Formulation and Testing of *Azadirachtin Indica* Based Bio pesticide and its comparative effectiveness in Replacing Synthetic Pesticide

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Abstract

Food problem is a global issue, today humanity is facing. To solve food problems farmers, use chemical pesticides to kill pests and increase crop yield. Overuse of synthetic pesticides in agriculture has led to severe environmental problems and health risks. So this research addresses the urgent need to develop sustainable alternative. One of the most effective methods for controlling these pests in an environmentally responsible way is the use of bio pesticides. The research objective is to promote environmental sustainability and food security by developing and using Neem base bio pesticide that reduce the reliance on synthetic pesticides. The methodology involves the usage of boiling method for bio pesticide formulation and hand-held spray used to spray on plants, and Microsoft excels for the analysis of results. The degree of coordination between the period of administration, aphid activity, crop variety, and environmental factors all affected the efficacy of neem insecticide against aphids. The study found that 95% of the pests could be eliminated with these solutions. This study concluded that as an alternative to the most widely advised chemical pesticide, neem pesticide appears to be a potential botanical option, according to the study.

Keywords: Pesticide; Crop Yield; Botanical; Management Practices.

Introduction

The worldwide population is presently 7.9 billion (Pison, 2019; Popp et al., 2013). In the upcoming decades, there will be significant challenges in providing adequate nutrition, safeguarding public health, supplying fuel and ignition demands, and concurrently preventing deforestation, monitoring the environment, and preventing population growth (Saxena, 2014). Wide, yield loss because of arthropods, sicknesses, and weeds are evaluated to represent about 35% in significant harvests (Carvalho., 2017). This investigation features the key job of harvest assurance in protecting yields and along these lines pledge nourishment security. Manufactured pesticides are seriously utilized in

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created and transitional nations to deal with those problems (Dougoud et al., 2019; shah et al., 2017).

Due to the usage of synthetic pesticides, there is a growing concern over environmental and human health. Reducing harvest disasters caused by pests and illnesses is essential. Additionally, increasing biophysical assets through the application of realistic techniques will be necessary for future food security and financial improvement (Carvalho, 2017; Chaudhary et al., 2017). Appropriate advancements ,which do not affect nature, will have key tasks to carry out in pledging food security, in improving open and creature wellbeing, and in restoring the earth(Arjjumend & Koutouki, 2018).

The use of neem-based pesticides may provide a significant portion of more sustainable rural frameworks for Pakistan and other countries, including irritability and supplementation of the executives, animal welfare, human welfare, and ecological preservation (Boadu et al., 2011; Usharani & RL, 2019). This paper explores the production and formulation of a biopesticide from neem leaves due to its effective bioactive compounds to bay pests from plants and to increase crop yield. This paper also evaluates its effectiveness and compared to synthetic pesticides. These are main active components in neem leaves which act against pest as a pesticide to increase yield and save crop from pest's harmful effects (Boadu et al., 2011). Both salanin and nimbolide have the most potent insecticidal, pesticidal, and fungicidal effects (Dhaliwal et al., 2004; Hayes, 2010). These compounds intrude the life cycle of pests, feeding deterrents, ovulation deterrent, and insect growth regulator, hence reducing pest population without affecting the environment and non-target organisms (Benelli et al., 2017).

Neem as a biopesticide solve the environmental problems and health issues caused due to the usage of different synthetic pesticides and promotes the sustainable approach to pest management, aligning with the principals of integrated pest management (IPM) and organic farming (Gurbuz et al., 2023). Unlike synthetic pesticides bio pesticides save the economy that consumed in agriculture, biodegradable don't accumulate in soil or water bodies, thus reducing the risk of pollution, and can enhance the soil fertility by promoting the activity of soil microbes (Bhattacharyya et al., 2007).

The aims of the proposed study are to evaluate the environmental and health risks of synthetic pesticides and investigate neem-based bio pesticides as a sustainable alternative for pest control. This study also aims to assess its efficacy through hand-held spray application, considering factors like timing, crop variety, and environmental conditions.

Materials and Methodology

Area of Study

This research is conducted at Punjab (31°N 72°E), the most populated province of Pakistan that is the lifeline for the country as it contains the most intensively cultivated areas and the greatest number of industrial units. Site selection is based on agricultural activities and biodiversity in Kot Daran. The research is conducted in village Kot Daran, tehsil Sambrial, district Sialkot (north east of Pakistan) as shown in Figure 1, having 20,000-30,000 population with 15 acre area.

The samples of the neem leave at the mature leaf stage are obtained from village Rampur, tehsil Daska, district Sialkot. Due to tropical and subtropical conditions that area contains plenty of neem trees.

Figure 1: Location of experimental area.

Materials

One kg of Neem leaves, five lit of water, and a lemon is required to prepare bio-pesticide. A squirt for trimming mature leaves from tree branches is used. A pot for gathering and washing leaves in water, Matchbox and stove for starting a fire, Pesticide-filtering sieve or strainer, kettle with stirrer, for small-scale spraying, need a shovel, a spraying machine, and a one-liter bottle.

Preparation of Pesticide

Figures 2 shows the preparation of pesticides. One kilogram of green neem leaves is taken to make five liters of water. This extract can be utilized for culinary and nursery gardens because it requires a significant amount of leaves nearly 80 kg for a hectare to prepare it (Campos et al., 2016). Pour five liters of water into a pot with the leaves. Boil the mixture

until the leaves have lost their green hue. When the green hue disappears, the portion of the leaf that attracts insects has submerged in the water. Overnight, allow the water to cool. Next day, take off the leaves or strain the mixture using a fine-mesh cloth or sieve. To increase its effectiveness, a piece of lemon is added at the end. Currently available for use on pest-containing citrus sinuses plants is a neem spray(Sridhar & Vijayalakshmi, 2002).

(a) Neem branches/leaves

(b) Boiled neem leaves

(c) Neem leaves

(d) Filtrations of pesticide

Figure 2:Preparation of pesticide.

Application of Bio-pesticide

In order to determine the pesticide's ability to keep pests away from plants, a study is undertaken from March 25 to 30, 2020. A brief shake is advised before applying the insecticide in this study since the mixture may separate when using a handheld spray bottle on citrus sinensis plants. After evenly dousing every leaf on the plant with pesticide, observe the effects of the pesticide on the leaves for a continuous period of 15 days. The experiment is repeated three times to increase consistency and reliability of results.

Statistical Analysis

Using tables and graphs, data are statistically examined. The pre- and post-potential values' significant differences are used to express the outcomes. In order to analyze the data, excel and stat graphics 5.1

software's is used.

Results and Discussion

The irritations noted on the citrus sinensis plant are aphids, ants, caterpillars, and ladybugs. Within the study area, the prepared neem insecticide is sprayed or scattered among the citrus sinensis plant leaves. The pesticide is examined by hand showering it on each leaf piece in a same manner, and its adequacy is rigorously verified. The insecticide is administered three times in the evening and over the course of several days during the investigation. The term "pesticide splash" is used for several days. Figure 3 shows the outcome is observed as the days went by, but in general, it is determined using the entire out-of-perception duration (15 days). The results are obtained based on the accompanying factors, such as the time of application, the quantity of pesticides applied, and any negative effects experienced. As some pests more active during evening time and some in the morning according to their comfortable climate. It is observed that results are more effective by increasing the quantity of pesticide. Bio pesticide is applied by the following this sequence; 250 g, 300 g, and 450 g as shown in Table 1.

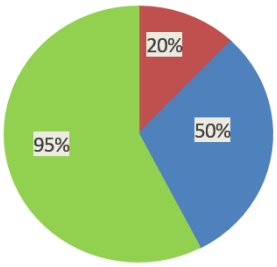

Figure 3: Pie chart showing the % removal of pests.

Table 1: % of pest's removal according to dose and observation time.

No of applications	Dose/con	Observation time	List of treated Pests	% of removal pests
1	250g	12 hours	Aphids	20%
2	300g	2 days	Caterpillar	50%
3	450g	15 days	Ants	95%

Figure 4 shows the efficiency rate which may be calculated as follows: total observations prior to application / total observations following application; % efficiency can be expressed as (efficiency rate / total observations prior to application) × 100%. Pesticide effectiveness is demonstrated by applications 1, 2, and 3. The study found that 95% of the

pests could be eliminated with these solutions. The overall effects of *Azadirachtin* on pests is shown in Table 2.

Through comparison between pre and post application of biopesticide study revealed that biopesticides also work effectively like synthetic pesticide but effecting process is slow. The slow process of biopesticide gives pollution free and effective results. Figure 5 shows percentage of aphids, caterpillar, andant's removal from citrus inensis plant by using biopesticide.

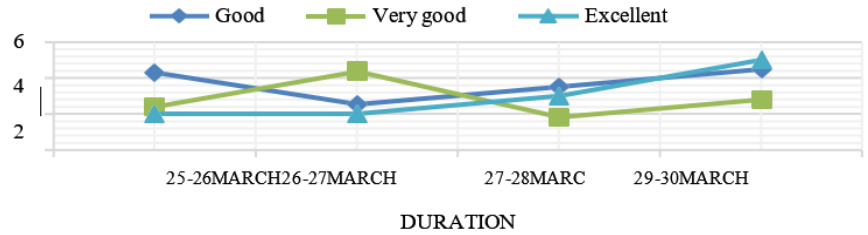

Figure 4: Relationship between application and duration of effectiveness of pesticide on pests in citrus sinensis plant

Table 2: Overall effects of Azadirachtin on pests.

Effects	Target	Mode of action
Primary Anti-feedancy	Mouth part & other Chemoreceptors	• Stimulating deterrent cells • Inhibiting sugar cells (Shendre et al., 2020; Kilani et al., 2021)
Secondary Anti-feedancy	Gut	• Inhibition of peristalsis • Decreased synthesis of enzymes • Absence of replacement of mid gut cells
Insect growth Regulation	Cuticle	• Molting defect caused by alteration to morphogenetic peptide block ecdysteroid
Sterility	Reproductive Organs	Reduced egg and live progeny production due to altered ecdysteroid
Cellular processes	Dividing cells	• In meiosis and mitosis, block cell division occurs after metaphase (Dhra et al., 2018)
Muscles	Muscles	• Loss of muscle tone
Cell synthetic machinery	Gut	• Prevent the production of proteins • Prevent the gut's generation of digesting enzymes (Gupta A,K 2022 ; Agbo et al., 2019)

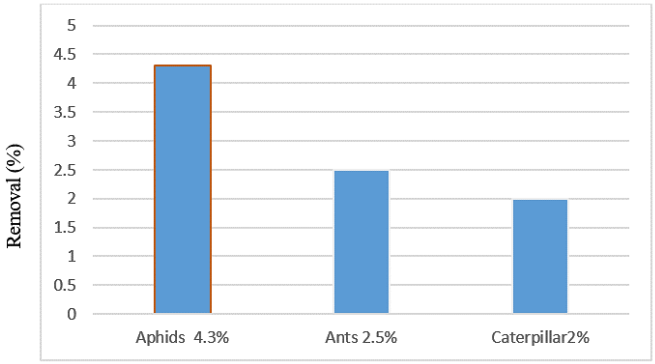

Figure 5: Percentage of aphids, caterpillar, andant's removal from citrus inensis plant by using biopesticide.

Discussion

In this investigation, four types of irritation's aphids, ants, caterpillar, and ladybug are recorded on citrus sinensis plant leaves. Those nuisances have been experienced or recorded among significant bug bugs that made harm citrus sinensis plant. Among the three species, aphids are the most agent regarding recurrence and numbers followed by ants, caterpillar, and ladybug.

The various medications and dosages of neem leaf remove affected the recurrence and quantities of the four bugs recorded on citrus sinensis plant. Hence, despite their reasonably recurrence and higher numbers on control plants, these irritations did not decrease yields on the last mentioned. Be that as it may, they could decrease the market esteem. This assertion aligns with prior research, corroborating the findings of (Sharma et al., 2019), who demonstrated that neem based pesticide is very effective as a mosquitocidal. During study period it is seen that control plants are more assaulted by these distinctive sorts of irritations when contrasted with those plants that are treated with various portions of neem leaf pesticide. This result stands in contrast to the consensus in previous literature (Gubka et al., 2020; Niue et al., 2014) that there is reduction of leafs and crown damage in treated plants compared to controlled plants.

The neem leaf are tried which contained the accompanying groups of compounds: anthraquinones, tennis, triterpenes, coumarins and flavonoids. A portion of these compounds substances present in the neem leaf concentrate may have kept the vermin from benefiting from the leaves. Salannin and triterpenoid, which are close together in the neem leaf concentrate, may have served as an antifeedant.

Table 1 shows that the normal centralization of biopesticide is essentially in consistent splashed on leaf's over a time of six days explore

different avenues regarding unfriendly change in appearance of bugs. Following 12 hours, it is seen that by utilizing 250g pesticide 20% irritations expelled after first application. The second application shows that by utilizing 300g pesticide half vermin is expelled and third application show that by utilizing 450g pesticide 95% bugs evacuated and it is exceptionally productive. The result follows study outcomes of Adusei & Azupio., (2022) according to which there is positive relationship between pests killing and number, and duration of pesticide application. In first diagram study presumed that pesticide focus and number of utilizations both assume key job in irritations' expulsion. The convergence of bugs is for the most part seen in leaves, so pesticide applies just on leaves rather on roots and shoots of plant. It is fascinating to take note of that first use of pesticide evacuates aphids and ants.

The most part, yet ladybug and caterpillar are beginning to expel in second application. The examination thinks about outcome when pesticide application and uncovered that after pesticide application result is exceptionally successful as appeared in Figure 5.

Azadirachtin expel irritation's focus from citrus sinensis plant leaves by affecting nuisances various parts in various method of activity as appeared in Table 2. In result it is seen that Azadirachtin or neem leaf extricate upgraded plant development and expanded the yield in plant as it has also been supported in the study of (Usharani et al., 2019). Network around study territory uncovered that throat and cerebral pain issues additionally cause due to biopesticide.

In any case, study saw that negative impact of manufactured pesticide is extreme contrasted with the readied test. By and large, no antagonistic impacts are accounted for from the utilization of the readied test. The readied pesticide is non allergic to people this study is contradict to previous study (Islas et al., 2020) according to which unstandardized extraction can lead to potential kidney and liver damage. The creation process does not involve any known chemical responses and is almost 99% devoid of ecological contamination. All of the raw materials used in the creation are everyday objects.

Conclusion

Based on the findings, natural botanical sources, such as neem leaves produce pesticides which are less hazardous compared to synthetic sources. Neem-based pesticides, which primarily contain azadirachtin, are selective in their action, targeting hormonal pathways in pests without significantly affecting non-target species, including beneficial insects like bees and predators. As a result, they can mitigate farmers' reliance on external inputs for their crops and are safer to use because they have little

to no effect on non-target species and human health when compared to synthetic pesticides. They have low toxicity to vertebrates and are biodegradable, reducing environmental persistence and harm to wildlife. Additionally, neem products often act as repellents or feeding inhibitors, minimizing direct mortality to non-target organisms and supporting eco-friendly pest management strategies.

Recommendations

- Awareness, education, and capacity building should be on integrated pest management practices and R&D will be encouraged.
- Efficient law enforcement shall be recognized as an essential means of effective pest management.
- Establish the optimal scale of pesticide production by analyzing market demand against production and setup costs.
- The potential of biopesticides to boost agricultural output and improve environmental quality should be investigated through creative research.
- Using parallels with prior experience, evaluate barriers to regulatory innovation for biopesticides, an environmentally benign method of pest management.

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