	8.13	4.15	4.45	5.50	5.73
8	Neem oil	400 ml	8.42	3.62	3.90	5.18	4.62
9	Neem oil	500 ml	7.42	3.17	3.60	3.73*	5.19
10	NSKE 5%	2.5 kg	6.92	4.28	4.63	5.75	6.38
11	NSKE 5%	5 kg	8.20	4.13	4.90	5.50	6.37
12	NSKE 5%	7.5 kg	8.28	3.87	4.90	6.33	6.30
13	Castor oil	10 ml	8.33	4.95	5.28	6.20	5.62
14	Castor oil	20 ml	8.10	4.47	4.67	4.58	4.63
15	Castor oil	30 ml	7.35	4.27	4.23	5.47	4.77
16	Sesame oil	600 ml	7.28	4.78	5.60	5.97	6.20
17	Sesame oil	800 ml	7.70	4.65	5.45	5.33	5.28
18	Sesame oil	1000 ml	8.60	4.05	4.48	6.93	6.78
19	Linseed oil	100 ml	8.40	4.13	5.73	5.57	5.85
20	Linseed oil	200 ml	7.73	4.92	5.53	4.92	5.10
21	Linseed oil	300 ml	7.18	5.12	4.77	7.03	6.62
22	Detergent powder	100 g	8.32	6.12	6.70	7.85	7.45

Sr. No.	Treatments	Dose/acre	Pre-spray count	*Adult population of B. tabaci per trifoliate leaf*			
				3 DAS	**5 DAS**	**7 DAS**	**10 DAS**
23	Detergent powder	300 g	9.52	5.98	6.38	6.90	6.42
24	Detergent powder	500 g	8.48	4.92	4.23	5.25	5.47
25	Actara 25WG (Thiamethoxam)	40 g	9.32	2.45**	2.78**	1.65**	1.90**
26	Untreated control	—	8.93	—	—	—	—
CD	CD (p = 0.05)		0.24	0.48	5.03	0.29	0.33

*Mean of 3 replications. DAS = days after spray. *At par with best treatment; **Positive standard (chemical check). Values are means of pooled 2022–2023 data.*

4 Conclusion

Among all botanical treatments evaluated, PAU homemade neem extract @ 2000 ml/acre consistently produced the lowest *B. tabaci* populations and performed at par with the chemical standard (Actara 25WG) on several assessment dates. Homemade dharek extract @ 2000 ml/acre and neem oil @ 500 ml/acre also demonstrated reliable efficacy. These eco-friendly formulations are recommended for integration into IPM programmes for kharif mungbean to reduce dependence on synthetic insecticides, minimise pesticide residues, and conserve natural enemies.

Declarations

Competing interests.

The authors declare no competing financial or non-financial interests.

Author Contribution

author 1 wrote the main manuscriptauthor 2 check statistical data and figures

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Figures

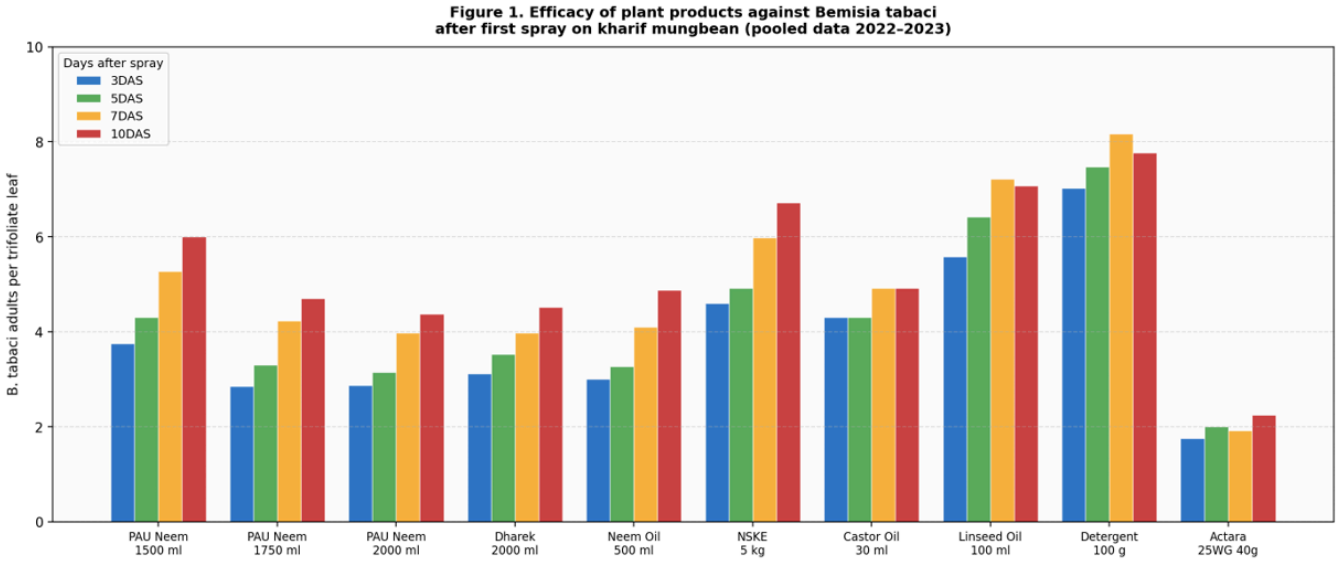


Figure 1

Efficacy of plant products against Bemisia tabaci after first spray on kharif mungbean (pooled data 2022–2023). DAS = days after spray.

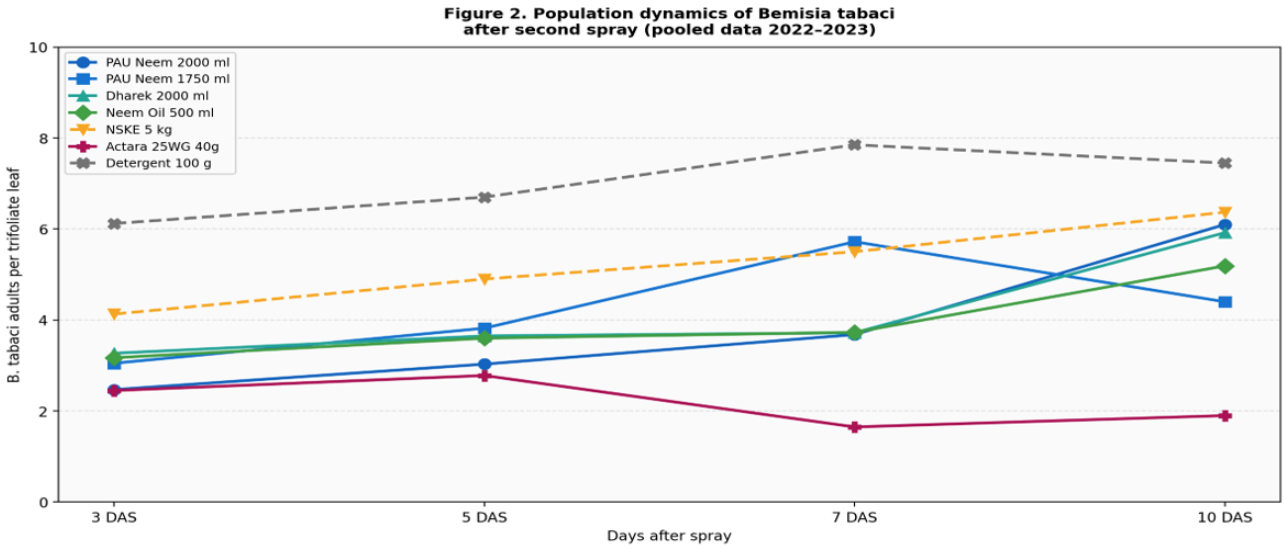


Figure 2

Population dynamics of Bemisia tabaci after second spray for key treatments (pooled data 2022–2023). DAS = days after spray.