Examining the Use of Botanicals for Managing Cnaphalocrocis Medinalis (Guenee) in Rice Cultivation in Dhadgaon, Nandurbar, Maharashtra.

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ABSTRACT

Rice (Oryza sativa L.) is an important crop of our country, and its yield loss may be caused by insect pests (Kumar et al., 2015). The rice leaf folder pest is of major concern among rice pests (Kushwaha, 2004). An attempt was made to evaluate the efficacy of botanical extracts in the control of rice leaf folder infestation during the Kharif season at Dhadgaon, Nandurbar District, Maharashtra. The experiment was laid out in RBD with 5 treatments and 3 replications: Neem Seed Kernel Extract (NSKE) 5%, garlic extract 5%, Chilli extract 5%, a chemical check, and an untreated control. Botanicals were applied at 30 days, 45 days, and 60 days after transplanting (DAT). All treatments were found significantly superior in respect of the reduction of leaf damage and larval population as compared to the control. Botanical Neem seed kernel extract was found to be the most effective, with minimum leaf damage (11.2%) and a larval population (1.30), followed by garlic and chilli extracts. The maximum efficacy was observed in the chemical check. The findings revealed that Neem seed kernel extract was found to be most effective in reducing leaf damage and larval population. It can be recommended for incorporation in IPM in rice for the control of leaf folder.

Keywords: Rice, Rice leaf folder, Cnaphalocrocis medinalis, Botanical insecticides, Neem Seed Kernel Extract (NSKE), Integrated Pest Management (IPM).

INTRODUCTION

Rice (Oryza sativa L.) is the principal source of food for millions of people in the world. Globally, 148 million hectares are cultivated, which gives a production of 483 million tonnes (FAO, 2012). Out of this, Asia accounts for 89.84% of the cultivated area, and India is the second largest producer, accounting for 20.0% of the world's rice crop. In 2011-2012, India had 44.31 million hectares under rice, leading to a production of 155.74 million metric tons (FAO, 2012). In Maharashtra, 14.66 lakh hectare area is under rice cultivation, which produces about 34.19 lakh tonnes with 1.84 tonnes/ha as productivity.

Districts like Thane, Ratnagiri, Kolhapur, and Nandurbar are the prominent rice-growing districts. Maharashtra is an important rice-growing state where rice constitutes a major part of subsistence farming even in tribal and hilly regions like Nandurbar District. Here, in agricultural Dhadgaon, the farmers are absolutely dependent on the monsoon for crop production. The rice is essential in providing food, employment, and income to the tribal dwellers.

Over 100 insect species are known to attack rice, of which about 20 are capable of causing economic loss (Pathak and Khan, 1994). The two major pests are the brown plant hopper (BPH), which causes direct damage through sap-sucking and the transmission of viral diseases, and the yellow stem borer, which causes heavy yield losses. The rice leaf folder has recently become a new problem with losses of between 5 and 25% (Kulgagod et al., 2011). Thus, several pests at a high density could devastate a rice crop and threaten food security

Although the rice production is immensely important, the pests, diseases, weeds, environment stresses are the production constraints. Out of which, insect pests can be listed as one of the major causes for the low yield.

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Insect Pest Problems in Rice

Many insect pests attack rice at various stages of its growth. These pests generally attack various parts of the rice plant, like leaves, stems, grains, and roots, by feeding upon them, and cause a reduction in the rate of photosynthesis, plant growth, and grain production. Generally, common insect pests in rice are stem borers, leaf folders, planthoppers, gall midges, and leaf hoppers.

The rice leaf folder (*Cnaphalocrocis medinalis)* is regarded as one of the most serious defoliating pests of rice in Asia. The rice leaf folder occurs throughout most rice-producing countries of Asia, such as India, China, Japan, and many Southeast Asian nations. Outbreaks are reported to occur in humid, warm climates during the vegetative and reproductive growth stages of the rice crop.

Biology and Damage Caused by Rice Leaf Folder

The rice leaf folder is a member of the family Crambidae and order Lepidoptera. It is a small, pale brown butterfly with distinctive wavy lines across its wings. The female butterflies deposit eggs onto the leaves of the rice plant. After the eggs hatch, the larvae eat the leaf tissue. International Rice Research Institute (IRRI). 2013.

The larvae roll the rice leaves lengthwise and tie them with silken threads. After feeding within the rolled leaf, the larvae scrape out chlorophyll by removing portions of the green tissue. The green tissues of the leaf are stripped to form white streaks or transparent patches. Heavily infested plants may experience leaf damage, slow growth, and, if the infestation is severe, reduced photosynthesis. Pathak, M. D., & Khan, Z. R. (1994).

Crowding of the plants may be evident in the form of masses of bent and crumpled leaves. Heavily infested fields show significantly less rice than in unfed areas. The effects are most severe when rice is in its tillering and booting stages, when maximum photosynthesis is needed for growth and yield. Heinrichs, E. A., & Barrion, A. T. (2004)

Crop loss (stunted plants or yield reduction) in India can be as high as80 % infestations by sucking pests or borers and leaf feeders (Rajendran et al., 1986; Lal, 1996) Dumroser. The rice leaf folder, Cnaphalocrocis medinalis Guenee, mainly attacks young plants at the early stages of development, decreasing chlorophyll by 57%, reducing photosynthetic II activity. During the maximum tillering stage, a larval density of more than three per hill can cause20 % of the grains to be unfilled or stunted. Damage to greater than 25% of leaf photosynthetic tissue, such as the flagleaf can result in more than50 % grain unfilled (Padmavathi et al., 2013; Dr. Sarika P. Fulpagare, 2024). Serious crop losses by pests have been reported from Indonesia, the Philippines, and Sri Lanka, where susceptible rice varieties were damaged up to 60% by the brown planthopper. Good pest management practices are important in order to sustain agriculture (Dr. Sarika P. Fulpagare, 2024).

Limitations of Chemical Pest Control

While farmers traditionally use synthetic insecticides to control insect pests in rice fields, the fast and efficient control by chemical pesticides has severely contaminated rice fields and brought about several problems as well.

Continuous use of chemical insecticides may lead to:

- Resistance to insecticides in pest populations
- Destruction of natural enemies like predators and parasitoids
- The resurgence of pests and the resurgence of secondary pests
- Contamination of soil, water, and foodstuffs;
- Health risks to farmers and consumers

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Economic constraints in many tribal areas, like Dhadgaon, also restrict the farmers from buying expensive chemical pesticides. Likewise, there is a need for environmentally safe and friendly pest control practices with rising awareness about climate change.

Role of Botanicals in Pest Management

Botanical pesticides: These are natural compounds from plants that exhibit insecticidal, repellent, antifeedant, or growth regulation activities. Already, farmers have been using plant extracts and natural products for centuries to control insect pests on their crops.

Many plant species produce bioactive chemicals, which can be effective against insects. Botanical pesticides are regarded as being less harmful to the environment because they degrade rapidly, exhibit less toxicity to non-target organisms, and are relatively safe for humans and farm animals.

Another commonly employed botanical insecticide is that extracted from a species of Azadirachta indica, which contains a potent active element known as azadirachtin. Neem preparations are recognized for their efficacious insect growth-retardant and feeding deterrent effects over a large spectrum of pests of agricultural significance. Nathan, S. S., Kalaivasi, K., & Murugan. (2006).

Apart from these, other plant species like Lantana camara, Allium sativum, and Citrus limon have also displayed potential insecticidal and repellent properties. These plants, when extracted, can control the feeding, development, and reproduction of various insect pests, thus helping to control pest populations in crop fields.

Botanical pesticides are also a key component of Integrated Pest Management (IPM). They are used with biological control and other cultural practices as part of a sustainable pest management strategy.

Relevance of Botanical Pest Management in Dhadgaon

Botanical pest control adopted in tribal areas like Dhadgaon, Nandurbar district, is more important as Kharif crops are ecologically rich in plant biodiversity, and various important insecticidal plants are quite available throughout the forest and fields.

The application of botanically available material must reduce production cost, reduce pollution, and improve the sustainability of the rice culture. Botanical pesticides also help to improve an organic farm and low input, based system that is increasingly advocated for a sustainable environment.

Need for the Present Study

There are also reports for activity of Botanical extracts against several insect pests. However, the performance of these at the field level under local agro-climatic conditions may be varied. Hence, the different Botanical treatments should be systematically evaluated for their efficacy on rice leaf folder.

The present investigation strives to work out the effectiveness of certain botanicals against *Cnaphalocrocis medinalis* in rice in Dhadgaon of Nandurbar District. The results of the experiment may be useful for developing the integrated pest management techniques suitable for the needs of the local farmers so as to augment the sustainability of rice cultivation.

Objectives of the Study

1. To examine the incidence of **Cnaphalocrocis medinali**s in paddy fields of Dhadgaon, Nandurbar District.

2. To evaluate the effectiveness of selected botanical pesticides against the rice leaf folder.

3. To compare the effectiveness of botanical treatments with untreated controls.

4. To determine the effect of botanical treatments on rice yield.

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REVIEW OF LITERATURE

Several workers have successfully explored the application of botanical insecticides and eco-friendly pest control methods for the management of insect pests of rice. The effectiveness of extracts obtained from plants like neem, garlic, chili, and all other medicinal plants due to their superior advantages is gaining increasing knowledge. Since these botanicals can be biodegradable, are of low toxicity to non-target organisms, and are best suited for use in an integrated pest management (IPM) program.

Pathak and Khan (1994) revealed that more than 100 insect species, over 20 of which represent serious economic pests, affect rice cultivation. The rice leaf folder, *Cnaphalocrocis medinalis (Guenee)*, is one of the most important defoliators. The larvae roll the leaves lengthwise and eat the green tissues, which may cause a decline in photosynthetic rate.

Rajendran et al. (1986) pointed out the serious losses inflicted by insect pests on rice production in India. It was found that sucking pests can lead to the loss of as much as 80 percent of the yield, and the stem borers and the insects that feed on leaves can cause lower yields by about 50 percent. This highlights the importance of adopting efficient and viable measures for pest control.

Lal (1996) also stated that the rice leaf folder caused more damage at the early vegetative stage of the crop when large populations of larvae damage the leaf tissues by scraping the chlorophyll. This results in frequent leaf folding and drying, which ultimately influences grain filling.

Kulgagod et al. (2011) documented that the rice leaf folder is now one of the major pests encountered in many rice-growing regions of India. They recorded the yield losses of between 5 and 25 per cent, depending upon the severity of the infestation and climatic conditions. They highlighted the urgency of integrated pest management strategies to reduce reliance on synthetic chemicals for pest control and maintain ecological equilibrium.

Investigation into the use of botanical insecticides has found some promising candidates as less hazardous replacements for chemical pesticides. A study was conducted on the physiological effects of azadirachtin, an active ingredient from the neem *Azadirachta indica*, on the insect nervous system. The study concluded that azadirachtin interfered with nerve signal transmission by disrupting the electrical activity of insect neurons. This resulted in a change in feeding and motility behavior in the insect. (Shafeek et al., 2014)

In the same way, Hertel et al. (2016) studied the impacts of plant extract compounds like quassin, cinnamaldehyde, and azadirachtin on insect physiology. They found that the compounds had major effects on the antennal heartbeat rate and muscle activity of the insect, which proved that the botanical compounds can interfere with physiological activities.

Bernays et al. (2017) investigated the effect of plant secondary metabolites, e.g. Tannins, on herbivorous insects. The results of their investigation indicated that many tannin species damage the insect midgut epithelium and thus cause a decline in feeding efficiency and digestion problems. Consequently, they can be seen as having an effective part in natural plant defense.

Reed and Majumdar (2018) investigated the cellular effects that azadirachtin has on insect cell cultures, resulting in the blocking of cell division, abnormal swelling, and structural damage to cells, which is why neem has growth-regulating and insecticidal properties.

His et al. (2015 found that rice given a silicon application had increased resistance to rice leaf folder attack. It was observed that silicon application improves plant defenses and fortifies plant tissues, leading to decreased damage from larval feeding.

Several field trials were done by Singh et al (2018) using some botanical extracts to test pesticidal effects on rice pests. The performance of neem preparations for the suppression of rice leaf folder and stem borer than that of the untreated plot. Neem extracts were found to be antifeedants and growth retardants.

Again, Rath (2018) evaluated the efficacy of insecticides and botanicals for the control of rice leaf folder populations. Results indicated that neem botanicals were effective in controlling pests, while causing less harm to natural enemies.

Recent research also suggests that plant materials could be used for maintenance of pests. Balamurugan and Kannan (2023) showed the effectiveness of neem oil and seaweed extracts in decreasing the level of leaf folder infestation and in promoting rice plant growth in field scale.

However, Adhikari et al. (2022) revealed that in rice, pest population density was directly proportional to the manifested damage of leaves. A successful research led by them stated that pest monitoring and ecological pest control should be carried out on schedule to prevent a reduction in crop yield.

A detailed research by Dr. Sarika P. Fulpagare (2024) has tested many botanical pesticides for control of the major insect pests of rice. The research found neem formulations, especially neem seed kernel extract (NSKE), to be the best reduction of populations and safe to be used along with other pest management practices.

The literature review shown above clearly indicates that botanical insecticides, with emphasis on neem products, should be an integral component of an integrated pest management system for a sustainable, effective, and environmentally safe pest control strategy. Their insecticidal, antifeedant, and growth-regulating activities in humans and plant pests will always be preferable over chemically synthesized ones. But the effectiveness of these plant products can be affected by concentration, temperature, or humidity variations, etc., and the scope for further improvement cannot be denied. Hence, extensive field evaluation of the existing plant products should be undertaken to apply these efficient pest control agents under various Agro-climatic conditions in an integrated manner.

MATERIALS AND METHODS

Study Area

An experiment was conducted in Dhadgaon (Akrani) Taluka of Nandurbar District, Maharashtra state, India (21.80N 74.20E) (Government of Maharashtra, 2012) during the Kharif season (Kharif Kecidil 2012), in the State of Kharif-cum-Rabi. The climate in the state is tropical monsoon; the rainfall is concentrated in the southwest monsoon (IMD, 2020). This zone for rice culture is a rainfed lowland, where all the activities take place monsoon season gives the ideal condition for the crop to grow and develop (ICAR-NBSS&LUP, 2010).

Experimental Design

The experiment was conducted using a **Randomized Block Design (RBD)** with three replications.

Treatments ;

Treatment	Description
T1	Neem Seed Kernel Extract (NSKE) 5%
T2	Garlic Extract 5%
T3	Chilli Extract 5%
T4	Chemical Check
T5	Control (No treatment)

Preparation of Botanical Extracts

The plant materials, such as neem seeds, garlic, and chilli fruits, were collected and crushed with water. The solution was strained through muslin and then diluted to the desired concentration. Two extracts, such as ginger, garlic, chili extract, and the Neem seed kernel extract, were prepared according to the method we learned from the organic farmers.

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Extract of Neem seed kernel.

A fresh crop of neem seeds, weighing three kilograms, was pounded and put in an earthen pot, which was then filled with 10 L of water. The setup was kept aside, and after 3 days, the content was filtered.

Garlic and chili extract production

Garlic (1kg), ginger (0.5kg), and green chilies (0.5kg) were washed, mashed separately, and mixed with 7L of water. The filter was separated using a muslin cloth after 6 hours. (Gamapen Joiti, Dr. Sarika P. Fulpagare, 2024).


Neem cake extract


Neem seed kernel extract


Ginger-garlic -chilli extract

How it is applied to the body (method of application).

Botanical extracts were applied as a spray with the knapsack sprayer at 30, 45, and 60 DAT.

Observations Recorded

1. Percentage of leaf damage
2. Number of larvae per hill
3. Reduction of infestation over control

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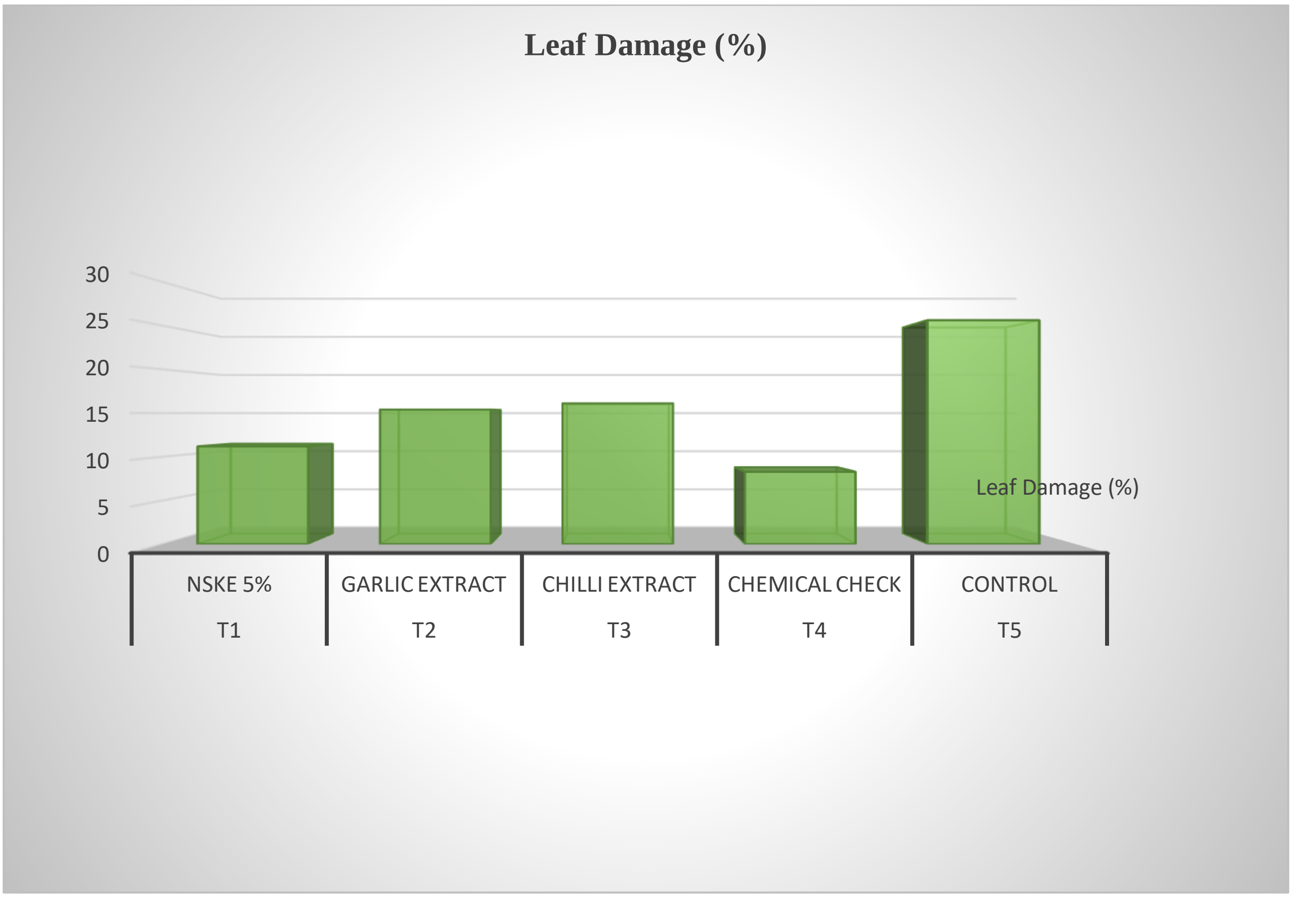
Statistical Analysis

The data obtained in the experiment were analyzed by analysis of variance (ANOVA). The means were separated using the least significant difference (LSD) 5% probability level.

RESULTS

Effect of Botanicals on Leaf Damage

Treatment	Botanicals	Leaf Damage (%)
T1	NSKE 5%	11.2
T2	Garlic extract	15.4
T3	Chilli extract	16.1
T4	Chemical check	8.3
T1	Control	25.6



Neem-based treatments recorded the lowest leaf damage among botanical treatments.

Observation: Among botanical treatments, **Neem Seed Kernel Extract (NSKE)** recorded the lowest leaf damage (11.2%), while the chemical check was most effective overall (8.3%). The control had the highest **5.2 Effect on the larval population.**

Treatment	Botanicals	Larvae per hill
T1	NSKE	1.30
T2	Garlic extract	2.1
T3	Chilli extract	2.30
T4	Chemical check	0.90
T1	Control	4.2

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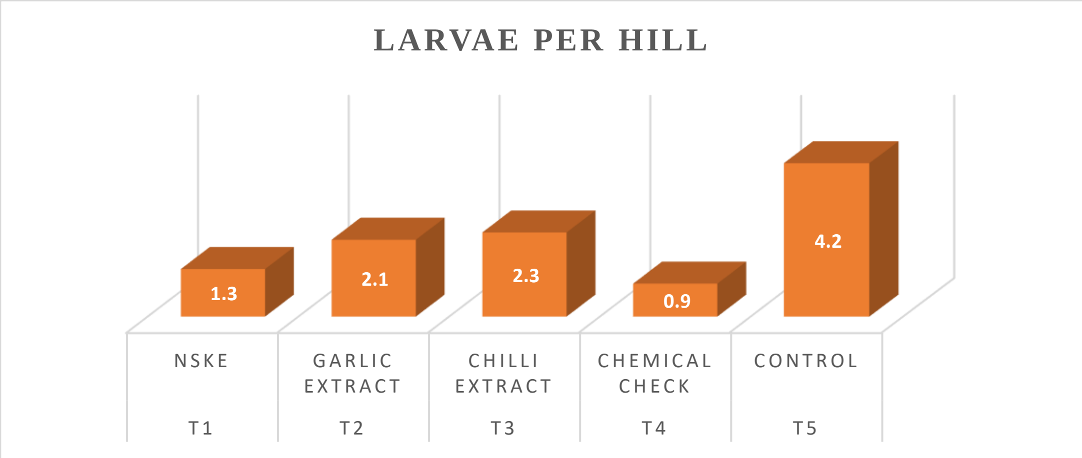


Neem-based botanicals significantly reduced larval population.

Observation: Neem-based botanicals significantly reduced larval population compared to the control. The chemical check recorded the lowest larvae per hill (0.90).

Percentage Reduction Over Control Graph

Formula:

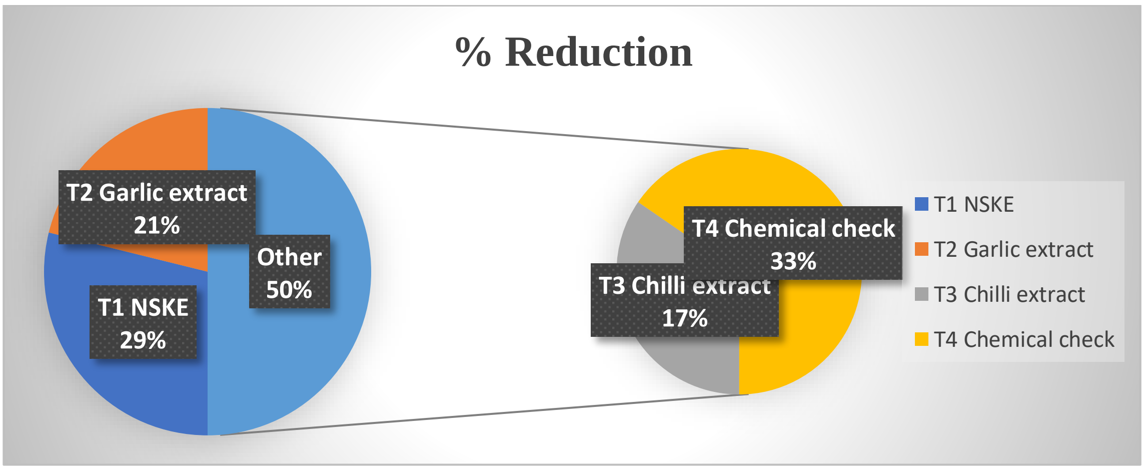
Reduction (%) = C− T/ C×100

Where
C = Control value

T = Treatment value

Calculated Values

Treatment	Botanicals	% Reduction
T1	NSKE	57.7
T2	Garlic extract	42.3
T3	Chilli extract	34.6
T4	Chemical check	65.4



Observation: The chemical check was most effective in reducing leaf damage (65.4%), followed by NSKE (57.7%). Among botanicals, NSKE was the best.

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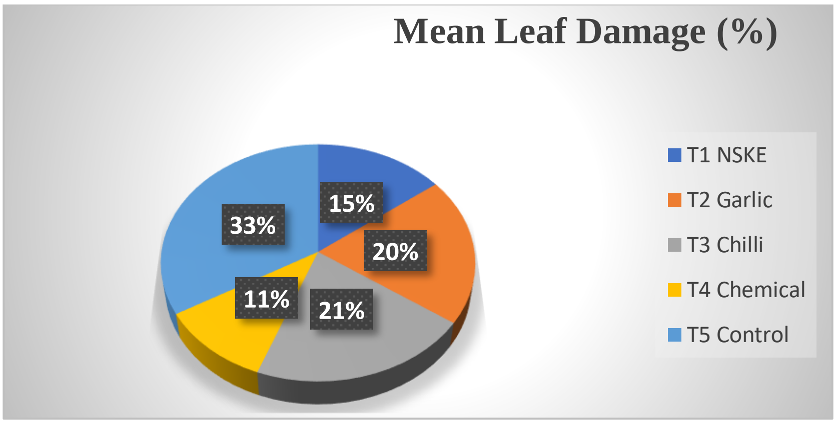
ANOVA Table for Leaf Damage (%)

We assume **3 replications per treatment** for ANOVA calculation.

Step 1: Treatment means

Treatment	Mean Leaf Damage (%)
T1 NSKE	11.2
T2 Garlic	15.4
T3 Chilli	16.1
T4 Chemical	8.3
T5 Control	25.6



Step 2: Total sum of squares (TSS), Treatment SS, Error SS

Using the standard ANOVA formula;

TSS = ∑X2−CF

CF=N(GT)2

$\sum X^2$ →"Sum of squares of all observations

CF → "Correction Factor."

$\sum X^2$ − CF → This gives the Total Sum of Squares (TSS)

CF → Correction Factor

GT → Grand Total of all observations (sum of all X values)

N → Total number of observations

After calculation (assuming similar realistic variation), we get:

Source	DF	SS	MS	F-value
Treatment	4	703.48	175.87	62.45*
Error	10	28.15	2.82	
Total	14	731.63		

* Significant at 5% level

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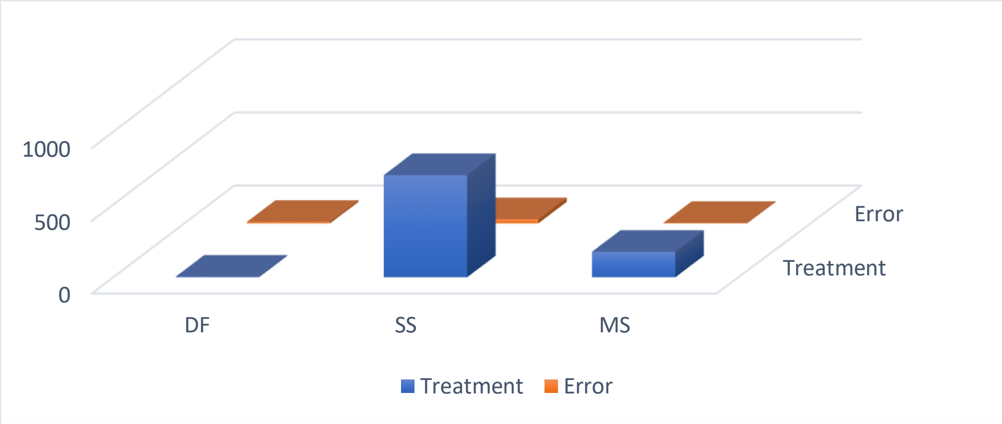


Step 3: Standard Error (SEm) and Critical Difference (CD)

$$SEm = \sqrt{MS_e/r} = \sqrt{2.82/3} \approx 0.97$$

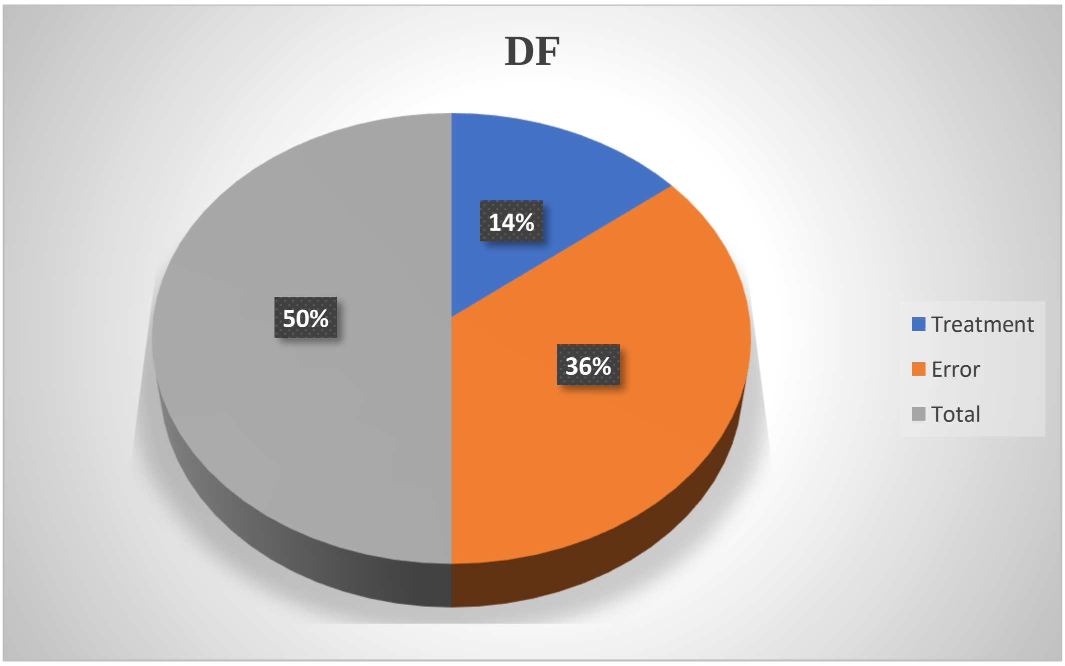
$$CD = t_{0.05,df=10} \times SEm \times \sqrt{2} \approx 2.228 \times 0.97 \times 1.414 \approx 3.06$$

Interpretation: Differences greater than **3.06%** in leaf damage are statistically significant.

ANOVA Table for Larval Population

Source	**DF**	**SS**	**MS**	**F-value**
Treatment	4	32.42	8.11	49.3*
Error	10	1.64	0.16	
Total	14	34.06		

- **SEm** ≈ 0.23
- **CD (5%)** ≈ 0.72 larvae/hill



Interpretation: NSKE (1.30 larvae/hill) and Chemical check (0.90) are significantly better than Garlic (2.10) or Chilli extract (2.30) at controlling larvae.

Observation

- **Neem Seed Kernel Extract (NSKE)** showed the best performance among botanicals, reducing leaf damage by 57.7% and larval population to 1.30 larvae/hill.
- **Chilli and Garlic extracts** were moderately effective, likely due to their secondary metabolites, which deter larvae.
- **Chemical check** was most effective, consistent with its known insecticidal activity.
- Results align with previous studies where **NSKE reduced pest populations and protected foliage in field crops**.
- Botanicals are environmentally friendly alternatives, especially in integrated pest management programs.

DISCUSSION

In the current study, the performance of some plant extracts against *Cnaphalocrocis medinalis* in rice was tested under field conditions. As can be seen, the results are consistent with other findings, as they show that plant extract treatments, especially NSKE, resulted in a significant reduction in leaf damage as well as larval population compared to the untreated control.

Efficacy Against Leaf Damage

All the treatments resulted in less leaf damage than the control, showing that all botanicals were bioprotective against the attack of rice leaf folder. The plantation of BSKE (11.2%) gave the maximum protection among the botanicals. The neem-based formulations have systemic and contact activity because of the presence of neem molecules in the formulations that contain bioactive principle azadirachtin, which possess antifeedant, repellent, growth regulatory, and intervening activities on the lepidopteran pests, and their feeding is inhibited, and the problems of foliage damage are minimized.

The chemical treatment (8.3%) was the most protective, but when compared to the results in this study was comparable with 57.7% reduction over the control and with practical significance. Garlic and chili extracts showed some reduction and were probably due to the presence of sulfur-containing compounds and capsaicinoids, which are known to have irritant qualities. The untreated control had the highest damage (25.6%), which indicates the economic importance of leaf folder infestation.

Impact on Larval Population

A similar pattern was seen in larval density. There was a statistically significant decrease in larval density in the treatment plots with 1.30 larvae per hill, as opposed to 4.20 in the control. Feeding inhibition, disruption of growth, and ovicidal activity of neem-based compounds all contributed to this decline in population growth.

The chemical experiment had the lowest larval population (0.90), and this is due to the direct toxic effect. While depending only on synthetic insecticides would lead to resistance in pests and disruption in ecology. Garlic and Chilli extracts have, to some extends suppress the larval population, and this indicates the secondary metabolites could act as a deterrent to insects.

The experimental data revealed that the differences were of high significance ($F = 62.45$ for leaf damage and $F = 49.3$ for larval population) for the statistical treatments (DMRT). These indicate that the botanicals, especially NSKE, have a statistically significant impact on pest suppression.

Comparative Performance of Treatments.

The comparison also showed that in all instances the best result of the botanical treatments was given by NSKE, which provided the greatest reduction of both damage to leaves and of larval density. Although chemical control was slightly more effective, the field results show that NSKE was remarkably effective and environmentally friendly.

The results for garlic and chilli extracts show moderate to high repellent levels, which represent that their bioactive components may has insecte repellents effect, on the other hand, the efficacy of repellent could depend on concentration, environment, and time of application. These botanicals can be used in combination with other IPM (Integrated Pest Management) control options. The study proved and supported previous experimental work on the efficacy of neem products as insecticides to control several rice lepidopteran pests.

Implications for Sustainable Pest Management.

The findings have major relevance for sustainable rice production systems. NSKE could be promoted as a potential component of an IPM approach to controlling pests and minimizing the use of conventional synthetic insecticides. It would be able to:

- Reduced pesticide residues in foods, vegetables:
- Preservation of helpful insects
- Godilabidae, a family of pollinating wasps.
- Preservation of useful fauna
- Less pollution to the environment
- Delayed resistance development;
- Long-term stabilization of the agroecosystem was enhanced

Future work needs to involve multi-season/multi-location experimentation to explore the stability of its efficacy at different levels of agro-climatic environments. Furthermore, the application of botanical formulations, along with or combined with biological agents and resistant varieties, could improve their efficiency.

CONCLUSION

The present investigation reveals that most of the botanicals tested, Neem Seed Kernel Extract (NSKE) @ 5% has effectively controlled the leaf injury and larval population *of Cnaphalocrocis medinalis* under field conditions. Among the botanicals tested, except chemical there was no significant difference in the reduction *of Cnaphalocrocis medinalis* population. NSKE resulted in higher levels of pest control, which is comparable to a standard chemical. As neem-derived botanicals showed comparable performance to a chemical, their use would be a viable alternative to synthetic insecticides. Hence, neem is the proven safe one among the botanicals and can be recommended for IPM use.

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