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EVALUATION OF INSECTICIDES AND BOTANICAL OILS AGAINST COTTON WHITEFLY *BEMISIA TABACI* (HEMIPTERA; ALEYRODIDAE)

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ABSTRACT

The research study was conducted to compare the efficacy of insecticides viz. imidacloprid, acetamiprid, lambda-cyhalothrin and botanical oils viz. neem oil, castor oil and linseed oil against *Bemisia tabaci* (Gennadius, 1889) under laboratory conditions. By following Completely Randomized Design, bioassay was performed by leaf dip method with three replications and mortality data were collected after 24, 48, 72 and 96 hours of treatment. The study revealed that both botanical and synthetic pesticides had significant effects on whitefly nymphal mortality. However, the most effective pesticides for whitefly up to 96 hours were imidacloprid and neem oil, while lambda cyhalothrin and linseed oil remained least effective, and the others showed 50-60% mortality throughout the experiment.

1. INTRODUCTION

Cotton whitefly *Bemisia tabaci* (Hemiptera: Aleyrodidae) is a destructive pest and virus vector, worldwide that infests food and fiber crops, including cotton, leguminous plant, vegetables, and ornamental plants (Horowitz *et al.*, 2020). Whitefly is one of the most important sucking insect pest of cotton in the Middle East, Europe, North America, and Central America (Li *et al.*, 2021) and in Pakistan (Khalil *et al.*, 2017). It sucks the cell sap of plants and excrete honeydews on leaves, which promotes the growth of sooty mould and limit photosynthesis, hence decrease crop quality and quantity (Jones, 2003). It causes severe economic damage directly by sucking plant sap and indirectly by transmitting 111 plant viruses especially begomoviruses on about 900 plant species (Polston *et al.*, 2014). These are highly important pests for cotton throughout the seedling and vegetative stages because they suck the plant sap, weaken it, and cause wilting and leaf loss in cases of severe infestation (Abro *et al.*, 2004).

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Since the 1970s, when whitefly outbreaks started to become more common, pesticides have been used in Pakistan to control whitefly in commercial cotton plantations (Kumar *et al.*, 2022), resulting in whitefly feeding damage and illnesses brought on by the cotton leaf curl virus complex (Parola-Contreras *et al.*, 2022). It tends to acquire resistance to many types of insecticides, including carbamates, organophosphates, pyrethroids, and several chemicals recently introduced for use in Pakistan, in cotton-vegetable cropping systems. which resulted in failure of whitefly control and lead to significant damage to the cotton crop (Ahmad & Khan, 2017; Shah *et al.*, 2021). This situation has led to a search for other efficient control methods, such as chemicals of plant origin, or compatible pest control strategies (Kumar *et al.*, 2020). The majority of these botanical pesticides are non-toxic to both humans and the environment even though it works well against a wide range of insect species (Patel *et al.*, 2022). Botanical pesticides which are rich sources of bioactive compounds, could be a substitute for traditional methods of controlling whiteflies (Gusmao *et al.*, 2013).

They are target specific and non-toxic to mammals and humans and are potentially suitable for use in integrated pest management (Tare *et al.*, 2004). In modern agriculture and an increasingly regulated world, natural botanical pesticides can be feasible in pest management practices and an effective alternative to synthetic pesticides to protect crops (Isman, 2006). Several plant-based materials have been considered for use as insecticides, antifeedants or repellents, which include terpenes, flavonoids, alkaloids, phenols, and other related compounds (Adeyemi, 2010).

Thus, there is a safe and alternative strategy for the control of whiteflies in the agricultural field is needed. Hence, the present study was focused to evaluate the efficacy of insecticides and botanical oils to combat the whitefly infestation in cotton in Pakistan.

2. MATERIALS AND METHODS

Collection and rearing of whiteflies

Whiteflies (*Bemisia tabaci* L.) were collected from pesticide-free cotton fields at the University of Agriculture, Faisalabad, using an aspirator. Subsequently, these whiteflies were reared on brinjal plants in a cage under semi-natural conditions. Brinjal leaves having whitefly nymphs were collected for bioassay.

Leaf discs

Brinjal plants were grown in pots and kept in semi-natural conditions that were free from any pesticide exposure. Middle-aged brinjal leaves, approximately three months old, were selected. The leaves were carefully trimmed to obtain circular leaf discs, each measuring 1.7 cm in diameter. The use of a cork borer ensured precision and uniformity in obtaining leaf samples (Kongchuensin & Takafuji, 2006).

Botanical pesticides

The common botanical pesticides which are used to control the sucking pest complex were selected. Different botanicals i.e., Neem (*Azadirachta indica*) seed oil, Castor (*Ricinus communi*) oil and Linseed (*Glycine max*) oil were purchased from the local market.

Synthetic pesticides

The insecticides used in the experiments are (imidacloprid, acetamiprid and lambda cyhalothrin). These pesticides were purchased from the local market.

Bioassay

An experiment was performed to screen the effectiveness of selected synthetic pesticides and botanical oils against whitefly nymphs on brinjal plants. The pesticides used were imidacloprid, acetamiprid, lambda-cyhalothrin, neem oil, castor oil and linseed oil with five concentrations (20%, 10%, 5%, 2.5% and 1.25%) tested for each. Water was used as the control treatment. Brinjal plants were grown under semi-natural conditions and infested with adult whiteflies. After one month, leaves with 3rd instar nymphs were selected and washed to remove debris. The selected pesticides were diluted and infested leaves were dipped in the solutions for 10-15 seconds. After air-drying, the treated leaves were placed on agar in petri plates. The effects on whitefly nymphs were observed under a microscope and mortality data was recorded.

Experimental conditions

The experimentation was carried out in a growth chamber under constant conditions, maintaining a temperature of 26±2°C and a relative humidity of 70±5%.

Data collection

Data was collected after 24, 48, 72 and 96 hours to assess the impact of insecticides and botanicals.

Data analysis

Minitab software was used for the Analysis of Variance (ANOVA) and comparison of means of significant treatments. Means were compared using the Tukey HSD test at α= 5%. (Najafpoor *et al.*, 2018).

3. RESULTS AND DISCUSSION

Efficacy of insecticides against whitefly

All tested insecticides caused significant mortality of whitefly after 96 hours of application (Table 1). Imidacloprid was statistically highly effective with mortality of 46.67% followed by acetamiprid and lambda cyhalothrin with mortality of 40.67% and 23.33% respectively, 24 hours of application. Statistically, whitefly mortality percentage caused by imidacloprid and acetamiprid at par while lambda cyhalothrin was least effective to control whitefly. The imidacloprid was again significantly more efficient with mortality of 50% than the acetamiprid and lambda cyhalothrin 43.33% and 28.67% respectively, 48 hours of application. After 72 hours of exposure, maximum whitefly mortality was 57% followed by acetamiprid 53.33% and lambda cyhalothrin 36% which were significantly different from each other respectively. However, after 96 hours application, imidacloprid caused the highest mortality 76.67% followed by acetamiprid and lambda cyhalothrin with mortality of 68.08% and 60% respectively which were also significantly different from each other, respectively. The insecticides 96 hours after treatments application showed gradual increase in percent mortality of the whitefly as compared to 24, 48 and 72 hours after treatment exposure.

Efficacy of botanical oils against whitefly

Table 2 showed significant differences among all the botanical oils. Neem oil was statistically highly effective with mortality of 30% followed by castor oil and linseed oil with mortality of 28.35% and 26.86% respectively, 24 hours of application. The neem oil was again significantly more efficient with mortality of 37.33% than the castor oil and linseed oil 34.73% and 31.12% respectively, 48 hours of application. After 72 hours of exposure, maximum whitefly mortality was 50% followed by castor oil 48.67% and linseed oil 45.67% which were significantly different from each other respectively.

However, after 96 hours application, neem oil caused the highest mortality 60.63% followed by castor oil and linseed oil with mortality of 53.33% and 50.60% respectively which were also significantly different from each other, respectively. The botanical oils 96 hours after treatments application showed gradual increase in percent mortality of the whitefly as compared to 24, 48 and 72 hours after treatment exposure. Amusan *et al*. (2013), Hossain *et al*. (2015), Mamun *et al*. (2015), Padmavathi *et al*. (2017) and Hussain (2022) who observed significant mortality of against sucking and chewing pests with application of neem oil. The finding of the current study agreed the results of Mohan and Katiyar (2000) who stated that imidacloprid was the most effective in controlling the whitefly population and its continuous use resulted in increased whitefly population due to development of resistance in this pest against imidacloprid.

4. CONCLUSION

Imidacloprid demonstrated effective control of whitefly as a synthetic insecticide, while neem oil showed promising results among botanicals. Among insecticides lambda cyhalothrin while among botanicals linseed oil demonstrated the lowest level of efficacy. In conclusion, botanical pesticide (neem oil) can be an efficient alternative to chemical pesticides for managing whitefly in agriculture, especially in situations where chemical resistance is a concern.

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6. CONFLICT OF INTEREST

All authors have declared that there is no conflict of interests regarding the publication of this article.

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Table 1. Mean percent mortality (M±SE) of *Bemisia tabaci* after 24, 48 72- and 96-hours application of insecticides in a laboratory test.

Treatments	Concentrations (%)	Percent Mortality (M±SE)			
		24 hours	48 hours	72 hours	96 hours
Imidacloprid	1.25	3.33±3.04^{b}	6.67±3.67^{c}	16.67±2.50^{bc}	23.33±1.25^{bc}
	2.5	6.67±3.33^{b}	15.00±3.58^{bc}	23.67±3.33^{bc}	33.33±2.23^{bc}
	5	16.67±0.33^{b}	20.00±3.33^{bc}	26.67±4.00^{b}	40.00±3.33^{b}
	10	20.00±3.46^{b}	26.67±0.21^{b}	36.67±4.33^{b}	50.00±3.67^{b}
	20	46.67±3.33^{a}	50.00±2.23^{a}	57.00±4.00^{a}	76.67±4.67^{a}
Acetamiprid	1.25	3.33±2.65^{bc}	6.67±2.32^{c}	13.33±2.40^{bc}	23.33±1.99^{bc}
	2.5	10.33±2.18^{bc}	16.67±2.65^{bc}	23.33±2.90^{bc}	30.00±2.45^{abc}
	5	13.33±3.33^{bc}	20.00±3.05^{bc}	30.00±3.25^{bc}	40.00±2.88^{abc}
	10	16.67±3.64^{b}	30.00±3.88^{ab}	33.33±3.84^{ab}	46.67±3.05^{ab}
	20	40.67±4.12^{a}	43.33±4.09^{a}	53.33±4.00^{a}	68.08±3.55^{a}
Lambda-cyhalothrin	1.25	3.33±0.19^{c}	6.67±2.87^{b}	13.33±3.33^{c}	20.00±2.13^{d}
	2.5	7.67±1.20^{bc}	11.16±2.98^{ab}	16.67±3.65^{bc}	27.67±2.18^{cd}
	5	12.33±1.34^{ab}	19.00±3.83^{ab}	26.67±2.56^{ab}	34.78±2.98^{bc}
	10	14.67±2.98^{ab}	22.67±3.33^{a}	33.33±3.33^{ab}	40.71±3.11^{b}
	20	23.33±3.33^{a}	28.67±4.32^{a}	36.00±4.19^{a}	60.00±3.33^{a}

Means in a column sharing same letter (s) are significant at 5% probability level using Tukey's test.
(M±SE)= Mean±Standard Error

Table 2. Mean percent mortality (M±SE) of *Bemisia tabaci* after 24, 48 72- and 96-hours application of botanical oils in a laboratory test.

Treatments	Concentrations (%)	Percent Mortality (M±SE)			
		24 hours	48 hours	72 hours	96 hours
Neem oil	1.25	10.00±3.33^{ab}	20.00±2.56^{bc}	23.33±1.56^{bc}	30.00±1.48^{b}
	2.5	16.67±0.54^{ab}	21.25±3.04^{bc}	26.67±3.33^{bc}	36.87±3.3^{b}
	5	23.33±1.46^{a}	25.64±3.33^{ab}	36.53±2.45ab	45.00±3.46^{ab}
	10	26.00±2.15^{a}	30.25±2.33^{ab}	40.37±1.25^{ab}	50.00±1.34^{ab}
	20	30.00±3.33^{a}	37.33±3.46^{a}	50.00±3.11^{a}	60.63±4.33^{a}
Castor oil	1.25	6.67±1.48^{cd}	13.23±1.08^{cd}	20.00±2.48^{cd}	26.23±1.70^{b}
	2.5	16.47±2.31^{bc}	20.00±4.10^{bcd}	26.67±1.3^{bc}	36.73±3.33^{ab}
	5	20.00±3.33^{b}	26.67±1.45^{abc}	33.63±2.46^{abc}	42.00±1.46^{ab}
	10	26.45±1.34^{ab}	31.33±3.33^{ab}	43.53±1.34^{ab}	47.36±3.34^{a}
	20	28.35±2.33^{a}	34.73±2.13^{a}	48.67±3.33^{a}	53.33±3.33^{a}
Linseed oil	1.25	6.67±1.20^{bc}	10.00±1.82^{bc}	16.43±3.33^{bc}	28.53±2.10^{b}
	2.5	13.33±1.85^{abc}	20.00±3.25^{abc}	25.13±2.43^{abc}	36.68±2.11^{ab}
	5	20.00±2.39^{ab}	23.67±3.33^{ab}	28.47±1.48^{ab}	40.82±3.33^{ab}
	10	23.33±3.31^{a}	26.34±2.67^{ab}	34.00±4.08^{ab}	46.48.00±4.11^{a}
	20	26.86±4.38^{a}	31.12±2.96^{a}	45.67±3.33^{a}	50.60±2.91^{a}

Means in a column sharing same letter (s) are significant at 5% probability level using Tukey's test.
(M±SE)= Mean±Standard Error