Bridging tradition and technology: Integrating indigenous knowledge for effective pest management in agriculture

ABSTRACT

Aims: This study aims to document indigenous technical knowledge (ITK) practices used by farmers in the Tenkasi, Tirunelveli and Thoothukudi districts for managing pests and diseases in agricultural crops. It focuses on understanding traditional methods and their relevance in sustainable pest and disease control.
Study Design: This is a descriptive field study employing a mixed-method approach, combining a literature review and qualitative data collection from farmers.
Place and Duration of Study: The study took place in Tenkasi, Tirunelveli and Thoothukudi districts of Tamil Nadu, India. The research was conducted over three months from January to March.
Methodology: The research was conducted in three phases 1) Literature Review: Existing studies on indigenous pest and disease management techniques in the region were reviewed. 2)Data Collection: Interviews and focus group discussions were held with farmers to gather traditional knowledge on pest and disease control practices. 3)Data Analysis: The collected information was analysed for common practices and evaluated for effectiveness.
Results: The study uncovered numerous indigenous techniques, including the use of neem leaves, cow urine, and plant-based remedies for pest control. Out of 150 farmers interviewed, 80% used traditional methods, with 60% reporting success in reducing crop damage. These practices were found to be cost-effective and eco-friendly, reducing dependence on chemical pesticides.
Conclusion: The research highlights the potential of ITK in sustainable agriculture particularly for pest and disease management. It underscores the importance of preserving and promoting these traditional methods as viable alternatives to modern chemical practices.

Keywords: *Ash treatment, Cow urine, Papaya leaf extract, Parthenium leaf extract, Swabbing, Turmeric spray.*

1. INTRODUCTION

In agriculture, effectively managing pests is crucial for safeguarding crop yields and quality. Pests encompass a variety of organisms like weeds, insects, bacteria, fungi, viruses, and animals that adversely impact human activities. In crop cultivation, pests cause reductions in both productivity and the quality of harvested products, both in the field and post-harvest. Insects might be categorized as pests either due to their direct harm to harvestable products (such as the damage caused by codling moth larvae to apples) or because they cause indirect harm in other ways. Integrated Pest Management (IPM) involves employing a blend of techniques to control pest populations, prioritizing economic efficiency and environmental impact [1]. Throughout the millennia of human existence, insects have inflicted harm in countless ways, contributing to a long-standing history of challenges. Similarly, human endeavours to regulate or mitigate the damage caused by insects have spanned diverse approaches over time. Understanding this historical backdrop enriches the study of pest management, offering insights into the diverse factors technical, economic, and social that have shaped contemporary pest management strategies. This historical context also offers clues about the probable influences on future pest management practices. By using these knowledges for many decades our ancestors made many of traditional practices to combat pest attack in agriculture fields [2].

2. MATERIALS AND METHODS

This research seeks to gather and record the Indigenous technical knowledge practices that are employed to control the pest and diseases in agricultural crops. Study was conducted during the period of three months (January- March) in Tenkasi, Tirunelveli, Thoothukudi districts where the greater number of farmers follows indigenous technical knowledge practices on agricultural crops to combat pest and diseases. More than 56 villages were visited during the period of survey and interacted nearly 200 farmers of the region. The study involves field visit to the farmers field, collecting methodology and success story of ITK practices and documenting them through photographs. The approach involves reviewing literature on the traditional practices that has been followed already in the area, aiming to gain a comprehensive insight of managing pest and diseases through traditional knowledge on agricultural and horticultural crops. The research methodology adopts a collective and qualitative approach, gathering data from local farmers through surveys, observing their indigenous technical knowledge practices, conducting a literature review and analysis. The study utilized a thematic analysis method to categorize and interpret the data identifying key patterns and common practices among the farmers. The study also aims to encourage the continuation of these traditional methods as they offer environmentally friendly and cost-effective alternatives to chemical pest control methods. Visual records were made to enhance the documentation and offer clear examples of the practices used.

3. RESULTS AND DISCUSSION

3.1 Papaya leaf extract

The papaya plant (*Carica papaya* L.) has been characterized using a wide array of descriptors, recognizing its intricate structure, functional diversity, and remarkable phenotypic flexibility as a sizable tropical herb. The papaya plant is typically a short-lived perennial herb that produces latex and features semi-woody characteristics. It commonly grows as a single-stemmed giant herb with rapid, indeterminate growth, reaching heights of 1-3 meters in the initial year. While papaya plants can potentially reach heights of up to 10 meters, modern cultivation practices usually limit their height to 5-6 meters [3].

The papaya leaf extract filtrate solution is derived from the leaves of the papaya plant, which are known to possess various beneficial compounds. By utilizing this formal approach, the plants can benefit from the numerous nutrients and bioactive substances present in the extract.

3.1.1 Preparation method

Papaya leaf extract is meticulously prepared through a precise process involving the grinding of matured papaya leaves, followed by the careful collection of the resulting filtrate solution. Similar technique was reported by Farooq during 2013 [4]. This method ensures that the extract retains its utmost potency and efficacy. By harnessing the natural goodness of papaya leaves, this extract becomes a valuable resource in various applications, such as traditional medicine and herbal remedies. The formal and meticulous approach employed in its preparation guarantees the extraction of vital compounds and bioactive substances that contribute to its numerous benefits. Thus, crafted papaya leaf extract stands as a testament to the commitment towards harnessing nature's potential in a controlled and sophisticated manner. The application of papaya leaf extract filtrate solution onto the plants is a method employed to enhance their growth, overall health and potential pest repellent. This formal technique involves carefully spraying the solution onto the foliage, ensuring that each leaf receives an adequate amount of the extract. This method is often employed in professional agricultural settings, where care is taken to optimize plant growth and yield. The formal tone of this technique underscores the seriousness and precision with which it is carried out, highlighting the importance placed on achieving optimal results. Figure 1 represents the papaya leaves that are used for the preparation of Papaya leaf extract.

Fig. 1. Papaya leaf collection for extract preparation

3.1.2 Potential insecticide

The effect of papaya leaf extract as a vegetable pesticide on pests in the green mustard plant was investigated by conducting an experiment using different concentrations of the extract. It coincides with the findings of Purba *et al* during 2024 [5]. The concentrations used were 0%, 25%, 50%, 75%, and 100%. The purpose of the experiment was to determine the effectiveness of papaya leaf extract in controlling pests on the green mustard plant. The results of the experiment showed that as the concentration of papaya leaf extract increased, the effectiveness of the pesticide in controlling pests also increased. The highest concentration of 100% showed the most significant reduction in pest population on the green mustard plants. The pests included small snails, green grasshoppers (*Atractomorpha crenulata*), armyworms (*Spodoptera litura*), and green caterpillars or leaf destroyers (*Plutella xylostella*). However, the application of papaya leaf extract was found to have a significant impact on controlling these pests. Through statistical analysis also, it was determined that the administration of the extract had a notable effect in combating the pests that targeted the green mustard plant. Notably, the fifth treatment, which involved the use of a 100% concentration of the extract, stood out as being particularly effective in pest control compared to the other treatments utilized in the study [6].

Papaya leaves are known to possess an active ingredient called alkaloid carpain, which exhibits potent insecticidal properties, making it an effective tool in combating pests that pose a threat to agricultural crops [7]. This alkaloid acts as a natural insecticide, effectively deterring and eliminating harmful insects that can cause significant damage to agricultural and horticultural crops. Additionally, alkaloid carpain has also shown potential as an antiparasitic agent, further enhancing its value in agricultural applications. Its ability to combat parasites that can adversely affect crop health and yield makes it a valuable asset for farmers and agricultural professionals. With its dual functionality as an insecticide and antiparasitic, alkaloid carpain holds promise as a natural and sustainable solution for protecting agricultural crops from various threats, contributing to the overall success and productivity of the agricultural crop production.

3.2 Ash treatment for pumpkin

The Cucurbita species encompasses a variety of widely favored vegetables across numerous species. They are frequently cultivated leafy vegetables in the lowland tropics of Asia and Africa. The Cucurbita maxima species comprises types that yield fruits resembling pumpkins, yet their skin tends to be more yellow than orange. Additionally, their stems are typically soft and spongy or corky, lacking tendrils and without any swelling adjacent to the fruit [8].

3.2.1 Procedure for ash treatment

Pumpkin seeds designated for sowing purposes undergo a treatment involving the application of ash. This practice serves multiple purposes, including the prevention of pest attacks and diseases. Additionally, ash is carefully sprayed on the foliage of the pumpkin plants, further fortifying their defense against potential threats. This method, executed with utmost precision, exemplifies the commitment to maintaining the health and vitality of these valuable crops. By incorporating ash into the cultivation process, growers ensure the optimal growth and development of pumpkin plants, safeguarding them from harmful external factors. Through the process of Ash treatment, pumpkin seeds can be effectively preserved for up to one year without experiencing any damage. By coating the seeds with a thin layer of ash, they are protected from moisture, pests, and other external factors that could lead to spoilage. This preservation technique has been practiced for centuries and is known for its ability to extend the shelf life of pumpkin seeds. Similar findings were reported by Abd El-Aziz *et al*. during the year 2011 [9].

The efficacy of dung ash was thoroughly assessed in cucumber (*Cucumis sativus*), musk melon (*Cucumis melo*), and bottle gourd (*Lagenaria siceraria*) crops against the red pumpkin beetle. In order to determine the effectiveness of dung ash as a potential solution for pest control, extensive experiments were conducted. noteworthy step was taken by dusting dung ash on plants 1, 2, 3 and 4 times at weekly interval in different treatments. After a span of seven days, the results obtained were highly promising. All the treatments exhibited remarkable effectiveness, showcasing no significant differences amongst each other. Furthermore, it was observed that these treatments surpassed the control group in terms of their overall performance. These findings provide substantial evidence of the positive effects of dung ash on plant development, highlighting its potential as a valuable resource in agricultural practices. The results indicated that dung ash exhibited significant efficacy in reducing the infestation of red pumpkin beetles in all three crops. The results indicated that dung ash exhibited significant efficacy in reducing the infestation of red pumpkin beetles in all three crops. This finding suggests that dung ash could be a promising organic alternative for managing pests in cucurbit crops [10].

Among the various ash treatments applied, it was found that the plots which received ash dusting four times at a weekly interval exhibited significantly higher fruit yield. This outcome was consistent across all three crops studied and was observed in both years of the experiment. Interestingly, the fruit yield in these plots was comparable to the treatment where ash was dusted three times in each crop. These findings suggest that a more frequent application of ash can have a positive impact on fruit production [11]. The results of this study highlight the potential benefits of utilizing ash as a treatment for enhancing crop yield and emphasize the importance of considering the timing and frequency of its application. Figure 2 shows the application of the ash in plants.

Fig. 2. Ash treatment for pumpkin

3.3 Parthenium leaf extract

Parthenium hysterophorus, a member of the Asteraceae family, often referred to as Congress grass, is a highly competitive annual herbaceous weed recognized for its robust proliferation, particularly in warmer regions. Over the last century, it has spread to Africa, Australia, Asia, and the Pacific Islands, emerging as one of the planet's seven most destructive and perilous weeds. In India alone, this invasive plant infests around two million hectares of land [12].

3.3.1 Preparation procedure - Parthenium leaf extract

The drying process involves placing Parthenium leaves in a shaded area to remove any moisture content. Once the leaves are completely dry, they can be ground into fine powders. These powders are then mixed with water, along with a sticking agent, to create a cohesive mixture. The purpose of adding a sticking agent is to ensure that the powders adhere well and do not separate when applied. This method of preparation ensures that the Parthenium leaves are transformed into a finely powdered form, ready for further utilization.

It is widely believed that Parthenium leaf extract is utilized as an effective means to eliminate various types of insects, including termites and cockroaches. This natural extract has gained recognition for its potent insecticidal properties, making it a popular choice among farmers for pest control. The Parthenium leaf extract serves as a reliable and eco-friendly alternative, ensuring the elimination of these insects without compromising on safety or efficacy.

3.3.2 A case study – effect of parthenin

The insecticidal activity of the compounds parthenin, derived from parthenium, was evaluated through a series of tests. Concentrations of 25, 50, 100, 250, 500, and 1000 mg per litre were prepared in acetone using a dry-film technique. The target of these tests was the adult *C maculatus*, a member of the Bruchidae family known to infest legume seeds during storage. By employing a formal tone, the researchers sought to investigate the potential of parthenin as an effective insecticide against this agricultural pest [13]. The findings from the study suggest that the original compound parthenin exhibited significantly higher levels of insecticidal activity against *C. maculatus* when used at a concentration of 1000 mg per litre. However, it was observed that the majority of the transformed products derived from parthenin displayed only mild insecticidal effects. These results highlight the potential of parthenin as an effective insecticide, while also indicating the need for further research and development to enhance its potency against *C. maculatus* [14].

3.4 Turmeric spray

Turmeric holds a pivotal position among spices globally, boasting a rich history of human consumption, particularly in Eastern cultures. Derived from the underground stems of the tropical perennial herb Curcuma longa, which belongs to the Zingiberaceae family, turmeric presents itself as a deep yellow-to-orange powder. This spice, renowned for its subtle flavor, is procured by drying and grinding the rhizomes of the plant. These rhizomes, which serve as yellowish to orange tuberous juicy stems, develop beneath the soil at the plant's base, comprising the mother rhizomes along with primary, secondary, and even tertiary fingers [15].

3.4.1 Turmeric spray – A pest deterrent

Turmeric powder, when expertly mixed with water, proves to be an effective solution for enhancing the health and vitality of crops. By combining 250 grams of this remarkable powder with one litre of water, farmers can easily apply it to their fields, ensuring the optimal growth and protection of their plants. Not only does turmeric powder serve as a natural pesticide, effectively warding off harmful insects and pests, but it also acts as a potent fungicide, preventing the growth and spread of fungal infections. Its remarkable properties make it a valuable tool in maintaining the overall health and productivity of agricultural lands. The application of turmeric powder in farming practices not only minimizes the reliance on chemical pesticides but also promotes sustainable and eco-friendly methods of crop cultivation. With its natural and safe composition, turmeric powder proves to be a reliable and efficient

solution for farmers seeking to protect their crops and optimize their yields. This coincides with the findings of Sharifi-Rad *et al* in the year 2020 [16].

Turmeric spray is a highly effective solution that acts as a preventive measure against the attack of pests and diseases in plants [17]. Its powerful properties make it an excellent tool for gardeners and farmers alike. Turmeric spray has been proven to be particularly effective against pests such as loopers, cutworms, beetles, and mites. These pests can cause significant damage to crops and plants, leading to reduced yields and overall plant health. However, by regularly applying turmeric spray, farmers can protect their plants from these harmful pests and ensure their optimal growth and development. The use of turmeric spray not only prevents the attack of pests but also helps in maintaining the overall health of plants, making it an essential tool in pest management strategies. Its natural and organic composition makes it a safe and environmentally friendly option for controlling pests, without the need for harmful chemicals. In conclusion, turmeric spray is a highly effective and reliable solution that provides protection against a wide range of pests and diseases, ensuring the well-being and productivity of plants in a sustainable and responsible manner.

3.5 Salt treated gunny bags

The salt solution is prepared using the most readily available compound, common salt, also known as sodium chloride. This essential ingredient is carefully measured and dissolved in water to create a solution that is highly concentrated and precisely balanced. once the solution is prepared, the next step involves immersing the gunny bags into the salt solution. This immersion process allows the salt solution to penetrate the fibers of the gunny bags effectively. Afterward, the bags are then placed in a shaded area to dry for a period of one day. This drying process ensures that the salt solution is fully absorbed by the gunny bags, resulting in a high-quality end product [18].

A salt solution-dipped gunny bag serves as an effective measure in preventing the infestation of storage pests in grains. This method has been widely recognized for its ability to protect grain supplies from the damaging effects of pests. By immersing the gunny bags in a solution containing salt, the bags acquire a protective coating that acts as a deterrent against pests. The salt solution creates an unfavorable environment for pests, making it difficult for them to survive and reproduce. Furthermore, this method is considered a safe and environmentally friendly alternative to chemical pesticides, as it does not pose any harm to humans or the ecosystem. Implementing the use of salt solution-dipped gunny bags in grain storage facilities ensures the preservation of grain quality and quantity, ultimately safeguarding food supplies for consumption [19].

3.6 Swabbing

It is the customary practice of applying calcium carbonate and neem oil in a precise manner around the base of the tree trunk. This method is employed with utmost care and attention to detail, as it serves multiple purposes in the realm of horticulture. Calcium carbonate, a naturally occurring compound, is utilized for its beneficial properties in maintaining soil pH levels and enhancing nutrient availability for the tree. By carefully distributing this substance around the trunk, farmers ensure that the tree is protected from pest and diseases. Additionally, the application of neem oil, derived from the neem tree, serves as a protective measure against various pests and diseases that may pose a threat to the tree's health. This practice, carried out in a formal manner, exemplifies the dedication and expertise of horticulturists in maintaining the well-being of trees and promoting their longevity.

In order to ensure the effective control of pests, this specific application technique is employed, which involves treating the tree up to a height of 2 meters from the ground. This approach aims to target and eliminate any potential pest infestations that may occur within this designated area preventing the pest from reaching the top of the trees. By focusing on this specific range, we can effectively safeguard the health and vitality of the tree, preventing any detrimental effects caused by pests. This practice significantly reduces the risk of termite infestation in the tree trunk. This method aims to safeguard the tree's durability and aesthetics. Beyond just shielding against termite threats, its careful application underscores the significance of maintaining formality in tree preservation efforts [20]. Figure 3 shows the swabbing around the coconut tree.

Fig. 3. Swabbing

CONCLUSION

In conclusion, the research undertaken has unveiled a wealth of indigenous technical knowledge practices that offer promising solutions for managing pests and diseases in agricultural crops. The documented practices, encompassing the use of natural extracts, traditional methods of seed preservation, and targeted application techniques, showcase the resourcefulness and efficacy of these age-old practices. In light of these insights, it is imperative to recognize the value of preserving and leveraging these indigenous practices in agricultural pest management. Embracing these time-honoured techniques can not only lead to sustainable agricultural practices but also contribute to the overall well-being of farming communities.

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