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Comparative efficacy of Botanical extracts against Whitefly (*Bemisia tabbaci)* on Cotton crop under climate change scenario

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Abstract

Pakistan comes in top exporter of cotton. Cotton crop is under different stresses during its production out of which pest pressure is most important to get good cotton yield. The established field study for use of (tobacco, neem, and kortomma) extract as botanical spray against sucking pests especially whitefly (Bemisia tabaci (Genn.). This experiment was done at Adaptive Research Farm Rahim Yar Khan, Punjab. Synthetic pesticides are excessively consumed to control crop pests but abundant use of chemicals may implicate the whole ecosystem badly in the end. Botanical spray was used against sucking pests to delay the application of first pesticide for maximum number days. This would ultimately reduce the number of pesticides applied along with less residual effects on humans and environment. All the plant products showed varying toxicity against whitefly of Bt cotton 24, 36 and 48 hours after application. Tobacco + neem and kortomma each @ 1483g/ha proved to be more effective (75.4%) against cotton whitefly followed by tobacco + kortomma each @1483g/ha i.e (66.9%) whitefly mortality. The pest scouting data of trial plot clearly show the decrease in pest population after application of neem extract i.e (55.8%).

Keywords: *Plant extracts; beneficial insects; insect resurgence; environment-friendly.*

Introduction

Cotton *Gossypium hirsutum* (L) is an essential cash crop of Pakistan for upholding the economy and is conventionally grown in agricultural plains of Punjab and Sindh. The value-added service of cotton contributes 8.2 percent to Agriculture sector continue to play a critical role in Pakistan economy and contribute about 3.2% of gross domestic product (GDP). Approximately 60% of the foreign exchange come from textile products which have boosted the national economy by over $2.5 billion mostly in ginning factories and textile mills in Pakistan that depend on cotton (Naheed and Rasul, 2010). Cotton (*Gossypium hirsutum* L.) is known as world most important cash crop. It is utilized as a part of various items like lint in textile; cottonseed is utilized as vegetable oil and feeds of animal. Cottonseed cake is a rich source of value protein (Sarwar et al., 2013). Moreover, Pakistan is the world's fourth-largest cotton-producing country, while the third-largest exporter of raw cotton and a leading exporter of yarn in the world as yield per acre ranks 13th in the world. On the other hand, the cotton yield is declined due to several biotic and abiotic factors, and insect pests are the major limiting factors (Morgan, 1984). Major devastating pests of cotton crop include sucking and chewing pests. Sucking pests include *Thrips tabaci*, *Tetranychus macfarlanei*, *Amrasca biguttula biguttula*, *Bemisia tabaci*, as well as *Aphis gossypii*, while chewing insect pests are termites, *Earias insulana*, *Pectinophora gossypiella*, and *Helicoverpa armigera* (Qasim et al., 2018; Qasim et al., 2015). Deterioration in lint quality of cotton crop due to insect pest infestation resultantly 10-40% losses occur in the cotton crop (Gahukar, 2006). Among the major pests, *Bemisia tabaci* is considered to be a risky pest to almost all crops as well as a vector of many viral diseases (Sharma and Joshi, 2010) and known as a polyphagous insect pest (Arif et al., 2009). Plant extracts contain a lot of natural compounds which are helpful to manage various pests worldwide (Islam et al., 2018). The pesticides of chemical nature when used continuously adds harmful impact in human health and environment (Atreya, 2005; Soares and de Souza Porto, 2009; Fantke et al., 2012; Rehman et al., 2019).

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Alternate ways to control sucking pest like whitefly are by knock down of candidate genes using RNAi technique (Vyas et al., 2017) or use of biopesticides and trap crop etc (Gupta and Dikshit, 2010; Sarkar et al., 2018). Use of botanical spray against sucking pests of vegetables was well studied and analyzed to be effective in controlling population of sucking pests on brinjal. Neem (Azadirachta indica) extracts in comparison to tobacco (Nicotina tabbacium) and trooh (Citrullus collocynthus) was used to control the sucking pest population (Kunbhar et al., 2018). The Azadirachtin is one of the natural compounds extracted from *Azadirachta indica* A. Juss, having insecticidal properties as well as antibacterial, antifungal, and antiviral for several years. Azadirachtin compound is useful for almost 400 pest species (Erler et al., 2010). *Moringa oleifera* (Moringa) is also a multifunctional plant and has extensively been cultivated in many countries (Fahey, 2005). Moreover, this plant is also being used for the management of several insect pests (Ali et al., 2016; Ohia et al., 2014). Different plant extracts like neem oil, garlic, eucalyptus and datura were used to control the population of sucking pests like jassid (Amrasca devastans), whitefly (Bemisia tabaci) and thrips (Thrips tabaci) on Bt cotton crop in field conditions. These plant products showed different level of toxicity against these sucking pests (Khan et al., 2013). Some of the insecticides first used in agriculture were derived from plants such as nicotine from tobacco (*Nicotiana tabacum*, Solanaceae) leaves; rotenone, from the roots of ‘‘timbo’’ (*Derris* spp.), ‘‘chaperno’’ (*Lonchocarpus* spp.), yam bean (*Pachyrhizus* spp.) and other leguminous plants; quassinoids, from bitterwood (*Quassia amara*, Simaroubaceae), azadirachtin, from neem (*Azadirachta indica*, Meliaceae) and pyrethrum, from *Chrysanthemum cinerariifolium* (Asteraceae). Other plants well known for having substances with insecticidal properties include ryania (*Ryania speciosa*, Flacourtiaceae) and ‘‘sabadilla’’ (*Schoenocaulon officinale*, Lilliaceae). However, their use in agriculture and even in traditional tropical systems vanished in the 1950s, as a result of the appearance and widespread use of synthetic insecticides as their rather simple molecules lend themselves for these materials to be manufactured at an industrial scale and a relatively low cost (Luko and Mora, 2006). Botanical insecticides are promising alternatives in insect pest management system because they are naturally occurring compounds derived from plant sources. Botanicals are selective in action and degrade easily in sunlight, air, and moisture by detoxifying enzymes (Tess and Weinzeiri, 1989). Neem Oil was effective treatment against sucking pests of cotton and have biopesticide value (Attri and Prasad, 1980; Ghelani et al., 2014; Vinodhini and Malaikozhundan, 2011; Mamoon-ur-Rashid et al., 2012).

The present study was designed to assess the performance of botanical extracts against cotton whitefly in the field conditions.

Materials and Methods

Botanical extracts were excessively evaluated against *Bemisia tabbaci* with different concentrations as mentioned in table-1. An experiment was carried out under a complete randomized block design (RCBD) with three replications, at Adaptive Research Farm Rahim Yar Khan Punjab Pakistan. The following treatments i.e tobacco, neem, kortomma, tobacco + neem, tobacco +kortomma and tobacco+ neem+ kortomma @ 1483g/ha as mentioned in table-1 each tested with a control check. Selected botanical plants were chosen due to their availability, pesticidal, medicinal value, and insect repelling properties as shown in fig.1. All plant materials were brought and plant leaves were washed thoroughly before use and soaked in sterilized distilled water for one night. After washing, the leaves were grinded thoroughly with a rotary shaker for extraction. Boil these in 20L of water by covering the pot with lid over it as shown in fig.2. The mixture is boiled till 10–12 L of water is remained in it. The extracted mixture is cooled down and filtered using muslin cloth. Spray was done below ETL i.e 5 adults or nymph/leaf. Whitefly population was recorded after pest scouting. The whitefly population was recorded before spray of botanicals and after 24, 36 and 48hrs of spray. Yield data will be recorded at the time of picking. All other agronomic and Plant Protection measures were remained same.

Population change increase or decrease was calculated by using modified Abbot’s formula as below:

below:

$$\% \text{ Population Change} = 1 - \frac{\text{Post treatment population in treatment}}{\text{Pre treatment population in treatment}} \times \frac{\text{Pre treatment population in control}}{\text{Post treatment population in control}} \times 100$$

(Flemings and Ratnakaran 1985)

Data were analyzed statistically with M-stat package and means were compared by DMR test at 5 percent probability level (Duncan, 1955).

Fig No.1 Neem, kortomma and tobacco.

Table 1. Different botanical extracts against whitefly (*Bemisia tabbaci)* with respective doses per hectare.

S. #	Botanicals	Dose (gm/ha)
1	Tobacco	1483
2	Neem	1483
3	Kortomma	1483
4	Tobacco + neem	1483+1483
5	Tobacco + kortomma	1483+1483
6	Tobacco + neem + kortomma	1483+1483+1483

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Fig No.2 Preparation of botanical extract and spray on site.

Results and discussions

Botanical extracts (Table 1) were sprayed in recommended doses when the population of cotton whitefly reached economic threshold level (ETL). Botanicals were dissolved in water to prepare solutions on Wt. / Vol. basis. The crop was sprayed in the morning before 10 a.m. The population of whitefly was recorded 24hrs, 36hrs and 48hrs after application. The data on whitefly population were analyzed by using the effectiveness of various botanicals was considered to be an indirect reflection of pest population in various treatments i.e. lower population of whitefly would represent higher toxicity and vice versa. The population of cotton whitely was significantly lower ($P<0.05$) in botanical treated plots as showed in (Table 2). Whitefly population fluctuated in terms of mortality (%) after 24hrs, 36hrs and 48hrs spray application. All tested botanicals in (Table 2) caused significant mortality in population of cotton whitely even 48hrs days after spray. Tobacco + neem and kortomma was statistically highly effective with mortality in cotton whitefly population as 61.7, 65.1 and 72.5% even 48hrs of spray during 2022 followed by tobacco + kortomma that caused mortality in population of cotton whitefly as 63.2, 65.1 and 66.1%. While in case of single treatment tobacco gave significant control as 50, 51.5 and 54.8% mortality of whitefly followed by kortomma 44.1, 45.4 and 46.7%. Alternate ways to control sucking pest like whitefly are by knock down of candidate genes using RNAi technique (Vyas et al., 2017) or use of biopesticides and trap crop etc (Gupta and Dikshit, 2010; Sarkar et al., 2018).

Table 2. Mean percent population change and percent control of cotton whitefly after application of different botanicals during 2022.

Treatments	Dose/ha (g)	A.v pest population before spray	Post treatment average population/plant			Population control (%)		
			24hrs	36hrs	48hrs	24hrs	36hrs	48hrs
Tobacco	1483	7.3	3.4	3.2	2.8	50.0	51.5	54.8
Neem	1483	8.0	4.3	4.1	3.6	36.7	37.8	41.9
Kortomma	1483	7.8	3.8	3.6	3.3	44.1	45.4	46.7
Tobacco + neem	1483 each	8.6	2.7	2.5	2.0	60.2	62.1	67.7
Tobacco + kortomma	1483 each	9.3	2.5	2.3	2.1	63.2	65.1	66.1
Tobacco + neem + kortomma	1483 each	7.3	2.6	2.3	1.7	61.7	65.1	72.5
control	-	9.6	6.8	6.6	6.2	-	-	-
LSD (0.05)								

Each value is a mean of three replications. Means sharing similar letters in columns are not significantly different by DMR test (P=0.05)

It is evident from the (Table 3) that botanical extracts were found to be effective in controlling population of cotton whitefly during 2023 under field conditions. All tested botanicals (Table 1) caused significant mortality in population of cotton whitefly even 48hrs after spray. Tobacco + neem and kortomma was statistically highly effective with mortality in cotton whitefly population as 38.5, 63.3 and 78.3% even 48hrs of spray during 2023 followed by tobacco + kortomma that caused mortality in population of cotton whitefly as 31.4, 58.8 and 74.0%. While in case of single treatment tobacco gave significant control as 31.4, 52.2 and 68.0% mortality of whitefly followed by neem 28.5, 45.7 and 61.8%. Neem Oil was effective treatment against sucking pests of cotton and has biopesticide value (Attri and Prasad, 1980; Ghelani et al., 2014; Vinodhini and Malaikozhundan, 2011; Mamoon-ur-Rashid et al., 2012).

Table 3. Mean percent population change and percent control of cotton whitefly after application of different botanicals during 2023

Treatments	Dose/ha (g)	A.v pest population before spray	Post treatment average population/plant			Population control (%)		
			24hrs	36hrs	48hrs	24hrs	36hrs	48hrs

Tobacco	1483	10.6	9.6	7.3	5.3	31.4	52.2	58.0
Neem	1483	11	10.0	8.3	5.0	28.5	45.7	69.8
Kortomma	1483	11.6	10.3	8.3	5.3	26.4	45.7	68.0
Tobacco + neem	1483 each	10.6	9.3	7.6	5.6	33.5	50.3	66.2
Tobacco + kortomma	1483 each	11.3	9.6	6.3	4.3	31.4	58.8	74.0
Tobacco + neem + kortomma	1483 each	11.3	8.6	5.6	3.6	38.5	63.3	78.3
control	-	11.6	14	15.3	16.6	-	-	-
LSD (0.05)								

Each value is a mean of three replications. Means sharing similar letters in columns are not significantly different by DMR test (P=0.05)

Conclusions

It is concluded from the research trial that all the botanicals proved to be effective for controlling cotton whitefly but the combined effect of these botanicals Tobacco + neem and kortomma each @ 1483g/ha proved to be more effective (75.4%) against cotton whitefly followed by tobacco + kortomma (66.9%) @1483g/ha.

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