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Comparative efficiency of certain indigenous plant extracts and a chemical pesticide against *Amrasca devastans* (Homoptera: Cicadellidae) on sunflower (*Helianthus annuus* L.)

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Abstract
The present research study on comparative efficiency of certain indigenous plant extracts and a chemical pesticide against *Amrasca devastans* (Homoptera: Cicadellidae) on sunflower (*Helianthus annuus* L.) was carried out at New Developmental Farm (NDF), The University of Agriculture Peshawar, (34.01 °N, 71.53 °E) Khyber Pakhtunkhwa, Pakistan for two consecutive years i.e. 2012-13. During the course of experimentation, comparative efficacy of six different indigenous plants extracts i.e. *Azadirachta indica* oil, *Azadirachta indica* seed, *Parthenium hysterophorus*, *Allium sativum*, *Datura alba* and *Curcuma longa* in comparison with a chemical pesticide, emamectin benzoate were tested against jassids associated with sunflower Hysun-33. Following emamectin benzoate, *D. alba* was the most effective treatment in term of population suppression of jassids, which was followed by *A. indica* oil and *A. indica* seed extract. Highest incidence of the sucking pests was recorded on un-treated control plot indicated that plant derived extracts and oil have the potential to be used for the control of insect pests. The present results thus, concluded that the indigenous natural botanical extracts could prove the excellent substitute to commonly used chemical pesticides for the successful management of jassids on sunflower.

Keywords: Sunflower, Jassids, *Amrasca devastans*, botanical extracts, chemical insecticide

1. Introduction
Sunflower belongs to the family Compositae and grown as oil producing crop in Pakistan [6]. In Pakistan, sunflower cultivation started in 1960 to bridge the gap between production and consumption of edible oil in the country [2]. Domestic oilseeds mainly include cottonseed, sunflower seed and rapeseed. The share of imported oil in total consumption is closer to 75 percent. The import bill of edible oil is growing into billions of dollars annually. Demand of edible oil is growing annually at the rate of 5 percent [10]. Currently sunflower (*Helianthus annuus* L.) has witnessed huge expansion in terms of area and production in Pakistan. Still, domestic edible oil production meets only 23% the country demand [10]. As per report, the import bill is approximately 2.84 million tons edible oil worth US $2.611 billion (Pak. Rs. 224 billion). The sunflower is a short season crop that can be easily identified by broad and dark yellow floral heads. Being an edible oil crop, sunflower has also gained much popularity as cut flowers and hence the endeavor of diversifying its benefits have been enhanced [3]. The major constraints to sunflower production are different insect pests. Many of these insect pests serve as vector for virus and other infectious diseases. For instance, infestation of *Empoasca abrupta* may lead to leaf curling, chlorosis and pre-mature senescence [14]. Jassids (Homoptera: Cicadellidae) are major sucking insect pest of sunflower throughout the India. Adult leafhoppers and their nymphs' suck the cell sap from the young leaves of the crop, heavy infestation leads to hopper burn and curling of leaves occur [13]. Botanicals are plant-based insecticides, which are naturally slow acting substances and mostly safer to non-target organisms and to environment as compared to common chemical pesticides. Botanical insecticides have been reported with minimum residual consequences. Plant-based pesticides contain biologically active substances due to which resistance is not build up in targeted insect pests and pathogens. Many scientists have recommended the application of botanical pesticides with low ill effects [5, 11].

Keeping in view the economic importance of sunflower, the present investigation was therefore conducted with the objectives to test the efficiency of six different indigenous plant extracts like *A. indica* oil, *A. indica* seed, *P. hysterophorus, Al. sativum, D. alba* and *C. longa* along with a chemical insecticide, emamectin benzoate against jassids associated with sunflower Hysun-33.

2. Materials and Methods

The present research work on efficiency of six different indigenous medicinal plants along with a chemical insecticide, emamectin benzoate against jassids associated with sunflower Hysun-33 was carried out at the New Developmental Farm (NDF) of The University of Agriculture Peshawar, Khyber Pakhtunkhwa, Pakistan. The experiment was conducted for two consecutive years 2012-2013. The experiment was laid out in a Randomized Complete Block (RCB) design 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 spacing 60 and 30 cm between rows and plants respectively. Number of plants in each row was ten and thus, each plot had 50 plants. Sowing of sunflower 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 course of the investigation. Following emergence, thinning was done in order to get optimum plant population. A total of six botanical pesticides were evaluated in comparison with standard chemical pesticide emamectin benzoate and untreated check plot. Various solutions of botanicals (*A. indica* oil, *A. indica* seed extract, *P. hysterophorus, Al. sativum, D. alba* and *C. longa*) and chemical (emamectin benzoate) treatments were prepared and sprayed on each experimental plot. High volume knapsack sprayer was used for imposition of different treatments. When the incidence of jassids reached Economic Threshold Level (ETL), spray material of different treatments were applied accordingly. Observation on population density of jassids on sunflower was recorded and all pesticidal treatments were applied according to the recommended criteria.

2.1 Preparation of plant extracts

Chemical pesticide, emamectin benzoate and *A. indica* oil was purchased from the local market, whereas the remaining plant materials were first shifted to the laboratory and shade dried. Following shade drying, the dried plant materials were ground by using electric blender and then sieved through kitchen strainer. Selected plant materials were extracted with distilled water. The residue from the final extracts was dried well for absolute evaporation of the solvent and the residue was collected in separate containers.

2.2 Preparation of concentrations

The required concentrations were prepared by using the following formula and the diluted concentrations were used for subsequent experiment.

C1V1 = C2V2

Where: **C1** = given concentration, **V1** = volume of water which is required, **C2** = required concentration, **V2=** volume of a known quantity of water.

By this way 2 per cent concentration of *A. indica* oil and 2.5 per cent concentration each of *A. indica* seed extract, *Parthenium, Al. sativum, D. alba, C. longa* and 0.07 per cent concentration of emamectin benzoate was made.

2.3 Population density of jassids

For recording observations on jassid's population density, five plants were selected randomly in each treatment. The population incidence of jassids (both nymphs and adults) was recorded on three leaves each from top, middle and bottom portion of the plant. The observations were made one day before application of spray and 1, 2, 3 days and then 1 week after spraying. Population of Jassids was recorded very early in the morning when they were sluggish.

2.4 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 the F- test was found significant.

Table 1: List of indigenous plants extracts used for the control of jassids on sunflower Hysun-33

Treatments	Concentration/dosage
T1: Emamectin benzoate 1.9 EC	0.07%
T2: *Azadirachta indica* (Neem) oil	2.0%
T3: *Azadirachta indica* seed (Neem) Extract	2.5%
T4: *Parthenium hysterophorus* L. Extract	2.5%
T5: *Allium sativum* Extract (Garlic)	2.5%
T6: *Datura alba* Extract	2.5%
T7: *Curcuma longa* Extract (Turmeric)	2.5%
T8: Untreated Control	--

3. Results

3.1 First spray

The results furnished in table 2 are mean comparison of the data regarding the efficacy of various treatments against population density of jassids at different post-treatment intervals. It was revealed that after the first day of first spray, significantly lowest (0.58 and 0.82) population density of jassids per plant was recorded in T1 treated with emamectin benzoate and *D. alba* which was found statically at par with that of other treatments. The next best botanical treatments followed by emamectin benzoate and *D. alba* were *A. indica* oil and *A. indica* seed extract, where mean number of jassids were counted as 1.10 and 1.26 per plant respectively. However, both plots varied significantly from each other. *C. longa* treated plot was recorded with 1.54 jassids per plant. Similarly, mean counts of jassids made on *Al. sativum* and *Parthenium* were 2.11 and 2.20 per plant respectively, however, they did not differ statistically from each other. The highest (2.36) frequency of jassids were recorded on un-treated control plot, where no pesticidal treatments was applied. After 2 days of first spray, the result showed that T1 (sprayed with emamectin benzoate) was found the most effective by showing the lowest (0.37) incidence of jassids per plant and was followed by *D. alba* and *A. indica* oil treated plot, where total number of jassids was recorded as 0.62 and 0.85 per plant. The population density of jassids recorded on these two test plots were found at par with each other. Seed extracts of *A. indica* and *C. longa* showed 1.17 and 1.38 jassids per plant respectively. It was found that both *Parthenium* and *Al. sativum* treated plots did not differ significantly from each other and showed population density of 1.98 and 1.92 jassids per plant respectively. Maximum (2.36) incidence per plant of

jassids was recorded on control plot, which was found at par from all other treatments. After 3 days of pesticidal application, counts on population density of jassids revealed that maximum suppression of the pest was noticed in the plots sprayed with emamectin benzoate, which showed 0.25 jassids per plant and was followed by a mean number of 0.53 and 0.65 jassids on *D. alba* and *A. indica* oil treated plot. However, all treatments were found at par from each other. *C. longa* treated plot was recorded with a mean population of 1.25 jassids per plant and was found at par different from other treatments. Untreated control plot recorded maximum population counts of the pest (2.56) which was significantly different from the remaining botanicals and chemical treatment. The next maximum (1.98 and 1.91) counts of jassids, followed by control plot were made on *Parthenium* and *A. sativum* treated plots. One week after application of first spray, the counts made on mean number of jassids per plant revealed that highest suppression of jassids were recorded on emamectin benzoate, where minimum (0.18) numbers of jassids per plant was recorded and was followed by *D.alba* and *A. indica* oil treated plots by showing 0.38 and 0.56 counts of jassids per plant respectively. Similarly, population density of jassids per plant was counted as 1.08 and 1.26 on *A. indica* seed extract and *C. longa* treatments, which were statistically at par with each other. Maximum population of 1.98 and 1.95 jassids per plant was recorded on *Parthenium* and *Al. sativum* treatments, which did not differ significantly from each other and were statistically same. However, both treatments were found significantly different from earlier treatments. Highest (2.69) population density of jassids was recorded on untreated check plot, which was significantly at par from remaining treatments.

Table 2: Efficiency of indigenous plants extracts and a chemical insecticide against jassids on sunflower Hysun-33 after 1st spray during 2012-13

Treatments	1 DBS	1 DAS	2 DAS	3 DAS	1 WAS
Emamectin benzoate	2.28 a	0.58 g	0.37 g	0.25 f	0.18 g
A. indica Oil	2.23 a	1.10 e	0.85 e	0.65 d	0.56 e
A. indica Seed extract	2.13 ab	1.26 d	1.17 d	1.18 c	1.08 d
Al. sativum extract	2.37 a	2.11 b	1.92 b	1.91 b	1.95 b
Parthenium extract	2.21 a	2.20 b	1.98 b	1.98 b	1.98 b
D. alba Seed extract	2.11 ab	0.82 f	0.62 f	0.53 e	0.38 f
C. longa extract	2.16 ab	1.57 c	1.38 c	1.25 c	1.26 c
Control	2.11 ab	2.36 a	2.47 a	2.56 a	2.69 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

3.2 Second Spray

The average population counts of jassids per plant of sunflower subject to different plant extracts and a chemical treatment has been shown in table 2. The data on frequency of jassids after 1 day of second spray indicated that the lowest (0.87) number of the pest was observed in emamectin benzoate treatment, which was found at par with the remaining treatments. *D. alba* and *A. indica* seed treated plots were recorded with a mean population of 1.62 jassids. Plots treated by *A. indica* oil and *C. longa* extracts were found with intermediate count of jassids i.e. 1.35 and 1.85 per plant respectively. *Parthenium* and *Al. sativum* treated plots were recorded least effective by showing heavy (2.06 and 1.92) incidence of jassids per plant. However, the highest (2.23 per plant) number of jassids was observed in control plots, which were found significantly higher than all other test plots. After 2 days of second spray, the results revealed that emamectin benzoate was the most effective treatment, which was observed with a minimum (0.50) population of jassids per plant and was significantly different from all other botanical treatments. Emamectin benzoate was followed by *D. alba* (0.78) but had significant differences between them. *C. longa* treated plot was observed with 1.62 number of jassids, whereas *Parthenium* and *Al. sativum* treatments were proved less effective in suppressing the population density of jassids by showing a mean population of 1.90 and 1.81 jassids per plant respectively. However, these treatments did not differ significantly from each other. The highest frequency of jassids (3.36 per plant) was recorded in untreated check plot, which was significantly higher than all other treatments. After 3 days, it was observed that emamectin benzoate and *D. alba* treatments significantly suppressed the population of jassids to a minimum number of 0.31 and 0.55 per plant respectively. However, both treatments were at par with each other. The next effective treatments were *A. indica* oil and *A. indica* seed extract, where population incidence of jassids was recorded as 0.96 and 1.25 per plant, but were found significantly different from each other. Extracts of *C. longa* showed intermediate (1.48) population of jassids. *Al. sativum* and *Parthenium* treated plots were recorded with more or less same population density (1.73 and 1.71) of jassids, which did not vary statistically from each other. Control plot was observed with the highest population count of jassids (2.51 per plant) which was significantly different from all treatments. Data recorded on average population of jassids on sunflower after one week of second spray indicated that lowest (0.18 and 0.38) frequency of jassids per plant were observed on emamectin benzoate and *D. alba* treated plots. However, they varied significantly with each other. Similarly, population density of jassids was recorded as 0.78 and 1.07 per plant on *A. indica* oil and *A. indica* seed extract treatments, which was further followed by *C. longa* with average counts of 1.56 jassids per plant. Population density of jassids were recorded as 1.86 and 1.83 per plant respectively on *Parthenium* and *Al. sativum* treated plots, which were statistically same to each other. Highest (2.67) population density of jassids was found in un-treated control plot, which was significantly different from all remaining treatments.

Table 3: Efficiency of indigenous plants extracts and a chemical insecticide against jassids on sunflower Hysun-33 after 2nd spray during 2012-13

Treatments	1 DBS	1 DAS	2 DAS	3 DAS	1 WAS
Emamectin benzoate	2.18 b	0.87 e	0.50 g	0.31 g	0.18 g
A. indica Oil	2.30 b	1.35 d	1.15 e	0.96 e	0.78 e
A. indica Seed extract	2.28 b	1.62 c	1.41 d	1.25 d	1.07 d
Al. sativum	2.15 bc	1.92 b	1.81 b	1.73 b	1.83 b
Parthenium	2.27 b	2.06 b	1.90 b	1.71 b	1.86 b
D. alba	2.32 a	1.62 c	0.78 f	0.55 f	0.38 f
C. longa	2.27 b	1.85 b	1.62 c	1.48 c	1.56 c
Control	2.12 bc	2.23 a	2.36 a	2.51 a	2.67 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

4. Discussion

Botanical insecticides have long been a focus of study in an endeavor to build substitutes to commonly used conventional chemical insecticides. The application of plant-based insecticides has a long-term tradition in many advanced countries. In the present study, six different botanical extracts in combination with a chemical insecticide were tested in order to evaluate the effectiveness of formulations in reducing population density of jassids. Overall, emamectin benzoate at 0.07% showed highest efficacy by suppressing the maximum number of jassids. *D. alba* was the next best botanical treatment followed by emamectin benzoate, which gave excellent results by controlling heavy incidence of the pest. *A. indica* oil and extracts of *A. indica* seeds also showed encouraging results by suppressing a reasonable number of jassids, whereas remaining botanical extracts did not gave fruitful results. However, in comparison with un-treated check plot, they proved their supremacy in reducing population density of jassids. The results on current research studies thus, indicated that extracts of indigenous plant materials have the potential to manage jassids on sunflower and other crops as well and there is a dire need to develop these plant materials as commercial products. Considering the mean population density of jassids, emamectin benzoate treated plots showed a minimum count of jassids per plant and was followed by *D. alba, Azadirachta indica* oil and extract of *A. indica* seed. Maximum suppression of jassids on sunflower might be due to quick action of chemical insecticide and plant extracts. Similarly, Barnby, [1] stated that *Azadirachtin* and its derivatives degraded quickly in sunlight, which resulting in a significant decrease in biological activities. Our results also collaborate the earlier findings of Naik, [9] who reported different species of *D. alba* from Marathwada, India. These species included *D. ferox, D. stramonium, D. metel*, and *D. inoxia*. Rajesh *et al.* [12] and Koushik *et al.* [7] reported that in addition to their therapeutic significance, *Datura* species have insecticidal and antimicrobial properties. Current results are in conformity with findings of Issac *et al.* [4] that emamectin is a powerful compound for controlling *H. armigera* and least toxic to non-target beneficial organisms. Similarly, extracts of *D. alba* as a biological plant based insecticide are recommended to be used in the integrated pest management for the control sunflower sucking pests and many other insect pests on different crops. The higher efficacy of *A. indica* oil against the jassids population on sunflower is also in line with Rosaiah, [15] who reported that *A. indica* oil @ 2 percent was found significantly higher by showing minimum counts of jassids per plant.

5. Conclusion

From the above-mentioned results, it can be concluded that certain indigenous plant extracts have high prospective to put back the indiscriminate use of chemical insecticides in protecting many agricultural crops including sunflower against the infestation of jassids. *D. alba*, *A. indica* oil and extracts of *A. indica* seeds protecting sunflower against jassid's infestation was found the most effective botanical insecticides. Further field trials of these plant-based formulations may be looked-for to ensure the on-farm efficacy against various pests. Similarly, the application methods of these extracts also need to be accurately assessed.

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