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Research Article

Efficacy of Plant Extracts and Selective Insecticides Against Wheat Aphid in Faisalabad, Pakistan

Usama Saleem[1], Muhammad Asrar[1]*, Dilbar Hussain[2], Saddam Hussain[1], Abdul Ghaffar[2], Hassan Usman[1], Muhammad Imran[1], Mubshar Saleem[3] and Maryam Hamid[1]

[1]Department of Zoology, Government College University Faisalabad, Faisalabad, Pakistan; [2]Entomological Research Institute, Ayub Agricultural Research Institute, Faisalabad, Pakistan; [3]Department of Plant Pathology, PMAS Arid Agriculture University Rawalpindi, Rawalpindi, Pakistan.

Abstract | Wheat aphid is a crop-damaging bug. It causes significant damage by sucking cell sap, injecting a poison into the plant, eliminating photo-assimilates, and spreading plant-destroying viruses. This study aimed to investigate the effectiveness of botanical extracts and synthetic insecticides in combating wheat aphids. Data regarding the aphid population was recorded 24, 48, 72, and 168 hours after the application of plant extracts and insecticides. Maximum mortality recorded after 168 hours was, 85.06% and 79.29% by Neem and Eucalyptus leaf extract followed by 72 hours 72.29% and 71.69%, 48 hours 63.35% and 62.45% and 24 hours 48.91% and 48.68% respectively. Among the botanical extracts, Neem leaf extract was more effective as compared to the Eucalyptus leaf extract and a significant difference between the treated and control plot was recorded. Carbosulfan and Imidacloprid showed 76.80% and 75.62% mortality followed by 84.40% and 84.08%, 91.35% and 90.53% and 95.39% and 93.85% after 48, 72 and 168 hours respectively. Carbosulfan and Imidacloprid similarly greatly reduced the aphid population in compared to the control, but no significant difference was seen between the two treatments. Based on the results, it is stated that botanicals provide cost-effective and ecologically friendly alternatives to wheat aphid control and that they should be incorporated into an integrated management approach.

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***Correspondence** | Muhammad Asrar, Department of Zoology, Government College University Faisalabad, Faisalabad, Pakistan; **Email:** asrar_agri@yahoo.com
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1. Introduction

Agriculture is an important sector of the economy in several developed and undeveloped countries like Pakistan that are considered to be among the world least developed. Agriculture is the cornerstone of Pakistan's economy and is regarded as the backbone of the economy, which relies heavily on its main crops. Wheat, cotton, rice, sugarcane, fruits, and vegetables are Pakistan's primary agricultural crops. Agriculture represents 26% of the gross domestic product. Pakistan's irrigation system is among the largest

agricultural support systems in the world (Azam and Shafique, 2017; Rehman *et al*., 2015).

The first cereal crop to be planted was wheat (*Triticum aestivum*), a member of the Poaceae family. Wheat is an annual monocotyledon plant that is cultivated in numerous regions of the world. It is the most significant crop for food production (Kole, 2011). Pakistan is the eighth largest producer of wheat in the world (FAOSTAT, 2015). The average wheat production in Pakistan is 24.946 million tons and its contribution is 1.7 percent to the GDP of Pakistan (Pakistan Bureau of Statistics, 2020). It is estimated that 64% of the world's *T. aestivum* is used for human consumption, 21% for animal feed, 8% as seed, and 6% in industry sectors (Ullah *et al*., 2020). Many EFSA health experts have approved that wheat fibers have a positive response on intestinal functions, glucose response, or cholesterol control (Giraldo *et al*., 2019). *T. aestivum* chaff is useful for protection against heart disease, constipation, obesity and diabetes (Kumar *et al*., 2011). Wheat hay is mainly used as animal feed, particularly during the dry season and when food becomes short (Shrivastava *et al*., 2011).

Insects are an important part of the agricultural system because they affect crop yield in different ways. Insects can decrease crop yield by direct damage or by spreading different diseases. Wheat is contrived by different kinds of insect pests like Aphids, Grasshopper, Termites, Flea beetles, Armyworms, *Helicoverpa armigera*, Stinkbugs, Wheat midges, Wheat weevil, and Hessian flies (Hussain *et al*., 2021; Khanal *et al*., 2020). Among the different insect pests, aphids are the most destructive pest of wheat crops and cause high yield losses (John *et al*., 2017; Khan *et al*., 2011; Akhtar *et al*., 2010). Aphids, often known as phloem feeders, are the closest relatives of Adelgidae and Phylloxeridae. They are members of the Hemiptera order and suborder Sternorryhncha, a large superfamily Aphidoidea and family Aphididae (Maryam *et al*., 2019). There are approximately 5,000 known species of aphids across the world; 24 of these species have been found in Punjab, Pakistan, and four of these species have been reported on wheat (Favret, 2018; Bodlah *et al*., 2011). English grain aphid (*Sitobion avenae*), Corn leaf aphid (*Rhopalosiphum maidis*), and Green-bug (*Schizaphis graminum*) and Bird cherry-oat aphid (*R. padi*) are the four aphid species that feed on the wheat crop in Pakistan (Shahzad *et al*., 2013; Aziz *et al*., 2013; Shahid *et al*., 2012). Among the aphid species that have been observed on wheat crop *S. graminum* is the most destroying because it attacks the spikes which directly bears the grain and *R. maidis* is mostly seen on stem and leaves of wheat (Wains *et al*., 2014). *R. padi* causes a loss of wheat yield up to 600 kg/ha (Ali *et al*., 2015). Barley yellow dwarf is a disease caused by a virus that is usually spread by *R. padi* or *S. graminum* (Bockus *et al*., 2016). Direct yield loss by aphids that are sucking insect pests is 35-40% and indirect loss is 20-80% by spreading fungal and viral diseases (Faheem *et al*., 2019; Zeb *et al*., 2016; Sabbir *et al*., 2014; Aslam *et al*., 2005). The yield loss is greater than 30% with 15 aphids per plant.

Numerous botanicals have been examined as potential synthetic pesticide alternatives. The usage of botanical extracts can result in mortality, infertility, slowed growth, and decreased egg viability. Botanical pesticides have a limited impact on the environment, and their low cost and use as food ingredients indicate minimal toxicity to humans (Bedini *et al*., 2020; Silva *et al*., 2017). Inherently biodegradable and less persistent than synthetic pesticides, botanical aphidicides are naturally biodegradable. Plant-derived aphicidal agents and various biologically active chemicals with high toxicity to insect pests are being developed (Nong *et al*., 2015). At present, insecticides, such as foliar sprays and seed treatments, are one of the primary control methods for limiting the damage caused by wheat aphids and the plant infection they transmit (Armstrong *et al*., 1993). By using insecticides, up to 98% of the aphid population can be eliminated (Royer *et al*., 2005). After pesticide spraying, a 2.06% increase in yield was found (Iqbal *et al*., 2008). Controlling aphid populations using insecticides is not advantageous for wheat because to numerous negative side effects, including chemical residues, environmental contamination, and ecological instability (Aktar *et al*., 2009; Yano, 2006; Fishel, 2005).

2. Materials and Methods

During the Rabi season of 2020-21, the research trials were done at the Entomological Research Institute, Ayub Agricultural Research Institute (AARI), in Faisalabad, Pakistan.

2.1 Cultivation of crop

Wheat variety Akbar-2019 was cultivated by the traditional method, also known as the Drill sowing

method. The experiment was designed with three repetitions using Randomized Complete Block Design. Following treatments were sowing; Neem leaf extract (50g/l), Eucalyptus leaf extract (50g/l), Carbosulfan (500ml/acre), Imidacloprid (200ml/acre) and Control. In addition, proper evaluation and identification were performed at the Entomological Research Institute, AARI Faisalabad.

2.2 Preparation of botanical extracts

Two botanical extracts, Neem leaf extract, and Eucalyptus leaf extract were used. For this purpose, Neem and Eucalyptus leaves were collected from Ayub Agricultural Research Institute Faisalabad, Pakistan, and transported to the laboratory where these leaves were thoroughly washed with distilled water. After drying in the shade, the fine powder was made by grinding the leaves through the electric grinder and mixing 200gm of powder of each plant leaves with 1000ml of water, keeping it overnight, and sieving it through muslin cloth to make a stock solution. When the aphid population reached the Economic Threshold Level (ETL), the solution was mixed with 20 L of water and sprayed on the wheat crop to overcome the aphid infestation. Calculation of percentage mortality of aphids was taken as.

$$\% \text{ Mortality } = \frac{Pretreatment - Post\ treatment}{Pretreatment} \times 100$$

2.3 Insecticides tested

When the population of wheat aphids reached Economic Threshold Level (ETL), insecticides (Carbosulfan @ 500ml/acre and Imidacloprid @ 200ml/acre) were sprayed using a knapsack hand sprayer. Each insecticide was dissolved in 1L water in a measuring jug to make a solution. Before application, of insecticide add 200 ml spray material to the spray machine tank and mix it thoroughly. The formula for calculating percent mortality was:

$$\% \text{ Mortality } = \frac{Pretreatment - Post\ treatment}{Pretreatment} \times 100$$

2.4 Data collection

After applying botanical extracts and insecticides for 24, 48, 72, and 168 hours, data regarding the wheat aphid population was recorded by randomly selecting 10 tillers on each plot. Aphid density was calculated by counting the number of aphids on each plant's tiller.

2.5 Statistical analysis

Using Statistics 8.1, an Analysis of Variance (ANOVA) and mean comparison were calculated. Tukey's HSD test was applied at 0.05 for comparing means.

3. Results and Discussion

3.1 Impact of botanical extracts on wheat aphid population

The comparison of means of aphid population is described in Table 1 by Neem and Eucalyptus leaf extract. On 24 hours, Neem leaf extract caused 48.91% mortality followed by Eucalyptus leaf extract 48.68%. Percentage mortality after 48, 72, and 168 hours by Neem leaf extract was 63.35%, 72.29%, 85.06% followed by Eucalyptus leaf extract 62.45%, 71.69%, and 79.29%, respectively as shown in Figure 1. The wheat aphid population was maximum in the control plot while Neem and Eucalyptus leaf extracts significantly reduced the wheat aphid population.

Table 1: Mean comparisons of wheat aphid population by treating botanicals.

Sr. #	Treatments	Pre-treatment	After 24 h	After 48 h	After 72 h	After 168 h
1	Neem leaf extract	7.83 B	4.00 B	2.87 B	2.17 B	1.17 B
2	Eucalyptus leaf extract	8.83 B	4.30 B	3.17 B	2.50 B	1.33 B
3	Control	11.30 A	14.13 A	13.30 A	12.53 A	11.87 A
	HSD	1.12	1.92	1.87	2.45	5.14

Table 2: Means comparisons of wheat aphid population by treating insecticides.

Sr. #	Treatments	Pre-treatment	After 24 h	After 48 h	After 72 h	After 168 h
1	Carbosulfan	12.37 AB	2.87 B	1.93 B	1.07 B	0.57 B
2	Imidacloprid	13.00 A	3.17 B	2.07 B	1.23 B	0.80 B
3	Control	11.30 B	14.13 A	13.30 A	12.53 A	11.87 A
	HSD	1.67	1.75	1.46	2.42	4.94

3.2 Impact of insecticides on wheat aphid population

The results described in Table 2 Carbosulfan and Imidacloprid significantly minimized the wheat aphid population after 24, 48, 72, and 168 hours while the population in the control plot was highest.

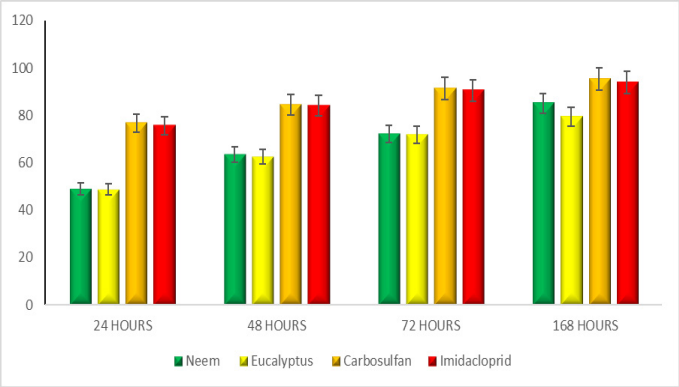

Figure 1: Percentage mortality of botanical extracts and insecticides against aphid population.

Figure 1 revealed the mortality of Carbosulfan and Imidacloprid against the wheat aphid population. Carbosulfan and Imidacloprid caused 76.80% and 75.62% followed by 84.40% and 84.08%, 91.35% and 90.53% and 95.39% and 93.85% after 48, 72 and 168 hours, respectively.

During the Rabi season, this research was carried out at the Entomological Research Institute in Faisalabad, Pakistan. This study aimed to assess the effectiveness of plant extracts and selective synthetic pesticides. Results revealed that botanical extracts and synthetic insecticides caused high mortality against the wheat aphid in comparison to control treatment within 24, 48, 72, and 168 hours. Ali *et al.* (2018) conducted an experiment to determine the effectiveness of entomopathogenic fungi and botanical extracts against wheat aphids. Their finding showed that Neem leaf extract was more effective to control the wheat aphid as compared to Eucalyptus leaf extract. This study's findings were in agreement with those of Ali *et al.* (2018), who investigated the effectiveness of botanical extracts to control the wheat aphid. As a result, it may be concluded that botanicals showed economical and environmentally safe product alternatives against wheat aphids, and it must be implemented into an integrated management program. The results of the study also paralleled those of Ahmad *et al.* (2016), who evaluated the effect of botanical extracts. Neem leaf extract was more effective to control the wheat aphid population as compared to the Eucalyptus leaf extract.

Ali *et al.* (2015) conducts an experiment to evaluate the efficacy of plant extracts against the wheat aphid population, and our findings were comparable. Their findings indicated that Neem leaf extract was effective to cause the mortality of wheat aphids as compared to other extracts. Neem leaf extract in our study caused maximum mortality (85.06%) after 168 hours of application, which showed significant mortality in comparison to the control treatment.

In this study, two synthetic insecticides (Carbosulfan and Imidacloprid) were used to manage the wheat aphid population. Results revealed that Carbosulfan@500 ml/acre was more effective in comparison to Imidacloprid@200 ml/acre. After 24, 48, 72, and 168 hours, the mortality rate of Carbosulfan was 76.80%, 84.40%, 91.35%, and 95.39%, respectively. Imidacloprid caused 75.62%, 84.08%, 90.53 and 93.85% mortality after 24, 48, 72 and 168 hours, respectively. Our findings were also consistent with those of Faheem *et al.* (2016), who conducted an experiment to assess the efficacy of the insecticide against a population of wheat aphids. Carbosulfan and Imidacloprid were found effective to manage the wheat aphid population. The significant difference between the Carbosulfan and Imidacloprid treated plot was recorded in comparison to the control plot. It may be concluded that synthetic insecticides can be integrated to manage wheat aphids.

Conclusions and Recommendations

It is concluded that botanical extracts were found effective and eco-friendly as compared to synthetic insecticides. Among the insecticides, carbosulfan was more effective as compared to the imidacloprid but had toxic effects on the natural enemies. Based on results it is stated that botanical extracts, which were used as part of integrated pest management, provide an alternative control to synthetic insecticides.

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Novelty Statement

Wheat aphid is a crop-damaging bug. It causes significant damage by sucking cell sap, injecting a poison into the plant, eliminating photo-assimilates, and spreading plant-destroying viruses. Based on the

results, it is stated that botanicals provide cost-effective and ecologically friendly alternatives to wheat aphid control and that they should be incorporated into an integrated management approach.

Author's Contribution

All authors play equal role in this article.

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Conflict of interest

The authors have declared no conflict of interest.

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