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Appraisal of Plant Extracts and Chemical Control against Whitefly *Bemisia Tabaci*, (Genn) and Its Effect on Associated Natural Enemies in Round Chili

Riaz Hussain[1], Adnan Ihsan[2], Najeeb Ullah[2], Azaz Ali Shah[2], Syed Fahad Shah[2], Muhammad Usman[3] and Muhammad Adnan Khan[4]

[1]Department of Entomology, The University of Agriculture, Swat, Pakistan, 19120 Pakistan
[2]Department of Entomology, The University of Agriculture Peshawar, Pakistan, 25100 Pakistan
[3]Department of Entomology, University of Agriculture, Faisalabad, Pakistan, 38000 Pakistan
[4]Department of Agronomy, The University of Agriculture, Swat, Pakistan, 19120 Pakistan

Corresponding Author: Adnan Ihsan
*E-mail address:adnanihsanuap40@gmail.com

ABSTRACT

Experiment was carried out in Rabi season during 2019 at district Swat to evaluate the efficacy of some plant extracts and chemicals against whitefly *Bemisia tabaci*, (Genn) along with its effect on natural enemies in Chili crop. Randomized complete block design (RCBD) was used with 7 treatments and control, replicated 3 times. The plant extracts and chemicals used were Garlic bulb, Tobacco dry leaf, Chinaberry dry fruits, Neem seed, Ulala (Flanicamid 50% WG), Acetamiprid 20 SP and Imidacloprid 25% WP respectively. Overall mean density and mean percent reduction of white fly was recorded after 10, 20, 30, 40 and 50 days interval of spray applications. Lowest mean density and highest percent reduction was recorded in plot treated with Flanicamid 0.98(87.6) followed by Imidacloprid, Acetamiprid, Tobacco, Chinaberry, Neem seed and Garlic (1.13(82.6), 1.15(82), 1.18(80.6), 1.36(75.2), 1.54(70.4) and 2.33(42.8) respectively while the highest mean density was recorded in untreated plot (3.15). The highest mean density of lady bird beetle was observed in a control plot (2.96) and followed by Garlic extract (1.84) while the lowest mean density was recorded in plot treated with Imidacloprid and Acetamiprid (1.10 and 1.08) which was statistically non-significant. Highest mean percent population of green lacewing was recorded in control plot (2.08) followed by Garlic (1.79) while the lowest population were observed in Acetamiprid (0.85) which was statistically non-significant to Flanicamid (0.89) and Imidacloprid (0.91). Maximum yield was observed in plot treated with Flanicamid (5456.7), followed by Imidacloprid (4039.7) and Acetamiprid (4022.3) was statistically non-significant while minimum was recorded in control (2066.7). Highest cost benefit ratios were recorded in plot treated with Flanicamid (11.23) followed by Imidacloprid (7.51) while the lowest was recorded in plot treated with tobacco (4.64). All the chemicals and plant extracts reduce the population of whitefly. Flanicamid 50 WG give highest yield and cost benefit ratio compare to the rest of chemicals and plant extracts applied.

Key Words: Rabi, garlic, chinaberry, whitefly and Solanaceae.

INTRODUCTION

Chili (*Capsicum annuum* L.) is an important commercial crops belonging to family Solanaceae. The genus name *Capsicum* derived from the Latin word 'capsa' meaning chest or box because of the shape of fruit which encloses seeds very neatly, as in the box. Chilies are cultivated mainly in tropical and sub-tropical countries (Panda, 2014).

Chili is the most important spice used as medicine, industrial product and salad. It is consumed as dry powder, fresh and as sauce. It inducing the consumption of other food and enhance food palatability. Worldwide the chilies act as natural flavor, food additives, colorant and pigments for pharmaceutical and physiological uses (Pineda *et al.,* 2007). It also contained considerable amounts of antioxidants such as vitamin E and C and carotenoids. Chilies, depending upon its use, are classified as vegetables, medicinal herbs, spices and ornamental plants.

During 2018-19, the total chili production of Pakistan was 126943 tones, cultivated in 47349 thousand hectares. In Punjab, chili was cultivated on 6842hectare area with production 11698 tones. In Sindh, chili is cultivated on 36067hectare area with production 108578 tones. The total chili production of Baluchistan is 6285 thousand tones cultivated on 4112hectare while the total production of KPK was 382 thousand tones cultivated on 328hectare area (Anonymous, 2019).

The quality and productivity of chilli is adversely affected by the insect pests. About 35 species of mites and insects like plant bugs, cutwarms, fruit borers, whiteflies, aphids, thrips and minor pests are reported to cause damage in crop (Sorensen, 2005). The main pests that effect the capsicum are gall midge *Asphondylia capsici*, leaf miner *Liriomyza trifolii,*whitefly *Bemisia tabaci*, aphid *Myzus persicae,* thrips *S. dorsalis*, mite *P. latus* and nematodes *Meloidogyne incognita* under controlled condition (Kaur *et al.,* 2010).

Whitefly (*Bemisia tabaci*) is one of the major sucking insect pests for many crops (Norhelina *et al.*, 2013). Both nymphs and adults feed on the leaves surface and suck the phloem sap from sieve tubes. They produce honey dew that reduces the capacity of photosynthetic on the foliage (Rahim Khan *et al.,* 2011).

Synthetic insecticides are highly preferred to be used for the management of whitefly due to its knock down and quick effects. Different types of the synthetic insecticides are used by farmers to obtainsuitable control of the pests. Though, injudicious practice of such insecticides results in numerous environmental and health problems (Aktar *et al*., 2009). It also effects the population of biological control agents like ladybird beetle, predatory bug and spiders (Shabozoi *et al.*, 2008).

Continuous use of chemicals developed resistance in pest against conventional insecticides and leaving fewer effective insecticides to control the pest in the market (Li *et al.*, 2001). In this study efficacies of selected chemicals and plant extracts on whitefly, *Bemisia tabaci* infesting chili were investigated and their effect on natural enemies were examined.

MATERIALS AND METHODS

The study was carried out at Shaltalo Malam Jabba, Swat during Rabi season 2019 to study the effect of different plant extracts and chemicals against whitefly *Bemisia tabaci*, (Genn) in round chili and its association with natural enemies.

Round Chili variety known "Longi" or "Dandicut" was sown in the nursery on raised bed at small village (Shaltalo) of Distract Swat.Transplanting was started at 1st week of April on ridges in the farmer field. Randomized Complete Block Design (RCBD) was used with 7 treatments and control, replicated 3 times. Plot size was 180m^2. Row to row distances were kept 60cm and plant to plant distances were kept 30cm respectively. Usual agronomic practices like weeding, irrigation and fertilization were applied to all plots uniformly.The chemicals were applied twice at 25 days interval by using knapsack sprayer machine. The data was observed in each treatment on randomly selected five plants. The chemical used in the experiment via Ulala (Flanicamid 50% WG), Acetamiprid 20 SP and Imidacloprid 25% WP were purchased from local market.

Preparation of Plant extracts

Garlic extract

Garlic bulb extract was prepared by taking 1 kg garlic and crushed with the help of juicer. Five liter of water was added with crushed garlic which gave us 20% solution for field application. (Munir, 2006).

Chinaberry fruit extract

Chinaberry fruit extract was obtained by crushing 200 gram of dry fruit. One liter water was added to crush chinaberry fruit and kept for 48hrs at room temperature. The obtained solution was then filtered and applied to field (Banchio *et al.,* 2003; Jazzar *et al* 2003; Hammad *et al* 2000).

Preparation of Neem Seed extract

According to Shah (2004) ½ Kg neem seed extract was crushed with grinding machine and mixed with 10g of detergent. The solution was then added with 5 liter of water and kept for 24hrs to get 10% solution of neem extract.

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Tobacco extract (*Nicotiana tabacum*)

Fifty grams of dried leaves were grinded and kept in 500ml of water for 24hrs. The solution was filtered with muslin cloth and added again with 1.5 liter of water to obtained field solution (Sohail *et al.,* 2012).

Method of recording parameters

Whitefly per plant

To record the number of whitefly per plant, 5 plants were randomly selected in each plot. Population of whitefly was observed by selecting 3 leaves from top, middle and bottom of the plant. Data was recorded 1 day before and after 10, 20, 30, 40 and 50 days sprayinterval. The data were then converted to per leaf. Data was observed in the early morning due to the reduced activities of whitefly (Zeeshan *et al.,* 2017).

Percent Whitefly reduction

After the interval of 10, 20, 30, 40 and 50 days after treatment, percent reduction was calculated for each treatment application. Percent reduction in whitefly *Bemisia tabaci* population was calculated using the following formula:

$$\%\textbf{Reduction over control} = \frac{\text{Un-treated plot - treated plot}}{\text{Un-treated plot}} \times 100$$

Natural enemies of whitefly

Randomly, five plants were selected to record the natural enemies of whitefly. Natural enemies' data was recorded 1 day before application of pesticides and then after interval of 10, 20, 30, 40 and 50 days for each treatment application.

Yield (kgha^{-1})

After every picking, yield was recorded for each of the plot separately. Total yield was obtained by adding the yields of all picking. The yield was then converted into kg/ha^{-1} by using the following formula:

$$\textbf{Yield (kgha}^{-1}\textbf{)} = \text{yield plot}^{-1} / \text{plot area (m}^{2}\text{)} \times 10,000$$

Cost benefit ratio

Cost benefit ratio was calculated by using the technique described by Usman *et al.*(2015) to find out the effective treatmentto get maximum return**.**

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Statistical Analysis

Data on the aforementioned parameters (a, b, c, d) were analyzed by using STATISTIX 8.1 and means were separated by LSD test at P=0.05%.

RESULTS

The study was carried out on evaluation of different botanical extracts and chemicals against whitefly *Bemisia tabaci,* (Genn) in Round Chili crop. The present study showed significant effect of botanical extracts and chemical insecticides against whitefly in round chili crop.

Mastoi *et al.* (2013) stated that the infestation of whitefly starts after 20 days of sowing and continues till the end of July. After that, reduction in whitefly population starts on subsequent observation. Leite *et al*. (2005) also reported that population of whitefly was recorded highest from May to June while peak population of nymphs was recorded in April.

The data pertaining to the efficacy of plant extracts and chemical insecticides against white fly infesting round chili at 10, 20, 30, 40 and 50 days interval are showed in the table (1). Total two sprays were applied at 25 days interval.

Results revealed that after 10, 20, 30, 40 and 50 days of spray application. The lowest mean density (1.28, 0.54, 0.31, 0.29 and 0.27) and highest percent reduction (74, 87, 91, 92 and 94) was observed in Flanicamid followed by Imidacloprid (1.16(63), 0.61(86), 0.47(87), 0.45(88), 0.44(89) and Acetamiprid (1.42(61), 0.85(87), 0.54(86), 0.47(89), 1.15(82) which was statistically non-significant. The highest mean density of whitefly population (3.29, 3.42, 3.67, 3.71 and 3.82) was recorded in control after 10, 20, 30, 40 and 50 days interval.
Overall, lowest mean density (0.98) and highest mean percent reduction of whitefly (87.6) after 10, 20, 30, 40 and 50 days was observed in Flanicamid followed by Imidacloprid, Acetamiprid and Tobacco (1.13(82.6), 1.15(82) and 1.18(80.6) which was statistically non-significant while the highest mean density was recorded in untreated plot (3.15). These finding are similar to the finding of Abbas *et al.* (2015), Morita *et al*. (2014) and Baraskar *et al*. (2019).

Table 1. Mean density and mean percent reduction of whitefly at different days interval of applications during 2019.

Treatments		Mean density and percent reduction of white fly per leaf at different DAS (days after spray)					
	Pre count	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	Means

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Garlic	3.15a ---	2.88b (33)	2.25b (45)	1.80b (48)	1.77b (49)	2.11b (39)	2.33b (42.8)
Tobacco	3.16a ---	1.54d (64)	0.87cde (77)	0.54de (87)	0.49d (87)	0.45d (88)	1.18d (80.6)
Chinaberry	3.16a ---	1.61d (65)	1.05cd (75)	0.81cd (77)	0.78c (78)	0.73c (81)	1.36c (75.2)
Neem seed	3.16a ---	2.31c (49)	1.17c (72)	0.94c (75)	0.79c (79)	0.86c (77)	1.54c (70.4)
Imidacloprid	3.19a ---	1.61d (63)	0.61ef (86)	0.47de (87)	0.45d (88)	0.44d (89)	1.13d (82.6)
Flanicamid	3.17a ---	1.28d (74)	0.54f (87)	0.31e (91)	0.29e (92)	0.27d (94)	0.98d (87.6)
Acetamiprid	3.16a ---	1.42d (61)	0.85def (87)	0.54de (86)	0.47d (89)	0.45d (87)	1.15d (82)
Control	3.18a ---	3.29a ---	3.42a ----	3.67a ----	3.71a ----	3.82a ----	3.51a ----
SE	0.02	0.16	0.14	0.17	0.06	0.08	0.06
LSD$_{(0.05)}$	**0.04**	0.35	0.30	0.36	0.14	0.18	0.13

Means followed by the same letters are non-significantly different at the P 0.05 level of significance followed by the LSD

Mean density of lady bird beetle per plant

Table 2 showed that the highest mean density of ladybird beetle (2.83, 2.89, 2.96, 3.13 and 3.16) after 10, 20, 30, 40 and 50 days interval of spray application was observed in control followed by Garlic (2.67, 2.04, 1.86, 0.89 and 0.84) respectively. The lowest mean density was observed in plot treated with Acetamiprid (1.70, 0.80, 0.62. 0.41 and 0.20) which was non-significant to Imidacloprid (1.67, 0.80, 0.63, 0.41, 0.26) and Flanicamid (1.70, 0.80, 0.74, 0.59 and 0.43).

Overall mean density of ladybird beetle at different days interval of spray application was observed highest in control (2.96) followed by Garlic extract (1.84). The lowest mean density of ladybird beetle was observed in plot treated with Acetamiprid (1.08) which was non-significant to Imidacloprid (1.10), Flanicamid (1.17) and Tobacco (1.23) respectively. These results are similar to the results of Rondeau *et al.* (2014) was also reported that Imidacloprid found to be toxic to beneficial insects.

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Table 2. Mean number of Ladybird beetle plant^{-1} recorded before and after different days interval of application during 2019

Treatments		Means density of lady bird beetle per plant at different DAS					
	Pre count	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	Means
Garlic	2.76a	2.67a	2.04a	1.86a	0.89b	0.84b	1.84b
Tobacco	2.77a	1.73b	1.18c	0.99c	0.42e	0.30de	1.23cde
Chinaberry	2.72a	1.77b	1.05c	1.13c	0.72c	0.64c	1.34cd
Neem seed	2.83a	1.80b	1.03c	1.16c	0.74c	0.65c	1.37c
Imidacloprid	2.84a	1.67b	0.80c	0.63c	0.41e	0.26de	1.10e
Flanicamid	2.77a	1.70b	0.80c	0.74c	0.59d	0.43d	1.17de
Acetamiprid	2.77a	1.70b	0.80c	0.62c	0.41e	0.20e	1.08e
Control	2.80a	2.83a	2.89b	2.96b	3.13a	3.16a	2.96a
SE	**0.09**	0.09	0.18	0.25	0.04	0.08	0.08
LSD $_{(0.05)}$	0.19	0.19	0.39	0.54	0.09	0.19	0.18

Means followed by the same letters are non-significantly different at the P 0.05 level of significance followed by the LSD

Mean density of green lacewing per plant

Table 3 showed that highest mean density of green lacewings per plant after 10, 20, 30, 40 and 50 days interval was recorded in control (2.0, 2.04, 2.10, 2.16 and 2.23) followed by garlic (1.87, 1.80, 1.74, 1.66 and 1.60) while the lowest mean density was recorded in Acetamaprid (1.47, 0.63, 0.43, 0.31 and 0.27) which was non-significant to Flanicamid and Imidacloprid respectively. Botanical extracts and control plot showed maximum population of green lacewing.

Overall, maximum mean density of green lacewing was observed in control (2.08) followed by Garlic (1.79) while minimum mean density was observed in Acetamiprid (0.85) which was statistically non-significant to Imidacloprid (0.89) and Flanicamid (0.91). These results are similar to the results of Rondeau *et al.* (2014).

Table 3. Mean number of green lacewing plant^{-1} recorded before and after different days interval of application during 2019

Treatments		Means density of green lacewing per plant at different DAS					
	Pre	10	20	30	40	50	Means

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	count	DAS	DAS	DAS	DAS	DAS	
Garlic	2.06a	1.87a	1.80b	1.74b	1.66b	1.60b	1.79b
Tobacco	2.03a	1.40b	0.85cde	0.52de	0.41de	0.36cd	0.93d
Chinaberry	2.00a	1.84a	0.94c	0.59cd	0.45cd	0.42c	1.04c
Neem seed	2.03a	1.84a	0.87cd	0.64c	0.51c	0.44c	1.05c
Imidacloprid	2.03a	1.41b	0.77e	0.47ef	0.36def	0.32cd	0.89de
Flanicamid	2.00a	1.50b	0.83de	0.51def	0.36ef	0.29d	0.91de
Acetamiprid	2.00a	1.47b	0.63f	0.43f	0.31f	0.27d	0.85e
Control	1.97a	2.00a	2.04a	2.10a	2.16f	2.23a	2.08a
SE	0.11	0.094	0.04	0.03	0.04	0.05	0.03
LSD $_{(0.05)}$	0.23	0.20	0.09	0.08	0.09	0.12	0.07

Means followed by the same letters are non-significantly different at the P 0.05 level of significance followed by the LSD

Yield kgha^{-1} and Cost benefit ratios of different treatments

Table 4 showed that maximum yield was observed in plot treated with Flanicamid (5456.7) followed by Imidacloprid (4039.7) which was statistically non-significant toAcetamiprid (4022.3) while minimum yield was recorded in control plot (2066.7).
Table 5 showed that highest cost benefit ratios was observed in plot treated with Flanicamid (11.23) followed by Imidacloprid (7.51) while the lowest cost benefit ratio was recorded in plot treated with Tobacco (4.64).

Table 4. Effect of different treatments on the yield of round chili crop

Treatments	Yield kgha^{-1}
Garlic	3116.7d
Tobacco	3036.7d
Chinaberry	3526.7c
Neem seed	3106.7d
Imidacloprid	4039.7b
Flanicamid	5456.7a
Acetamiprid	4022.3b
Control	2066.7e
SE	82.59
LSD $_{(0.05)}$	177.15

Means followed by different letters are significantly different at

P 0.05 level of significance followed by LSD Test.

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Table 5. Cost Benefit Ratio of different treatmentsagainst whitefly on chili crop

Treatments	Yield (kgha^{-1}) A	Gross income (Rs.) B	Cost of control ha (Rs.) C	Return over control (Rs.) ha^{-1} D	Estimated net benefit (Rs. ha^{-1}) E (D-C)	C: B F(D/C)
Garlic	3116.7	109084.5	7345.67	36750	29404.33	5.00
Tobacco	3036.7	106284.5	7316.9	33950	26633.1	4.64
Chinaberry	3526.7	123434.5	7218.9	51100	43881.1	7.08
Neem seed	3106.7	108734.5	6971.2	36400	29428.8	5.22
Imidacloprid	4039.7	141389.5	9192.3	69055	59862.7	7.51
Flanicamid	5456.7	190984.5	10568.5	118650	108081.5	11.23
Acetamiprid	4022.3	140780.5	10395	68446	58051	6.58
Control	2066.7	72334.5				

DISCUSSION

The study was carried out on appraisal of different botanical extracts and chemicals against whitefly *Bemisia tabaci*, (Genn) in Chili crop at district Swat. The botanical extracts and chemical insecticides showed significant effect against whitefly in round chili crop.

The whitefly population density was non-significant before spray application but after spray application significant difference was observed. The agreement was similar to the Solangi*et al.* (2007). All the treatments give a significant result to manage whitefly population as compared to control after different spray applications.

After 20 days of planting the whitefly infestation was started and continued till last week of July. The decline in whitefly population was subsequently observed. The results are in line with Mastoi *et al.* (2013). Similar results were observed by Leite *et al*. (2005) showing that the population density of whitefly was maximum from May to June while highest number of nymphs were recorded in April.

The minimum mean density of whitefly and highest percent reduction was recorded after first spray application in plot treated with Ulala (Flanicamid 50 WG) and Imidacloprid. Similar results were observed by Abbas *et al.* (2005). The Ulala (Flanicamid 5o WG), new chemistry insecticide was highly effective against sucking insect pest like whitefly, jassid, thrips and mites.

The results revealed that (Ulala (Flanicamid 50 WG) was effective for 3 weeks. The findings of Morita *et al*. (2014) also observed that Ulala (Flanicamid 50 WG) had a long-lasting efficacy. Similar results were observed by Baraskar*et al*. (2019) that Ulala (Flanicamid 50 WG) had effective for three to four weeks against aphids and other insect pests. The findings of Baraskar

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et al. (2019) also revealed that Flanicamid gave best result in 1st and 2nd spray against sucking insects.

The Ulala (Flanicamid 50 WG) new chemistry insecticide did not cause phytotoxicity. Kodandaram *et al.* (2017) also observed similar results. The insecticides Imidacloprid had faster results against the immature stage of sucking insect pest, matched with Fernandes *et al.* (2010). The study revealed that Ulala showed 80.4% reduction in whitefly population. The present results were similar to the results of Kodandaram *et al.* (2017), recorded more than 85% reduction in the population of whitefly as compared to untreated plot. Insecticides like imidacloprid did not causes phytotoxicity when it is applied by recommended dose. These findings showed similarity with the results of kar, (2017). Salehia *et al.* (2013) observed that insecticides imidacloprid showed toxicity during first nymphal instar of whitefly.

In present experiment two insect predators green lacewing and ladybird beetle were observed. The maximum predators' population was recorded in control plot. The predators' density was maximum in field treated with plant extracts as compared to chemical insecticides. The chemical insecticides Ulala (Flanicamid 50 WG) and Imidacloprid have highest cost benefit ratios (11.23, 7.51) and highest yield (5456.7kg/ha, 4039.7/ha) respectively.

CONCLUSION

All the pesticides and plant extracts reduce the population of whitefly. Chemical insecticides Flanicamid 50 WG gave better result as compared to other chemicals and plant extracts against whitefly population. But plant extracts are eco-friendly to natural enemies than chemical insecticides. So for the conservation of natural enemies, these plant extracts should be incorporated in IPM programs.

Authors' Contributions

Adnan Ihsan: Conducted research work
Syed Fahad Shah: Main Supervisor
Riaz Hussain and Muhammad Adnan Khan: Wrote the Article.
Azaz Ali Shah: Co-supervisor
Najeeb Ullah and Muhammad Usman: Proof reading

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