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Integrated Pest Management of Crops in India

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Abstract: ***India is an agricultural country. There are different varieties of crops grown in India, like rice, wheat, pulses, several cash crops, different types of fruits and vegetables. Pests are those organisms that cause damage to the crops thereby decreasing the yield. Pests can damage the crops either directly by feeding on the plant tissue that leads to growth retardation in crop plants or indirectly by allowing various viral and bacterial infections. To manage the crop pest interactions, to prevent the loss of yield, to control the use of pesticides, and to conserve the environment, INTEGRATED PEST MANAGEMENT (IPM) strategy was used.***

Keywords: Integrated pest management (IPM), Insecticides, Pesticides, Trap Crops

1. Introduction

India is an agricultural country. Farmers are the backbone of India

There are different varieties of crops grown in India. Rice and wheat are the staple food crops in our country. Other food crops like different types of Pulses, Legumes, Fruits, Vegetables, etc; Commercial crops like cotton, Tobacco, Oilseeds, Tea, coffee, Sugarcane, etc. contribute to major crop production in India. Pests are those organisms that cause damage to the crops thereby decreasing the yield. Pests may be insects, nematodes, molluscus, mites, etc. Pests can damage the crops either directly by feeding on the plant tissue that leads to growth retardation in crop plants or indirectly by allowing various viral and bacterial infections.

Pests cause great damage to the crop yield. About 30 - 35% of the annual crop yield gets wasted because of pests in India. To control the pest the farmers use pesticides (1). Pesticides are chemical or biological agents like viruses, bacteria, or disinfectants that kill pests. The most commonly used pesticides are insecticides to kill insects, fungicides to kill fungi, molds, rodenticides to kill rodents, bactericides to kill bacteria, etc. Pesticides are helpful to kill the pests and increase the yield but on the other hand, these chemical pesticides are very toxic and they are a great loss to the environment. They change the natural biodiversity of the soil thereby decreasing soil fertility. Pesticides are targeted to kill pests but a large percentage of pesticides other than their target end up in the air, water, soil, and even in our food. Pesticides also cause several human health hazards like cancers, reproductive harm, etc. To prevent the loss of yield, to control the use of pesticides and insecticides, and to conserve the environment, INTEGRATED PEST MANAGEMENT (IPM) strategy was used.

1.1 Integrated Pest Management (IPM)

The technique of avoiding or suppressing destroying species of insect pests through the systematic and organized coordination of multiple control strategies is known as **Integrated pest management** (IPM) or **Integrated pest control (IPC**). The multiple regulation methodologies, such as chemical, biochemical, and cultural tactics were used in IPM.

In 1985, the Indian government declared IPM to be a cardinal concept of plant protection. The use of naturally occurring insect pest enemies (parasitoids, predators, and pathogens) in IPM has resulted in the development of new technologies. Trichogramma, Bracons, etc are commercially available and most significant. A variety of plant materials, such as azadirachtin (neem), pyrethrum, tobacco, and others, are also effective biopesticides. More than 160 natural enemies have been analyzed in India for their potential use in combat pest insects. (2)

IPM's key aim is to reduce pesticide use. IPM is a cost - effective technology. IPM relies heavily on the complementarities and interactions of various pest control approaches (chemical, biochemical, cultural, and mechanical), and each of these methods has its own set of advantages and disadvantages. Each variable has its unique characteristics and specifications, which makes IPM a complex technology. Farmers, in general, use components that have an immediate impact that is readily available.

In the sense of IPM, collaborative pest management becomes more relevant. Observance of synchronicity in sowing dates, use of resistant crops, seed rotations, and other management methods are only a few examples. They necessitate close cooperation among farmers to achieve maximum results in integrating pest management.

1.2 Integrated Pest Management in Rice crop

Rice is one of the staple food crops in the Indian agricultural system. Different types of pests attack the rice fields and lead to a decrease in their yield. Gall midge has become a major problem in many areas, and its activity has also spread to the dry season, particularly in coastal areas. Stem borer has become a lethal pest in areas like Punjab and Haryana. Rice hispa, ear - cutting caterpillar, and Gundhi bug which are sporadic pests have been causing significant harm to rice. Brown planthooper, white backed planthooper, Green leafhooper, etc are some of the pests that attack rice crops.

In India, pest outbreaks have triggered major losses in rice production systems in the past. The cost of damage caused by a gall midge outbreak in Kerala's Kuttanad region during the Rabi season in 1996 is estimated to be Rs 6 crores (8). Stem borer, gall midge, planthoppers, and other intermittent

pests have been estimated to cause yield losses ranging from 21 to 51 percent in rice - growing areas throughout the world. So, it is essential to implement appropriate Integrated Pest Management (IPM) strategies, like;

- **Host Plant Resistance:** The most efficient, cost - effective, practical, and simple method of pest control is host plant resistance. The majority of new crops cultivated in pest/disease - prone areas are resistant to at least one insect pest or disease. There are 51 gall midge resistant varieties among the 570 commercial varieties published in India, 25 brown plant hopper resistant varieties, three stem borer, and green leafhopper resistant varieties, and two white backed plant hopper resistant varieties. Many of these pest - resistant varieties have high yields and other favorable agronomic characteristics, and they are widely grown in pest - endemic areas (3).
- **Cultural Control:** Cultural practices are traditional agronomic practices that are used to improve crop production and help to control pests. Insect pests such as yellow stem borer, gall midge, BPH, WBPH, and GLH, as well as blast disease, are often managed by early and synchronous planting, particularly in Kharif. This, however, necessitates community involvement and is often contingent on the availability of water in command areas. Crop rotation is crucial to break the cycle of insect pest buildup and disease. To prevent the stem borer and gall midge from spreading, destroy the stubble as soon as possible after harvesting (6). The cultural practices are simple and offer a lot of potential for future pest management, particularly in rainfed rice, where the application of insecticides and fungicides is limited due to risk and uncertainty.
- **Use of Botanical Pesticides:** Botanical pesticides, especially neem formulations, are a novel approach because they are both safe for humans and the environment. Unlike conventional insecticides, neem formulations incapacitate insect pests by repellency, feeding deterrence, reproductive inhibition, and oviposition deterrent rather than killing them outright.
- **Biological Agents:** The use of biological agents to control crop pests is an important component of IPM. Biological regulation has been projected as a potential alternative to chemical control following the active use of multiple entomophages and entomopathogens. Biological control agents account for about 60% of natural insect control in many crops, including rice, and they must be preserved and conserved by limiting the use of chemical pesticides.
- **Inundative Releases can help with Rice IPM:** Trichogramma spp. (paddy environment adapted strain) can be beneficial in paddy against the stem borer, S. incertulas, rice leaf folder complex, C. medinalis, and Marasmia. Egg parasitoids such as T. japonicum, T. brasiliensis, T. chilonis, and T. exigua have been confirmed to be effective against stem borers when mass multiplied and released in farmer's fields (5).

1.3 Integrated Pest Management in Vegetable Crops

Tomatoes, Brinjal, cabbage, cauliflower, okra, beans, and cucurbits are some of India's most common vegetables. The fragile equilibrium between insect pests and their natural enemies has been disturbed by off - season cultivation of hybrids or improved varieties of plants, vigorous agronomic methods, and indiscriminate use of insecticides. Several IPM techniques were used to control the pests in vegetable crops.

- **Trap Crops:** Two important conventional IPM innovations open to farmers are the use of mustard and marigold as trap crops in cabbage and tomato. Two rows of bold - seeded Indian mustard should be planted after every 25 rows of cabbage, according to a technology established in 1989 (7). The first row of mustard is planted 15 days before the cabbage, and the second row is planted 25 days after the cabbage is planted. More than 80% of cabbage pests are drawn to mustard. In 1992, the use of tall African marigold as a trap crop for the control of *Helicoverpa armigera*, the tomato fruit borer, as illustrated (6). To synchronize flowering in both crops, a 45 - day - old marigold is planted for every 16 rows of tomatoes in this box. Borer eggs are often laid in marigold flowers or flower buds, with just a few eggs laid in tomatoes.
- **Use of Neem Seed Kernel Extract (NSKE) SPRAYS:** NSKE sprays are recommended for all pests on cabbage, cauliflower, tomato, and cucurbits, as well as for serpentine leaf miner on tomato and cucurbits, and stem fly, Ophiomyia phaseoli, on beans. NSKE sprays offered excellent protection overall pests in cabbage and cauliflower, enabling the crop to be cultivated without the use of any insecticides. (6).
- **USE OF NEEM CAKES:** Neem seed cakes are well - known for their ability to control nematodes. Termites, grubs, and other soil - borne insects are also reduced. The cakes are used to control many insect pests in brinjal, okra, cucurbits, and other vegetables. Cakes mode of operation tends to be repellency due to the volatiles in the cakes. During the summer and pre - monsoon months, the influence was also observed to be minimized by increasing temperatures and high wind velocity.

a) **Tomato:** Major pests - *Helicoverpa armigera*
Management - Marigold as a trap crop, use of neem cakes, spraying of NSKE.

b) **Brinjal**: Major pests - Shoot and fruit borer (*Leucinodes orbonalis*), ash weevil (*Myllocerus subfaciatus),* gall midge (*Asphondylia sp.),* leaf - feeding beetle (*Henosepilachna vigintioctopunctata*), leaf hopper (*Amrasca bigutula biguttula*), aphids (*Aphis gossipii*), and red spider mite (*Tetranychus cinnabarinus*).

Management – Use of neem cakes, Use of NSKE sprays.

1.4 Integrated Pest Management in Chickpea and Pigeon pea

The main pulse crops grown in India are chickpea and pigeonpea. These crops cover more than half of the total area under pulses cultivation and account for 60% of total pulse output. Chickpea and Pigeonpea are extremely susceptible to a variety of viruses, insect pests, and nematodes and are weakened from seedling to maturity and in storage (5). The main pest of chickpea and pigeonpea is the gramme pod borer (*Helicoverpa armigera*), while the

pod fly (*Melanagromyza obtusa*) is the second - largest pest of pigeonpea.

With the establishment of the Project Directorate of Pulses in Kanpur in 1979, research on Integrated Pest Control in pulses began. Common approaches for disease and pest control in chickpea and pigeonpea include field rotations, intercropping, broader spacing, restricted use of fungicides, and the occasional planting of resistant varieties. To some level, the use of chemicals, resistant/tolerant varieties, and biological agents, as well as changed cultural practices, can aid in the control of diseases and pests (8).

1.5 Integrated Pest Management in Cotton

Cotton is a cash crop that has a significant economic impact on the Indian farming population. Despite this, it is particularly vulnerable to a range of insect pests. While the pest problem cannot be completely solved, it can be reduced by using an effective pest management technique, such as chemical pest control, ecological pest control, or advanced pest management (IPM). There are several insect pests that affect cotton - like;

- **Aphids (*Aphis gossypii* Glover):** Aphids are commonly found on the roots, terminals, and undersides of leaves, causing them to curl and twist upward. Early in the season, systemic insecticides (Imadacloprid or carbosulfan) added as a seed dresser or at planting time help combat aphids. Other compounds, such as aphidin mist, can also help to reduce its occurrence.
- **Jassid (*Amrasca bigutulla bigutulla* Ishida):** The pest threatens the crop for the first 50 days after sowing, and it is especially bad in the early winter.
- **Thrips (*Thrips tabaci* Lind):** Thrips eat the young leaves and buds of the seed, stunting its development and growth.
- **Whiteflies (*Bemisia tabaci* Genn.):** Whiteflies destroy cotton by sucking sap from the plants and secreting honeydew, which causes sooty mould to form on the lint and stain it. The lint is polluted by sooty mould. The insect assists in the propagation of the leaf curl virus (CLCV).
- **Bollworms:** Cotton bollworm and tobacco budworm are indeed harmful pests of cotton crops.
- Spotted bollworm (*Earias insulana* Boisd. and or *Earias vitella*), Pink bollworm (*Pectinophora gossypiella* Saunders), **American bollworm (***Helicoverpa armigera* Hubner), **Semi - looper (***Anomis flava* Fabricius.), Bacterial blight (*Xanthomonas axonopodis* p. v. *malvacearum*), **Grey mildew (***Ramularia areola* Atk), etc are some other pests that attack the cotton crop and leads to decrease in the yield.

IPM practices were used to control the pests in the Cotton crop.

- **Cultural Practices**: Acid de - linted seed provides resistance against seed - borne diseases. High plant populations, high nitrogen rates, late planting, and excessive rainfall and moisture will all lengthen the fruiting cycle while also directly affecting insect pests, so they must be prevented. Early harvesting without ratooning or stalk removal decreases the food supply for key pests, causing the pest population to remain below the threshold level.
- **Predators and Parasitoids:** The first line of defense against sucking bugs, bollworms, and tobacco budworms is parasites and predators. Coccinellids, spiders, pirate bugs, green lacewing larvae, and parasitic wasps (*Bracon spp. and Encarsia spp*.) are potent inducers, especially in the early and mid - season.
- **Selective and Judicious Use of Insecticides:** Insecticides can only be used after the insect has reached an economic threshold and is uncontrollable. This can be calculated by scouting at least twice a week and setting up pheromone traps in random locations in the fields to collect population densities of both harmful and beneficial insects. Pesticides would be used only where they were absolutely necessary to combat cotton insects, which would not only limit insecticide usage but also avoid the creation of pesticide resistance. It will reduce application costs while also reducing the number of unwanted insecticides in the environment.

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Author Profile

Pallapothula Devi Akilandeshwari received the B. Sc and M. Sc degrees in Botany from Miranda House, the University of Delhi in 2019 and 2021, respectively. During the period of masters and bachelors she presented a poster on Morphogenetic Studies in

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