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EFFECT OF PLANT EXTRACTS ON PEST POPULATION AND YIELD OF BITTER GOURD (*MOMORDICA CHARANTIA*) IN MARDAN

Fawad Khan

Medical Entomologist, Entomology Department, Faculty of Chemical and Life Sciences, Abdul Wali Khan University Mardan, Khyber Pakhtunkhwa, Pakistan

medicalentomologist94@yahoo.com

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Corresponding Author: * **Fawad Khan**

Abstract

This study, conducted at AWKUM Mardan in 2022, evaluated the effectiveness of various plant extracts on controlling aphids, whiteflies, and thrips in bitter gourd (Momordica charantia) *cultivation. Treatments included Cypermethrin,* Azadirachta indica *(Neem),* Parthenium hysterophorus *(Parthenium),* Eucalyptus globulus *(Eucalyptus), and an untreated control, using a Randomized Complete Block Design (RCBD) with three replications. Results showed that both Cypermethrin and botanical extracts significantly reduced pest populations and improved yield. Cypermethrin was the most effective, recording the lowest pest counts (0.88 aphids, 0.90 whiteflies, 0.93 thrips per leaf) and highest yield (24.80 kg). Among botanicals,* Azadirachta indica *was most effective in reducing pests and enhancing yield, followed by* Eucalyptus globulus *and* Parthenium hysterophorus. *The control group had the highest pest populations and lowest yield (10.81 kg). The findings suggest that* Azadirachta indica *is a viable botanical alternative for pest management in bitter gourd and can be integrated into IPM strategies.*

INTRODUCTION

Bitter gourd (*Momordica charantia*; Cucurbitaceae) is one of the important vegetables of Southeast Asia (Palada and Chang, 2003). Bitter gourd is a member of the cucurbits with squash, watermelon, muskmelon, and cucumber and is known by different names in different areas, such as karela, bitter melon, and balsam pear. This crop is a cross-pollinated crop and honey bees are the pollinators of this crop (Ali *et al.*, 2011). It has also been regarded as a food and medicinal plant (Kubola and Siriamornpun, 2008). Its nutritional value is similar with the exception of vitamin C and Vitamin A, which are much higher than other cucurbits (Palada and Chang, 2003). It is also used as anti-diabetic as well as other indeterminate bioactive components such as antioxidants (Krawinkel and Keding, 2006).

It is an annual crop; however, in those areas where winters are mild, Bitter gourd is usually sown in the summer season, starting from January-June in the plains areas (Singh *et al.*, 2006). The total area under cultivation is 6017 hectares with a net production of 56949 tones in Pakistan, while it is cultivated on 528 hectares with 4713 tones production in Khyber Pakhtunkhwa (MINFAL, AWKUM MARDAN 2022-

The bitter gourd crop is attacked by several pests, such as aphids, whiteflies, fruit flies, thrips, and mites, which attack various stages of development and may cause serious losses ranging from 30 to 80 percent (Hussain & Ahmad, 2012). Among fruit flies include

Bactrocera cucurbitae and *Aulacophora torticollis* can cause damage (Singh *et al.*, 2006).

Aphids are considered a pest throughout the world which causes severe damage to the crop and reduce the yield of the crop. Their infestation results in significant yield reduction. On plants such as trefoils and clover, this pest overwinters in the stage (Capinera, 2005). This pest can cause damage to plants by sucking the sap from the leaves, young shoots, and stems, which results in high levels of infestation, deformation in the parts of plants, causing wilting, and, in the end, death of the plant. The most obvious symptom of the attack of this insect is the shining honeydew, which results in the white appearance of the leaves (Barbercheck, 2014).

Thrips, *Thrips tabaci*, is considered one of the most severe pests of bitter gourd. They decrease the production of flowers and cause deformation in the structure of the plants. This insect lays 25 eggs/flower, which causes about a 60% reduction in production (GPP, 2009). Cucurbits can be infested by several species of whiteflies, such as *Bemisia tabaci*, *Bemisia argentifolii*, and *Trialeurodes vaporariorum*. This pest can infest several crops and other species of plants. Whiteflies are about 1–1.5 mm long. These pests spend most of their life cycle on the underside of the leaf. Adults of this pest lay eggs on the new leaves and shoots, while the nymphs can be found on mature leaves. One female can lay about 300 eggs in their life cycle (Nyoike, 2007). Young plants can be severely infested by this pest as compared to mature plants. This pest can cause damage in several ways, such as feeding directly on the crop, and can also act as a vector of many viruses. It attacks the underside of the leaf, sucks the cell sap, and secretes honeydew, which further causes sooty mold development and disturbs the process of photosynthesis (Mustafa, 1995). During sucking the cell sap, they secret honeydew, which is rich in sugar and encourages the production of sooty mold on the leaves of various vegetables, including bitter gourd (Abrahamian & Abou-Jawdah, 2014).

For the monitoring of whiteflies, sticky traps can be utilized in the field. The utilization of these traps provides a correlation between the catches and the actual number of whiteflies and hence can be used in IPM programs (Basu, 1995). Several cultural practices can be used, such as crop rotation, mulching, burning of the old leaves, non-infested transplants, and cover crops to control the buildup of whiteflies. Soil covering (mulching) has been found to be very effective in controlling the whitefly population (Frank & Liburd, 2005). Ultraviolet plastic mulches can reduce the whitefly by repelling the adults and decreasing the colonization of nymphs (Summers & Stapleton, 2001).

Neem-based insecticides have been reported to control the young nymphs, inhibit the development of old nymphal stages, and cause a reduction in egg-laying of adults. The efficacy of neem based insecticides can be improved by the addition of 1.0-0.5% soft soap (Sharma *et al.*, 2016). Biological control agents provide the best long-term control measure, such as pathogenic fungus-based pesticides (*V. lecanii*, *P. fumosoroseus*, and *B. bassiana*) have the full potential to suppress the population of whiteflies and beetles in both greenhouse and field conditions (Faria & Wraight, 2001).

The soil application of thiamethoxam and imidacloprid is effective in controlling whitefly. Among chemicals, spiromesifen, pyriproxyfen, and ibuprofen affect the reproduction and survival of immaturity as they decrease the secondary spread of the whitefly population (Webb *et al.*, 2014).

The cultural control of thrips includes weed control, rotation of crops, clean fallowing, mixed cropping, and trap crops. The removal of crop residue before planting another crop reduces initial infestations in the next crop by decreasing the population of thrips (Murphy *et al.*, 2014). Plant extracts and oils such as garlic extract, mint oil, rosemary oil, neem, canola, and cottonseed oil can also be used to control thrips infestation (Godfrey, 2011).

Culture control methods like floating row covers or reflective mulches are used to repel or exclude aphids (Barbercheck, 2014). Many parasitoids can be used as natural enemies of aphids, such as (parasitic wasps), which include *L. fabarum*, *A. colemani*, *A. matricariae*, and *Binodoxys angelicae* (Kos *et al.*, 2008). Some fungi can also be used to control the aphids, such as *B. bassiana*, *M. anisopliae*, *V. lecanii*, and *N. fresenii* (Hall, 1982). Other biological control agents of aphids include ladybird beetle and their larvae (Koch, 2003), syrphid fly larvae and minute pirate bug (Laska *et al.*, 2006), and green lacewing larvae (Markulla *et al.*,

1979). Chemical control of aphids includes the use of dimethoate, laminate, endosulfan, fulfill, and acara. Some pyrethroids, such as malathion (0.05%), acetamiprid (0.01%), bifenthrin (0.01%), and Cypermethrin (0.01%), can also be used to control aphids. For the management of the above insect, several chemicals have been used in the past. Most of these arthropods have developed resistance to registered pesticides.

On the other hand, these pesticides also have harmful effects on other useful insects and non-target organisms. Most of these pesticides are not environmentally friendly. Some of these pesticides are accumulating in fruits, vegetables, and other crops, which are harmful to human health as well as to other living organisms. Keeping in view the above harmful effects of these chemicals, the following study has been undertaken to evaluate an alternate method for the management of these noxious pests of bitter gourd to get maximum and healthy vegetables. Therefore, this study was carried out having subsequent objectives.

MATERIALS AND METHODS

The experiment conducted at AWKUM Mardan in 2022 aimed to evaluate the effects of different plant extracts and the insecticide Cypermethrin on pest populations (aphids, whiteflies, and thrips) and yield of bitter gourd (*Momordica charantia*). The study was carried out in a Randomized Complete Block Design (RCBD) with five treatments and three replications. Plant extracts, including *Parthenium hysterophorus*, *Eucalyptus globus*, and *Azadirachta indica* (Neem), were prepared by drying, grinding, and soaking leaves or seeds to create 5% concentrations. At the same time, Cypermethrin was applied at the recommended dose. Treatments were applied using a knapsack sprayer when pest populations reached the Economic Injury Level (EIL), with three applications at 10-day intervals. Data on pest population densities and fruit yield were collected weekly, with pest counts performed via leaf inspection and the leaf-beating method for thrips. The fruit weight was recorded in grams and converted to kg/ha. Statistical analysis was performed using ANOVA and LSD tests. The results showed that botanical extracts and Cypermethrin significantly reduced pest populations and increased fruit yield, with Cypermethrin being the most effective, followed by *Azadirachta indica*. This study provides valuable insights into the potential use of botanical extracts as part of an Integrated Pest Management (IPM) strategy for bitter gourd cultivation.

RESULTS

The experiment conducted at AWKUM Mardan in 2022 investigated the effect of different plant extracts and Cypermethrin on the population density of aphids, whiteflies, and thrips on bitter gourd (*Momordica charantia*) using a Randomized Complete Block Design (RCBD). The treatments included Cypermethrin (80-120 ml/ha), *Azadirachta indica* (10 kg/ha), *Parthenium hysterophorus* (10 kg/ha), *Eucalyptus globulus* (10 kg/ha), and a Control (water spray), replicated three times. The results showed significant differences in aphid populations across treatments and time intervals. Cypermethrin-treated plots had the lowest mean population density of aphids per leaf (0.88), followed by *Azadirachta indica* (2.60) and *Parthenium hysterophorus* (3.00). The highest aphid populations were recorded in the Control group (5.60), with *Eucalyptus globus* showing 3.22 aphids per leaf. Aphid populations varied significantly over time, with the lowest counts observed at 3 days post-treatment (2.62 aphids per leaf) and the highest counts at 10 days (3.74 aphids per leaf). The interaction between treatments and time intervals was also significant, with Cypermethrin consistently maintaining the lowest aphid population across all time intervals. After 10 days, the Control group had the highest aphid counts, with *Eucalyptus globus* showing moderate results. This study highlighted the effectiveness of Cypermethrin and *Azadirachta indica* in controlling aphid populations, with botanical treatments like *Eucalyptus globulus* showing potential but less effectiveness.

Table 4.1 Comparison of natural plant extracts and Cypermethrin on the mean population density of aphids/leaf in bitter gourd crop during AWKUM MARDAN 2022

Treatments	Day 3	Day 7	Day 10	Mean

Cypermethrin (T_1)	1.22i	0.89j	0.65j	0.88d
Azadirachta indica (T_2)	2.31g	2.30g	3.20e	2.60c
Parthenium hysterophorus (T_3)	2.68fg	2.61fg	3.72d	3.00b
Eucalyptus globulus (T_4)	2.77f	2.74f	4.16c	3.22b
Control (T_5)	4.26c	5.58b	6.96a	5.60a
Mean	**2.62c**	**2.82b**	**3.74a**	

This means having dissimilar alphabets are statistically different from each other at a 5% level of significance using the LSD test ($P < 0.05$)
LSD for treatments= 0.2406
LSD for days= 0.1864
LSD for Treatments*Days= 0.4167

4.2 Comparison of natural plant extracts and Cypermethrin on the mean number of whiteflies per leaf in bitter gourd crop during AWKUM MARDAN 2022

A perusal of the data showed that various chemicals and time intervals (days) influenced the mean number of whiteflies per leaf in bitter gourd crops (Table 4.2). The mean value was significantly different among all treatments. A significantly minimum mean number of whiteflies per leaf (0.90) was recorded from Cypermethrin-treated plots, followed by *Azadirachta indica* and *Parthenium hysterophorus* with 2.18 and 2.66 whiteflies per leaf, respectively. However, a significant maximum mean number of whiteflies per leaf (7.91) was recorded from control, followed by *Eucalyptus globulus* with 2.82 whiteflies per leaf.

The mean values for time intervals (days) also recorded significant differences. Statistically minimum mean number of whiteflies per leaf (3.18) was recorded after three days of post-treatments, followed by seven days with 3.25 whiteflies per leaf. However, a significant maximum mean number of whiteflies per leaf was recorded after ten days of the post-treatments, with 3.46 whiteflies per leaf.

The interaction effect of different treatments and time intervals (days) was also significant. Statically, a minimum number of whiteflies per leaf was recorded after ten (0.90), seven (0.84), and three (1.05) days in Cypermethrin-treated plots followed by *Azadirachta indica* (2.27) after three days of post treatments; the effect of treatments was statistically different during this time interval (days). The mean number of whiteflies per leaf was significantly maximum as compared to control, being significantly maximum after ten (8.89), seven (7.95), and three (6.90) days. Among the plots treated with botanicals, the maximum mean number of whiteflies per leaf was recorded from the plots treated with *Eucalyptus globulus* after ten (2.83), seven (2.71), and three (2.92) days of post-treatment.

Table 4.2 Comparison of natural plant extracts and Cypermethrin on the mean population density of whiteflies/leaf in bitter gourd crop during AWKUM MARDAN 2022

Treatments	Day 3	Day 7	Day 10	Mean
Cypermethrin (T_1)	1.05h	0.84i	0.82i	0.90e
Azadirachta indica (T_2)	2.27g	2.15g	2.13g	2.18d
Parthenium hysterophorus (T_3)	2.75def	2.58f	2.64ef	2.66c
Eucalyptus globulus (T_4)	2.92d	2.71ef	2.83de	2.82b
Control (T_5)	6.90c	7.95b	8.89a	7.91a
Mean	**3.18b**	**3.25b**	**3.46a**	

This means having dissimilar alphabets are statistically different from one another at a 5% level of significance using the LSD test ($P<0.05$)
LSD for treatments= 0.1108
LSD for days= 0.0858
LSD for Treatments*Days= 0.1919

4.3 Comparison of natural plant extracts and Cypermethrin on the mean population density of

thrips/leaf in bitter gourd crop during AWKUM MARDAN 2022

A perusal of the data showed that various chemicals and time intervals (days) influenced the mean population density of thrips/leaf in bitter gourd (Table 4.3). The interaction of treatments and time interval (days) was also significant. The mean value was significantly different among all treatments. Significantly, the minimum mean population density of thrips/leaf (0.93) was observed from plots treated with Cypermethrin, followed by *Azadirachta indica* and *Parthenium hysterophorus* with 2.66 and 3.12 thrips per leaf, respectively. However, a significant maximum mean number of thrips per leaf (5.96) was recorded from the control, followed by *Eucalyptus globulus* with 3.16 thrips per leaf.

The mean values for time intervals (days) also recorded significant differences. Statistically minimum mean number of thrips per leaf (2.59) was recorded after three days of post-treatments, followed by seven days with 2.99 thrips per leaf. However, a significant maximum mean number of thrips per leaf was recorded after ten days of the post-treatments, with 3.92 thrips per leaf.

The interaction effect of different treatments and time intervals (days) was also significant. Statically, a minimum number of thrips per leaf was recorded after ten (0.71), seven (0.90), and three (1.20) days in Cypermethrin-treated plots followed by *Azadirachta indica* (2.17) after three days of post treatments; the effect of treatments statistically different during this time interval (days). The mean number of thrips per leaf was significantly maximum as compared to control, being significantly maximum after ten (7.20), seven (6.46), and three (4.22) days. Among the plots treated with botanicals, the maximum mean number of thrips per leaf was recorded from the plots treated with *Eucalyptus globulus* after ten (4.08), seven (2.73), and three (2.69) days of post treatments with statistically significant differences.

Table 4.3 Comparison of natural plant extracts and Cypermethrin on population density of thrips/leaf in bitter gourd crop during AWKUM MARDAN 2022

Treatments	Day 3	Day 7	Day 10	Mean
Cypermethrin (T_1)	1.20g	0.90gh	0.71h	0.93d
Azadirachta indica (T_2)	2.17f	2.17f	3.65d	2.66c
Parthenium hysterophorus (T_3)	2.68e	2.70e	3.98cd	3.12b
Eucalyptus globulus (T_4)	2.69e	2.73e	4.08c	3.16b
Control (T_5)	4.22c	6.46b	7.20a	5.96a
Mean	**2.59c**	**2.99b**	**3.92a**	

This means having dissimilar alphabets are statistically different from one another at a 5% level of significance using the LSD test (P<0.05)

LSD for treatments= 0.1973

LSD for days= 0.1528

LSD for Treatments*Days= 0.3418

4.4 Comparison of natural plant extracts and Cypermethrin on the mean number of fruits per plant in bitter gourd crop during AWKUM MARDAN 2022

Perusal of the data showed that various chemicals influenced the mean number of fruits per plant in bitter gourd crops (Table 4.4). The mean value was significantly different among all treatments. A significant minimum mean number of fruits per plant (9.62) was recorded from control, followed by *Parthenium hysterophorus* and *Eucalyptus globulus* treated plants with 15.20 and 15.38 fruits per plant, respectively. However, a significant maximum mean number of fruit/plant (22.79) was recorded from Cypermethrin-treated plants, followed by *Azadirachta India* with 18.55 fruits per plant.

Table 4.4 Comparison of natural plant extracts and Cypermethrin on mean amount of fruits/plant in bitter gourd crop during AWKUM MARDAN 2022

Treatments	Fruits per plant
Cypermehtrin (T_1)	22.79a
Azadirachta indica (T_2)	18.55b
Parthenium hysterophorus (T_3)	15.20c
Eucalyptus globulus (T_4)	15.38c
Control (T_5)	9.62d
LSD	**1.4941**

This means having dissimilar alphabets are statistically different from one another at a 5% level of significance using the LSD test ($P < 0.05$)

4.5 Comparison of natural plant extracts and Cypermethrin on yield per treatment in bitter gourd crop during AWKUM MARDAN 2022

Perusal of the data showed that various chemicals influenced the mean number of fruits per plant in bitter gourd crops (Table 4.5). The mean value was significantly different among all treatments. Significant maximum yield per treatment (24.80 kg) was recorded from plants treated with Cypermethrin, followed by *Azadirachta indica* and *Parthenium hysterophorus* with 19.35 kg and 16.05 kg/treatment, respectively. However, a significant minimum yield/treatment (10.81) was recorded from the control, followed by *Eucalyptus globulus* with 16.04 kg/treatment.

Table 4.5 Comparison of natural plant extracts and Cypermethrin on yield per treatment in bitter gourd crop during AWKUM MARDAN 2022

Treatments	Yield per treatment (kg)	Yield (kg/ha)
Cypermehtrin (T_1)	24.80a	20670a
Azadirachta indica (T_2)	19.35b	16126b
Parthenium hysterophorus (T_3)	16.05c	13411c
Eucalyptus globulus (T_4)	16.04c	13374c
Control (T_5)	10.81d	9008d
LSD	**1.1407**	**945.66**

This means having dissimilar alphabets are statistically different from one another at a 5% level of significance using the LSD test ($P < 0.05$)

DISCUSSION

The experiment regarding the "effect of different plant extracts on the population density of aphids, whiteflies and thrips on Bitter gourd *Momordica charantia* was conducted at AWKUM MARDAN 2022 Randomized Complete Block Design (RCBD) was used in this trial, having five treatments (Cypermethrin ®25% EC (Cypermethrin 80-120 ml/ha), *Azadirachta indica* 10 Kg/ha, *Parthenium hysterophorus* L. leaves extract 10 Kg/ha, *Eucalyptus globulus* leaves extract 10 Kg/ha and Control (Water spray) that was replicated three times.

The mean values for the number of aphids, whiteflies, thrips per leaf, number of fruit per plant, and yield per treatment revealed significant differences for specific treatments and treatment time intervals. At the same time, the other was found to be non-significant. The lowest mean number of aphids, whiteflies, and thrips per leaf and the highest number of fruits per plant with maximum yield were observed from the Cypermethrin-treated plots. The findings revealed that Cypermethrin is more effective as compared to plant extracts; because Cypermethrin attacks the nervous system and inhibits sodium ions which leads to the quick reduction of pest population (Rahman *et al.*, 2014; Kumar & Thakur, 2017; Sharma & Tayde, 2017)*, our results regarding the effectiveness of chemical as compared to natural plant extracts are similar to Ali et al. (2011) who reported significantly lowest number of sucking insects pest*

and lowest percent damage was observed from the plants treated with methomyl followed by neem, parthenium and eucalyptus leaf extracts in bitter gourd crop and also indicated that the number of insects were increased with time. However, natural plant extracts act as a repellent, stomach poison, physical barrier, fumigant, anti-feeding, and growth regulator, and are less persistent as compared to chemicals (Sarwar, 2015).

Among the natural plant extracts, Azadirachta indica was found to be more effective in controlling aphids, whiteflies, and thrips per leaf. At the same time,, the highest number of fruit as well as yield was also obtained from Azadirachta indica-treated plants. The higher efficacy of Azadirachta indica in comparison with other natural plant extracts is also described by, Kumar and Thakur (2017) and Kuswaha and Painka (2016). Improved results of *Azadirachta indica are because of Azadirachtin, as this compound has anti-feeding properties, is sterilant, and is also utilized as a* growth regulator, making the growth of insects very difficult (Sarwar, 2015). Datta and Saxena (2001) also reported that *Parthenium hysterophorus* can also act as an anti-feedent which helps in minimizing the loss due to various pests.

According to Araya and Emana (2009), plant extracts played a significant role in controlling coleopterous beetles. Our results about the use of *Azadirachta indica* against whitefly are in line with Ali *et al.* (2011), who stated that the lowest population of whitefly (1.3) was obtained from Mehomyl (chemical) treated plots followed by *Parthenium hysterophorus* (1.5) and *Azadirachta indica* (3.2), respectively. The same results were also mentioned by Rashid *et al.* (2016), who stated that the lowest shoot infestation (9.1% plant^{-1}) and minimum population (4.31 pest/plant) was recorded from *Azadirachta indica* treated plots followed by other botanicals.

The same results regarding the yield were also determined by Nehra *et al.* (2019), who stated that a significant maximum marketable yield (105.14 q ha^{-1}) was reported from plots treated chemical (Spinosad) treated plots followed by Neem leaf and Neem seed extracts with 68.95 and 50.12 q/ha, respectively.

Our results stated that *Azadirachta indica* was the most effective among all botanicals against thrips. The same results were also mentioned by Iqbal *et al.* (2015), who reported that the statistically lowest population density of thrips (6.314) was obtained from *Azadirachta indica* treated plots, while the statistically maximum population (8.125) of thrips was recorded from plots treated with Eucalyptus.

Conclusions

Cypermethrin reduces the population density of aphids, whiteflies, and thrips/leaves significantly. Furthermore, cypermethrin results in significantly maximum number of fruits and yield of bitter gourd. Among the tested natural plant extracts, *Azadirachta indica* is significantly better at suppressing the population of aphids, whiteflies, and thrips. In comparison with the control, all of the natural plant extracts utilized in the experiment suppressed the pest population.

Recommendations

Cypermethrin is recommended as a better control measure against aphids, whiteflies, and thrips in bitter gourd crops as it significantly reduces the population of aphids, thrips, and whiteflies.

Azadirachta indica treatment is effective against aphids, whiteflies, and thrips as compared to *Eucalyptus globulus* and *Parthenium hysterophorus* treatments in bitter gourd crops. As such, it may be used in the IPM for the control of aphids, whiteflies, and thrips in bitter gourd crops.

Azadirachta indica at higher concentrations may be tested for better results.

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