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EFFICACY OF DIFFERENT BOTANICALS AND A NEW CHEMISTRY INSECTICIDE AGAINST *Bemisia tabaci* (HEMIPTERA: ALEYRODIDAE) ON SUNFLOWER *(Helianthus annuus* L.)

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ABSTRACT

Vulnerability to a number of insect pests is one of the major constraints towards the successful production of sunflower. Among these insect pests, whitefly is considered key pest that contributes huge losses to sunflower yield. The present study was conducted at New Developmental Farm (NDF), The University of Agriculture Peshawar, (34.01° N, 71.53° E) Pakistan during the years 2012 and 2013 to determine the efficacy of different botanicals and a new chemistry insecticide against whitefly associated with sunflower Hysun-33. Whitefly population was recorded a day before and 1, 2, 3 and 7 days after application of each spray material on the crop. The results showed that low population of whitefly was recorded in the emamectin benzoate treatment while among the botanicals, Datura alba was the most effective treatment in terms of population decline of whitefly, which was followed by Azadirachta indica oil and A. indica seed extract. Highest pest population was recorded on untreated check plots. The present results indicated that plant derived extracts and oil have the potential to be used for the successful control of whitefly on sunflower.

Keywords: Sunflower, *Bemisia tabaci*, botanicals, control measures, new chemistry insecticide, emamectin benzoate, Pakistan.

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INTRODUCTION

Sunflower is a rich source of edible oil (40-52%) and considered as high-quality oil from the health point of view due to the presence of poly unsaturated fatty acids (55-60% linoleic acid and 20-30% oleic acid) that are known to reduce the possibilities of cardiac

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diseases. The potential of sunflower is, far from being exploited, the yield levels in the country are the lowest as compared to other developing countries due to several biotic, and abiotic factors (Asha, 2011). Currently, sunflower (*Helianthus annuus* L.) has recorded a huge expansion in terms of area and production in Pakistan. Still, domestic edible oil production meets only 23% of the country demand (PODB Annual Report, 2013-14). According to report, the import bill is approximately 2.84 million tons edible oil worth US $2.611 billion (224 billion Pak rupees). A skyrocket increase in the population will require more edible oil, which has to be substituted from locally available resources. Pakistan already pays an ever-larger imports bill to meet up the oil consumption needs, which will become hard as the population grows. Sources of local oil seed production needs to be explored in the present cropping system of the country with future climate changes and rising population (PODB Annual Report-2013). The net yield level has been considerably low, due to its poor cultivation and management practices. Among these, insect pests are the major limiting factors for high yield in sunflower crop for many years. Many of these insect pests ultimately result in a huge yield reduction in sunflower production throughout the world (Carl, 1990). Whitefly, *Bemisia tabaci* (Genn.) (Hemiptera: Aleyrodidae) is a major insect pest of many crops and an important vector of gemini viral pathogens worldwide. *B. tabaci* has been considered as a species complex containing several genetic and biological variants undergoing continuous evolutionary changes (Brown, 2000; Perring, 2001). Extensive developments have been made while understanding the population trends, behavior, biology and ecology of the *B. tabaci* in developing and carrying out an integrated pest management system. Various genetic characters like high reproductive ability, carrying ability of many plant viruses, and tolerance for a wide range of environments and resistant to a broad range of pesticides enhances its pest perspectives (Gerling and Mayar, 1996). Presently, whitefly has emerged as the new serious sucking insect pest on sunflower and serves as vector of leaf curl virus. This has attracted a lot of attention of the entomologists and pathologists, as it affects the productivity of sunflower (Katti, 2007). The unsystematic use of synthetic insecticides has created many problems, such as secondary pests' emergence, threats to non-target species like human beings, livestock, beneficial insects, fish and pollinators that ultimately affect the natural ecosystem (Shukla *et al.,* 1998). To address all these issues, it is of prime importance to focus on non-toxic materials for the management of various insect pests on our crops. Botanical insecticides are not only economically and ecologically safe but are also free from residual problems. For the last few years, the importance in the botanical insecticides has considerably increased because of environmental risks and development of tolerance in insect pests against synthetic insecticides. The present study was therefore, conducted to assess the efficacy of different plant extracts and a chemical insecticide against whitefly on sunflower crop under field conditions.

MATERIALS AND METHODS

Field experiment on efficacy of different botanicals and a synthetic insecticide (emamectin benzoate 20EC) against whitefly on sunflower was conducted at the New Developmental Farm (NDF) of the University of Agriculture Peshawar, Pakistan for two growing seasons i.e. spring and autumn of 2012 and 2013. Total area of Peshawar district (34.01° N, 71.53° E) is 1,257 km^2. It is situated at an altitude of 347 m (1,138 ft) above sea level. The mean maximum temperature exceeds 40° in summer while, the mean minimum temperature is 25°C. During winter, the mean minimum temperature is 4°C, whereas the maximum is 18.35°C. The average annual precipitation level recorded is 400 millimeters (16 in) and the highest annual rainfall level of 904.5 millimeters (35.61 in) during 2003. The relative humidity varies from 46 to 76% during June through August. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. Each replication comprised of eight treatments. Sunflower Hysun-33 was raised as test crop in plot measuring 3 x 3 m^2 with a space of 60 and 30 cm between rows and plants, respectively. Number of plants in each row was ten with a total of 50 plants in each plot. Sowing of sunflower crop at the rate of 2.5 kg per hectare was done manually on ridges by dibbling 3 seeds per hill to a depth of 3 cm to maintain optimum population per plot. All the recommended agronomic practices were applied uniformly for healthy growth of plants during the experimental period. After germination, hand thinning was done in order to get optimum plant population in the field. All inter-cultural practices required for sunflower crop including thinning, hoeing, weeding out, earthing up, etc. were carried out at appropriate timings. Various solutions of botanicals (*Azadirachta indica* oil, *A. indica* seed extract, *Parthenium hysterophorus, Allium sativum*, *Datura alba* and *Curcuma longa*) and a synthetic insecticide (emamectin benzoate) treatments were prepared and sprayed on each experimental plot. High volume knapsack sprayer was used for the application of different spray treatments. Two spray applications were done on need basis. Observations on population density of whitefly associated with sunflower were recorded and all insecticide treatments were applied according to the recommended criteria.

Preparation of plant extracts (Botanical insecticides)

Synthetic insecticide, emamectin benzoate and *Azadirachta indica* oil was purchased from the local market, whereas the procedure adopted for the preparation of remaining botanical insecticides is enlightened here under.

A. indica seed extract

About ½ kg of *A. indica* (neem seeds) was shade dried, crushed and then soaked overnight in a little quantity of water. Later, the mixture was squeezed through the muslin cloth and the volume was made up to five liter, to obtain 10 per cent solution. A 10g detergent was added before application of treatment for better emulsion (Munir, 2006).

Parthenium hysterophorus extract

Small chopped pieces of *Parthenium* plants were shade dried, crushed and then soaked in water with a ratio of 1:10 (w/v) for 48 hrs and then filtered to collect the respective water extracts. Before application 10g detergent was added for better emulsion.

Allium sativum extract

Allium sativum (garlic) extract prepared by taking 1/2 kg of garlic and crushed in juicer. Then crushed garlic was added in 5 liter of boiled water, which gave 10 per cent of garlic extract solution (Munir, 2006).

Datura alba extract

About 1/2 kg seeds and chopped leaves of *D. alba* were crushed and then boiled for five minutes in five liters of water to make a 10% concentrated solution. The solution left for two hours to cool down. After those 10 grams of soap or detergent was added to the infusion as an adjuvant. The mixture was thoroughly stirred for ten minutes and strained through a sieve.

Curcuma longa extract

Curcuma longa (turmeric) crude extract was prepared by boiling 1/2 kg turmeric stems for 30 minutes in 5 liters of water, which gave 10 per cent turmeric concentration (Munir, 2006).

Preparation of concentrations

The required concentration of extracts was made by using the following formula:

$$C1V1 = C2V2$$

Where:

C1 = given concentration of stock solution
V1 = volume of water of stock solution
C2 = required concentration of working solution
V2= volume of water of working solution

In this way 2 per cent concentration of *A. indica* oil and 2.5 per cent concentrations for each *A. indica* seed extract, *P. hysterophorus, A. sativum*, *D. alba*, *C. longa* and 0.07 per cent concentration of emamectin benzoate was prepared.
The following observations were recorded during the experiment:

Population density of whitefly

For recording observation on whitefly incidence, five plants were selected randomly in each treatment, and the whitefly population (both nymphs and adults) were recorded on three leaves each from top, middle and bottom portion of the plant. The observations on population density of whitefly were made a day before spraying and 1, 2, 3 and 7days after application of spray. Finally, average whitefly population was calculated and for drawing the inference, the data were statistically analyzed by using Gen-Stat discovery third edition.

Statistical analysis

The collected data were analyzed according to the procedure appropriate for randomized complete blocked design by using statistical software, Gen-Stat third edition. Least significance test was performed for separation of means when F- test was found significant.

RESULTS AND DISCUSSION

Whitefly population after first spray application

Whitefly population one day before application of different insecticide treatments was found non-significant (Table-1). However, significant variation after one day of first spray was noticed in their occurrence. After one day of spray application, the least population density was recorded on emamectin benzoate (1.32) and *D. alba* (1.78) treatments. However, their number was significantly different from each other. The next best botanical treatments were *A. indica* oil and *A. indica* seed extracts, where mean counts of whitefly were recorded as 2.23 and 2.52 per leaf, respectively. *P. hysterophous* and *A. sativum* treated plots were recorded with heavy incidence (3.47 and 3.40) of whitefly. However, their counts did not differ significantly with each other. The highest frequency of pest per plant was counted on un-treated check plot (4.61).

After 2 days of first spray, emamectin benzoate was found to be the most effective treatment by showing minimum population (0.93 per plant) which was significantly different from remaining treatments. Followed to emamectin benzoate, *D. alba* treated plots were also recorded with lower population (1.41) of whitefly per plant whereas, *A. indica*oil and *A. indica* seed extract showed 1.78 and 2.11 per plant population of whitefly, respectively. Extracts of *P. hysterophorus, A. sativum* and *C. longa* proved to be least effective treatments by showing 3.12, 3.00 and 2.97 whitefly counts per plant, which varied significantly from other botanicals and chemical treatment. Maximum (5.00) incidence per plant of the pest was recorded on control plot.

After 3 days, emamectin benzoate was the most effective treatment with only 0.70 whitefly per plant, which was followed by *D. alba* treated plot by showing 1.20 counts of specimens. The *A. indica* oil and extracts of *A. indica* seed were statistically at par that showed good response in suppression of whitefly after emamectin benzoate and *D. alba* with 1.66 and 1.92 per plant respectively. Extracts of *Parthenium* and *Al. sativum* showed 3.03 and 2.85 and per plant population of whitefly, which did not differ significantly from each other. *C. longa* treated plot was recorded with mean population of 2.65 whitefly per plant and was significantly different from other treatments. Untreated plot showed maximum population density of whitefly (5.00 per plant) which was significantly different from all other botanicals and chemical treatment (Table-1).

After 1 week of application of first spray, the data on average incidence of the pest revealed that minimum (0.46) numbers of whitefly was recorded on emamectin benzoate treated plot, which was followed by *D. alba* with 0.98 counts of whitefly per plant. Similarly, the population density counted as 1.56 and 1.75 per plant on *A. indica* oil and *A. indica* seed extract treatments, which were statistically same to each other. However, were significantly different from previous two treatments. Maximum (3.15) population was noticed on *Parthenium* treatment, which was followed by *Al. sativum* (2.92) and *C. longa* (2.88) treated plots. Control plot was recorded with highest (5.15) counts of whitefly, which was significantly different from all remaining treatments.

Whitefly population after second spray application

After one day of second application of spray, it was revealed that emamectin benzoate treated plot showed significantly minimum numbers of whitefly (1.07) which was followed by *D. Alba*, where mean population was 1.76 per plant (table 2). Other effective treatments were *A. indica* oil and *A. indica* seed extract with total number of 2.23 and 2.55 whitefly per plant respectively. However, these treatments varied significantly from each other. Maximum incidence of the pest was recorded on plots treated with *Parthenium, Al. sativum* and *C. longa* with 3.87, 3.56 and 3.33 whitefly per plant respectively. The highest (4.57) count of whitefly per plant was made on un-treated check plot.

After 2 days of second spray, the results showed that emamectin benzoate treatment had lowest population density of whitefly (0.72) which was significantly different from all other treatments (Table 2), followed by *D. alba* (1.42) . Similarly, *A. indica* oil and extract of *A. indica* seed had 1.92 and 2.32 whitefly per plant respectively. *Parthenium*, *Al. sativum* and *C. longa* treatments proved less effective in reducing population of whitefly by counting 3.60, 3.32 and 2.82 whiteflies plant^{-1}, respectively. However, these treatments showed better results as compared to control treatment, where highest (4.75) population density of whitefly was recorded.

After 3 days, emamectin benzoate and *D. alba* were most effective treatments by reducing mean number of whitefly to a minimum count of 0.46 and 1.11 per plant respectively. Furthermore, population density of whitefly was recorded as 1.75 and 2.10 per plant on *A. indica* oil and *A. indica* seed extract treatments and were found at par from each other. Extracts of *P. hysterophorus, Al. sativum* and *C. longa* showed maximum population of whitefly (3.42, 3.10 and 2.40) per plant, but were differ significantly from each other. Untreated check plot recorded maximum population of whiteflies (4.91 per plant) which was significantly different from all treatments.

After application of second spray, it was noticed that after one week significantly least (0.26) count of whitefly was made on emamectin benzoate treated plot, which was followed by *D. alba* by counting 0.83 number of whitefly per plant (Table-2). Similarly, population density of whitefly was counted as 1.53 and 1.91 per plant on *A. indica* oil and *A. indica* seed extract treatments, which were found at par with each other. Population density of whitefly was recorded as 3.78, 2.95 and 2.35 per plant respectively on *P. hysterophorus, Al. sativum* and *C. longa* treatments, which were at par with each other. Untreated check plot was recorded with highest (5.02) population of whitefly and was significantly different from all remaining treatments.

It was found that the influence of all treatments was significant in terms of population reduction of whitefly after 1, 2, 3 days and 1 week after application of first and second spray. The results indicated that the population density of whitefly was greatly suppressed in all the above-mentioned time intervals as against control plot, where no pesticide treatments were applied. Botanical *D. alba* proved to be the most effective treatment after synthetic insecticide (emamectin benzoate) which was followed by *A. indica* oil and *A. indica* seed extract treated plots.

The present results are in agreement with those of Isman, (2006) who reported that botanicals are plant-based insecticides that could be effectively used for the successful management of insect pests. Extracts of plants are naturally slow acting substances and are mostly safer to non-target organisms and to environment as compared to synthetic insecticide. Results on efficacy of different botanical insecticide are also in agreement with that of Zhang *et al.* (2004), who found that botanical insecticides like *Datura*, essential oils *(A. indica)* and other plant extracts have a number of advantages i.e. least residual effect, lower mammalian and non-target toxicity etc.

As the botanicals and plant-based essential oils have a very complex chemical composition as compare to newly used chemical insecticides for the control of different insect pests, there is minimum possibilities of resistance development in insect species. The essential oils have the ability to meet the requirements of the current century of insecticides for the control of various insect pests on the crops. Investigation made by Basappa (1998) are in compliance with our results that application of *A. indica* oil and seed extracts not only reduce damage due to *Helicoverpa* attack on sunflower but also help in preserving the activity of natural enemies as well as honeybees and other pollinator species. According to Ghani (1998), plant-based crude extracts are encouraged for the control of insect pests of different stored commodities and many other pests on different crops.

In the present studies, it was revealed that *P. hysterophorus*, *Al. sativum* and *C. longa* did not effectively control the population of whitefly. This might be the reason that these botanical insecticides alone are not much capable in suppression of sucking pest on sunflower. In addition, short residual effect could also be one of the reasons for recording high incidence of the pests on the crop. However, Ladaji (2004) and Vijayalakshmi *et al*. (1996) evaluated that *Al. sativum* in combination with other plant products and kerosene as quite effective for egg-plant fruit borer control, which strongly supports the current results.

CONCLUSION

As a result of present research findings, it can be concluded that indigenous botanical insecticides (*D. alba, A. indica* oil and *A. indica* seed extract) @ 2.5, 2 and 2.5 per cent concentrations respectively were found superior in minimizing the population density of whitefly, thereby eventually enhancing the yield of the sunflower as well. Among various botanicals and a new chemistry insecticide applied for the suppression of whitefly infestation on sunflower, *D. alba, A. indica* oil and *A. indica* seed extracts are much safer and may be applied against whitefly on sunflower.

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Table-1. Efficacy of different botanicals and a new chemistry insecticide against whitefly on sunflower Hysun-33 after 1st spray during 2012-13

Treatments	1 DBS	1 DAS	2 DAS	3 DAS	1 WAS
Emamectin benzoate	4.58 a	1.32 g	0.93 f	0.70 g	0.46 g
A. indica oil	4.48 a	2.23 e	1.78 d	1.66 e	1.56 e
A. indica seed extract	4.28 bc	2.52 d	2.11 c	1.92 d	1.75 e
A. sativum extract	4.47 a	3.40 b	3.00 b	2.85 b	2.92 c
P. hyterphorus etract	4.42 a	3.47 b	3.12 b	3.03 b	3.15 b
D. alba seed extract	4.41 a	1.78 f	1.41 e	1.20 f	0.98 f
C. longa extract	4.13 c	3.26 c	2.97 b	2.65 bc	2.88 cd
Control	4.35 b	4.61 a	4.79 a	5.00 a	5.15 a

Means followed by same letters do not differ significantly at P = 0.05%,
DBS = Day before spray, DAS = Day after spray, WAS = Week after spray

Table-2. Efficacy of different botanicals and a new chemistry insecticide against whitefly on sunflower Hysun-33 after 2nd spray during 2012-13

Treatments	1 DBS	1 DAS	2 DAS	3 DAS	1 WAS
Emamectin benzoate	4.45 a	1.07 h	0.72 h	0.46 h	0.26 h
A. indica Oil	4.35 a	2.23 f	1.92 f	1.75 f	1.53 f
A. indica Seed extract	4.10 ab	2.55 e	2.32 e	2.10 e	1.91 e
A. sativum extract	4.18 ab	3.56 c	3.32 c	3.10 c	2.95 c
P. hysterophorus extract	4.53 a	3.87 b	3.60 b	3.42 b	3.78 b
D. alba seed extract	4.26 ab	1.76 g	1.42 g	1.11 g	0.83 g
C. longa extract	4.33 a	3.33 d	2.82 d	2.40 d	2.35 d
Control	4.33 a	4.57 a	4.75 a	4.91 a	5.02 a

Means followed by same letters do not differ significantly at P = 0.05%
DBS = Day before spray, DAS = Day after spray, WAS = Week after spray

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