Pak. j. sci. ind. res. Ser. B: biol. sci. 2024 **67B**(2) 110-116

The Efficacy of Different Plant Extracts Against Whitefly *Bemisia tabaci* (Aleyrodidae: Hemiptera) on A Tomato Plant

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(received October 25, 2021; revised December 20, 2022; accepted March 28, 2023)

Abstract. Whitefly (*Bemisia tabaci*) is a well known pest of many crops specially vegetables including tomato plant. Mostly tomato plant disorders are directly and indirectly related to the silver leaf whitefly (*Bemisia tabaci*) feeding. In this manner, most countries use lots of pesticides which are really threatening to the environment and ecosystem at an alarming position. Thus we aim to use different plant extracts to control whitefly efficiently and minimize the negative impact of pesticides on the environment. This experiment was conducted in a greenhouse and field as well to draw complete conclusion. In this experiment we used five different treatments, T1-NLE (neem leaves extracts), T2-TLE (tobacco leaves extracts), T3-combination (TLE+NLE+ neem kernels), T4-insecticide (Movento) and T5-un-treated. According to our findings in the greenhouse, adult whitefly population's lowest count is (0.66±0.248) in NLE treated tomato plants and highest whitefly numbers found were (5.84±1.04) in un-treated plants. For the nymph, the same result follows (0.23±0.20) in NLE treated plants and (5.62±1.20) in un-treated plants. In field's experiment lowest adult population of whitefly found in NLE (1.74±0.48) and highest numbers found in un-treated (9.64±1.23). This experiment proves that plants extracts are more effective, economical and eco-friendly. This study can be potentially extended to other pests and crops. Consolidated viewpoint of this investigation, we state that plants extricates all the more integral assets to control sucking complex or whitefly.

Keywords: whitefly, tomato, plant extracts, neem leaves, tobacco leaves

Introduction

Whitefly developed resistance against insecticide e.g. three organophosphate and four pyrethroid is observed since 1992 to 2000 in Pakistan (Ahmad *et al*., 2010). Likewise against dimethoate, deltamerthrin and recently against monocrotophos during 1992 to 1996. Whitefly additionally created protection against traditional insecticide e.g. acephate, fenpropathrin, lambdacy-halothrin (Ahmad *et al*., 2010). Pakistan is one of countries overall which utilized more pesticides against pests which is causing ecological issues and expands contamination particularly in Sindh and Punjab, where groundwater is tainted by the abundant utilization of the pesticides (Tariq *et al*., 2007). Its broad host run covers 481 host plants having a place with 295 genera and 90 families, including a few vegetables, natural products, ornamentals and road trees (Gopi *et al*., 2001; Srinivasa, 2000). In India, it has been accounted for on more than 253 plant species having a place with 176 genera and 60 families (Gopi *et al*., 2001). Green lacewing is quite effective against all soft bodied insects reported by (Gupta and Rai, 2006). The green lacewing well known biological control agent to eat a wide range of other delicate bodied arthropods including many aphid species which is reported by Khan *et al*. (2012). It is a ravenous feeder on the first instar larva of mealy bug (*Phenacoccus solenopsis*).

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With the development of the worldwide bio pesticide showcase, azadirachtin is extraordinarily situated to end up a key pest spray to grow in this market fragment. Azadirachtin control other major agricultural pests for example, whiteflies, leafminers, parasite gnats, thrips, aphids and numerous leaf-eating caterpillars (Immaraju, 1998). Neem plants parts having all insecticidal and pest repellent properties (Jacobson, 1986). Azadirachtin have different mode of action, such as, antifeedant, regenerative and IGR on against pest (Mordue and Blackwell, 1993).

Immaraju (1998) reported that there are more than 200 pest species having a place with the significant insect of seven orders out of nine major order of insect pest. Neem leaves and garlic extracts control whitefly and aphid populace in field condition (Nzanza and Mashela, 2012). The field explores different ways regarding tomato demonstrated that neem, wild garlic, alone or a mixture of both, have insecticidal properties to control whitefly and aphid. All parts of neem contain insecticidal properties (Chawla *et al*., 1995; Van der Nat *et al*., 1991). Neem extracts also give control in whitefly and aphid population on cabbage (Zaki, 2008). We noticed that watery leaves and organic product extricates from relative of neem, more prominent control whiteflies than on un-treated plants (Jazzar and Hammad, 2003). Additionally, extricates from the *Alliacae* family was appeared to lessen populace densities of sucking insect (Prabal *et al*., 2000). The expanding enthusiasm for bio-insecticides has conveyed new regard for the neem tree, certainly known on the Indian sub-mainland (Philogene *et al*., 2005).

The natural exercises of *Azadirachta indica* A. Juss, seed concentrates or dynamic basic azadirachtin (AZA) is presently known for above 400 types of insects (Schmutterer, 1990). Neem seed oil, for example, is impediment to just 50% of six aphid species treated for the action (Lowery *et al*., 1993). Plants may give a contrasting option to right now utilized pesticides for the control of plant bothers, as they constitute a rich wellspring of bioactive chemicals (Daoubi *et al*., 2005; Kim *et al*., 2005). Late examinations have shown the insecticidal properties of chemicals got from plants that are dynamic against particular target species, biodegradable to non-poisonous items and possibly reasonable for use in coordinated administration programs (Tare *et al*., 2004; Markouk *et al*., 2000).

The effectiveness of many organic insecticides to control of whitefly is proved such as different plants extracts included neem and tobacco, different oils, such as fish and neem oil (Geetha, 2000; Ranjith *et al*., 1996). Chemical control unfeasible, as considered to organic insecticide uneconomic and due specified control, pest's broad host range, with high human inhabitation. Spraying different detergent to reduce infestations and light traps covered with Vaseline coating to trap to control adults flies (Ganeshkumar *et al.,* 1997).

The present investigation gives an in-depth analysis of different plant extracts against whitefly on tomato plants, which can be exploited to control the whitefly population and hence minimizing the use of pesticides. The field data compared with the greenhouse data. This investigation has three principle points of interest, for example, decrease pesticide utilized, limit remaining impacts and effect of pesticide in the environment as well as human health.

Materials and Methods

Greenhouse. This experiment was performed in a 3 m x 5 m nursery. Initially, 1/2″ inch PVS pipes and clear plastic (0.05 mm) was utilized to construct the greenhouse infrastructure. Similarly, some bamboo was also used to support the architecture (Fig. 1a). The environmental conditions inside the nursery were maintained using a hygrometer to control humidity, temperature meter for temperature control and air cooler as an evaporator. The overall mean of environmental conditions were as follows; temperature=28.42±2.96 °C; humidity=32±3.48%; photoperiod=10.55±0.18 h and light intensity 2400 Lux. The whitefly adult flies were carefully collected by homemade suction apparatus (Fig. 1b). Only, the adult whiteflies were used in our experiment. Approximately, 250-300 whiteflies gathered by suction apparatus were released into the nursery on 25 plant pods, used 5 plants/treatment. In the greenhouse we used Complete Randomized Design (CRD). In this experiment used 5 treatments and 5 replications. Different plant extracts were applied after a week of release of collecting whitefly in Jan 2018.

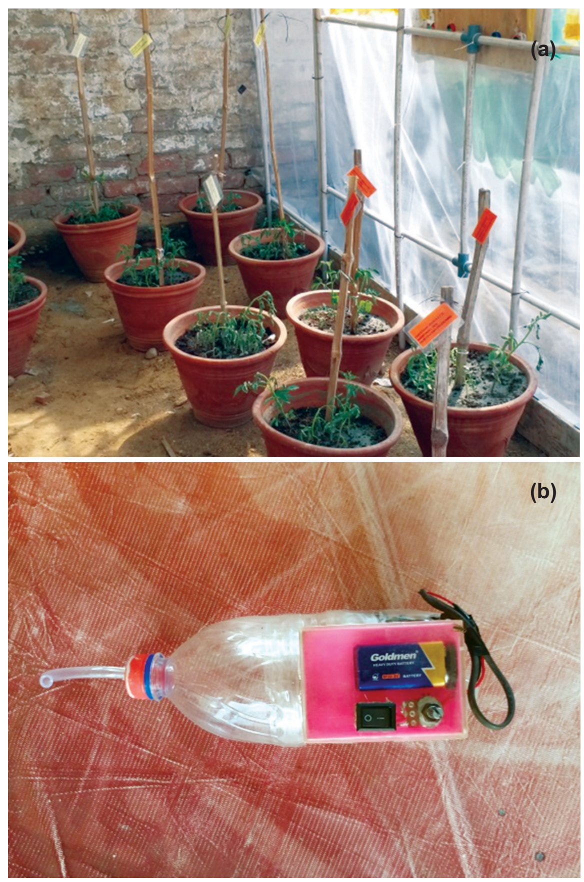

Fig. 1. **(a)** Greenhouse uses in experiment; **(b)** Aspirator (handmade) for collection of whitefly from field to greenhouse.

Chart of recommendation, chemical formulas and active ingredients

	Neem leaves extracts (NLE)	Tobacco leaves extracts (TLE)	Combination (NLE+TLE+NK)	Movento®
Recommendation	1 Kg/ 5 L 30 Kg/acre	500 g/5 L 10-15 Kg/acre	1 Kg (NLE)+250 g (TLE) +100 g (Neem Kernels)	160 mL/acre
Chemical formula	$C_{35}H_{44}O_{16}$	$C_{10}H_{14}N_2$	$C_{35}H_{44}O_{16} + C_{10}H_{14}N_2$	$C_{21}H_{27}O_5$
Active ingredient	azadirachtin	Nicotine/Nicotrol	Azadirachtin+Nicotine	Spirotetramat 240 g/L

Field. We selected ½ acre tomato field near Hoshri, Hyderabad, almost 5 Km away from the greenhouse. Here we used Randomized Complete Block Design (RCBD). TO-1057 variety was used for this experiment, well known variety, mostly farmers used in Hyderabad. Row to row distance 2 ft and plant to plant distance 1 ft. Plants were transplanted in October, 2017. After the appearance of a whitefly large number applied treatments in January, 2018. In this experiment used 5 treatments and 5 replications. Treatments used in experiments such as:

Neem leaves extracts (NLE). Collect 1 Kg fresh neem leaves locally available in Sindh directly from the tree, chopped and 5 L hot water added to it and stored in plastic cane for 15 days.

Tobacco leaves extracts (TLE). In this extract we purchased 500 g stored dry tobacco leaves from the wholesale market. We selected the variety of Attock, Pakistan, the main tobacco growing area of Pakistan, which is very famous for their insecticidal properties. Also 5 L hot water was added to it and stored in a plastic cane for 15 days.

Combination (NLE+TLE+neem kernels). For this combined extract we used 100 g chopped neem kernels, 250 g chopped tobacco leaves, 1 Kg neem leaves and add 5 L hot water, all was added to it and stored in a plastic cane for 15 days.

Insecticide (Movento). For this treatment we purchased insecticide (Movento), popular for whitefly control in the area. Used as per recommended by the company.

Un-treated. Do not apply any treatment or leave untreated.

Observation. All plant extracts were applied to a tomato plant in greenhouse and field during growing season 2017. In greenhouse used barber sprayer and in a field used knapsack sprayer. Treatment was applied in Jan, 2018. 1^{st} observation was taken day before spray (DBS) and 1^{st}, 2^{nd}, 3^{rd} and 10^{th} day after spray (DAS). Selected 5 plants/treatment in greenhouse and 10 plants/treatment in field. Randomly 20 leaves were selected from each replication to record whitefly population (nymph-adult). Temperature and relative humidity % and photoperiod were also recorded regularly. The data was statistical analysis using Statistix 8.1, the data was subjected to analyze used ANOVA (α=0.05). Use Abbot's formula for % population reduction of whitefly mentioned by (Flemings and Ratnakaran, 1985).

$$\text{Population change \%} = \left(1 - \frac{\text{n in Co before treatment} \times \text{n in T after treatment}}{\text{n in Co after treatment} \times \text{n in T before treatment}}\right) \times 100$$

where:

n=Insect population; Co=Control and T=Treatment

In control plot.

$$\text{Change \% in control plot population} = \frac{(\text{n in Co after treatment} - \text{n in Co before treatment}) \times 100}{\text{Population in control plot before treatment}}$$

Result and Disscussion

Efficiency of different plant extracts. All plant extracts showed high effectiveness against whitefly adult and nymph. Bioassay of NLE, TLE, combination used against the whitefly on tomato crops in greenhouse and field showed not significantly different in between treatments (P<0.05). Null population of whitefly nymph and adult in the greenhouse is observed till 4^{th} week after spray as compared to untreated tomato plants. After 4^{th} week we observed a slight increase in it, but very low as compared to un-treated plants. But in field experiment the population of whitefly is low and same till 6th week as compared to untreated plants which show a higher number of whitefly nymph and adult population.

Greenhouse. The treatments were used such as T1=NLE (neem leaves extracts); T2=TLE (tobacco leaves extracts); T3=Combination (TLE+NLE+neem kernels NK), T4=Insecticide (Movento) and T5=un-treated, shown in (Table 1-2). In adult, change in population range from 79.55% to 83.15% and in nymph, change in population range from 81.73% to 95.52%. Overall mean population T1=(NLE) 0.600±0.248; T2=(TLE) 1.058±0.396; T3=(combination) 0.925±0.347; T4=(Insecticide) 1.408±0.491; T5=(un-treated) 5.842±1.041 was recorded (Table 1). Here we ordered treatments possessing highest to the lowest adult population: un-treated>insecticide>TLE>combination> NLE. We found the lowest nymph population (0.233±0.204) NLE and the highest number was found in un-treated plants (5.625±1.209). We ordered treatments possessing highest to the lowest nymph population as un-treated>insecticide>TLE>combination>NLE (Table 2).

On the bases of percentage (%) change in population of *B. tabaci* determined the viability of various concentrates in greenhouse and field as well. In the greenhouse, % change in adult population of *B. tabaci* is recorded as, T1 (83.15%), T2 (73.66%), T3 (82.53%), T4 (79.55%) and T5 (-8.7%) (Fig. 1). The nymph population, most extreme change in density recorded as T1 (93.96%), T2 (93.95%), T3 (95.52%), T4 (81.73%) and T5 (-19.64%) (Fig. 2). Extremely important diminished was seen in all treated with the exception of un-treated plots. The extraordinary consequence of neem extracts saw in a greenhouse on the adult and nymph of *B. tabaci* population density. As indicated by % change in adult *B. tabaci* density in a greenhouse from low to high lineup, T1 (NLE)<T3 (combination)< T2 (TLE)<T4 ((Movento)<T5 (control). In nymph density of whitefly population % change from lowest to highest lineup, T1 (NLE)<T2 (TLE)<T3 (combination)<T4 ((Movento)<T5 (control).

Field. In the field, the same procedure was followed was used in the greenhouse, but used randomized complete block design (RCBD) was used in the same five treatments. In adult, population change ranges from 52.41% to 81.77% and in nymph, reduction in population range from 37.03% to 98.86%. Overall mean population, T1 (NLE) 1.742±0.480, T2 (TLE) 2.033±0.522, T3 (combination) 1.783±0.503, T4 (untreated) 9.642±1.236, T5 (insecticide) 4.383±0.987 was recorded (Table 3). In nymph, the overall mean population of whitefly recorded in T1 (NLE) 0.392±0.274, T2 (TLE) 0.292±0.251, T3 (combination) 0.325±0.265, T4 (un-treated) 6.425±1.389 and T5 (Insecticide) 4.483±1.041 (Table 4).

In the field, the percentage change in population of whitefly adult was recorded as, T1 (79.70%), T2 (75.24%), T3 (81.77%), T4 (52.41%) and T5 (-7.73%) (Table 3) and in nymph, T1 (98.86%), T2 (89.59%), T3 (84.25%), T4 (37.03%) and T5 (-14.35%) was recorded (Table 4). In field treatment had position, from high to low in population reduction as treatment

Table 1. Overall mean population of *Bemisia tabaci* (adult) on tomato crop after use of different plant extracts in greenhouse.

Overall mean population of whitefly in greenhouse			
Treatment	Pre treatment population	Whitefly adult population	% Adult whitefly population change
Neem	3.900±0.640	0.600±0.248c	83.15%
Tobacco	4.400±0.819	1.058±0.396bc	73.66%
Combination	5.800±0.827	0.925±0.347bc	82.53%
Insecticide	7.500±1.500	1.400±0.491b	79.55%
Un-treated	6.400±1.980	5.842±1.041a	-8.71%

Overall mean in the same column followed by the same letter are not significantly different using General AOV/AOCV LSD (α=0.05).

Table 2. Overall mean population of *Bemisia tabaci* (Nymph) on tomato crop after use of different plant extracts in greenhouse.

Overall mean population of whitefly in the greenhouse			
Treatment	Pre treatment population	Whitefly nymph population	% Whitefly nymph population change
Neem	4.800±1.254	0.233±0.204c	93.96%
Tobacco	7.200±1.914	0.350±0.263c	93.95%
Combination	6.700±0.890	0.241±0.189c	95.52%
Insecticide	6.300±1.010	0.925±5.770b	81.73%
Un-treated	7.000±1.230	5.625±1.209a	-19.64%

Overall mean in the same column followed by the same letter are not significantly different using general AOV/AOCV LSD (α=0.05).

Table 3. The overall mean population of *B. tabaci* (adult) on the tomato crop after use of different plant extracts in the field.

Overall mean population of whitefly in field			
Treatment	Pre treatment population	Whitefly adult population	% Whitefly adult population change
Neem	9.300±1.239	1.742±0.480c	79.70%
Tobacco	8.900±0.983	2.033±0.522c	75.24%
Combination	10.60±1.733	1.783±0.503c	81.77%
Insecticide	11.00±1.243	4.383±0.987b	52.41%
Un-treated	10.45±2.140	9.642±1.236a	-7.73%

Overall mean in the same column followed by the same letter are not significantly different using General AOV/AOCV LSD (α=0.05).

Table 4. Overall mean population of *B. tabaci* (adult) on the tomato crop after application of different plant extracts in the field.

Overall mean population of whitefly in the field			
Treatment	Pre treatment population	Whitefly nymph population	% Whitefly nymph population change
Neem	7.800±1.245	0.076±0.274c	98.86%
Tobacco	7.100±2.350	0.633±0.514c	89.59%
Combination	6.300±1.560	0.850±0.590c	84.25%
Insecticide	6.312±1.890	4.483±1.041b	37.03%
Un-treated	7.502±1.650	6.425±1.389a	-14.35%

Overall mean in the same column followed by the same letter are not significantly different using general AOV/AOCV LSD (α=0.05).

1<treatmen 2<treatmen 3<treatmen 4<treatmen 5 and nymph population possessed position was treatment 1<treatmen 2<treatmen 3<treatmen 4<treatmen 5. In the field, all plant extracts were profoundly decreased population density of *B. tabaci* adult and nymph as compared to un-treated plots.

Results and Disscussion

For eco-accommodating administration of pest an ever increasing number of agriculturists examine various plants and there parts to create natural pesticide which have harmful, repellant, antifeedant or against hormonal qualities (Thomas and Callaghan, 1999). Neem and neem plants parts for example neem kernels, leaves have been used from long ago in agriculture for control pest (Immaraju, 1998). We recorded that 90% of whitefly not survived till 6th week after treatment, such as T1 (NLE), T2 (TLE) and T3 (NLE+TLE+neem kernels). This conform the findings of (Immaraju, 1998). The regulate growth activity in all nymphal instars including the pupal stage and exclusive mode of action, make azadirachtin is key for integrated pest control and organic pest control programs. *Bemisia tabaci* all phases of life were upset by treated with T1, T2 and T3 when contrasted with un-treated plants.

We are agreed with (Nzanza and Mashela, 2012; Immaraju, 1998) experiments in tomato crops showed that plant extracts of neem and wild garlic, alone or in combination, control population densities of whitefly and aphid. Remaining low density of whitefly adult and nymph was recorded till 6th week as compared to untreated plots in the greenhouse as well as in the field, also reported by (Nzanza and Mashela, 2012; Zaki, 2008; Jazzar and Hammad, 2003; Basedow *et al*., 2002) that those material reduced population of whitefly. However, their survival rate was higher as compared to nymphal population of *Bemisia tabaci*. (Gokce *et al*., 2007; Lowery *et al*., 1993) also observed that mortality rate in nymph is higher as compared to adult. The all extracts have very good IGR (Insect growth regulator). As the data clearly shows that whitefly on treated plants totally regulate the both the stages nymph and adult as compare to untreated, Reported also by (Koul., 1999; Lowery *et al*., 1994). This conclusion is also supported by (Mordue and Blackwell, 1993; Schmutterer, 1990) that obviously there is a significant effect on fecundity and fertility of these insects as has been demonstrated in other aphids and many other insect species. In the greenhouse we ranked adult population in contrast to treatment from low to high NLE (0.600±0.248)<combination (0.925±0.346)<TLE (1.058±0.396)<un-treated (5.842±1.041) and in nymph count ranked from low to high population NLE (0.233±0.204)<combination (0.242±0.190)<TLE (0.350±0.263)<un-treated (5.625± 1.209). Which showed that plant extracts is observed in the plant and work as systemically and effect insect pest specially sucking complex pests. This conforms by (Schmutterer, 1990) that this is very effective against piercing or rasping insect due to their absorbed by the plant and work as a systemic pesticide. (Lowery and Isman, 1994) also stated that the mode of penetration plays major role in effect of extracts. Especially neem plant extracts work as repellent in the greenhouse which is also observed by (Mordue and Blackwell, 1993). We found an immediate effect against whitefly especially in neem

extracts results in the greenhouse. Same results explain on strawberry aphid *C. fragaefolli* by (Lowery *et al*., 1993).

Conclusion

According to neem extract absolutely control whitefly nymph and adult population infield as well as in a greenhouse. According to combination of neem, tobacco and neem kernels additionally demonstrated positive impacts on whitefly control in greenhouse and field on tomato crop. In contrary, these concentrates impact whitefly populace on tomato crop. On the other hand, pesticide and untreated plants showed a more whitefly population as compared to plants treated with various plant parts extracts. In the nursery, once plants extricates is sufficient yet in the field required repeated application. Consolidated viewpoint of this investigation, we state that plant extracts is major IPM tactics to control sucking complex especially the whitefly.

Novelty statement. The main objective of this paper is to discover the eco-friendly management of whitefly on tomato crop. Despite the fact numerous researchers were working in the management of whitefly, not many analysts were examination led in both in greenhouse and field too. Additionally, not many announced near examination, which totally finished up the proficiency of various extracts.

Conflict of Interest. The authors declare that they have no conflict of interest.

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