Agricultural Pest Management

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Amit Kumar

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CHAPTER 1

AN OVERVIEW OF INTEGRATED PEST MANAGEMENT IN INDIAN AGRICULTURE

Amit Kumar, Assistant Professor, Department of Agriculture and Environmental Sciences,
Shobhit University, Gangoh, Uttar Pradesh, India,
Email Id- amit.kumar@shobhituniversity.ac.in

ABSTRACT:

To meet the rising population's demand for food over the next three decades, India must raise foodgrain output by at least 2 million tonnes annually. Agriculture used to produce more through the usage of high yielding seeds, chemical fertilizers, herbicides, and irrigation water, as well as by expanding the area under cultivation. Presently, it appears to be very difficult to increase agricultural productivity by area expansion and the use of current technologies. There is little to no room to cultivate more land because land frontiers are rapidly narrowing. With the widespread adoption of green revolution technologies, the decreasing returns from using more inputs has already begun. A multitude of biotic and abiotic variables continue to limit agricultural production concurrently. For instance, weeds, illnesses, and insect pests all seriously hamper the potential for agricultural productivity. Evidence suggests that pests reduce crop yields of rice by 25%, wheat by 5–10%, pulses by 30%, oilseeds by 35%, sugarcane by 20%, and cotton by 50%.

KEYWORDS:

Adoption, Biopesticides, Pesticide, Technology.

INTRODUCTION

Although the losses cannot be completely eliminated, they can be decreased. Chemical insecticides were mostly used up until recently to reduce production losses. In India, pesticide use rose from 15 g/ha of gross cultivated land in 1955–1956 to 90 g/ha in 1965–1966. Pesticide use surged after the introduction of green revolution technologies in the middle of the 1960s, reaching 266 g/ha in 1975–76 and a peak of 404 g/ha in 1990–91. Although there is a lack of trustworthy time-series data on production losses caused by pests, anecdotal evidence points to an increase in losses. Despite an increase in pesticide use, studies from 1983, 1986, and 1996 still support these findings. The growing pest problem, technological shortcomings with chemical pesticides, and modifications to industrial processes are used to explain the paradox. Nevertheless, since 1990–1991 pesticide use has begun to decline, reaching 265g/ha in 1998–1999, with little impact on agricultural output. The central government's economic strategy and advancements in pest management technology can be held responsible for the downward trend in pesticide use in agriculture during the 1990s. In the 1990s, subsidies for pesticides began to phase out and levies on them were raised. All around the nation, programs were launched to train farmers and extension staff in integrated pest management (IPM). In actuality, IPM was established as a fundamental principle of plant preservation by the Indian government in 1985. Despite these endeavour's, IPM uptake has not been particularly encouraging as biopesticides only account for about 2% of the agrochemical market. This review summarizes the papers that were presented at the workshop and points out technological, socioeconomic, institutional, and policy challenges that are crucial for making IPM effective in real-world settings.

Current Technologies

For application in IPM, research has produced novel methods that exploit parasitise, predators, and pathogens that are naturally existing enemies of insect pests. Trichogrammatid, Bra cons, Crispello crane, Crataegus nondrowsier, Bacillus thuringiensis, Bacillus spherics, Nuclear polyhedrosis viruses (NPV), and Trichoderma are a few significant commercially accessible items. As biopesticides, a variety of plant compounds, including azadirachtin (neem), pyrethrum, nicotine, etc., are also useful. Over 160 natural enemies have been researched in India for use against insect pests, 26 eggs parasitise, 39 larval/nymphal parasitises, 26 predators, and 7 weed species have standardized technologies for reproduction. In collaboration with IPM specialists from the Indian Council of Agricultural Research, State Agricultural Universities, and the State Departments of Agriculture, the Directorate of Plant Protection and Quarantine of the Ministry of Agriculture, Government of India, has developed location-specific IPM packages for both the Kharif and Rabi crops [1]–[3].

Technical Excellence

IPM needs to meet both technological and financial criteria to be successful. IPM's technical viability is determined by two factors: the change in pesticide use and the yield over traditional chemical control. The fundamental objective of IPM is to reduce pesticide use, and this goal has been strongly supported by research in both experimental and field settings. Its impact on yield is uncertain. However, the findings in this study suggests that IPM has a significant yield-saving benefit over chemical control in both food and non-food crops.

Financial viability

Technical viability is a requirement, but it's not enough for a technology to be adopted and commercialized. The net benefits it brings to the producers above traditional technologies are the fundamental prerequisite. The difference in per-hectare net revenue caused by the use of new technology and/or changes in unit costs of production can be used to calculate net benefits. IPM is cited as a technology that is cost-effective in the studies in this volume. The sort of input used in the IPM package, its application rate, and price, however, would determine how much of a net gain there would be. Evidence suggests that even in experimental settings, some technically viable IPM packages end up being economically unfeasible because certain of their elements are more expensive. IPM has the ability to replace chemical pesticides without requiring any extra resources or having a negative impact on agricultural productivity, according to the implication. However, the cost of the inputs is a key factor in determining the economic viability of IPM, and any increase in the cost of essential inputs could have an adverse effect on its economics.

Policy and Socioeconomic Issues

Despite being technologically and economically superior to traditional chemical control, IPM usage is still limited to just 2% of the area treated with plant protection inputs. This estimate is based on the knowledgeable assessments of researchers, extension specialists, and decision-makers. Similar levels of acceptance are also shown by the structure of the agrochemical market; biopesticides account for barely 2% of the agrochemical market in India. IPM adoption on a broad scale may be constrained by a variety of technological, social, economic, institutional, and policy issues [4], [5].

Technology factors play a significant role in adoption decisions

Decisions about technology adoption by farmers are significantly influenced by its features. IPM strongly relies on the interactions and complementarities of several pest management techniques (chemical, biological, cultural, and mechanical), and each of the components has unique properties and application needs. IPM is a sophisticated technique as a result. Farmers typically use ingredients that have an instant impact and are readily available. IPM includes biopesticides as a significant element. The majority of biopesticides have a short shelf life, sluggish rates of action, and are host-specific. In addition, applying some of the components requires more labor than using traditional chemical control. In other words, farmers are risk adverse, and these technical features raise concerns among farmers about their ability to effectively control pests. Due to the intricacy of IPM, stakeholders' researchers, extension specialists, and farmers must take an active role in reducing concerns through participatory/adaptive research trials. The development of broad-spectrum biological insecticides and enhancements to their efficacy and shelf life will be the main challenges that researchers face in the decades to come. Insecticide resistance, resurgence, and secondary pest outbreak issues are not currently recorded in relation to biological alternatives. This trait would require ongoing research to maintain. Chemical pesticides are vulnerable to biopesticides based on predators, parasites, viruses, fungus, etc. This justifies putting more focus on research on creating bio-pesticides that work better with chemical pesticides. It won't be long before genetic engineering for resistance breeding becomes clear. The potential for creating biopesticides through biotechnology is enormous.

DISCUSSION

The extension system's function goes beyond technology transfer. IPM is similar to a new technology and knowledge heavy, in contrast to many other technologies that just need a minimal amount of information and delivery to be adopted. Before the technology is given to the farmers, extension personnel must have a thorough awareness of the technology's properties, its target host and connection with natural enemies, and its mode of application. Its adoption would suffer if any of these were not understood. The farmer should take a more active part in information distribution, with the extension workers acting more as a collaborator, adviser, and facilitator. Both the central and state governments have worked hard to provide training to the extension workers in order to achieve this. An extension worker received an average of three IPM methodology trainings between 1995 and 2000. More than 6200 farmers' field schools were developed to help farmers acquire the necessary skills. However, these efforts did not have a significant impact because just 0.2% of the farmers received training during this time. To hasten the adoption of IPM, the extension system needs to be updated with knowledge of IPM inputs, IPM technique, and timely service delivery to farmers.

Community involvement is essential for IPM success

Pest has traits that make it a bad resource for common property. It is not aware of geographic limitations. In other words, effective pest management requires teamwork. However, most of the time, pest control measures are individualized, leading to a variety of pest control-related issues, including pest resistance, resurgence and secondary outbreaks, and the eradication of beneficial and natural enemies of insect pests. In the context of IPM, collective pest management assumes increased significance. To achieve the highest level of pest control effectiveness, it is necessary for farmers to work closely together on a number of management strategies, including the observance of synchronicity in planting dates, the adoption of resistant varieties, crop rotations, etc. IPM also depends on inputs from live organisms, therefore using other control measures locally, especially chemical pesticides, might have a negative impact on the activities of the biological inputs [6]–[8].

Despite the fact that most farmers may be aware of the advantages of collective action, a variety of socioeconomic constraints deter them from taking part. Researcher conducted an empirical analysis of the variables limiting community involvement and discovered that social heterogeneity (caste disparities) was the primary barrier. Additionally, the farmers using IPM methods were more open to taking part. Therefore, institutional mechanisms that encourage group activity must be developed. Although the present idea behind Farmers' Field School is built on the idea of communal action, it is frequently noticed that either no groups form or, if they do, they disband as soon as the program is discontinued. Local bodies, such as Panchayats, Non-Governmental Organizations, Self-Help Groups, etc. should be encouraged to take on this role. Community participation is crucial to the effective adoption of IPM and needs to be perpetuated by developing a suitable exit policy. Farmers and organisations who use IPM practices should receive incentives and awards.

The sustainability of IPM depends on the availability of biopesticides

As was already mentioned, just 2% of the market for agrochemicals is taken up by biopesticides, despite the fact that many of these chemicals have been created for mass production. Furthermore, the public sector comprises the majority of the production facilities. Their distribution is also. In India, there are about 400 biocontrol laboratories, and the public sector accounts for 70% of them. The majority of laboratories are modest and only serve a limited area's location-specific needs. A lot of land is often grossly cropped each biocontrol laboratory. This demonstrates how unevenly distributed biopesticide production is. Nevertheless, there is a lot of room for the biopesticide industry to grow given the agriculture sector's continental breadth. However, certain technical aspects of bio-pesticides operate as barriers to the entry of the commercial sector.

The majority of bio-pesticides 7 lack a broad spectrum and have a slow onset of action, in contrast to chemical pesticides. Many of these, like Trichogrammatid and Crispello, only have a few weeks to a few months of shelf life. Therefore, there are risks involved in producing biopesticides. Uncertain demand and a lack of adequate infrastructure for marketing, storage, and transportation are additional barriers to the growth of the biopesticide business. Young adults in rural areas who are educated and unemployed should be urged to start small-scale biopesticide production facilities at the village or block level. The production of biopesticides would be boosted by policies including entrepreneurship training, institutional finance, subsidies, insurance against low input offtake due to low pest infestation, and tax and duty exemptions. Additionally, there are stringent registration and quality control requirements for biopesticide manufacturing facilities. Potential business owners are put off by the time-consuming and expensive registration process. Although without compromising on quality standards, registration restrictions should be reduced in light of the significance that biopesticides play in ecological conservation and human health safety.

IPM adoption will increase with the enforcement of pesticide regulations

In light of their detrimental impacts on the environment and public health, the central government has outlawed the use of a number of pesticides in agriculture. Despite this, there are a lot of these on the market. For instance, DDT and BHC are often used in agriculture and are approved for use in the fight against malaria. Furthermore, Indian farmers have access to a variety of pesticides that have been outlawed in other parts of the world. Farmers are encouraged to use these insecticides by their lower prices. Due to lax enforcement of rules and/or regulatory loopholes, a variety of fake pesticides are sold on the market. Farmers would gain from strict enforcement of the laws governing the manufacturing, usage, distribution, and quality of pesticides by removing fraudulent actors from the industry [9].

Farmers switching to IPM will be encouraged by financial incentives

The cost of a technology plays a significant role in farmers' adoption decisions. Currently, the public sector supplies the majority of the biopesticides, frequently at discounted rates through IPM programs. According to the facts, figure 1, IPM adoption has a few advantages over traditional chemical pest control. The economics of IPM would be thrown off if the cost of biopesticides rose or if subsidies were removed. Since biopesticides have significant positive social and environmental effects, the government ought to consider placing them in the "green box" to qualify for subsidies. In addition, all incentives or subsidies for synthetic pesticides should be discontinued at the same time, with the savings going toward IPM promotion.

Figure 1: Farmers switching to IPM.

IPM may spread more quickly if agricultural loans and insurance are linked to it. Another option is to employ fiscal tools like taxes, excise duties, sales taxes, etc. on intermediate inputs and final output to make the manufacturing and use of chemical pesticides unappealing. The early 1990s saw a fall in pesticide use as a result of the sector being subjected to high taxation. It's possible that the pesticide industry, which has built a sizable market over the past three decades, may fight the move to produce safer pesticides and biopesticides. Farmers would transition to IPM if subsidies for chemical pesticides were removed and instead directed toward the development and use of biopesticides, as well as if institutional credit and insurance were linked to IPM adoption [10]–[12].

The creation of a market for items free of pesticides is essential

Economic inducements might not last for very long. As an alternative, markets for food with little to no pesticide residue can be developed by educating consumers about the advantages of such produce for their health. In India, there aren't any upscale marketplaces or organic food standards yet. Even if farmers are eager to embrace IPM, they might not because there is a chance that there will be a shortfall in output in the short term. Pesticide-free products are becoming more popular in industrialized nations, where they command higher prices. However, India is poor in this. To win the trust of the consumer, this would necessitate more than just the development of certification processes and libelling systems. For a single farmer, certification comes at a considerable expense. If a collaborative approach is used, the cost can be reduced significantly. IPM adoption will increase with the development of easy, affordable certification and labelling systems that allow farmers to create pesticide-free goods and win customer confidence.

CONCLUSION

India has successfully decreased its use of pesticides without having a negative impact on agricultural productivity. This was made possible by suitable policies that promoted the use of IPM and opposed the use of pesticides. Despite this, IPM adoption is minimal because of a variety of socioeconomic, institutional, and legislative barriers. The main barriers to greater IPM deployment on the supply side are the lack of commercial biopesticide availability and inadequate institutional technology transfer mechanisms. Economic incentives must be used to increase the small role that the private sector now plays in the manufacturing and sale of biopesticides. Although farmers are aware of the technological shortcomings of pesticides in controlling pests and their detrimental effects on the environment and human health, the risk of pests is still too great for them to try out newer pest management techniques. IPM is a complicated process, and farmers lack knowledge of how to apply new technological components as well as the biological processes of pests and their predators. The adoption of IPM is significantly influenced by the farming community's socioeconomic context. Several IPM techniques are most effective when used synchronously and by the entire community. Without proving the advantages of a group approach, as well as providing the farmers with outside incentive and assistance, this is unlikely to occur. Even though the community approach is the foundation of many technological programs, the group approach is not properly supported by their lack of an exit strategy. Incentives for farmers to adopt IPM as a fundamental principle of plant protection should also be included in the IPM policy.

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CHAPTER 2

UTILIZING INTEGRATED PEST MANAGEMENT IN AGRICULTURE

Amit Kumar, Assistant Professor, Department of Agriculture and Environmental Sciences,
Shobhit University, Gangoh, Uttar Pradesh, India,
Email Id- amit.kumar@shobhituniversity.ac.in

ABSTRACT:

India's population, which has been increasing at a rate of 1.8 percent per year, is anticipated to reach 1.3 billion people. At this rate of population growth, the nation will need an extra 2 million tonnes of foodgrain each year. Although India has become self-sufficient in the production of foodgrains in recent decades, concerns about food security will continue to exist because there is little room to cultivate additional land, the agricultural production technology is beginning to show its age, and the natural production resource base is degrading. Despite these facts, the extra production needs to come from productivity gains that don't compromise agriculture's ecological roots. This explains the requirement for the development and spread of innovative technologies that generate enough food while safeguarding the environment and public health. In the 21st century, agriculture production systems must be built on the appropriate application of biotechnology, information technology, and ecotechnology, according to eminent agricultural scientist M.S. Swaminathan (1999). One such technology is integrated pest management (IPM). This essay presents an overview of IPM research and development in India and a look ahead.

KEYWORDS:

Agricultural, Crops, Management, Pesticides.

INTRODUCTION

Weeds, illnesses, and insect pests are the main obstacles to increased agricultural productivity. An estimated 26% of the potential food supply is consumed by herbivorous insects. Insecticide resistance issues, secondary pest outbreaks, and resurgence all raise the price of plant protection. In India, annual crop losses from insect pests and disease are thought to account for 18% of agricultural output. Particular bugs may cause higher losses. In cotton, Chelicera spp. can result in losses of up to 50%. Raheja and Tewari estimate that the H. armiger (American bollworm) alone results in an annual loss of almost Rs. 1000 crores. Over time, there has been a rising tendency in the production losses. According to Krishnamurthy Rao and Murthy (1983), insect pest losses were estimated to be about Rs 6,000 crores in 1983 that figure had risen to Rs 20,000 crores, and by 1996, it had reached Rs 29,000 crores. Due to the modifications in cropping patterns and the use of intensive agricultural techniques, new pests have emerged.

Evolutionary Trends in Pest Management Using Chemicals

Farmers used only cultural measures to control pests up until the turn of the 20th century, including crop rotation, healthy crop variety, modification of sowing dates, etc. The advent of arsenical and copper-based insecticides in the 1870s marked the beginning of pest management, but it wasn't until World War II that the pesticidal characteristics of DDT were discovered, revolutionizing the field. DDT was largely safe for people, animals, and plants while being effective against practically all insect species. Because it was less expensive and still effective at low application rates, Indian businesses also joined the race. Farmers were astounded by its efficacy and began using it more frequently, especially during the green revolution era. The pesticide industry quickly increased its research on synthetic organic insecticides as well as on other compounds that control pests as a result of the increase in demand. However, shortly after DDT was introduced, harmful side effects of chemical pesticides began to surface. The use of more recently created, harmful insecticides like pyrethroids and organophosphates (OP) by producers led to the emergence of resistant strains. Originally, the majority of pesticides were based on dangerous heavy metals including arsenic, mercury, lead, and copper [1]–[3].

Along with the pests, pesticides frequently kill their natural adversaries. It is challenging to stop restored pest populations from growing to greater and more dangerous levels and frequently acquiring resistance to chemical pesticides once natural foes have been eradicated. Only 13 pesticide applications made repeatedly go through this cycle. The benefits of insect control were modest at low yields. However, the usage of pesticides started to spread as yields started to rise. They quickly became known to have harmful impacts on both the environment and human health. In her groundbreaking book "Silent Spring," which was released in 1962, Rachel Carson ignited popular attention about these impacts in the early 1960s. Pesticide use that was indiscriminate, extensive, and ongoing exerted strong selection pressure on the pests' genetic make-up. In a pest population, naturally resistant individuals were able to withstand pesticide attacks, and the survivors could pass on the resistance qualities to their offspring. This led to a substantially higher percentage of pests in the population developing pesticide resistance. There are already 150 plant diseases that are fungicide-resistant and 270 weed species that are resistant to herbicides, according to estimates. More than 500 insect species have developed resistance to pesticides, which is a regular occurrence.

India's Intensive Agriculture and Pesticide Use

Since the early 1970s, the use of pesticides has been rising at a pace of 2.5 percent per year. Currently, the nation produces about 96,000 tonnes of technical grade pesticides, of which two-thirds are used in agriculture (Anonymous, 1997) (Khader Khan, 1996). The adoption of cereal varieties with high yields resulted in a significant increase in agricultural yields. The use of pesticides increased dramatically from 5,700 tonnes in 1960 to 46,195 tonnes in 2000 as a result of maintaining better yields. Although India uses roughly 250g of pesticides per hectare, pesticides are applied carelessly (Dhaliwal and Arora, 1996). Since cotton only makes about 5% of all farmed land, the majority of pesticides used in agriculture are employed to manage its insect pests and diseases. Up to 15-20 rounds of pesticide spraying are applied to cotton from the vegetative stage until it reaches maturity. 3.75kg of pesticides are used to one hectare of cotton, according to estimations [4], [5].

With a 24 percent area share, rice accounts for 17 percent of all pesticide usage. Intensive agriculture was the foundation of India's "Green Revolution," one of the greatest success stories in history with a significant impact on food security. A few high yielding crop varieties have replaced the rich diversity of traditional crop varieties, eroding genetic resources, and inappropriate use of vital inputs like chemical fertilizers and pesticides are just a few of the newer 14 issues brought on by intensive agriculture. Therefore, as agriculture has become more intensive and crop genetic homogeneity has increased, so too have insect pests, illnesses, nematodes, and weeds. The pests that were once unique have evolved into the main pests harming a variety of crops.

The growing use of pesticides in intensive agriculture, especially throughout the years of the green revolution, is one striking aspect. Insecticides accounted for 80% of the chemical pesticides used in agriculture up to 1995–1996. Fungicides came in at 10% and herbicides at 7%. Following that, the share of insecticides decreased while the shares of herbicides and fungicides increased at the same time. In 1999–2000, insecticides made up 60% of the market, followed by fungicides at 21% and herbicides at 14%. Although the number of pesticides used per hectare has significantly decreased, the number of pesticides used on various crops varies significantly. Since the early 1990s, the number of insecticides used per acre has decreased. This is undoubtedly attributable to growing awareness of environmental issues and IPM measures implemented by various state governments. The usage of pesticides and its trend vary significantly by area. Prior to state government measures, Andhra Pradesh, Karnataka, and Gujarat accounted for the majority of the nation's pesticide consumption, but this has significantly decreased. According to recent figures, the main consumers are Uttar Pradesh, Punjab, and Haryana. Figure 1 Per ha pesticide use in India.

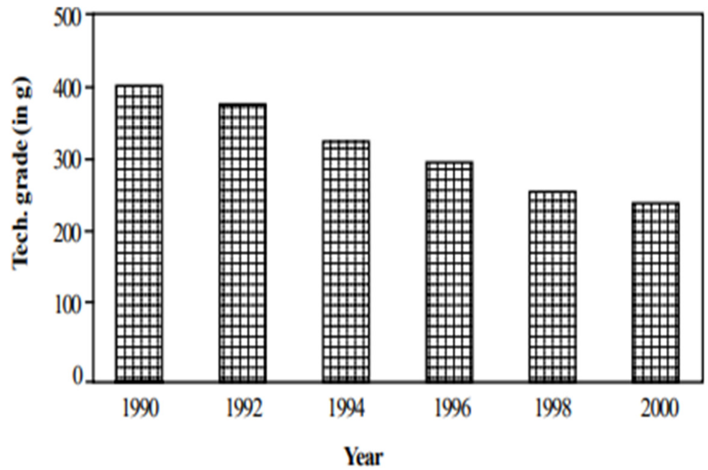

Figure 1: Per ha pesticide use in India.

DISCUSSION

Implementing Integrated Pest Management (IPM), which integrates the use of several pest control tactics (cultural, resistant cultivars, biological, and chemical control), is the answer to the problem of pesticide externalities. IPM involves knowledge of the dynamics of the pests, which makes it more difficult for producers to execute. Table 1. Major crops' pesticide usage, 1993–1994 Crop (%) Cropped area Use of pesticides (%) 54 Cotton 17 vegetables and fruits and 24 rice Sugarcane 2 8 Other 2 3 Plantation crops 3 13 Source: 1997, anonymous Table 2 shows total pesticide use by state in 2000. Total State Consumption (tonnes) % Gujarat 3646 7.90 Maharashtra 3614 7.83 West Bengal 3370 7.30 Uttar Pradesh 7459 16.15 Punjab 6972 15.10 Haryana 5025 10.88 Andhra Pradesh 4054 8.78 Tamil Nadu 1685 3.65 Karnataka 2484 5.38 Source: 2001 data from the Directorate of Plant Protection, Quarantine, and Storage 16 in addition to widespread producer cooperation for efficient execution. There were fewer IPM technologies available for field use in the 1960s when IPM started to be pushed as a pest management technique.

Research in the 1970s produced some cutting-edge goods and information for IPM implementation in crops like rice, cotton, sugarcane, and vegetables. However, it was not possible to satisfy the overly optimistic assumptions that IPM adoption would result in a major reduction in pesticide use without a sizable decline in agricultural yields. The goal of integrated pest management (IPM), which is ecologically oriented, is to eliminate pests over the long-term using a variety of methods, including biological control, habitat alteration, altered agronomic practices, and the adoption of resistant cultivars. Even if a particular approach is a crucial component of the IPM system, using it to control a single organism does not constitute IPM. The best chance of maintaining long-term crop protection is through the integration of numerous insect suppression approaches. Only when monitoring and scouting data suggest that pesticides are required to avert economic harm can they be used to eradicate or prevent the target organism. Pest management methods, such as the use of pesticides, are carefully chosen and implemented to reduce risks to the environment, beneficial and non-target creatures, and human health. Sustainability in the context of crop protection refers to the replacement of capital and pesticides with farm-grown biological inputs and knowledge with the goal of lowering production costs without lowering yields (Swaminathan, 1995) [6]–[8].

Agriculture has made significant strides recently, and sustainability builds on those successes by using a smart strategy that may maintain high yields and farm profits without depleting the resources. Based on human objectives and knowledge of the long-term effects of human activity on the environment and other animals, sustainable agriculture is a reality. This way of thinking blends the use of past knowledge with the most recent scientific discoveries to develop integrated, resource-conserving, fair farming systems. The systems approach increases economic viability in the medium and long term, reduces environmental degradation, preserves agricultural productivity, and upholds living quality.

Common sustainable agricultural techniques include: Crop rotations that limit the danger of agricultural pesticides contaminating water, provide alternate sources of soil nitrogen, ameliorate weed, disease, insect, and other pest concerns, and prevent soil erosion are listed as number 17. The application of integrated pest management approaches, including as scouting and monitoring, the use of resistant cultivars, timing of planting, and biological pest controls, can reduce the need for pesticides. Increasing soil and water conservation techniques, mechanical/biological weed control, and the thoughtful application of green manures Making use of inputs, whether natural or synthetic, in a way that doesn't endanger people or the environment seriously.

IPM Monitoring Tools

IPM is built on crop monitoring, which keeps tabs on pests and any possible damage they may do. This information about the state of the crops and pests now is useful for choosing the most effective pest management strategies. In comparison to other monitoring devices like light and sticky traps, pheromone traps offer an advantage. They have demonstrated their value in extensive IPM validations in cotton, basmati rice, chickpea, and pigeon pea due to their selectiveness to certain pests. types resistant to pests the process of breeding for pest resistance is ongoing. Additionally, pests co-evolve with their hosts, particularly plant diseases. Gene transfer technique is therefore helpful in creating cultivars that are resistant to pesticides, plant diseases, and insects. As an illustration, cotton, corn, and potatoes include genetic material from the naturally occurring bacterium Bacillus thuringiensis (Bt), which renders the plant tissues hazardous to insect pests.

The scientific community is awed by its enormous potential for controlling pests, but it is equally worried about the prospect of increasing selection pressure for resistance against it and its consequences on non-target natural species. This possible technology has, however, generated debate due to ethical, scientific, and social issues. 18 Cultural pest management: It consists of agricultural production techniques that reduce the susceptibility of the crop environment to pests. Some cultural approaches for managing pests include crop rotation, fallowing, altering planting and harvesting dates, altering plant and row spacing, and destroying old crop detritus. Important management approaches include the interplanting of various crops, the planting of cover crops, and the planting of plants that produce nectar. Cover crops, which are frequently legume or grass species, stop soil erosion and control weed growth. A cover crop can also be utilized as green manure, which is added to the soil to provide the succeeding crop with nitrogen and organic matter. Some cover crops from the Brassica family can control nematode pests and wilt diseases when they are introduced into the soil. Rye and wheat, when left in the field as residues, effectively reduce weeds by more than 90%. Based on an understanding of the biology and development of the pest, cultural controls are chosen. Controls that are physical or mechanical [9]–[11].

These are based on an understanding of how pests behave. One instance of physical control is digging holes coated with plastic in potato fields to trap Colorado potato bugs that are migrating. In locations where pigeon peas are grown, shaking the plant to get rid of Chelicera larvae is a popular technique. The simplest form of pest control may be hand plucking insects. The bollworm infestation in cotton and chickpea crops has been successfully controlled by installing both live and dead bird perches. Other examples include installing row coverings to shield plants from insects and using mulch to smother weeds. Biological controls: These involve preserving and enhancing the pests' natural predatory insects, parasitise, parasitic nematodes, fungus, and bacteria. Native natural enemy populations are preserved in IPM programs, and non-native agents may be discharged with extreme caution. The most widely used parasitism on a variety of host crops are Trichogrammatid spp. Numerous microorganisms that target and suppress plant infections, including Trichoderma spp., Verticillium spp., Aspergillus spp., Bacillus spp., and Pseudomonas spp., have been used as biological control agents. Chemical safeguards.

When pest populations cannot be controlled by other means, pesticides are employed to keep the numbers below levels that are economically detrimental. Pesticides encompass both the 19 pesticides originating from plants and the synthetic pesticides. Synthetic pesticides are made up of a variety of synthetic compounds. These are quick-acting, simple to use, and reasonably priced. IPM programs should ideally only use pesticides as a last option due of the possible harm they may cause to the environment. The best pesticides are those with minimal side effects on the environment and non-target creatures. Fortunately, new generation pesticides are being created and approved for usage. These chemicals have novel mechanisms of action and little environmental consequences. This category includes pesticides that have a short lifespan or only affect one or a few particular organisms. The idea that most plants can withstand at least some pest damage serves as the foundation for economic threshold assessment. Despite extensive research, there is still no consensus over the damage thresholds for a range of crops and pest circumstances.

Chemical controls are only used in an IPM program where the economic threshold is known when the pest's ability to cause damage is getting close to it, even while other alternative management measures are being used. Different methods can be used to create botanical insecticides. They can be as straightforward as unprocessed, crushed plant leaves, plant extracts, and compounds made with only the best plant materials. Botanicals include, among others, pyrethrum, neem, tobbaco, garlic, and pongamia compositions. Some plants have broad-spectrum insecticide properties. Because of their rapid degradation, botanicals tend to be less damaging to the environment. They are easier to move safely. The main benefit is that farmers themselves may create these on-farm.

Techniques for Implementing IPM

The IPM packages outperform farmers' techniques, according to tests conducted at various research facilities. IPM techniques made it possible to use less chemical sprays. According to Dhaliwal and Arora (1996), the IPM system also caused a three-fold rise in natural enemies and a decrease in insecticide use and environmental degradation. By (i) developing new varieties with built-in resistance, (ii) developing effective methods of pest control through pest surveys and monitoring, and (iii) biologically controlling pests with the aid of conservation and augmentation 20 of natural enemies like parasites, predators, and insect pathogens, a comprehensive strategy for the management of major pests and diseases is possible. Major pests in rice, cotton, legumes, sugarcane, and other crops have been controlled using economically sound integrated pest management systems.

The discharge of biocontrol agents has been successful in controlling the Perilla and top borer of sugarcane, mealy bug of coffee, lepidopterous pests affecting cotton, tobacco, coconut, sugarcane, etc. The invention of mass rearing techniques for biocontrol agents including and nuclear polyhedrosis viruses (NPV) of Heliothids and Spodoptera has been a significant accomplishment. The concept of economic thresholds and the negative externalities of pesticides are both understood by Indian scientists and extension personnel. The State Agricultural Universities and other research institutions receive financial support from the Department of Biotechnology, Government of India, for the development and production of biopesticides and biocontrol agents. In recent years, a number of biopesticide production facilities and clinical plant protection centres have been built and reinforced. As a result, although it has not yet achieved the required level, India is using more biopesticides and biocontrol chemicals.

Less expensive than chemical insecticides are biopesticides. They are not only eco-friendly but also do not run the risk of developing resistance. If a mission-oriented strategy is not used, it appears that the estimations will be challenging to meet. It seems that farmers are just beginning to consider the use of biopesticides and biocontrol agents. Of the 6 lakh villages in the country, just roughly 2500 villages, or 1% of the 143 million hectares of agricultural land, have been covered by IPM. As a result, it's important to create, test, and promote location-specific IPM modules [12], [13].

Major Challenges

Although IPM has been recognized as the most appealing approach for protecting crops from pests, farmer adoption has been rather low. The biggest threat to IPM is the continued dominance of pesticides and their careless use. The following are some of the barriers to its dissemination that must be identified for an effective implementation strategy: Low awareness and innovativeness of extension personnel and target groups Inadequate interaction between research and extension agencies Problem of timely and adequate supply of quality inputs, including biocontrol agents and biopesticides Complexity of IPM vs. simplicity of chemical pesticides The dominant influence of the pesticide industry.

CONCLUSION

There is a growing consensus that industrial farming based on petrochemicals is unsustainable and that ecological approaches to food production need to be developed and promoted. Biotechnology provides a lot of opportunity to do this. The most straightforward and ostensibly eco-friendly substitute for pesticides is to use naturally existing biological methods. Numerous plant species have been shown to have pesticidal and growth-inhibiting capabilities, but the industry has yet to fully utilize these abilities. Farmers are given the management tools they need via holistic planning to efficiently manage biologically complex farming systems. IPM programs need time, money, patience, flexibility, dedication, and both short- and long-term planning to be successful. The research managers must invest time in their own education as well as networking with extension and research staff to talk about farming practices, which differ greatly. This would make it easier to create comprehensive plans. Government policies could be developed to support IPM promotion. The federal and state governments must take the lead in transforming the pest control landscape by implementing legislative, regulatory, and fiscal measures that would reduce the appeal of chemical pest control. The development and promotion of IPM throughout the nation is a priority for the Indian Council of Agricultural Research (ICAR) and the Department of Agricultural Research and Education of the Ministry of Agriculture, Government of India. The ICAR and the Government of India place a high premium on offering secure and efficient solutions to guard against unacceptable losses brought on by weeds, diseases, and insect pests.

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CHAPTER 3

INTEGRATED PEST MANAGEMENT IN RICE IN INDIA STATUS AND PROSPECTS

Amit Kumar, Assistant Professor, Department of Agriculture and Environmental Sciences,
Shobhit University, Gangoh, Uttar Pradesh, India,
Email Id- amit.kumar@shobhituniversity.ac.in

ABSTRACT:

The rice crop persisted for decades with traditional variations having a robust plant type but poor yield before the introduction of the contemporary cultivars in the 1960s. In the past, farmers would cultivate a mosaic of genetically diverse types, which would result in the presence of multiple varieties in the field during the growing season. This, along with little or no fertilizer application, was probably the main factor in keeping insect numbers at a low level. A variety of biotic and abiotic stressors could be handled by these types. Modern high yielding varieties (HYVs), on the other hand, were created and introduced in the middle of the 1960s. With a limited genetic background, one or a few of these kinds began to colonize large areas of land. These types could also be grown in unconventional locations and were photo-insensitive. These responded to fertilizer, so farmers began using higher rates of fertilizers generally, and nitrogen in particular. The microenvironment was altered as a result of these modifications in rice agriculture, which accentuated the difficulties with insect pests and diseases.

KEYWORDS:

Abiotic Stressors, Fertilizer, Natural Pests, Stem.

INTRODUCTION

Leafhoppers, planthoppers, and leaf folders, which were once of little significance, are now considered to be serious pests. The gall midge has developed into a significant issue in many regions and has increased its activity during the dry season, especially in coastal areas. In states like Punjab and Haryana, where it was previously unknown, stem borer has turned into a lethal pest. Periodically, sporadic pests like the gundi insect, ear-cutting caterpillar, and rice hips have caused significant harm to rice. In the coastal regions and the Indo-Gangetic plains, bacterial leaf blight epidemics and rice turgor disease are frequent occurrences. A significant production barrier in irrigated ecosystems has been identified as blast. Many diseases, including leaf scald, sheath rot, false smut, and sheath blight, have gotten worse across the nation. Atwal et al. are only a few examples of the extensive losses in rice production systems that have been caused by insect outbreaks in India in the past.

According to Devi et al, the cost of the damage caused by the gall midge outbreak in the Kutani region of Kerala during the Rabi season of 1996 is estimated to be Rs 6 crores. The cultivation of modern varieties over long distances, the cultivation of varieties lacking resistance to significant pests, the year-round cultivation of rice, the provision of a constant food source for pests, the use of high nitrogen levels, and an increased emphasis on insecticides are just a few of the factors that have contributed to pest outbreaks. The moderate to substantial occurrence of stem borer, gall midge, planthoppers, and other occasional pests in the country's rice-growing regions has been estimated to cause yield losses ranging from 21 to 51 percent. To get beyond the biotic constraints mentioned above, including pests and diseases, and to maximize the yield potential of rice, it is crucial to create effective Integrated Pest Management (IPM) solutions. Since farmers have largely relied on chemical management to manage pests, it is essential to create an all-encompassing approach that is environmentally friendly, economically feasible, and socially acceptable. Table 1 intensity of insect pest problem on rice in various states.

Table 1: Intensity of insect pest problem on rice in various states.

State	Stem borer	Gall midge	Brown plant hopper (BPH)	Green leaf hopper (GLH)	Leaf folder (LF)	White backed plant hopper (WBPH)	Cut worms	Hispa	Gundhi bug
Andhra Pradesh	S	M	S	S	S	M	M	M	L
Assam	M	-	L	L	M	-	M	M	M
Bihar	M	M	-	M	L	L	-	L	L
Gujarat	M	-	-	M	M	L	L	L	L
Haryana	VS	-	-	L	S	S	L	L	L
Himachal Pradesh	M	-	-	L	M	M	-	L	-
Jammu & Kashmir	L	-	-	M	M	L	-	-	L
Karnataka	M	M	M	L	M	M	-	L	L
Kerala	S	S	S	M	M	L	L	L	L
Madhya Pradesh	M	S	M	S	M	M	L	L	L
Maharashtra	S	S	M	L	M	L	L	L	L
Manipur	L	S	-	L	M	-	-	-	L
Meghalaya	L	L	L	L	L	-	-	L	L
Nagaland	L	-	-	L	L	L	-	L	-
Orissa	S	S	M	S	M	L	M	L	L
Pondicherry	S	M	S	M	S	M	L	L	L
Punjab	VS	-	-	L	M	M	-	M	-
Rajasthan	L	-	-	L	L	L	L	-	-
Tamil Nadu	S	M	M	M	S	M	L	M	L
Tripura	L	L	-	L	L	L	L	L	L
Uttar Pradesh	M	L	M	M	M	M	M	L	M
West Bengal	S	M	S	M	M	M	-	M	M

L – Low, M – Moderate, S – Severe, VS – Very Severe

Resistance In Host Plants

The most efficient, cost-effective, and practical method of pest management is host plant resistance. It is also compatible with other insect management strategies. The majority of contemporary varieties that are commonly cultivated in pest- and disease-prone areas are resistant to at least one pest bug or disease. Out of the 570 commercial cultivars made available in India, 51 are resistant to the gall midge, 25 to the brown planthopper, 3 to the stem borer and 2 to the white-backed planthopper. All gall midge-resistant cultivars are biotype 1 resistant; 24 are biotype 2 resistant; 11 are biotype 4 resistant; and 6 are biotype 5 resistant. Eleven resistant donors were used in the development of the brown planthopper resistant cultivars. In the pest endemic areas, many of these resistant varieties are widely planted because they produce a high yield and other desirable agronomic traits Insects and diseases exhibit a wide range of genetic variability to cope with the genetic variety of the host plant, which leads to varying reactions to specific cultivars in different regions.

After comprehensive differential testing over a period of 13 years at 11 field locations in 7 states, three biotypes of gall midge were identified Although these varieties had been widely farmed in this area for more than ten years, the gall midge resistant types Phalguna and Surekha fell victim to the pest's 29 onslaught when the fourth biotype first arrived in 1986 in the north-eastern regions of Andhra Pradesh. comparable information was reported in 1990 from the Vidarbha region of Maharashtra, when it was discovered that the cultivation of resistant varieties like Phalguna had led to the emergence of a population comparable to biotype 4. In Kerala, recent examination of the common differentials revealed the existence of a second biotype. The finding of yet another biotype 6 in Manipur in the late 1990s was made possible by the ongoing testing of host plant differentials. The differentials' reaction pattern can be used to extremely effectively distinguish the gall midge biotype that has been identified so far.

Cultural methods are common agronomic procedures used to boost crop output and, simultaneously, to control pests. These can sometimes be quite effective at stopping the transmission of diseases and the growth of pest insect populations. Among them: Early and synchronous planting frequently prevents the emergence of insect pests including the yellow stem borer, gall midge, BPH, WBPH, and GLH as well as the blast disease, especially in the kharif season. The availability of water in command regions is often a determining factor in this and calls for community response. Application of the recommended amount of nitrogen in two to three splits prevents the accumulation of diseases like blast and bacterial leaf blight as well as insects like the gall midge, leaf folder, BPH, and WBPH. Higher quantities of N fertilizer (> 100 kg/ha) enhance the severity of bacterial leaf blight and lower production in susceptible variety, but not in resistant ones.

Crop rotation is essential to disrupt the progression of a disease cycle or the accumulation of insect pests. Especially in BPH/WBPH endemic areas, providing alleyways of 30 cm width after every 2-3 meters aids in reducing their infestation. Water management includes draining water from the fields when an abundance of planthopper population is anticipated, including stubble destruction shortly after harvesting to limit the spread of the stem borer and gall midge (Krishnaiah, 1995). The cultural techniques are straightforward and have significant potential for future efficient pest management, especially in rainfed rice where there is less opportunity to apply pesticides and fungicides due to increased risk and uncertainty.

DISCUSSION

One of the quickest and most efficient ways to control insect pest populations is chemical treatment. When insect pests suddenly arise in the early or late stages of crop growth, it is frequently the only option. The proper active ingredient, appropriate formulation, and effective administration methods must be based on the biology of the pest and the crop being controlled. For effective and cost-effective pest control, it is also essential to have information of the pest's most vulnerable stage, quantitative data on pest occurrence, and the importance of certain insect populations on yield loss. It is also crucial to comprehend the potential risks that pesticides pose to customers, users, and the environment. Under the coordinated and lead research programs of the Directorate of Rice Research (DRR), Hyderabad, several insecticides, both granules and spray formulations, were assessed for their efficacy against particular pests to identify their dose and range of toxicity [1]–[3].

To manage stem borer and gall midge infestations in the wet nursery, it is standard practice to broadcast carbofuran or pharate granules 10 days after sowing. As an alternative, it has been discovered that soaking sprouted seed in 0.2% chlorpyriphos for three hours before sowing is beneficial against gall midge. It has been suggested to soak seedling roots in 0.2% chlorpyriphos for 12 hours to control insect pests like stem borer and gal midge during the early phases of crop growth. Farmers, however, had trouble putting sowing root dip into practice on a big scale. A different approach that involves applying granular insecticides such carbon furan, quinalphos, or isophase to the nursery at a rate of 1.5 kg i.e., /ha five days before plucking out the seedlings has developed.

Using natural pesticides

Using natural insecticides, especially neem formulations, is an innovative strategy because they are safe for both people and the environment. Neem formulations, in contrast to conventional insecticides, incapacitate insect pests through repellency, feeding deterrence, reproductive suppression, and oviposition deterrence. Neem formulations are relatively efficient against BPH, WBPH, GLH, and leaf folder, according to greenhouse and field research. In addition to chemical control, entomopathogens have suggested that biological control is a possible alternative. It has a significant impact on other significant pests like gall midges and planthoppers, but only offers an adequate remedy for a single or a small number of pest species like yellow stem borer and leaf folder [4], [5].

They have only marginal effectiveness against occasional pests like cutworm, Gandhi insect, and rice hips. Also unlike other crops, the rice ecosystem has shown sporadic success with the employment of biocontrol agents through inundate or inoculative releases (Pathak et al., 1996). Therefore, it is important to emphasize how to maximize the impact of in situ natural enemies as a key component of an IPM program. The biological pest control agents, which must be safeguarded and conserved by avoiding the needless use of chemical pesticides, are responsible for around 60% of the natural control of insects in many crops, including rice. Natural enemies' activity significantly influences the amount of damage inflicted by the principal rice pests (Rao et al., 1983). The majority of the other IPM components work very well with biocontrol agents.

Increased rice IPM with flood releases

Only egg parasitoids, particularly T, have been released as inundate natural enemies in India. juniper and T. chelones, primarily because they may be multiplied in large numbers. Trichogrammatid species are released into the paddy. (Strain adapted to the paddy habitat) may be effective against S. the stem borer. compound of incredulous and rice leaf pages, C. Maras Mia and medicals. discharge of Trichogrammatid spp. in a flood. The Central Biological Control Stations, spread out over the nation and run by the Directorate of Plant Protection, Quarantine and Storage, Government of India, are engaged in the practice of controlling stem borers and leaf folders in rice fields. parasitic oocytes, such as T. Japanesque, T. Brasiliense, and T. the chicons and T. According to Matthew (1983), mass-multiplied exiguous discharged in farmer's fields have proven effective against stem borers. The widespread distribution of the unusual parasite T. According to Gupta et al. (1987), japonicum @ 20,000 per acre was successful in controlling stem borer infestation.

T releases four to nine times. 3.7 to 59.0% less leaf damage from leaf folder was seen in japonicum @ 1,00,000 adults/ha starting from 20 to 38 days after transplanting with a gap of 7–10 days. According to research by Bendor et al. (1994), there was a negative association between leaf damage and the amount of parasitoid releases. Native natural enemies can be employed effectively in pest management, according to studies done in India and overseas (Ridgeway and Vinson, 1976). The preservation of natural enemies is currently receiving more focus. Although it is not calculated, biological management in paddy appears to be primarily by natural control, and when their populations are preserved, some of the natural enemies offer effective pest control. From various rice-growing regions across the nation, a number of natural enemies have been found (Table 8). In Kerala, researchers have examined the prevalence and co-occurrence of natural enemies and phytophagy's in various rice environments (Beevi et al., 2000). The All India Coordinated Rice Improvement Programmers multi-location trials for studies on the effects of natural enemies have shown that stem borer egg parasites Tetrastichous, Telenomus, and Trichogrammatid spp. contrasted to those in need-based protection (NBP) and schedule-based protection (SBP), seem to flourish in the natural biocontrol plots (NBC) with higher parasitism. The parasitism caused by the main parasite, Platy aster coryzas, does not appear to have much of an effect on gall midges in the wild. Schedule-based protection (SBP) in the case of leaf folders occasionally has negative effects on larval parasitism in addition to increasing pest infestation [6]–[8].

Dragon flies, damsel flies, ground beetles, staphyloma's, and ear wigs were also seen at low to moderate levels among the predators, although spiders, mirid bugs, and coccinellids were found to be more prevalent and dominant. Studies have conclusively shown that predator populations were at higher levels in natural biocontrol and need-based application settings and were comparatively undisturbed due to less pesticide use, as compared to that in SBP. However, these investigations demonstrated that SBP led to increased yields. However, the need-based application of pesticides produced larger revenues in terms of net returns. Thus, applying insecticides depending on crop needs is a cost-effective and practical strategy to guarantee improved yield. Additionally, it maintains a pest population at a very low level, which aids in the expansion of populations of natural enemies.

Thus, estimating natural biocontrol in various rice ago-ecosystems and proving the potency of natural enemies would aid in reducing the use of insecticides. When applied carelessly, conventional procedures have contributed to the extinction of some predatory animals and frequently led to outbreaks of pests that were previously managed by their natural enemies. The All India Coordinated Rice Improvement Programmed (AICRIP) multi-location testing has nevertheless shown that some insecticides, such as carbofuran and pharate as well as new granular insecticides, such as cartop and isopodous, are safer to natural enemies than spray formulations of recommended insecticides, such as monostrophe’s, chlorpyriphos, etc. Additionally, recent research suggests that stem borer egg parasites, predatory mirids, and spiders are relatively less vulnerable to traitorhoods and ace hate spray formulations. Neoma, Rakshan, economy, nemoral, and neem gold are among the neem formulations that are safe for use against important natural enemies like water bugs stem borer egg parasitoids.

Biopesticides are used

Another helpful strategy is the use of microbial pesticides like But formulations with endotoxins. They are only effective against insect pests and harmless to humans, as well as to other non-target creatures and the pests' natural adversaries. Some of these formulations have been evaluated, and the results show that they are efficient against stem borer and leaf folder. Some fungi-based infections, such Pandora delphacid against BPH, Beauveria bassinet against rice hispid, etc., have also shown promise.

Pheromones from insects

Yellow stem borer treatment has been found to be successful with the use of sex pheromones. They either mass-trap insects or interfere with mate-to-mate transmission in order to catch and destroy the insect. As part of monitoring, attempts are made to develop "trap capture thresholds" for use as decision-making aids when using insecticides to manage stem borer populations. Under a moderate pest load, mass trapping using 20 sleeve traps/ha each with mg pheromone-impregnated lures helped to minimize the stem borer infestation. The season-long control of stem borer could be achieved by a single application of slow-release pheromones @ 40g a.m./ha within a fortnight of planting through multipoint sources, which would disrupt mating and result in grain yields comparable to plots treated with two sprays of conventional insecticide. 37 According to Krishnaiah et al. (1998), pheromones are anticipated to play a significant role in future IPM methods for rice. Sex pheromones, however, are species-specific and thus useless when two or three insect pests are present at once. Use of cultural traditions along with acceptable and safe insecticides seems to be unavoidable in such circumstances [9]–[11].

Pest Monitoring

The most crucial and essential component of IPM technology is pest surveillance. It entails routine direct measurements of pest or disease presence, population growth, and damage. Typically, sampling 25 plants in 5 clusters along a diagonal line of the plot at intervals of 7–10 days is sufficient to determine the populations of natural enemies, the prevalence of insect pests, and the harm caused by diseases. These serve as the foundation for reaching control decisions when economic thresholds are used as guidance. lists the speculative economic thresholds. Light traps have historically been employed for indirect assessment of the presence or growth of insect pest populations. But pheromone-baited traps have been used successfully for stem borer and leaf folder monitoring.

Implementing IPM on-Farm

IPM implementation on a large scale requires collaboration between government agencies, NGOs, business, and farmers. IPM calls for communal action, hence a cluster technique of choosing communities and farmers in nearby areas must be used. The Directorate of Rice Research (DRR), Hyderabad, Kerala Agricultural University, and the Department of Agriculture, West Bengal oversaw the six Operational Research Projects (ORPs) on IPM for rice that the Indian Council of Agricultural Research (ICAR) started in 1975. The monitoring of insect, parasite, and predator populations, the limited application of pesticides at predetermined intervals to promote the development of natural enemies, the tillage of rice stubble, and the use of early maturing, short-duration resistant types of rice were all IPM components. In Andhra Pradesh, the use of IPM techniques increased the production of rice.

According to Sankaran Kerala reduced the frequency of insecticide spraying from 4-6 to an average of 2. The following idea uses a "prescriptive approach," in which technologies suited to farmers' needs are created in research institutes and given to farmers for use. There are more instances of IPM being successfully implemented in rice in particular districts. However, many of the technologies that academics developed are no longer used since they are no longer relevant to the needs of farmers. For instance, the seedling root dip strategy of using insecticides to prevent early season pests after transplanting was never adopted by farmers. This is mostly because carrying treated seedlings on heads is harmful to human health and the seedling root dip technique is thought to be tedious.

The poor thresh ability and grain quality of many of the cultivars created with BPH resistance prevented them from taking their proper place in farmers' fields. The 'bottom-up' or 'participatory method' is the newest trend in IPM. IPM can therefore be defined as the optimal combination of control strategies that leads to increased yield, profit, and safety for both people and the environment. The goal is to use biological and cultural elements as effectively as possible, including biological control agents and host plant resistance. The goal should be to use pesticides as little as possible in situations where they have been used for a long time. IPM programs can still be created in settings where pesticides have never been utilized by employing alternative suitable control technologies. IPM entails controlling the pest within the framework of the agricultural system while explicitly referencing social, economic, and environmental concerns.

This demonstrates how important it is to comprehend farmers' perspectives, skills, and circumstances in the context of farming systems as a whole, rather than simply the rice crop. IPM therefore entails collaborating with farmers in their fields to develop technologies that are suited to their circumstances. Farmers are able to distinguish between various crop growth phases and insect infestations that are external and alarming. However, they frequently cannot tell apart the harm done by internal feeders. Farmers frequently fail to distinguish between dietary abnormalities and disease symptoms. They frequently overlook plant damage caused by moths, egg masses, and stem borer during the vegetative and heading stages. Very few farmers truly comprehend the role that the common predators, such as spiders, mirid beetles, etc., play. As a result, IPM strategies going forward should be bottom-up and developed in response to farmer needs. Trials carried out under the coordinated programs using the aforementioned strategy had demonstrated that choosing a gall midge or brown planthopper resistant variety followed by need-based application of insecticides against other pests was a useful strategy in areas where these pests were the main issues Insecticide use might be kept to a minimum in the resistant types while yet generating higher net profits. IPM implementation on a broad scale using a farmers' participation method was carried out by DRR in two villages, Mandapaka and Serapeum, as well as IPM verification trials carried out under farmers' circumstances under the coordinated programs.

CONCLUSION

Only when there is a demonstrable need for efficient pest management and it will result in considerable financial gains can farmers adopt new tactics. Only if IPM technologies are applicable to local agronomic and socioeconomic situations can farmers' interest be maintained. Labor-intensive IPM methods should be given less priority if labor is a limited resource. The strategy should involve a variety of stakeholders, including government organizations, academics, extension agents, non-governmental organizations, farmers, etc. It is important to consider both the NGOs' strengths and shortcomings when requesting their participation. Numerous NGOs are inexperienced, small, and lack project and financial management ability. They frequently fail even to test new IPM modules in local settings. Farmers in general, and especially those with little resources, frequently look to local leaders like progressive farmers and educators as mentors. When implementing the latest IPM technologies, their recommendations are given significant weight. IPM as a national policy must have the unequivocal support of the federal and state governments. Pesticide use should be limited if the state or country is pursuing an agricultural program that heavily intensifies production. The pesticide business is a significant participant in the IPM programs. The pesticide dealer's word frequently has the most weight with farmers. Therefore, it is essential that the pesticide sector contribute to the development of IPM programs. IPM must incorporate the process of developing human resources, with a focus on the researchers' ecological studies. It should be seen as a method of sustainable agricultural production rather than just a program. Undergraduate and graduate programs should include courses in applied ecology, with a focus on IPM. The development of curricula for vocational institutes is also necessary.

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CHAPTER 4

INTEGRATED PEST MANAGEMENT TECHNIQUES FOR RICE-FED ECOSYSTEMS THE RAIN

Amit Kumar, Assistant Professor, Department of Agriculture and Environmental Sciences,
Shobhit University, Gangoh, Uttar Pradesh, India,
Email Id- amit.kumar@shobhituniversity.ac.in

ABSTRACT:

In India, 55% of the land is planted with rice, and 30% of the nation's rice is produced using this method. In rainfed rice ecologies, rice yield is constrained by rice tango disease blast, sheath blight, brown plant hopper white backed plant hopper green leaf hopper (glh), and other biotic variables. At various stages of growth, a variety of insect pests and diseases harm the rice crop, causing an annual loss of rice production of roughly 10%, or rs 5,000 crores. The loss can rise to as much as 20% in some years. A brown spot disease outbreak in Bengal in 1943 caused the great Bengal famine, which resulted in the starvation deaths of around 3 million people. In both the pre- and post-semi-dwarf hive eras, leaf and panicle blast was a serious disease in rice grown in upland areas and in hilly places. Following the introduction of hive in the late 1960s, bacterial leaf blight (blb) and rtd emerged as serious issues. Several rice pests' status has recently seen a significant alteration as well. The production of semi-dwarf cultivars and intensive farming are to blame for this. Many once-minor pests are now considered to be serious pests.

KEYWORDS:

Ecosystems, Pests Management, Rainfed, Weed.

INTRODUCTION

Blast, BLB, RTD, sheath blight, fake smut, brown spot, sheath rot, and sheath rot are some of the prevalent diseases at the moment. Insects include the yellow stem borer (YSB), BPH, GLH, gall midge, hispid, leaf folder, and gundi bug. New pathotypes and biotypes have continued to evolve even after resistant cultivars were introduced. The development of pesticide resistance in many pest insects is another difficulty. In recent years, mites and nematodes which were previously unimportant in rainfed ecologies have grown in importance. 10 IPM modules have been created for various rainfed rice growing ecologies and production systems in India, of which 4 are for irrigated rice and 6 are for rainfed rice (Singh and Gangopadhyay, 2000). Each module's pest problem and how it is managed varies depending on the region. the main types of rice grown in each state.

Ecology of Rainfed Upland Rice

There are over 6 million hectares of upland rice. Due to biotic restrictions such root knot nematode, termites, weeds, leaf and panicle blasts, brown spot, gundi insect, and grain discoloration, its production is modest. Pest issues are also made worse by abiotic factors like as dryness, poor soil quality, and acidic highland soils. However, by successfully managing these, upland rice productivity can be increased to 3.0 t/ha. A comprehensive IPM program for upland rice should put an emphasis on weed management using economical techniques. Because weeds serve as alternative hosts for many pests, efficient weed removal also reduces the prevalence of insects and diseases. Such an IPM strategy should be aware of how to control nematodes, weeds, illnesses, and insects in concert with one another lists the IPM strategy created for this ecosystem. Table 1 IPM module for irrigated and ramified rice ecologies and production systems in India.

Table 1: IPM module for irrigated and ramified rice ecologies and production systems in India.

Modules	Ecologies and production system	Area (m ha)	Region*
1.	Irrigated rice, wet season	14.0	H, NW, NE, E, C, S
2.	Irrigated rice, dry season	4.0	E, NE, S
3.	Hybrid rice	0.5	E,S,N
4.	Scented rice	2.0	NW
5.	Upland rice	6.0	H, E, NE, C, W
6.	Rainfed lowland, shallow drought prone	4.0	C, E, NW
7.	Rainfed lowland, shallow favourable	4.0	E, NE, C
8.	Medium-deep waterlogged and flood prone	5.0	E, NE
9.	Deep-water rice	4.0	E, NE
10.	Coastal wetlands	1.0	E, W
	Total	**44.5**	

* H= Hills; NW= North West; E= Eastern; NE= North East; C= Central; S= Southern; W= Western

The ideal rice variety for red and lateritic uplands that are prone to dryness should be weed competitive and disease- and insect-tolerant. Weed competitiveness and disease tolerance are characteristics of the varieties Kalinga III and Vandana. In several upland areas of eastern India, these cultivars have been flourishing. The yield is significantly increased when weeds are controlled using a variety of techniques, such as off-season tillage, correct soil preparation, optimal seed rates, row seeding, delivery of moderate quantities of nitrogen in split applications, and balanced fertilization. Application of herbicides such butachlor, thiogenic, pendimethalin, and but anil, along with hand weeding, aid in the cost-effective management of weeds. Fields with insufficient soil moisture promote the growth of termites and illnesses like brown spot and blast. Bundling of plots and summer poling are two useful in situ moisture conservation techniques. By treating seeds with chlorpyrifos (0.02%), which minimizes termite infestation, which significantly affects plant stand in lateritic soils, termite problems can be efficiently handled.

Need-based applications of dust formulations like monostrophe's 36EC or chlorpyrifos have been found to be effective at controlling the gundi bug. By administering Bavistin as a preventative seed therapy, the blast disease can be managed. It is advised to spray beam 75, Hinson, or Bavistin on the area if the economic threshold level (ETL) has been exceeded. To effectively reduce blast, it has been found useful to use environmentally friendly botanicals such aqueous extracts of bagel leaves (Aegle Mar melas) and Tulsi leaves. We still don't fully understand the interactions between seed treatment, chlorpyrifos, and Bavistin (or other chemicals), and we need more research. Chlorpyrifos seed treatment is successful in regions with root knot nematode infestations. Similar to this, rotating pulse crops like pigeonpox, sesame, green gram, and black gram (urbane) lowers nematode infection. Nematode numbers are also decreased by using neem cake and carbofuran. Based on the requirements specific to the site, the historical context, and the financial efficiency, several approaches may be employed. Research should find common methods with many advantages when creating a holistic bundle.

DISCUSSION

Million hectares of rainfed lowland rice are cultivated in India, a country with a slow adoption of high yielding varieties. Depending on the moisture stress and water depth, this ecosystem can be further split into three main categories: shallow drought prone, shallow advantageous, and medium-deep waterlogged. Root knot nematode, weeds, brown spot, leaf and panicle blasts, sheath 57 rot, and stem borer are the main issues in 4 million hectares of shallow rainfed lowland drought-prone zones. In this environment, land races predominate. However, numerous enhanced cultivars that are chosen from land races, such as Sarri 17, T141, BR 8, BR 34, Sudha, Janaki, and Vaidehi, are also well-liked. In this environment, managing pests includes weeds as a key element. Even though weeds are less of an issue in lowland rice than in upland rice, hand weeding and the use of weedicides for weed control should be judiciously coupled to achieve cost-effective weed control. The developed IPM package is provided [1].

Favourable Rainfed Lowland-Shallow Ecology

This ecology and the irrigated ecology are comparable. Many pests, which are one of the main obstacles to raising rice output, thrive in the warm, humid atmosphere. Therefore, it is crucial to develop appropriate, site-specific pest management solutions that are both financially and environmentally sound. A number of rice pests have recently seen a shift in status. Even while stem borer is still the principal insect issue, other smaller pests and weeds have become more significant. In this ecosystem, improved varieties like Sambha Mahsuri, Pankaj, Savitri, Gayatri, Moti, Pooja, Monohedral, Rajshree, and Ranjit are grown. Its size is roughly 4.0 million acres. The main pests include the gall midge, false smut, leaf folder, hasp, mites, BPH and WBPH, and panicle blasts.

Limited progress has been made in developing genetic resistance to pests such stem borer, bacterial blight, RTD, and sheath blight; for the most part, chemical control is used to address these problems. Inoculative or inundate releases of biocontrol agents, a crucial element of IPM, have had only patchy success. Consequently, it is important to protect natural biocontrol agents in this ecosystem. Recently, it has been discovered that pest monitoring and bulk yellow stem borer trapping utilizing pheromone traps are both effective. For the management of stem borers, a number of cultural measures have been recommended, including glowing following paddy harvest and, in extreme circumstances, burning of stubbles. In the absence of alternative management techniques, it is vital to employ chemicals and botanicals based on need for the management of various pests, therefore numerous compounds and their application techniques have been found. The created IPM package is provided [2]–[5].

Ecology of Coastal Wetlands

Wetlands, or simply a "wetland," is a particular habitat that experiences seasonal or permanent flooding or saturation by water over a period of weeks or months. When there is flooding, anoxic (oxygen-free) processes take over, especially in the soils. Figure 2The peculiar flora of aquatic plants, adapted to the special anoxic hydric soils, is the main property that distinguishes wetlands from terrestrial land formations or water bodies. Wetlands, which are home to a variety of plant and animal species, are among the habitats with the greatest biological diversity. For many areas of the world, methods for evaluating wetland functions, wetland ecological health, and overall wetland status have been established. These techniques have helped preserve wetlands in part by increasing public awareness of the uses some wetlands serve. Built-in wetlands are intended to redirect stormwater runoff and treat industrial and municipal wastewater. A component of water-sensitive urban design may also include constructed wetlands.

Natural wetlands can be found on every continent. Wetlands typically contain freshwater, brackish water, or saltwater. The primary wetland kinds are categorized according to the prevalent vegetation and/or the water source. Swamps, on the other hand, are wetlands where woody vegetation, such as trees and shrubs, predominates (although reed swamps in Europe are dominated by reeds, not trees). For instance, marshes are wetlands where emergent vegetation, such as reeds, cattails, and sedges, predominate.

Figure 2: Coastal Wetlands

Tidal wetlands water from overflowed rivers or lakes, springs, seeps, and fens groundwater discharge out onto the surface and bogs and vernal ponds rainfall or meltwater are a few examples of wetlands classified by their sources of water. Some wetlands are challenging to categorize because they support a variety of plant species and receive water from various sources. The Amazon River basin, the West Siberian Plain, the Pantanal in South America, the Sundarbans in the Ganges-Brahmaputra delta, and other areas are home to some of the largest wetlands on earth. There are several benefits for individuals that wetlands provide. Water purification, groundwater replenishment, shoreline stabilization, storm protection, water storage, flood control, processing of carbon fixation, decomposition, and sequestration processing of other nutrients and pollutants, and support of plants and animals are some of these so-called ecosystem services. Wetlands provide wetland products and serve as biodiversity reservoirs. Wetlands are more impacted by environmental deterioration than any other ecosystem on Earth, according to the UN Millennium Ecosystem Assessment. Depending on the specific wetland, wetlands can be significant sources and sinks of carbon. As a result, they will play a significant role in climate change and must be taken into account in efforts to reduce it. But certain wetlands produce a sizable amount of methane emissions, and some of them also produce nitrous oxide emissions.

During the monsoon season, rice is a significant crop in the coastal areas. Old traditional rice varieties are grown by farmers. Salinity of the soil. IPM deepwater module Pest Name Sol No. Control measures 1. Pests collared stem After harvesting the borer (YSB) deep-water crop in December and January, the ground is flowed. YSB monitoring at 5 pheromone traps per hectare and above ETL bulk trapping at 20 traps per hectare Release T. japonium at 50,000/ha three times while the eggs are incubating Mealybug Spot application of portae @1.0 kg a.i./ha Hsipaw Use phosphamide at a rate of 0.5 kg a.i./ha. illness bacterial Before water builds up in the field, spray foliar leaf blight with cow dung slurry at a rate of 2 kg/litre. When grain discoloration first occurs, apply a foliar spray of dithiane M-45 (1%) or false smut Klaasen @ 2 g/litre. RTD Develop hardy varieties like Sabita (West Bengal) and Durga (Orissa) [6]–[8].

Nematode Ufra: Soak seeds in hot water before planting; sprinkle with arbuscular at 0.04% twice: once at the PI stage and once at the heading stage. Rats and mice Rats are a problem in these locations; the bait is 1% (W/W) zinc phosphide. Salts build up on the soil surface during the dry season in some areas when the groundwater is likewise salty. Insect pests such stem borer, gall midge, and leaf folder, as well as bacterial leaf blight and sheath rot, as well as weeds like wild rice, Chinalco species, Cyperus species, and Spheroplasts species, are frequent. The yield in coastal regions is thus low, averaging 1.5 t/ha on average, which is lower than the national average. A need-based integrated pest control strategy is required for an economical and sustainable yield in coastal salinity settings to address these issues. Plant defines techniques include nursery treatment (carbofuran or portae @ 1.0 kg a.i./ha), seedling root dip (0.02% chlorpyrifos), monitoring and controlling of YSB through sex pheromone traps and troche-cards, seed treatment for sheath rot, control of vector for RTD, and need-based fungicide application. Additionally, integrated weed management techniques including summer ploughing, pre-emergence herbicide application (followed by the use of butachlor @ 1.5-2 kg a.i./ha), and hand weeding 34–40 days following sowing aid in reducing weed growth. Since the field conditions do not allow for fertilizer top dressing [9]–[11].

Specialized terminology

Wetland is defined as "an area of land that is typically saturated with water" in its simplest form. Wetlands, to be more precise, are places where "water covers the soil, or is present either at or near the surface of the soil either all year or for varying periods of time during the year, including during the growing season" Even when a piece of land is wet, it may not necessarily be referred to be a "wetland" if it forms pools of water after a rainstorm. Wetlands are distinct from other water bodies or landforms due to their specific features, like their water level and the kinds of plants that thrive there. In particular, wetlands are defined as having a water table that is at or close to the surface of the land for an amount of time each year that is sufficient to support aquatic vegetation.

A community made up of hydrophytes and hydric soil is a clearer definition

Wetlands are sometimes referred to as ecotones because they serve as a transitional area between dry ground and water. Wetlands are at the interface between truly terrestrial ecosystems and aquatic systems, making them inherently different from each other, yet highly dependent on both." There are agreed-upon subsets of definitions that are used in environmental decision-making to make regulatory and policy judgments.

CONCLUSION

In various Indian states since 1965, over 630 different rice types have been introduced. However, most farmers in rainfed ecosystems cultivate land races or varieties of land races. Pest incidence and management are greatly influenced by the timing of sowing and planting as well as the careful use of fertilizers. To prevent a pest resurgence, pesticides must be used as needed and according to a timetable. It must be incorporated into every module that is suggested for various ecologies. Plant spacing, irrigation from plot to plot, and nitrous fertilizer all have an impact on the prevalence of diseases like BLB. Spraying should be avoided in these situations in order to conserve the natural parasite and predator populations. According to economic analysis, host plant resistance is the most profitable IPM technology. After a disease or insect outbreak, susceptible kinds are wiped out. It is necessary to create numerous host plant kinds that are resistant to worms, diseases, and insects. However, because of the pest's shifting selection pressure, it is also crucial to apply biopesticides based on need and supplement them with biocontrol agents, cultural practices, cow dung, and urine, among other things.

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CHAPTER 5

INTEGRATED PEST MANAGEMENT IN BASMATI RICE

Amit Kumar, Assistant Professor, Department of Agriculture and Environmental Sciences,
Shobhit University, Gangoh, Uttar Pradesh, India,
Email Id- amit.kumar@shobhituniversity.ac.in

ABSTRACT:

The northern states of Uttar Pradesh, Haryana, Punjab, Uttaranchal, Rajasthan, and Jammu & Kashmir are where basmati or fragrant rice is primarily farmed. Due to India's extensive exportation of scented rice, it has become recognized as a commercial crop and commands high prices on both the domestic and international markets. The traditional tall Basmati cultivars produce less grains since they are subjected to heavy nitrogen fertilizer applications. The development of high producing, semi-dwarf varieties like Pusa Basmati-1, Kasturi, and Haryana Basmati is the outcome of research efforts over the past 20 years. None of these types, however, are immune to illnesses and insect pests. IPM, commonly referred to as integrated pest control (IPC), is a multifaceted strategy that combines chemical and non-chemical approaches for effective pest control. Pest population control under the economic injury level (EIL) is the goal of IPM. IPM is described as "the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justifiable and reduce or minimize risks to human health and the environment by all available pest control techniques," by the UN Food and Agriculture Organization.

KEYWORDS:

Aggression, Basmati, Food and Agriculture Organization, Field.

INTRODUCTION

Furthermore, pathogens including sheath blight (Rhizoctonia solan), bacterial leaf blight (Xanthomonas campestris up coryza), blast, and brown spot significantly lower their potential yield. Farmers use pesticidal methods, which are costly and frequently result in pesticide residual issues, to control these pests. Since it is an export-oriented crop, pesticide residues frequently reduce its ability to export. Integrated pest management (IPM) is seen as a workable solution to address these issues. However, there have only been a few attempts to introduce IPM technologies to Basmati producers. The technical and financial viability of IPM in Basmati rice under field settings is examined in this research.

Assessment of the IPM Module an IPM component

Initially assessed between 1994 and 1996 at the Rice Research Station, Kaul (Haryana), of the CCS Haryana Agricultural University, Hisar, a facility run by the National Centre for Integrated Pest Management, New Delhi. The main components of the module were: (i) the release of the parasitoid Trichogrammatid japonicum against the major insect pests LF and YSB; (ii) the use of neem-based pesticides and insecticides as a last resort; (iii) the use of rice husk containing silicon to control blast disease; and (iv) the application of fungicides based on the need. Chemical control was contrasted with this module. Tadanori local, an enhanced Basmati rice type, was used for the studies. For the sake of pest management measures, the prevalence of the illnesses and insect pests was frequently tracked. Standard practices were followed for collecting the pest data. According to the information obtained over the course of the three years about the LF and YSB infestation, IPM and chemical control were both equally efficient at squelching LF and YSB. Blast had the lowest incidence of all the illnesses in IPM plots. This demonstrates silicon's efficacy in reducing blast occurrence. In comparison to the untreated control, the grain yield was higher following IPM and chemical control treatments. Due to decreased expenses, IPM had a slightly greater benefit cost ratio than chemical control, which was marginally higher.

IPM Module Validation in Farmers' Fields The mainly sugarcane-growing region of western Uttar Pradesh is rapidly shifting to paddy. Low sugarcane prices and flooding in low-lying areas next to the Yamuna canal are the main causes of this. These factors make it the perfect place to grow paddy, especially the more lucrative Basmati kind. In and around the western U.P. regions of Baghat, Barau, and Shamli, the transformation is more obvious. Farmers invest a lot of money on chemical control and other plant protection methods in an effort to get higher yields. With this in mind, the NCIPM conducted on-farm trials of IPM in 1997 with Pusa Basmati variety in seven acres, adopting the same agronomical practices that farmers in the area typically follow, with the exception of in IPM plot, application of balanced fertilizers and irrigation schedules were advised. Three different approaches were used: (i) IPM, which relied on observation and monitoring, the release of parasitoids like T. japonicum, and the application of insecticides as a last resort against major insect pests like LF and YSB; (ii) need-based fungicide application against major diseases like blast and sheath blight; and (iii) farmers' practices, which primarily involved the use of pesticides. The trial was repeated in 1998 at seven farms with the same three treatments, with the Pusa Basmati variety occupying around an acre of space under each treatment. Table 1 provides information on interventions made during the treatments for both years.

Table 1 provides information on interventions made during the treatments for both years.

Treatment	Intervention
Kharif 1997	
· IPM	4 Releases of *T. japonicum* @ 100,000 eggs/ha
· Chemical	2 Applications of insecticide (monocrotophos @ 0.05% a.i.) + 1 application of fungcide (carbendazim @ 0.05% a.i.)
· Farmers' practices (FP)	1 Application of insecticide (monocrotophos)
Kharif 1998	
· IPM	Release of *T. japonicum* 4 times on all the farms, spray of fungicide (carbendazim) on farm 4, 5, 6, and 7
· Chemical	Spray of insecticide 2 times and single spray of fungicide
· Farmers' practices (FP)	One spray of different insecticides on farm 1 (chlorpyriphos @ 0.05% a.i., 3 (endosulfan @ 0.07% a.i.), 6 and 7 monocrotophos @ 0.05% a.i.)

Pest activity

The leaf folder (LF) and yellow stem borer (YSB) are the two insect pests that are most prevalent in the area. According to farmers' practices, LF infestation peaked in 1997 at 50 days after transplanting (DAT) (I7.68%), followed by chemical treatment (12.58%). The infestation was significantly (4.61%) decreased by the discharge of T. japonicum in IPM areas. The final observation at 80 DAT showed that the FP plots had the worst LF infestation, followed by the IPM and chemical control plots. At the vegetative stage in all treatments, YSB incidence was only occasional and remained low at 68 for the entire crop season. The virus was barely present throughout the pre-harvest phase as well. Its lowest level was found in IPM regions, proving that T. japonicum significantly impacted YSB.

DISCUSSION

According to disease observations, the symptoms of brown spot disease in 1997 started to show up in the first week of September. Three times, 12 kg/ha of nitrogenous fertilizer was administered to IPM fields, compared to 140 kg/ha for FP and chemical control fields. Sheath blight, a sometimes-destructive disease of rice, was also observed in IPM, FP, and chemical management techniques as well as at the mid-tillering stage of the crop. In IPM, the illness was found in a 2 m2 patch where 67% of the tillers had been positively identified as infected. Daily monitoring revealed no illness progression. The chemical control treatment, however, employed a 69 spray of carbendazim to stop the illness. No field had any indication of the two primary diseases, blast and bacterial leaf blight (BLB), with the exception of leaf blast evidence on a few plants. The most prevalent disease in 1998 was sheath blight, but it persisted in being rare. In chemical control, spraying carbendazim prevented its occurrence. In IPM, a fungicidal spray wasn't necessary. Farmer methods were largely the same. To suppress it, nevertheless, several farmers applied the fungicide.

Grain yield and the economy

In 1997, IPM and chemical control both generated good yields. The lowest yield (43.68 q/ha) was in FP. The economic study showed that IPM and chemical control had the best cost-benefit ratios FP and chemical control farms received their transplants about a week later than IPM fields, which may have contributed to the production discrepancy, despite the fact that IPM significantly decreased pest prevalence. IPM treatment produced higher yields for all farmers compared to chemical control or their own management techniques, per yield data from 1998. Farm 1 had the largest yield, measuring 65.97 q/ha, and Farm 6 came in second with 58.69 q/ha. Farms 1, 2, 5, and 6 had yields that were obviously superior, though. It appears that effective crop management practices, such as wise nitrogen fertilizer application and effective water management, had contributed to a rise in output [1]–[3].

Low to severe lodging was produced in nearly all of the fields during the first week of the season by extremely heavy rains and swift winds. In IPM areas, good water management and fertilizer application decreased lodging because none of these crops had the severe lodging. It can be concluded from the yield data that IPM with certain improved crop management techniques is a better answer than chemical control or farmers' practices because the lodging in these treatments further increased the production levels.

IPM implementation in Shikohpur village

In 1999, a community in the same district called Shikohpur was chosen for thorough IPM validation. The decision to choose this hamlet was influenced by survey findings that showed the farmers in this village were using pesticides carelessly for pest control—some even applying 10–12 sprays of pesticide. Even then, they were helpless to reduce the damage posed by the pests. Most likely, the improper use of pesticides had drastically reduced the beneficial natural fauna of the environment, which may have contributed to the extremely high prevalence of bug pests. A total of 23 farmers owned 100 acres of land in the IPM program in 1999, while another 30 acres were listed as non-IPM. IPM trials on several fields' basmati rice yield (q/ha), Barut, 1998 Chemical Control IPM Farm No. Farmers' techniques 71 farmers had the opportunity to use chemical pesticide at their discretion, which resulted in a decline in output as shown by the following numbers The coverage area of the program was increased to 300 acres in 2000 as a consequence of the farmers in the village's tremendous excitement for embracing IPM. A neighboring village called Saturnus was classified as a non-IPM village. Similar to other villages, farmers in this one mostly grows Pusa Basmati and use pesticides to control pest problems [4]–[6].

Pest problem

The gundi bug, LF, and YSB were the three most common insect pests found. In 1999, YSB incidence was relatively low, both during the vegetative and panicle growth stages. According to records on LF infestation in 1999, IPM had a much lower infection rate at 50 DAT than non-IPM (15.03%) (8.75%). Evidently, the amount of LF infestation was greatly reduced by the discharge of T. japonicum. At 75 DAT, incidence in IPM was 3.90 percent, down from earlier, whereas incidence in non-IPM was 14.45 percent higher. Sheath blight was shown to be the major ailment. Its prevalence was much lower in IPM in 1999 as a result of quick intervention in the damaged fields, whereas it peaked at 13.02 percent in non-IPM at 55 DAT. Regular monitoring of the insect pests and diseases in 2000 revealed LF and YSB as the primary insect pests, after irregular and low rates of the gundis bug and hasp.

The most frequent disease was sheath blight, followed by bacterial blight. YSB incidence in IPM peaked at 5.98 percent during the vegetative stage, but as the plant developed into the flowering stage, there was no evidence of infestation. There was a significant frequency of YSB in the vegetative stage in a non-IPM hamlet, and the largest proportion of "dead hearts" was 8% in the last week of August. At the post-flowering period, the incidence rose to up to 20%, nevertheless. According to data on the disease, the incidence of LF was originally rather high in IPM (29.12 percent), but has since dramatically declined. The discharge of T. japonicum during the third week of August significantly decreased its prevalence. A second distribution during the first week of September further reduced the prevalence of both LF and YSB.

The incidence in non-IPM was much higher and peaked at 38.12% in the last week of August. The incidence remained high relative to IPM village despite a subsequent tendency toward reduction. The frequency of LF appears to have been very little affected by insecticides like portae. In a few IPM-managed crops, the gundis bug became a nuisance, but it was successfully managed by dusting 10 kg/acre of methyl parathion. In places not covered by IPM, this issue did not appear to have done much damage. One of the diseases that was prominent in a few fields in IPM village during the first two weeks of August was sheath blight. Its spread was halted by timely carbendazim administration. It might have gone as high as 31.0 percent in non-IPM, severely hurting the crop. In non-IPM crops, sheath blight was more frequent overall. Different disease known as bacterial blight was also discovered in one or two locations, but it was contained by spraying streptomycin. Brown spot infestation was also seen in certain crops, but no treatment was required [7], [8].

inherent hostility complex

Compared to non-IPM fields, IPM fields have more natural enemies. Common predators like grasshoppers, Cynocephalus longipin’s, crickets, and spider fauna were discovered to be abundant in IPM areas. Other predators, such as carabids and ladybugs, were also found. IPM fields were found to have a reasonably high level of major insect pest parasitism. However, the population of all these natural enemies was basically nonexistent in non-IPM areas. Although some people can channel their aggression into creative and useful outlets, aggression is hostile and adversarial behavior, frequently with the aim to do harm. It could happen in a provocative or unprovoked way. Numerous triggers might lead to hostility in people. For instance, pent-up resentment brought on by unmet aspirations or perceived disrespect. Human aggression can be divided into two categories: direct aggression and indirect aggression. The former is characterized by behavior meant to damage another person physically or verbally, whilst the latter is characterized by behavior intended to harm an individual's or group's social relationships.

Aggression is defined as an action or response by a person that causes anything unpleasant for another person in the social sciences and behavioral sciences. According to certain definitions, the person must intent to hurt someone else. Aggression is seen as "an ensemble of mechanisms formed during the course of evolution to assert oneself, relatives, or friends against others, to gain or to defend resource by harmful damaging means," according to an interdisciplinary perspective. These processes are frequently sparked by feelings of fear, frustration, anger, stress, dominance, or pleasure (referred to as "proximate causes"). Aggressive behavior can occasionally provide stress relief or a distorted sense of power. Aggression may not be the same thing as predatory or protective behavior amongst members of different species.

Anti-predator aggression, defensive aggression predatory aggression, dominance aggression, inter-male aggression, resident-intruder aggression, maternal aggression, species-specific aggression, sex-related aggression, territorial aggression, isolation-induced aggression, irritable aggression, and brain-stimulation-induced aggression are just a few examples of the many different ways that aggression can manifest. Human aggression can be divided into two subtypes: reactive-impulsive aggression which frequently results in inappropriate or unpleasant actions that are out of control and controlled-instrumental violence which is intentional or goal-oriented. Although the terms are sometimes used interchangeably by laypeople as in expressions like "an aggressive salesperson", aggression varies from what is typically referred to as assertiveness [9]–[11].

Grain yield and the economy

IPM fields produced a mean yield of 56.92 q/ha in 1999, compared to 50.33 q/ha for non-IPM fields. Despite the use of pesticides, the average yield in IPM fields was 58.04 q/ha in 2000 as opposed to 48.21 q/ha for farmers in Sarupa village. Costs and returns are shown in Table 7 both with and without IPM. The implementation of IPM led to higher economic returns in both years. Furthermore, any potential pesticide residues are completely disregarded. Non-IPM farmers were unable to enhance their output despite using additional pesticides. The low yield may be due to other aspects of crop management even though there were more diseases and insect pests in non-IPM locations.

A better yield may only be obtained by planting at the proper time. The recommended planting dates for Pusa Basmati-1 are 20–30 May and 20–30 June, respectively. Planting is delayed, which results in lower yield. Farmers in this region typically planted one seedling or hill at a time, and IPM farmers were told to follow these dates; however, transplanting was delayed in non-IPM, with the exception of a few rare cases. IPM-using farmers were told to plant 2-4 seedlings per hill. Farmers employed significantly greater rates of nitrogen fertilizer, which stimulated the growth of the plants' leaves and stems and made them more succulent and prone to lodging. Additionally, both of these characteristics make plants more susceptible to ailments like bacterial blight and sheath blight.

It is also well known that increased nitrogen fertilizer use encourages the growth of a number of insect pests. According to Garg effective water management and sensible fertilizer use are crucial for lowering lodging in IPM fields. Either farmers didn't use seed dressers at all or they did so improperly. A number of small insect pests and diseases also made a comeback and increased in population as a result of farmers' incorrect pesticide applications. Occasionally, farmers' use of insecticides like portae granules aided in the establishment of leaf feeders like LF. It also injured several of its natural adversaries.

CONCLUSION

The sustainability of the rice production system is in threat due to the use of chemical fertilizers and pesticides. The IPM can improve the system's sustainability if it is used. IPM currently only extends to about 1% of the 143 million hectares of arable land in the country. Some attempts have been made to synthesize the site-specific IPM modules to manage insect pests, diseases, weeds, and other crop-damaging species collectively. IPM programs may decrease the need for pesticides and enhance crop productivity, according to studies on the effectiveness of IPM. IPM must be used on Basmati rice in order to reduce the pesticide residual problem and cut the cost of production. Large export consignments of basmati rice are prohibited due to substantial pesticide residues. This issue will be solved by the creation and implementation of inexpensive, environmentally friendly, and region-specific IPM techniques. The majority of basmati or fragrant rice is grown in the northern states of Uttar Pradesh, Haryana, Punjab, Uttaranchal, Rajasthan, and Jammu & Kashmir. It has gained recognition as a commercial crop and demands high prices on both the domestic and international markets as a result of India's substantial exportation of scented rice. Traditional tall Basmati cultivars produce less grains because they receive frequent applications of nitrogen fertilizer.

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CHAPTER 6

GROUNDNUT DISEASE MANAGEMENT THROUGH INTEGRATED APPROACHES IN INDIA

Amit Kumar, Assistant Professor, Department of Agriculture and Environmental Sciences,
Shobhit University, Gangoh, Uttar Pradesh, India,
Email Id- amit.kumar@shobhituniversity.ac.in

ABSTRACT:

In India, arachis hypogea or groundnut, is the most significant oilseed crop. It takes up 35% of the total area planted with oilseeds and makes up more than 40% of the overall output. The vulnerability of the groundnut crop to disease is substantially greater than that of many other crops. More than 100 pathogens, including viruses, have been reported to affect groundnut, but only a small number are significant economically in India. These include leaf-spots, such as "Tikka," early leaf-spot, late leaf-spot rust and aflatoxin contamination The other diseases, such as clump and peanut (groundnut) mottle disease, collar rot, stem-root, root-rot, and bud necrosis (tomato spotted wilt virus), are confined. Some diseases that were once of modest relevance have now grown to be significant ones. Rust and bud necrosis, which were unknown twenty years ago, are now recognized as having economic relevance. Recently, the production of groundnuts in southern India has come under threat from a new illness known as peanut stem necrosis disease (PSND), which is brought on by the tobacco streak virus (TSV). Large amounts of groundnut are grown by small farmers. Because infections are the greatest obstacle to continuous groundnut production, a disease management strategy that is inexpensive for small farmers is also necessary. The approaches taken to combat groundnut illnesses also differ significantly, ranging from little input but labour-intensive techniques in a number of Indian states to partial mechanization in particular places like Gujarat and Punjab. minimal disease control, judicious or selective fungicide use, or total reliance on host plant resistance.

KEYWORDS:

Crop, Disease, Groundnut, PSND.

INTRODUCTION

Small farmers cultivate groundnut in great quantities. A disease management approach that is affordable for small farmers is also required because illnesses are the main barrier to sustained groundnut production. The methods used to manage groundnut diseases also vary greatly, ranging from no input yet labour-intensive methods in several Indian states to partial mechanization in select regions like Gujarat and Punjab. Minimal disease management, selective or indiscriminate fungicide usage, or complete dependence on host plant resistance (HPR) are all possible. According to Madden (1987), integrated pest management (IPM) is "a holistic, multidisciplinary management system that integrates control methods for pests that co-exist in an argon-ecosystem on the basis of ecological and economic principles." This idea undoubtedly includes disease control within the Indian groundnut producing systems. The nature of the diseases, the microorganisms that cause them, and an understanding of the ongoing issues are all well-covered in two important treatises on groundnut diseases and their management. An integrated illness management has received a lot of attention in this research. Cultural practices, HPR, and prudent fungicide use can be incorporated into location- and problem-specific management programs to reduce early disease levels and/or halt the spread of disease to maintain it below levels that result in economic loss. The distribution, evolution, and costs associated with diseases are also covered.

Disease Proportions in India

In practically all of the country's groundnut-growing regions, early leaf spots (ELS) and late leaf spots (LLS) are more common during the kharif season than during the rabi season or in the summer and frequently become endemic. Although ELS outbreaks have been significant recently in the states of Andhra Pradesh, Karnataka, and Tamil Nadu, LLS is typically more severe than ELS. Following the initial discovery of groundnut rust in Punjab (Chahal and Chohan 1971), it was discovered in several Indian systems for growing groundnuts. Rust was reported from the southern states of India by Subrahmanyam et al. in 1979. In all groundnut-growing districts in the Saurashtra region, surveys carried out by the National Research Centre for Groundnut throughout the kharif seasons of found a moderate to heavy incidence of rust. In Orissa near Cuttack and in Saurashtra near Junagadh it was also noted to have affected the rabi/summer crop in April 1981. According to survey, rust on groundnut 79 crop appears to be widespread in India at the moment. Nearly all of the nation's regions that grow groundnuts are affected by collar-rot.

The sandy loam soils and medium black soils of Punjab, Andhra Pradesh, Tamil Nadu, Uttar Pradesh, Rajasthan, Orissa, Madhya Pradesh, Karnataka, Maharashtra, Gujarat, and Haryana are particularly susceptible to the disease. Compared to rabi and/or summer, this disease is more devastating in the kharif season. According to Pande and Narayana Rao, stem-rot brought on by S. Rolfson is sporadic in the majority of the nation's groundnut-growing regions and is becoming more prevalent in Tamil Nadu, Andhra Pradesh, and Karnataka. Gujarat and Madhya Pradesh have also reported disease epidemics. Similar to this, which is severe in Tamil Nadu, Andhra Pradesh, Maharashtra, Uttar Pradesh, and Rajasthan, is scattered throughout the country in light soils. While yellow mould and the associated aflatoxin contamination of groundnut seed are a global problem, subtropical and tropical areas are especially affected.

It has been recorded from every region in India that produces groundnuts. The most potent known carcinogens are aflatoxins, which are generated by the fungus A. flavus and A. parasitic us. When the tissues are infiltrated by the cause of yellow Mold, aflatoxins might appear in the stems of peanut seedlings, in pods, or in seeds. There are two types of contamination associated with aflatoxin and yellow mild: pre-harvest and post-harvest. Drought, inadequate calcium feeding, damage from soil insects, high soil temperatures, biological damage, mechanical damage, vulnerable cultivars, and incorrect nematicide and fungicide application are some of the variables that impact pre-harvest contamination. Inadequate artificial drying, a high moisture content, moisture leaks during storage, a higher storage temperature, damage from rodents and storage insect pests, and microbiological deterioration are all factors that contribute to postharvest contamination.

The widespread peanut virus known as tomato spotted wilt has a wide host range and causes bud necrosis. In Madhya Pradesh and Andhra Pradesh, it is a significant disease Pande and Narayana Rao, 2000. In recent years, it has also begun to gain significance in Haryana. Sundara Raman originally identified the lump disease virus in the erstwhile Madras State in 1880. It was later discovered in 1977 in crops produced in the sand-based soils of Punjab and Gujarat, and also reported from Uttar Pradesh and Andhra Pradesh. It was the first to note the presence of the peanut groundnut mottle disease virus in Andhra Pradesh. Additionally, it has been seen in the fields of farmers in Maharashtra and Andhra Pradesh. Gleaned noted a higher incidence of this disease in Saurashtra's rabi/summer crop, with nearly 40% of plants afflicted. An epidemic of a novel illness known as "peanut stem necrosis disease" (PSND), which resembled bud necrosis and was brought on by an isolate of tobacco streak virus (TSV), was reported from Andhra Pradesh during the 2000 kharif season.

DISCUSSION

Rust and leaf spots resulted in yield losses that ranged from 15 to 80 percent. According to Siddaramaiah et al., rust at Dharwad caused pod yield losses of up to 29%. Similar to this, Guge et al. claimed that rust alone reduced pod production by 50%. According to Subrahmanyam et al, the combined attack of rust and leaf-spots resulted in losses in the vulnerable genotypes of up to 70%, whereas rust alone resulted in 52 percent lower pod yields. Pande et al. recently observed an increase in haulm production of up to 80% and pod output of up to 60% in fungicide-protected plots compared to unprotected plots in an on-farm participatory research on the management of foliar diseases, primarily late leaf-spot and rust of groundnut. The likelihood of a good groundnut crop is drastically reduced by the substantial seedling mortality caused by the diseases of groundnut seeds and seedlings (collar-rot, stem-rot, and root-rot). In Punjab, collarets is said to reduce crop establishment and yield by 40%.

In recent years, farmers' fields in the states of Andhra Pradesh, Karnataka, and Tamil Nadu have experienced up to 30% decreases in plant stand owing to collar-rot and an estimated 20% reduction in pod output. In Uttar Pradesh and the Deccan Plateau, stem-rot led to losses of up to 27%. According to seed rot and seedling collapse cause a 5–15% loss in the early crop stand. Furthermore, it has been noted that the pod degeneration brought on by the soilborne pathogenic fungi may be severe in a number of farmer's fields in Andhra Pradesh, Tamil Nadu, and Karnataka. According to report, the bud necrosis disease in India led to yield losses of up to 50%. Losses of up to 60% have been reported in cases of late infection brought on by clump disease. In Andhra Pradesh during the kharif 2000 season, a novel virus disease called peanut stem necrosis (PSND) resulted in crop losses.

Integrated Disease Management

The degree of disease prevalence and the size of the losses suggest that diseases are the main barrier to groundnut production in India. Management of the pod and haulm is required to generate sustainable yields. The following are the components of illness management and how they are integrated: [1]–[3].

Resistant hosts

High-yielding groundnut cultivars do not have host-plant tolerance to foliar diseases. At ICRISAT, a significant portion of the world's germplasm has been tested for resistance to leaf-spots and rust under laboratory and field circumstances Similar attempts to evaluate germplasm for disease resistance have also been performed at the National Research Centre for Groundnut (NRCG), Junagadh, Gujarat Various degrees of disease resistance have been identified. There are resources for modest levels of multiple resistance against rust and leaf spots. For instance, the groundnut line NiCad 17090 has substantial levels of protection against both of these ailments. At ICRISAT and NRCG and its centres in India, efforts have been undertaken to incorporate a number of resistant lines in disease resistance breeding programs. In India, a small number of wild Arachis species have also been noted to be extremely resilient to rust and leafspots. At ICRISAT and other places attempts have been undertaken to quantify and transmit resistance to leaf-spots and rust from numerous wild species into the cultivated groundnut.

Despite being resistant to foliar diseases, several wild Arachis species derivatives have long durations and are therefore unsuitable for the rainfed environments in India. S-resistance has been described in the NC-2 and Nacka 18016 and T-17, T-11-11, EC 1682, RB-4, T-25, T-9, and Mainpuri local genotypes. Roelf’s in greenhouse tests or outdoor screenings. There is currently no known stable stem-rot resistance across environments and sites. Based on temperature, stem-rot susceptibility varied amongst groundnut genotypes. Some genotypes that were resistant at 16 o C (min) to 31 o C (max) and susceptible at 23 o C (min) to 36 o C (max) suggest that the groundnut stem-rot resistance gene may be temperature sensitive

(Pande et al., 1994). In general, cultivars that are agronomically acceptable do not have stem-rot resistance. No consistent and reliable sources of resistance to viral infections have been identified in the nation to yet [4]–[6].

Control of culture

In particular, the groundnut crop was neglected or overlooked in terms of this component of crop health management. Farmers can readily adopt some cultural measures, such as: Changing the date of sowing if necessary, so that the vulnerable stage of crop development does not coincide with climatic conditions that are very conducive to pathogen establishment and increased damage to groundnut crops. Planting close together or farther apart is necessary because distance affects the microclimate, which, together with virulent pathogens, determines how diseases develop.

Although foliar disease development is generally reduced by greater spacing, thin plant stands have poor yields. Only a little amount of research has been done to determine how disease develops in a single groundnut crop compared to a combination of groundnut and other crops in the same season (Pande et al., 1993). Because they are airborne diseases, leaf spots and rust spread swiftly in regions with a constant supply of their host plants.

Knowing the different 83 economically successful combinations is important because they could serve as spore barriers and, to some extent, limit the spread of the disease. It is unknown how fertilizer affects the progression of illness in groundnut. On the whole, very little information has been reported about how crop rotation affects the control of groundnut disease. Although it is well established that crop rotation with non-host crops might lower the prevalence of soilborne illnesses, it is not a feasible idea under India's rainfed groundnut production. In order to control leaf-spot and rust infections, appropriate cultural practices have been attempted to establish.

Foliar infections should be controlled by clearing diseased debris from the field and burning it. Prior to planting, phosphorus was added to the soil, which decreased the frequency and severity of rust. In general, stringent plant quarantine laws ought to be implemented to prevent the spread of rust on pods or seeds to asymptomatic regions. By avoiding mechanical damage, removing plant waste, deep poling, and crop rotations, the prevalence of collar-rot disease may be reduced. Early sowing (June) and close plant spacing (22.5 7.5/10 cm) have been linked to decreased incidences of collar-rot, stem-rot, and bud necrosis [7], [8].

Biological Défense

It would be important to investigate the options for using biological control agents to manage the diseases. Several bacterial and mycoparasites like Verticillium laconic, Penciller islandic, Eudarluca crisis, Acremonium peridium, Darluca filum, Tuberculoma contrarians, Hannaford pulvinata and Euphysothrips Micozzie on uredia of groundnut rust (P. arachidis) pathogen have been reported. Additionally, groundnut leaf-spot diseases have been seen to be parasitized by P. lacani. It is necessary to develop and research how they might be used effectively in real-world settings. biological control of pathogens that live in soil, like M. stepheolin and S. rolfsii can be prevented by introducing antagonists into the soil or by using resident antagonists. Both T. In addition to T. It was discovered that harzianum could lower the number of sclerotial cells in M. the phaseolina. Seed treatment with 84 T. repens mycelium spores. Seeds are shielded from M invasion by polysporum. phaseolina. To prevent groundnut stem rot, several Trichoderma species have also been treated to seeds. They include T. Field-scale harzianum cultivation with Celaton-molasses media has been successful [9]–[11].

Chemical regulation

The development of effective fungicidal regimens for the control of groundnut diseases has been continuously pursued. Small and marginal farmers recently discovered that managing foliar diseases with a combination of low fungicide application and moderate doses of HPR was affordable and acceptable In addition, weather-based disease forecasting systems have been created for effective management of foliar diseases and their application at the field scale is being studied. Spraying carbendazim (Bavistin) at 0.05 percent and mancozeb (Dithiane M-45) at 0.2 percent at intervals of 2 to 3 weeks, 2 or 3 times, beginning 4-5 weeks after planting, prevents leaf-spots and rust. This combination effectively controlled both illnesses in the all-India trials and produced the maximum yields (Reddy, 1982). Rust was completely controlled by Tridemorph spray application at 0.07 precent.

To control rust, suggested two sprayings of Triadimefon @100 g acre-1 as a 200 L spray solution. Pande et al. (2001a) recently found that a single application of chlorothalonil @ 2 g L-1 water and 800 L solution ha-1 effectively controlled LLS and rust in groundnut cultivars ICGV 89109 and ICGV 91114. This was done as part of the farmers' participatory evaluation of a combination of moderate levels of HPR with prudent use of fungicides. By treating the seeds with Thiram 75 WP @ 3.5 g kg-1 kernel, the incidence of collar-rot can be reduced.

Carbendazim/Mancozeb/Captafol @ 2.0-2.5 g kg-1 kernel may be utilized in locations where Thiram is unavailable a successful solution to M. pre-emergence rot. By seed dressing with Captafol, phacelias has been produced, brassicol 75 percent WP (0.5%) can also be sprayed at 1 liter per square meter or in the form of soil dust at a rate of 25 kg per hectare spread across two applications: one 12.5 kg before planting and the other 12.5 kg after 15 days. 85 different fungicides, i.e. In order to treat stem-rot disease, terrachlor + terrazole @ kg ha-1 + 40 kg ha-1 at pegging was proven to be effective. Carboxin-soaked soil has been said to be beneficial against S. rolfsii. Although a number of chemicals have been proven to be beneficial in reducing stem-rot, smallholders cannot use these.

By avoiding the A, it is possible to manage aflatoxin exposure in groundnuts and control yellow mold. By either removing or redirecting the contaminated seeds and implementing enhanced crop husbandry, it is possible to prevent the flavus group from entering groundnut tissues. These are: Harvest at the proper maturity; Dry the produce in the fields as quickly as possible; Prevent rewetting during or after drying; Remove damaged or moulded pods and seeds; Dry to safe moisture level (8%) before keeping in storage; Store at low temperature and low humidity. Large farmers in developing nations have implemented the most of these ideas with great success, however because to various socioeconomic issues, India has not followed them.

The presence of an intact seed test is necessary for the genetic resistance, according to various researchers, and any damage to the test significantly lowers the levels of resistance. Bud necrosis and stem necrosis diseases may be prevented by controlling vectors (Thrips) using systemic insecticides as dimethoate (400 mL/ha) or methyl demeton (360 mL/ha). Nem agon and Temik applied to the soil one week prior to planting was shown to be the most efficient at lowering the incidence of clump disease and increasing yield when compared to untreated plots. The vector population is often controlled wherever possible to treat viral infections [12]–[14].

CONCLUSION

The integrated disease management approach, which asks for properly combining all possible control measures in boosting groundnut output, is obviously the most ideal since we no longer seek to achieve absolute control but rather an economic reduction in disease level. However, a plant pathologist and a farmer are very far apart. To help smallholders produce sustainable yields of groundnuts, gaps between technology developed in the field of disease management and their transfer and adoption must be filled. Arachis hypogea, sometimes known as groundnut, is the most important oilseed crop in India. It accounts for more than 40% of the total yield and 35% of the area planted with oilseeds. Compared to many other crops, the groundnut crop is far more susceptible to disease. There have been reports of more than 100 diseases, including viruses, affecting groundnut, but just a few are significant commercially in India. Leaf spots like "Tikka," early leaf spots, late leaf spots, rust, and aflatoxin contamination are among them. The other illnesses, such as tomato spotted wilt virus and bud necrosis (clump and peanut (groundnut) mottle disease), are contained.

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CHAPTER 7

INTEGRATED PEST MANAGEMENT IN VEGETABLE CROPS

Amit Kumar, Assistant Professor, Department of Agriculture and Environmental Sciences,
Shobhit University, Gangoh, Uttar Pradesh, India,
Email Id- amit.kumar@shobhituniversity.ac.in

ABSTRACT:

In India, key vegetables like tomatoes, brinjal, cabbage, cauliflower, okra, beans, and cucurbits are grown. The delicate balance between insect pests and their natural enemies has been upset by intensive agronomic methods, the off-season cultivation of hybrid or enhanced vegetable varieties, and the indiscriminate use of insecticides. A few examples are the development of pesticide resistance in the Chelicera armiger a tomato fruit borer, Leucin odes orbitalis a brinjal fruit borer, Irimia trifolin a serpentine leaf miner, and Plutellid Xylo stella a diamond-back moth in cabbage. IPM strategies are being developed to address these insect pests that are resistant to insecticides. Some well-known IPM techniques include the use of marigold as a trap crop for tomato fruit borer, H. armiger a, mustard as a trap crop in cabbage and cauliflower, the use of NPV and Trichogrammatid against tomato fruit borer, and the use of neem seed kernel extract against all crucifer pests. The novel methods developed for managing pests in brinjal, cucurbits, and okra use neem and pangamic cakes. IPM has yet to have a significant effect on farmers' fields on a broad basis. Therefore, it is imperative to spread awareness of new technologies after evaluating current practices and, if necessary, adapting them to meet various ecological needs. In this research, the current state of IPM methods for vegetable crops is discussed, along with its drawbacks and financial implications.

KEYWORDS:

Borer, Cabbage, Fruit, Neem, Pests.

INTRODUCTION

Catch Crops The two most significant traditional IPM techniques available to farmers are the use of marigold and mustard as trap crops in cabbage and tomato. Vegetable crops with Integrated Pest Management Indian Horticulture Research Institute, Hessarghatta Lake, Bangalore 560 089 7 96, P.N. Krishna Moorthy and N.K. Krishna Kumar1 Neem seed kernel extract (NSKE) for cabbage, cauliflower and mustard as a trap crop According to the 1989 technique, two rows of bold-seeded Indian mustard should be planted after every 25 rows of cabbage. 15 days before planting cabbage, the first row of mustard is sown, and 25 days later, the second row. More than 80% of the bugs that attack cabbage are drawn to mustard. However, in addition to 2-3 applications of NSKE, dichlorvos has to be sprayed on the mustard foliage to eliminate pests. This package has been approved for Rahurias and Hyderabad centers of the All India Coordinated Vegetable Improvement Project (AICVIP) after being examined.

Along with the release of Diademed semi clausum in Tamil Nadu, this technology was also exhibited in Ooty as part of SAVERNET (South Asian Vegetable Research Network, supported by ADB and carried out by Asian Vegetable and Research Centre, Taiwan). Although the adoption rate of this package is unknown, many farmers in Bangalore grow mustard alongside their cabbage crops and apply pesticides to both crops at the same time. The diamond back moth (DBM) may not lay eggs in areas where insecticides are treated, thus this is undesirable. The technology's drawback is that farmers must forgo two rows of their primary crop in order to plant a trap crop. The second row of mustard is likewise challenging to raise. These issues are in addition to the one of constantly wet grinding NSKE for spraying.

Marigold is used as a tomato fruit borer trap crop

The management of the tomato fruit borer, H. armiger a, using tall African marigold as a trap crop was proven in 1992. To synchronize flowering in both crops, under this approach, one 45-day-old marigold is planted for every 16 rows of tomatoes. Only a small percentage of borer eggs are placed in tomato, with the majority being in marigold flowers or flower buds. Endozoan spraying is used to reduce any insect activity that does occur at 28 and 35 days after planting (DAP). This package has been validated at Rahurias and 97 Hyderabad centers after being assessed as part of the All India Coordinated Vegetable Improvement Project (AICVIP). Many tomato growers also market the marigold flowers they grow around their produce. The disadvantages of this method are that certain tomato rows must be sacrificed for marigolds and that marigold and tomato flowering must occur at the same time Subramaniam, 1997.

Using botanicals: Using sprays made from neem seed kernel extract

It is advised to use NSKE sprays on a number of crops, including beans and cucurbits to protect against the stem fly, Ichinomiya phaseoli, and tomato and cucurbits to protect against all pests. When used on cabbage and cauliflower, NSKE sprays provided excellent control of all pests, allowing the crop to be grown without the use of any insecticides. It demonstrated the use of NSKE sprays in mechanized cabbage growing throughout a sizable portion of Tamil Nadu. Although many farmers are aware of the benefits of NSKE sprays, they are unsure of how to properly prepare them. Others lament the lack of neem seeds in the market during the summer, when pest issues are more prevalent. Furthermore, grinding and filtering the extract, which irritate eyes, complicate its preparation. Neem seed powder NSP and neem seed kernel powder NSKP were utilized for extraction under the Institute Village Link Programmer IVLP of IIHR in 1996 as an alternative to NSKE and both were proven to be successful in suppressing DBM. According to storage trials on these powders conducted at IIHR, NSP can be kept in polyethene bags for up to 5 months without suffering significantly from loss of effectiveness. As a result, powders can be made, wrapped in polythene bags, and kept.

You can use this powder for extraction by soaking it the previous night. Private businesses, particularly those in and near regions where cabbage is grown, can market NSKP or NSP on a large scale. But this hasn't yet been used for profit. There are many neem formulations on the market, however they are only marginally as effective as NSKE Srinivasan and Moorthy, 1993. Maybe the new powder version with 6% azadirachtin is the 98 only exceptions. It was discovered to be extremely efficient against DBM in tomato and cabbage (at a dose of 1g/L). Numerous neem formulations have also been discovered to be successful against serpentine leaf miner. Neem seed cakes are frequently used to combat worms. These also lessen insects that live in the soil, such as termites and grubs. Recently at IIHR, Bangalore, the application of cakes for the management of numerous insect pests of brinjal, okra, cucurbits, etc. was demonstrated. Cakes appear to have a "repellency" effect thanks to the volatiles they contain. Additionally, it was discovered that the effect diminished during the summer and pre-monsoon months when the temperature rose and the wind speed was high.

Following is a brief explanation of the role that cakes play in IPM for various insect pests and crops. Neem and pangamic cakes applied to the soil twice at a rate of 250 kg/ha significantly decreased the insecticide-resistant brinjal shoot and fruit borer to 6–10%. It was discovered that doing this effectively reduced the occurrence of ash weevil, gall midge, and thrips with the least amount of insecticide treatment. However, the cakes were unable to lower the incidence of mite and aphid. Okra: Neem cake was reported to diminish the incidence of petiole maggot Melanogromyza hibiscus, fruit borer Erias vitelli, and hopper Marascas bigitalin digitule by applying it to the soil at sowing and twice more at 30–45-day intervals.

provides information on the prevalence of several pests throughout the 2000–2001 IPM programs. Neem cake practically eliminated all insect pests and viral infections. The plots treated with neem cakes also had very low levels of powdery mildew. Additionally effective was pangasii cake. Powders had little impact. Neem cakes can therefore be used in disease management as well as integrated pest management (IPM) for okra. Cucurbits: According to studies done at IIHR, using neem cake or using NSKE sprays to control fruit fly in cucumbers was quite efficient. Neem cake applied to the soil decreased the incidence of fruit fly to 6%, but plots treated with insecticide had an incidence of more than 15%.

DISCUSSION

Results showed that applying neem cake considerably reduced DBM in both cauliflower and cabbage. These crops require a very long time to establish foliage that covers the soil's surface. As a result, the volatiles in the cakes may evaporate quickly. Figure 1 Therefore, when the crop canopy is weak, especially during the crop's early growth stage, the effect may not be very noticeable. According to the research on cauliflower, when temperatures and wind speed are low in the winter, it may be quite successful. neem cake was only moderately successful at preventing fruit borer infestations, although neem and pangasii soaps appeared to be more beneficial. When planting potatoes, brinjal, cabbage, etc., many farmers use both neem and pangasii cakes in the hope that pest and ant issues will be lessened.

Figure 1: cabbage

Only 30 days after planting or during the flowering season do the majority of insect pests become active. Therefore, it is difficult to illustrate how they affect insect pests. The cake's biggest drawback is that it loses its effectiveness in hot weather and with strong winds. Only moderate weather conditions are therefore recommended for its use. It might be successfully used from July to February for 8 months of the year in Bangalore's climate. Farmers have received this delivery of brinjal with open arms. This bundle could be expanded to include crops like cotton and red gram. using soap Neem and pangasii soap sprays were discovered to be very successful at preventing insecticide-resistant DBM in cabbage. According to research done at IIHR, soaps can help reduce Chelicera armiger a in tomatoes and, to a lesser extent, shoot and fruit borer in brinjal. Oil sprays could lessen the occurrence of DBM in cabbage, although they were slightly phytotoxic and had a smaller head size than soaps [1]–[3].

During the summers of 2000 and 2001, the IVLP program successfully carried out on-farm trials to demonstrate the efficacy of soaps in cabbage. These can also be employed in other crops, such as beans, cucurbits, and tomatoes, as an element of IPM. The benefit of soap is that it is easily removed with water and has very little residual toxicity. The bug may not die unless the soap droplet touches it, therefore the plant surface needs to be thoroughly covered. Spraying soaps should be done sparingly and infrequently to avoid inhibiting vegetative development. Additionally, these soaps, which are not yet commercially accessible, have potential in both domestic and foreign markets.

Trichogrammatid Release for Biocontrol

For the management of fruit borer, inundate releases of the egg parasitoid Trichogrammatid brasilin’s are also advised. Figure 2 It is advised to apply six releases at weekly intervals of 40,000/ha, the first of which should be applied when tomato flowers are 50% complete. This IPM was demonstrated using tomato sprays infected with the nuclear polyhedrons virus NPV. The discharge of the parasitoid is ineffective on its own. spraying of NPV.

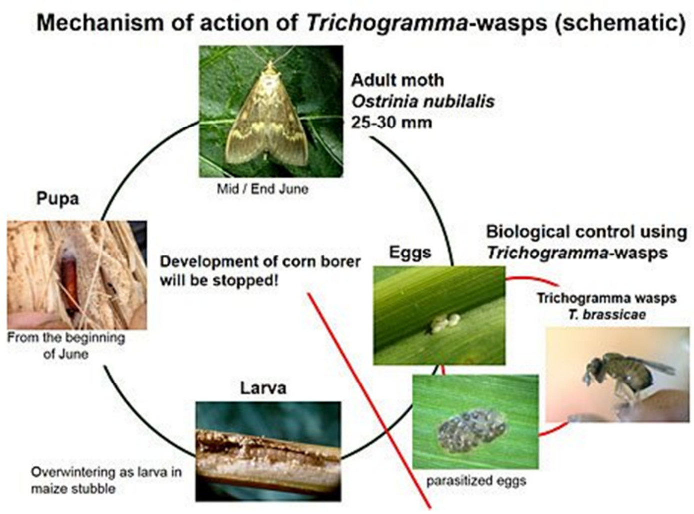

Figure 2: Trichogrammatid Release.

It has been discovered that spraying of Ha NPV at 250 larval equivalents/ha are successful in suppressing fruit borer. Three to four treatments at weekly intervals, with the first spray occurring on the same day, according to studies at IIHR. Neem and pangamic soaps' impact on cabbage output and DBM Treatments Plant/incidence of DBM Gain. Pheromone traps were placed on the tender leaves at the top of the plant to detect the presence of H. armiger eggs. The biggest drawback, however, was its lack of accessibility and the poor NPV quality provided by the private businesses. Employing barriers, The Indian Institute for Vegetable Research (IIVR), Varanasi, and IIHR, Bangalore, investigated the use of nylon net as a barrier for the control of the brinjal shoot and fruit borer. By using this method with shoot trimming, the borer incidence might be decreased by 16%. However, because nylon net is expensive, research is being done on the use of living obstacles, such as maize. The wind effect when cakes are applied may be lessened by these barriers [4]–[6].

IPM tomato economics

The main pest on tomatoes is the tomato fruit borer, H. armigers. Khader khan et al. evaluated the benefit-cost ratio of marigold as a trap crop for tomato fruit borer management and found that it was 1.53 as opposed to 1.08 for non-IPM technologies. In comparison to chemical control, IPM had a net return of Rs 60,168/ha as opposed to Rs 47,359/ha. A significant tomato pesto in addition to the fruit borer is the introduced insect pest known as the serpentine leaf miner (SLM), Lilima trefoil. Consequently, the following IPM is advised for tomato crops: Apply neem cake/pangasii cake at a rate of 250 kg/ha during planting to prevent the egg-laying of fruit borer and leaf miner, as well as spotted wilt disease [7]–[9].

Plant concurrently 25-day-old tomato seedlings and 45-day-old marigold seedlings in a design with one row of marigolds for every 16 rows of tomatoes (optional for controlling tomato fruit borer). Spray NSKE (4%) or neem seed powder (7%) at 15 and 25 DAP (if necessary) to decrease serpentine leaf miners. Apply neem cake again at blooming to lower fruit borer incidence. For a harvest of just tomatoes, use NPV 250 LE four times in the evening at intervals of 4–7 days. Marigold should only be sprayed twice, at 28 and 35 DAP, if it is planted as a trap crop.

Brinjal

Some significant pests of brinjal include the shoot and fruit borer While fruit borer and hoppers are the main issues, some places may also see significant output loss due to mites, gall midges, and ash weevils. Under temperate weather, neem cake has been proven to be quite promising. In the years IVLP program at IIHR evaluated its use in farmer fields. It provides the economics of the IPM for the kharif of 2000–2001. provides the cost and returns without IPM. Neem integration produces higher yield and net higher returns while being cost-effective, according to a study of net returns with and without IPM. As a result, the following IPM techniques are advised for brinjal: To control ash weevil, apply neem/Karan cakes while planting at 250 kg/ha in the furrows. To control ash weevil and early incidence of shoot and fruit borer, repeat cake application at 30-40 DAP. To control fruit borer, midge, hoppers, and thrips, repeat cake application at 90-100 DAP.

Mustard saw fly planting Indian mustard as a trap crop and applying snake to these crops eliminates all pests. nuke spars on their own are also efficient. under the ill initiative, the economics of several packages, including the use of solely insecticides (only snake, mustard as a trap crop + snake sprays, etc.), were investigated. presents the findings. demonstrates that farming practices are not at all cost-effective. the air has created two alternatives in response to the farmers' preference for ready-made formulations: one involves the use of neem seed powder, and the other involves the spraying of neem and pangamic soaps. soaking neem seed powder is possible [10], [11].

The extract can be sprayed after being filtered and left overnight. The powder can be kept in the polythene bags for three to five months without having to grind the kernels by hand each time, saving time and effort. Neem and pangamic soaps have recently become popular for the control of insect infestations. In the summer of 2001, it was investigated in four fields. Table 9 provides the IPM's economics. Aborted heads and multiple head formation were observed in many plants in the above cabbage plot because the soap spraying was completed a bit late (this was caused by the cabbage stem borer, Shellular unbales. In order to prevent this, contact pesticides were sprayed within 10 days following planting, especially in the summer. Early NSKE spraying and excessive NSKE spraying are not advised because they could cause head size to decrease. Only after 20 DAPS are NSKE sprays to be administered. In this specific farm, although being applied late, soap sprays provided excellent DBM control, and the farmer saw good results. The crop in nearby villages was severely destroyed by DBM. The recommended IPM kit is.

CONCLUSION

Despite the usage of pesticides, illnesses and insect pests result in significant losses for crops. In addition, many insect pests are now resistant to the pesticides used to control them, necessitating more insecticide applications and raising the expense of protection. The more modern IPM techniques and technology increase crop yields, offer greater defense against insect pests, and ultimately benefit farmers. Important vegetables are grown in India, including tomatoes, brinjal, cabbage, cauliflower, okra, beans, and cucurbits. Through intensive agronomic practices, the off-season production of hybrid or improved vegetable varieties, and the indiscriminate application of insecticides, the delicate balance between insect pests and their natural foes has been disturbed. Examples include the evolution of chemical resistance in the tomato fruit borer Chelicera armiger, the brinjal fruit borer Leucin odes orbitalis, and the serpentine leaf miner Irimia trifolin.

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CHAPTER 8

PIGEON PEA AND CHICKPEA INTEGRATED PEST MANAGEMENT

Amit Kumar, Assistant Professor, Department of Agriculture and Environmental Sciences,
Shobhit University, Gangoh, Uttar Pradesh, India,
Email Id- amit.kumar@shobhituniversity.ac.in

ABSTRACT:

The chickpea and pigeon pea are the two most significant pulse crops grown in India. More over half of the total area planted with pulses is taken up by these, and they produce 60% of the total. The average productivity of chickpea and pigeon pea, at 800 kg/ha and 750 kg/ha, respectively, is significantly lower than their potential yields. Biologic restrictions are the most important of the many challenges that stand in the way of this potential. Among biotic stresses, diseases and insect pests are the primary production-limiting elements that cause a yield loss of about 30%. This can be decreased by using pest management strategies like Integrated Pest Management (IPM). IPM, commonly referred to as integrated pest control (IPC), is a multifaceted strategy that combines chemical and non-chemical approaches for effective pest control. Pest population control under the economic injury level (EIL) is the goal of IPM. IPM is described as "the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justifiable and reduce or minimize risks to human health and the environment by all available pest control techniques," by the UN Food and Agriculture Organization. IPM highlights the expansion.

KEYWORDS:

Chickpea, Food and Agriculture Organization, IPM, Pioneer, Techniques.

INTRODUCTION

Entomologists in California created the idea of "supervised insect control" shortly after World War II, when synthetic insecticides were widely accessible. Entomologists in the US Cotton Belt were promoting a similar strategy at the same time. According to this plan, qualified entomologists "supervised" insect management, and insecticide treatments were made based on findings from routine monitoring of pest and natural enemy populations. This was considered a substitute for calendar-based software. Based on ecological information and analysis of expected changes in pest and natural enemy populations, supervised control was carried out.

Entomologists at the University of California developed "integrated control" in the 1950s, with a large portion of its conceptual underpinnings being supervised control. For a specific insect pest, integrated control aimed to determine the ideal combination of chemical and biological controls. Chemical pesticides had to be applied in a way that didn't interfere with biological control. Thus, the words "integrated" and "compatible" were interchangeable. To avoid a pest population reaching a level at which economic losses would exceed the cost of the control measures (the economic injury level), chemical controls were to be used only after routine monitoring indicated that a pest population had reached a level that required treatment.

IPM broadened the idea of integrated control to all pest classes and all available methods. As with integrated control, controls like pesticides had to be used, but they now had to be compatible with strategies for all classes of pests. The IPM framework now includes other strategies, such as host-plant resistance and cultural modifications. Entomologists, plant pathologists, nematologists, and weed scientists all worked together in IPM. In February 1972, President Richard Nixon ordered federal agencies to take action to accelerate the adoption of IPM in all pertinent areas, establishing IPM as a national policy in the United States. To oversee the creation and application of IPM techniques, President Jimmy Carter established an interagency IPM Coordinating Committee in 1979.

Losses Approximately 30% of the potential pulse production

Each year, illnesses and insect pests cause the loss of crops. Based on the incidence of these diseases between 1975 and 1980, losses due to wilt and sterility mosaic in pigeon pea have been estimated to be around 302 thousand tones. Chickpea losses from the pod borer complex have reached 668 thousand tones, and pigeon pea losses have reached thousand tones. According to estimates of 10 percent, or around 520 thousand tones yearly, grain is lost each year as a result of chickpea wilt and root rot. Pigeon pea and chickpea are typically grown by resource-constrained farmers on marginal or sub-marginal areas. Although extensive pest and disease protection plans have been devised, they have not been used successfully to stop losses because of the weak economic standing of the pulse growers. Farmers are not sufficiently trained to apply these inputs in the appropriate way and at the right time, even in cases where they are ready to use management approaches to generate higher yields. The All India Coordinated Project on Improvement of Pulses centers and the Indian Institute of Pulses Research, Kanpur, developed the key management factors, which are now available to farmers for dissemination for instance, there are efficient chemical and biological ways to manage the gram pod borer, but the resistant types have not yet been created. In Andhra Pradesh, a tolerant pigeon pea variety has just lately been made available. Similar to that, many natural.

Pigeon pea has pest foes known to exist, but nothing is known about how to utilize these as 'biological tools' to control insect pests, particularly against pod fly. The traditional approaches for managing diseases in chickpea and pigeon pea include crop rotations, intercropping, broader spacing, sparing use of fungicides, and occasionally cultivating resistant cultivars. Development of chickpea and pigeon pea wilt/root rot resistant cultivars has advanced significantly in recent years. These have contributed to some output stability in disease-endemic areas. However, further management choices must be offered in order to further improve the effectiveness of these kinds. There are currently no pigeonpox varieties that are wilt resistant for the northeastern plains (Uttar Pradesh, Bihar, and West Bengal), where the crop covers a sizable region. Another potential disease is Phytophthora blight, particularly in short-duration pigeon pea varieties where biocontrol techniques and resistant cultivars are not yet available.

Comprehensive Pest Management

To some extent, diseases and pests may be controlled through the use of pesticides, resistant/tolerant cultivars, biological agents, and changed cultural techniques. Any one approach, however, might not be very efficient given the variety of pathogens and insect pests, the variety of agroclimatic variables, and the cropping situations that influence the pests and diseases. In order to create integrated pest management (IPM) plans that are financially sustainable, it is worthwhile to incorporate the available and compatible control techniques. The Project Directorate of Pulses was established in Kanpur in 1979, marking the beginning of research on integrated pest management in pulses. The incidence of disease and insect pests was initially researched in relation to the effects of different management components. The All India Coordinated Research Project on Pulses network was then used to integrate management components. In the late 1980s, practical IPM packages were found and suggested for field adoption in significant pulse-growing regions.

The host plant resistance was given a lot of attention as individual components continued to be refined concurrently. In order to create resistant lines to wilt in chickpea and pigeonpox, sterility mosaic in pigeon pea, and Ascochyta blight tolerance in chickpea, a variety of resistant sources against key diseases were discovered. A few lines with tolerance in both chickpea and pigeon pea have been isolated, despite the fact that no true or significant level of resistance against Chelicera armigers could be found. Additionally, lines with a fair amount of pod fly resistance have been found. They serve as donors for the creation of tolerant varieties. The proper use of pesticides, their safety around natural enemies, their numerous actions, biorationals, growth regulators, biopesticides, plant products, and cultural practices have also been highlighted.

DISCUSSION

To spread IPM technology in chickpea at various sites across the nation, FLDs were held between 1993 and 1998. With an average increase of 24.3 percent, the designed IPM package has been demonstrated to be successful in increasing crop output by 16 to 34 percent. Although there was a sizable yield boost under IPM plots, the technique still has to be improved to have a greater impact. 176 IPM demonstrations in pigeonpox were carried out during this time. The yield gain, which ranged from 5% to 40% and had a mean of 28.2% demonstrated that IPM was better to traditional chemical control. Field trials conducted by the AICRP from 1992 to 1998 also shown a better impact of IPM technology, with yield increases of 33% to 39%.

Limitations to the Adoption of IPM

IPM has been demonstrated to be a successful approach of pest management. But due to a number of obstacles, farmers are not adopting it to the required level. Here are some significant restrictions: IPM adoption in pulses is severely hindered by a lack of biopesticides and bioagents on the supply side. Their bulk multiplication in the lab requires a laborious and challenging procedure. Additionally, there is a paucity of trained workers for the maintenance and large production of bioagents. IPM, commonly referred to as integrated pest control (IPC), is a multifaceted strategy that combines chemical and non-chemical approaches for effective pest control. Pest population control under the economic injury level (EIL) is the goal of IPM. IPM is described as "the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justifiable and reduce or minimize risks to human health and the environment by all available pest control techniques," by the UN Food and Agriculture Organization. IPM fosters natural pest management mechanisms and places an emphasis on the growth of a healthy crop with the least amount of interruption to agro-ecosystems Since the 1970s, entomologists and ecologists have pushed for the use of IPM pest management. IPM makes pest control safer [1]–[4].

History

Entomologists in California created the idea of "supervised insect control" shortly after World War II, when synthetic insecticides were widely accessible. Entomologists in the US Cotton Belt were promoting a similar strategy at the same time. According to this plan, qualified entomologists "supervised" insect management, and insecticide treatments were made based on findings from routine monitoring of pest and natural enemy populations. This was considered a substitute for calendar-based software. Based on ecological information and analysis of expected changes in pest and natural enemy populations, supervised control was carried out.

Entomologists at the University of California developed "integrated control" in the 1950s, with a large portion of its conceptual underpinnings being supervised control. For a specific insect pest, integrated control aimed to determine the ideal combination of chemical and biological controls. Chemical pesticides had to be applied in a way that didn't interfere with biological control. Thus, the words "integrated" and "compatible" were interchangeable. To avoid a pest population reaching a level at which economic losses would exceed the cost of the control measures the economic injury level, chemical controls were to be used only after routine monitoring indicated that a pest population had reached a level that required treatment the economic threshold.

IPM broadened the idea of integrated control to all pest classes and all available methods. As with integrated control, controls like pesticides had to be used, but they now had to be compatible with strategies for all classes of pests. The IPM framework now includes other strategies, such as host-plant resistance and cultural modifications. Entomologists, plant pathologists, nematologists, and weed scientists all worked together in IPM. In February 1972, President Richard Nixon ordered federal agencies to take action to accelerate the adoption of IPM in all pertinent areas, establishing IPM as a national policy in the United States. To oversee the creation and application of IPM techniques, President Jimmy Carter established an interagency IPM Coordinating Committee [5]–[7] For promoting the use of IPM, Perry Adkisson and Ray F. Smith were awarded the 1997 World Food Prize.

Applications

IPM is utilized for general pest control, including structural pest management, turf pest management, and ornamental pest management, in horticulture, forestry, human habitations, and preventive cultural property conservation. IPM techniques, also referred to as resistance management, aid in the prevention and slowed development of resistance.

A typical American IPM system is built around six fundamental elements

Acceptable pest levels Control, not eradication, is the focus. According to IPM, it is frequently impossible to completely eradicate a pest population, and doing so can be risky and expensive. IPM programs first try to define action thresholds acceptable pest levels and then implement controls if those thresholds are crossed. These criteria are pest and location specific, so having a weed like white clover may be okay in one location but not at another. Selection pressure is lessened when a pest population is given a chance to persist at a safe level. Because those bugs with resistance will be the genetic foundation of the future population if practically all pests are eliminated, this slows the rate at which a pest acquires resistance to a management. The predominance of any resistant genes that emerge is diluted by keeping a sizable number of non-resistant specimens. Similar to how using a single class of controls repeatedly makes pest populations more resistant to that class, switching between classes helps avoid this [8], [9].

Preventive cultural practices

The first line of defines is choosing types that are optimal for the local growing circumstances and maintaining healthy crops. Then comes plant quarantine and "cultural techniques" like agricultural cleanliness, such removing sick plants and sterilizing pruning shears to stop the spread of pathogens. The demand for fungicides is significantly reduced when beneficial fungi and bacteria are added to the potting soil of horticultural crops susceptible to root diseases. Monitoring Continuous observation is crucial. Inspection and identification are two divisions of observation. Insect and spore traps, visual inspection, and other techniques are employed to keep an eye on pest activity. A thorough understanding of the behaviour and reproductive cycles of the target pest is crucial, as is the maintaining of records. Insects have cold blood; thus, the temperature of their environment affects how they grow physically. The development cycles of several insects have been modelled in terms of degree-days. The best time for a certain bug outbreak depends on the environment's degree days. Plant pathogens respond to weather and season in comparable ways.

Mechanical controls

If a pest problem becomes intolerable, mechanical methods are the first line of Défense. To prevent breeding, they include basic hand-picking, obstacles, traps, vacuuming, and tillage. Biological controls Control can be achieved using natural biological processes and materials, generally at a lower cost and with a minimal impact on the environment. Promoting beneficial insects that prey on or parasitize target pests is the major strategy. This group also includes biological insecticides made from naturally occurring microorganisms, such as Bt, entomopathogenic fungi, and entomopathogenic nematodes. More "biology-based" or "ecological" methods are being considered.

Synthetic pesticides are used responsibly when necessary and frequently just during specified phases of a pest's life cycle. Many modern pesticides are made from plants or naturally occurring compounds such as nicotine, pyrethrum, and analogues of insect juvenile hormones, although the toxophore or active ingredient may be changed to boost biological activity or stability. The desired targets of pesticide applications must be reached. It is crucial to match the application method to the crop, the pest, and the pesticide. The overall pesticide use and labour costs are decreased by the use of low-volume spray equipment.

A simple or complex IPM regime is possible. Historically, agricultural insect pests were the primary focus of IPM programs. IPM programs are now being created to cover diseases, weeds, and other pests that interfere with management objectives for sites like residential and commercial structures, lawn and turf areas, and home and community gardens, despite the fact that they were originally developed for agricultural pest management. The use of predictive models as tools to support the execution of IPM programs has proven to be effective.

Process

IPM, which is applicable to the majority of agricultural, public health, and amenity pest management scenarios, is the selection and use of pest control measures that will assure favourable economic conditions, ecological repercussions, and social implications. The creation of economic injury levels comes after monitoring, which involves identification and inspection. The economic threshold level is determined by the economic injury levels. When pest damage and the advantages of treating the pest outweigh the cost of treatment, that is. This can also be a threshold for taking action when defining an undesirable level unrelated to financial harm. Action thresholds and economic injury levels are more frequently used in structural pest management than in traditional agricultural pest management. One fly in a hospital operating room is unacceptable, but one fly in a pet kennel might be. This is an example of an action threshold.

Action must be made to minimize and control the pest population once a certain point has been reached. The use of cultural controls, such as physical barriers, biological controls, such as the addition of and conservation of natural enemies and predators of the pest, and finally chemical controls, such as pesticides, are all part of integrated pest management. IPM is suitable for organic farming (with the exception of synthetic pesticides) because it relies on knowledge, experience, observation, and the integration of numerous techniques. Materials listed on the Organic Materials Review Institute (OMRI) may or may not be among these.[19] Although organic farming and gardening utilize pesticides and insecticides that are generally safer than synthetic pesticides, they are not necessarily more safe or environmentally friendly than synthetic pesticides and can still be harmful. IPM can potentially minimize expenses for traditional farms by lowering the exposure of people and the environment to dangerous chemicals [10]–[12].

Characterization of biological control agents, health hazards, environmental risks, and efficacy are the four main components of risk assessment. Ineffective actions may stem from incorrect identification of a pest. For instance, since many fungal and viral illnesses develop in damp environments, plant damage brought on by over watering may be misinterpreted for a fungal infection. Prior to the pest's activity becoming noticeable, monitoring starts right away. Monitoring of agricultural pests includes keeping an eye on water quality and soil fertility. The pH, alkalinity, dissolved mineral content, and oxygen reduction potential all have a significant impact on the general health and pest resistance of plants. Many infections are water-borne and are spread both directly and indirectly by splashing and irrigation water.

Knowing the pest and understanding its lifecycle can help determine the best times to intervene. Mulches and pre-emergent herbicide, for instance, can stop weeds from sprouting from last year's seed. If the pests are not numerous or are not growing quickly, interventions may not be necessary for pest-tolerant crops like soybeans. If the estimated cost of the pest's damage is more than the cost of control, intervention is necessary. Health risks may necessitate intervention that is not justified by economic factors. dissemination at the right moment. Additionally, the current IPM packages have gaps. The main flaws include the absence of warning systems, the poor technology for applying pesticides, and the lack of real resistant types. Additionally, there are few connections between the systems for extension and research. The primary barriers to demand on the supply side are producers' lack of collaboration and farmers' ignorance of IPM technology and application techniques.

Effective Pest Management Techniques In order for IPM to be effective, the restrictions must be effectively handled and the knowledge gaps must be filled through R&D. The following tactics could promote IPM adoption: IPM approach training for farmers and extension agents Aggressive demonstration campaigns run by research and development (R&D) organizations in partnership with government officials and non-governmental organizations (NGOs) 116 Improved access to vital inputs including biopesticides, bioagents, and resistant varieties; Development of monitoring tools and forewarning systems; Promotion of the use of safer pesticides and suitable application techniques; Research on several disease- and pest-resistant kinds; Holistic integration of all data to create cost- and bio-efficient processes.

CONCLUSION

Stronger plants were introduced during the Green Revolution of the 1960s and 1970s so that grain loads could be heavier due to intense fertilizer use. According to FAO statistics, the value of pesticide imports by 11 Southeast Asian nations nearly multiplied by seven between 1990 and 2010, with severe effects. Farmers of rice get used to spraying shortly after planting since it is prompted by the leaf folder moth's early-season appearance. It doesn't affect yields and only has little damage. In 1986, Indonesia outright stopped funding the use of 57 pesticides. The 2000s saw a reversal of progress as prices fell as a result of expanding production capacity, particularly in China. Asia's rice output more than doubled. However, it led to farmers believing that using more seed, fertilizer, or pesticides is always better. The primary target of the farmers, the brown planthopper Nila Parvata lunges, has grown more resilient. In Asia, outbreaks have wreaked havoc on rice crops since 2008, but not in the Mekong Delta. In Vietnam, less frequent spraying made it possible for natural predators to eradicate planthoppers. Massive planthopper outbreaks that affected 400,000 hectares of Thai rice fields in 2010 and 2011 resulted in losses of roughly $64 million. The idea of "no spray in the first 40 days" is currently being promoted by the Thai government.

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CHAPTER 9

EXPLORING THE PEST MANAGEMENT IN COTTON GROWN BY RAINFALL

Deepak Kumar, Assistant Professor, Department of Agriculture and Environmental Sciences,
Shobhit University, Gangoh, Uttar Pradesh, India,
Email Id- deepak.kumar@shobhituniversity.ac.in

ABSTRACT:

Since it is a cash crop, cotton has a significant economic impact on the Indian farming community. However, it is extremely vulnerable to several illnesses and insect pests. Prosperity comes from a healthy crop with little pest activity, while sorrow comes from a serious pest infestation. This is especially true in rainfed regions, where the agricultural environment is marginal and there are few opportunities to grow alternative crops. Pest thus has a significant role in determining the success of rainfed farms. Although the pest problem cannot be completely eliminated, it can be reduced by using the right pest management technique, whether it be chemical pest control, biological pest control, or integrated pest management (IPM). The increasing issue of pesticide resistance, however, has led to a decline in the effectiveness of chemical-based pest management. The majority of the insecticides designed to control the bollworm, Chelicera armigers, have been rendered ineffective by the bug. This led to the creation and field testing of an IPM package that included cultural practices, resistant cultivars, insect reconnaissance, beneficial insects, and the selective application of pesticides. When all producers utilize IPM on a local rather than regional basis, their effectiveness is maximized. IPM just seeks to bring insect populations down to a level below those that would cause economic harm, not to zero.

KEYWORDS:

Bolls, Crop, Cotton, Pest Management.

INTRODUCTION

Numerous illnesses and insect infestations can affect cotton. Here is a succinct description of them Aphis gossypii Glover Aphids are typically found on the stems, leaf terminals, and undersides of the leaves, which causes the leaves to coil and twist upward. Between June and October, the pest is active. Aphids are parthenogenetic organisms that live in colonies. Nymphal stage lasts 7-9 days, while adults have a lifespan of 12–20 days. The pest has 12–14 generations annually as a result. Nymphs and adults both weaken the plants by sucking sap from the delicate buds, twigs, and leaves. Each aphid creates multiple punctures and excretes honeydew, which promotes the growth of sooty mild on the twigs and leaves, giving plants a bluish appearance. Ants and sooty mould are attracted to honeydew, which promotes the growth of dangerous microorganisms.

Early in the season, aphid control is aided with systemic insecticides Imidacloprids at 7g/kg or Crosland at 4g/kg of seeds administered as seed dressing or at planting time. Application of other chemicals, such as 'Aphidiid' spray, also lowers its prevalence. Marasco bagatelles Ishida's Hassid: The first 50 days after sowing are when the insect affects the crop, and early winter is when it is most severe. Adults are approximately 3 mm long, greenish yellow in the summer, and reddish in the winter. On the vertex of the forewing's hind half, there are two black specks. The nymphal stage lasts for 7–21 days, whereas the adult stage lasts for 35–50 days. Nymphs are wedge-shaped and greenish yellow. Both adults and nymphs consume the sap from the underside of the leaves, dehydrating the plants and turning them a pale red rust that falls to the ground and eventually dries up.

Thrips impede crop growth by feeding on the buds and young leaves. The cupped, warped leaves that have gone dark around the edges are a common indicator of a severe thrips infection. It is active from May to September. Both nymphs and adults scavenge sap from the underside of leaves, tearing the tissues. Older leaves develop a brown upper surface and a silvery white lower side. Curled, wrinkly, and eventually desiccated leaves. Crop maturity is typically accelerated when thrips are controlled. 121 Whiteflies wreak havoc on cotton by sucking plant sap and secreting honeydew that fosters the growth of sooty mould and colours the lint. Heavy feeding weakens plants, speeds up defoliation, and lowers yield. The pest is present all year long. On the underside of the leaves, nymphs and adults are grouped together and lethargic creatures. On the underside of cotton leaves, you can find every stage of the whitefly.

The adults and nymphs feed on the cell sap, weaken the plant by preventing normal photosynthesis through the excretion of honeydew, the development of sooty mould on the leaf surface, and the lint of the opening bolls, which causes the process of blackening. On leaves, chlorotic patches appear, and in extreme cases, the veins turn translucent. The lint is contaminated with sooty mold. The bug aids in the spread of the leaf curl virus (CLCV). Bollworms: Cotton is severely damaged by tobacco budworm and cotton bollworm. Insecticide resistance has recently become a major issue, particularly against pyrethroids in all cotton-growing regions. It is therefore vital to control high levels of bollworm infection by using alternate insecticides. Field monitoring should be done twice a week when there are lots of moths around. When infestation is minimal, use an approved larvicide in the fields that had not previously been treated.

In locations with low rainfall, E. insalata is more common than E. vitelli. Between the ages of 35 and 110 days, the pest attacks the crop. Moths lay their eggs on flower buds, branches, and twigs. They pupate inside frail cocoons found in dirt, fallen buds, or other plant debris. In the summer, the development takes 17–29 days to complete; in the winter, it takes 42–84 days. By burrowing into the developing shoots, buds, flowers, and bolls, caterpillars harm plants. Attacked shoots eventually wilt, droop, and die, and flowers and buds fall off. Bolls that are infected fail to shed, open too soon, and produce lint that is of inferior quality. The growth of the bolls is hampered by pupation, which occurs inside the bolls. One of the most harmful pests to cotton is the pink bollworm Ctenophora gossypols Saunders The pest is present from July to November.

Dark moths with black patches on their forewings are the adults. The immature, creamy-yellow caterpillars change to pink as they get older. The underside of the plant's vulnerable portions, including the stalks, flower 122 buds, leaves, and green bolls, is where the eggs are placed. The duration of the egg, larval, and pupal phases are, respectively, 4- 15, 8-42, and 8-12 days. In three to six weeks, the life cycle is over. Feeding on the flower buds, panicles, and bolls results in the damage. Excreta from larvae feeding inside the seed kernels shut the openings of entry. They create "double seeds" by cutting window holes in the two adjacent seeds, which ultimately causes harm. Buds and immature bolls that have been attacked fall off. Oil content, ginning percentage, and lint content are all compromised. The insect hinders the growth of the bolls by hibernating in "double seeds" and hiding in the cavities.

Chelicerae armiger a Hubner, sometimes known as the American bollworm Polyphagous is the pest, which is most dangerous during an attack and active from July to October and February to April. The hind wings are whitish with a blackish patch along the outer margin, and the forewings have greyish wavy lines and a black kidney-shaped mark. The adult moth is thick, yellowish brown with a dark spot and area on them. The larva measures around 35 mm in length and has stripes along the sides of its body that are dark grey and yellow. On the plant's tender areas, eggs are laid. The larvae initially consume leaves before drilling into square/bolls and seeds while still leaving the rest of its body outside. One larva is capable of destroying 30–40 bolls. At the base of the boll, there are sizable, circular entry holes. Anomies flava Fabricius, a semi-looper Small, greenish looping worms called loopers have thin white stripes running down their backs. These worms seem ragged because they munch on leaves. The soybean looper species is most likely the source of the large late-season populations of loopers. With currently approved insecticides, it is exceedingly difficult to manage this species. Start controlling while the worms are little and the top bolls that should be harvested are not yet fully developed.

Although late-season loopers are infrequent in their appearance, they have the potential to severely defoliate cotton communities when they do. It is a sporadic bug that can occasionally seriously harm the crop. The forewings of the adult are reddish brown with two dark zigzag stripes running across them, while the hind wings are pale brown. Semilooper larvae are 25–30 mm long, pale yellowish green, with six pairs of black and yellow markings on the back and five white longitudinal lines on the dorsal side. On the upper surface of the leaf, eggs are placed singly. In the earth or in plant debris, pupation occurs. It takes 28 to 42 days to complete the life cycle. The juvenile larvae gather in groups, move about aggressively, and eat by puncturing the leaf lamina. The midrib and veins are all that remain after the adult larvae's ravenous feeding. They obtain their food by eating the leaves from the border to the veins. The caterpillars consume buds, bolls, and delicate shoots. Xanthomonas axopods' p.v. malvaceous (Smith) Dye, a bacterial blight: The bacterial blight affects cotton plants at every step of their growth, beginning at the seedling stage. The disease is seed-borne, spreading from the cotyledons to the leaves, then to the main stem and bolls.

The damaged plant organ or growth stage determines the distinct descriptive symptoms at each step, such as seedling blight, angular leaf spot, vein blight, blackarm, and boll lesions. Angular leaf spot (ALS) is a term for foliar symptoms. The dots are first more noticeable and wet on the dorsal surface of the leaf. When lesions extend along the sidewalls of the primary veins, this is another typical leaf symptom that appears. Vein blight is the term used to describe this condition, which can occur in conjunction with ALS or without it. The infection moves from the leaf lamina via the petiole and stem in cultivars that are sensitive to it. The phrase "black-arm," by which the illness is frequently referred to, derives from the sooty black lesions that occur. The stem may become totally girdled by the lesion, which could make it break in strong winds or from the weight of growing bolls. In India, where the crop is irrigated, losses between 5 and 20 percent are not uncommon. Ramularia areola Atka Grey mildew When the plant reaches maturity, usually after the first boll-set, the disease first manifests itself on the lower canopy of older leaves. It appears as irregular, angular, pale transparent dots with a distinct or erratic border made of leaf veins. Intense sporulation on the dorsal surface of the leaves gives the lesions a white mildew-like look. The ventral (upper) leaf surface then develops a light green to yellow green colouring, which eventually turns necrotic and dark brown in hue. They are now easily confused with the angular leaf spot stage of the bacterial blight. The badly damaged leaves frequently defoliate, which causes early boll opening and immature lint.

DISCUSSION

For the main diseases, weeds, and insect pests, an IPM module has been created. The main IPM elements used in field settings are shown below. In order to prevent pest damage to collections and cultural property, integrated pest management is the practice of monitoring and managing pest and environmental information with pest control techniques in museums, libraries, archives, and private collections. These institutions' ultimate objective is to preserve cultural property. Pests occur in a variety of shapes and sizes, including insects, mites, rats, bats, birds, and fungi. Insects and fungus are the two most prevalent types, according to Every museum should have some kind of pest control and monitoring system in place to protect their collection, and they should also review their storage and museum facilities to figure out how to control and prevent pest infestations using an Integrated Pest Management plan. The implementation of integrated pest management in museums and other cultural institutions is the subject of the subspecialty of museum IPM. The key distinction between IPM and Museum IPM is that in a museum, the protection of collections from pests takes precedence [1], [2].

The goal of integrated pest management is to comprehend what attracts bugs, their habits, and their life cycles in order to control pests in a "holistic" manner. This program includes identifying the kinds of pests that are present in the structure, setting the museum's short- and long-term IPM program goals, and fostering staff consensus. The museum must "select the most appropriate and secure control methods for eradication" of the pests, consulting experts as necessary. If a few pests are found, it's crucial not to freak out and make snap judgments. Before acting, a museum should think things out and prepare their steps. The museum must set aside time and resources for Integrated Pest Management in order to implement and track the development of their program. In order to be properly implemented, an IPM program "will require the coordinated effort of all staff members, and may initially be more expensive than conventional pest management." [3]–[5]

Cultural customs

After taking into account their total impact on crop output, some cultural practices need to be recommended since they have a major impact on crop management. Acid-delinked seed offers effective protection against illnesses transmitted by seeds. Any method that postpones or prolongs fruiting is likely to encourage more insect and disease attack. In addition to directly affecting insect populations, factors including high plant populations, high nitrogen rates, late planting, heavy watering, and dampness should be avoided because they can lengthen the fruiting period. It is not necessary to stop the attack of grey mildew during harvest. Early harvest without ratooning and stalk destruction limits key pests' access to food, which helps keep the pest population below the critical level [6]–[9].

parasites and predators

The initial line of define against sucking pests, bollworms, and tobacco budworms is comprised of parasites and predators. Important regulators, especially in the early and middle of the growing season, include predators including coccinellids, spiders, pirate bugs, green lacewing larvae, and parasitic wasps. Some pesticides are more harmful to parasites and predators than others, thus they should only be applied sparingly and when absolutely required to kill the target insects. chelicerae was the main pest in this study, and Trichogrammatid chelones was released at a rate of 1.5 lakh/ha to suppress it. The idea of a crop café needs to be promoted in order to increase the population of beneficial insects. In cotton fields, growing cowpeas, marigolds, sorghum, and tobacco is beneficial. Growing cowpea and maize together on the borders have proven to be quite efficient in reducing the number of sucking pests. Similar to how Sutaria's growth in the 10th row draws raptors to eat bollworm larvae.

cautious and selective use of pesticides

Numerous considerations should go into the selection of insecticides. The only factor in pest management should not be a pesticide's efficacy. The emergence of insect resistance has an impact on both target and nontarget organisms, posing risks to human safety. Additionally significant and deserving of equal consideration are the economic factors. Only after the pest has grown out of control and reached an economic threshold level may insecticides be used. The population densities of 125 damaging and beneficial insects can be obtained by installing pheromone traps at random locations in the fields and conducting at least twice-weekly surveying to determine this. Insecticide use would be decreased if pesticides were only used when necessary to manage cotton pests, and pesticide resistance wouldn't grow. It would reduce the cost of spraying and the overall amount of pointless insecticides in the environment. Additionally, timing and coverage must be done correctly. Pesticides can be applied in a timely manner thanks to field scouting and data on moth catch obtained through pheromone trap. Apply 500 to 600 litres of water per hectare (ha) to ensure enough coverage using ground equipment. Spray nozzles must be kept clean in order to perform properly. The majority of the pests' future generations are found on the lower surface, so adjust spray booms to prevent nozzles from dragging through the foliage [10]–[12].

A Case Study of IPM

IPM package were conducted on farms at the Cotton Research Station in Nanded, Maharashtra, as well as simultaneously in the villages of Barad and Kinwat. Pesticide treatments could be cut from an average of 6 to 2 with the help of IPM while still maintaining crop output. The goal was to educate farmers on the importance of pests and their naturally occurring predators as well as the negative effects of the excessive and careless use of chemical pesticides. Learning is a crucial component that gives farmers a new capability for dealing with physical, social, and environmental issues with self-assurance in addition to assisting them with pest management. Additionally, it increases knowledge of and enthusiasm for alternative biologically-based technology. The systemic pesticide treatment of seeds, which is less dangerous than aerial applications, regular scouting and monitoring of pest incidence through the installation of pheromone traps, augmentation of natural enemies.

integration with a variety of cultural methods (an uniform plant stand) by using the same genetic material, and application of fertilizer are the key components of the cotton IPM module. Apply insecticide during the middle of the day if necessary to keep pollinators and predators away. Encouraged by the ongoing performance, the NCIPM expanded the IPM package's application in Astha village, Nanded district, during the subsequent kharif season (1998). The village is situated in the tribal region, straddling the boundaries of the Andhra Pradesh district of Adilabad and the Maharashtrian district of Yavatmal. The district of Nanded represents the cotton-growing regions of the neighbouring districts of Andhra Pradesh and Madhya Pradesh as well as the cotton belt of Maharashtra. Under the direction of an expert, the package was moved onto 127 hectares of land that belonged to 76 cotton producers. Farmers' Field Schools were held to educate the farmers about IPM techniques [13]–[16].

In addition, the NCIPM offered free access to important biological inputs including Hap and trichogrammatid chalones. Farmers showed a lot of interest in the novel pest management strategy. This was owing, in part, to cotton suffering significant losses from chelicerae the year before. They had failed in their attempts to chemically control chelicerae. The continuous use of pesticides increased costs, reduced net returns, and increased the farmers' debt. By educating farmers about the benefits of the technology over their traditional methods and providing training through routine farmers field schools, the novel measures were put into action. The socio-economic impact analysis was created primarily to assess the effectiveness and economic performance of the IPM technology in comparison to the farming practices. The economic analysis shown in Table 1 serves as a good indicator of IPM's success. The following strategies contributed to the IPM implementation's success.

CONCLUSION

IPM technology has various uses in agriculture, such as generating Hamp at the village level to fulfill local needs, preventing subsequent outbreaks of pest and disease, being reasonably priced, without polluting the environment or soil, and assisting in the maintenance of natural bio-agents. Normally, Chelicerae armiger switches from cotton to other Rabi/summer crops like chickpea and pigeon pea. When H. armiger a in the cotton crop is successfully suppressed early on, farmers are better equipped to collect their Rabi/summer crops. IPM calls for local marketing. It is necessary to launch widespread PR and outreach campaigns. IPM should concentrate on pest management rather than a particular crop. Networking between the community and SAUs is essential. Forecasting of disease and pest outbreaks has to be improved. Cotton has a huge financial impact on the Indian farming community because it is a cash crop. However, it is particularly susceptible to a number of diseases and pest insects. A good crop with low insect activity leads to prosperity, while a significant pest invasion leads to misery. In rainfed locations, when the agricultural environment is poor and there are few opportunities to grow alternative crops, this is particularly true. Thus, a major factor in determining the performance of rainfed crops is pest. Although the pest issue cannot be entirely resolved.

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CHAPTER 10

ECONOMIC ANALYSIS OF COTTON PEST MANAGEMENT TECHNOLOGIES

Deepak Kumar, Assistant Professor, Department of Agriculture and Environmental Sciences,
Shobhit University, Gangoh, Uttar Pradesh, India,
Email Id- deepak.kumar@shobhituniversity.ac.in

ABSTRACT:

Pesticides have significantly aided in the expansion of world agriculture, along with high yielding seeds and fertilizers. Despite this, pesticides have faced harsh criticism because of the risks they may pose to the environment and public health. More issues are raised in wealthy nations. The failure of insecticides to control pests and rising cost of plant protection in emerging nations are more concerning. Cotton is a soft, fluffy staple fiber that develops around the seeds of cotton plants of the genus Gossypium in the mallow family Malvasia in a boll, or protective casing. The fiber is almost entirely made of cellulose, with traces of wax, fat, pectin, and water. The cotton bolls will speed up the dissemination of the seeds in their natural environment. Native to tropical and subtropical regions of the world, including the Americas, Africa, Egypt, and India, the plant is a shrub. Mexico has the most varieties of wild cotton, with Australia and Africa coming in second and third. Both the Old and New Worlds independently domesticated cotton. Most frequently, the fiber is spun into yarn or thread and used to create a supple, breathable, and long-lasting textile. It is known that cotton has been used for clothing from ancient times; remnants of cotton fabric from the Indus Valley civilization, dating to the fifth millennium BC, have been discovered.

KEYWORDS:

Cotton, Control, Loss, Management, Yield.

INTRODUCTION

It's possible that 5000 BC saw the domestication of cotton in eastern Sudan close to the Middle Nile Basin, where cotton textile was already being made. In Mero, cotton cultivation and expertise in its spinning and weaving both peaked about the fourth century BC. One of Mero's sources of income was the export of textiles. Physical traces of cotton processing tools and the presence of cattle in some regions indicate that ancient Nubia had a "culture of cotton" of sorts. According to some researchers, cotton's use in trade with the nearby Egyptians contributed to the Nubian economy's importance. In his inscription, Aksumite King Ezana bragged about razing substantial cotton plantations in Mero during his invasion of the area.

Numerous cotton textiles from the Meroitic Period starting in the third century BCE have been discovered and survived because of the suitable dry conditions. The majority of these fabric fragments are from Lower Nubia, and 85% of the textiles found in Classic/Late Meroitic sites are made of cotton. Cotton, a plant that typically thrives in moderate rainfall and better soils, requires additional irrigation and work in Sudanese climate conditions because of these arid conditions. As a result, a lot of resources would have been needed, probably limiting its cultivation to the aristocracy. Beginning in the first to third century CE, the direction of spun cotton and weaving technique all started to reflect the same style and manufacturing process. Additionally, cotton textiles can be seen in revered locations like sculptures and burial stelae.

As a result, insect pests cause the loss of nearly half of the cotton crop's potential productivity and with time, the loss has grown. From the early 1960s, when it was around 18 percent, to the early 1990s, when it was over 50 percent. Despite the use of pesticides worth Rs 50 million annually, Economic Evaluation of Pest Management Technologies in Cotton Pratap S. Birthal1 and Trichoderma, two naturally occurring foes of insect pests, research has produced novel technologies. Additionally, there are a variety of plant compounds that can be used as biopesticides, including azadirachtin (neem), pyrethrum, nicotine, etc. These are said to be effective at repelling pests, especially when combined with other pest management techniques such agronomic measures, chemical pesticides, and mechanical control. However, there have only been a few isolated instances of these technologies being used in the field. These technologies are only applied to about 2% of the total cropped area. Numerous obstacles can be preventing farmers from utilizing this technology. However, their modest acceptance shows that technical efficacy is a required, but not sufficient, requirement for a technology to be used more widely. It needs to pass other performance standards like practicability, economic effectiveness, and sustainability in order to get widespread adoption. This study compares traditional chemical pest control technology to biological pest management technology in order to evaluate the technical and financial performance of each.

Data

This study looked at the technical and financial effectiveness of several pest control methods using experimental data. From the annual reports of the Project Directorate on Biological Control, Bangalore, a division of the Indian Council of Agricultural Research, data on pest infestation, pest management inputs, and crop output were assembled. On a variety of crops, the PDBC 131 conducts multi-location pest management trials. For Gujarat, Punjab, and Tamil Nadu, information on cotton pest management was gathered. Data for Tamil Nadu covered the years 1992–1997, 1990–1998 for Punjab, and 1991–1998 for Gujarat. Averages for the crop period are used to represent the information on pest populations and the inputs used to control them. Damage to the bolls or buds was utilized as a stand-in for the degree of pest infestation. In addition, the data did not maintain consistency over time with regard to the types and amounts of inputs. Every crop season, the quantities were frequently but not significantly altered.

As a result, we divided the trials into four categories for analysis:

(i) Natural control

(ii) Chemical control

(iii) Biological control

(iv) IPM

describes a condition when a pest infestation occurs naturally without the use of pest management measures. Pesticides must be applied for chemical control, and one or more biological pesticides (bioagents, biopesticides, and herbal pesticides) must be used for biological control. Chemical and biological methods are both used in integrated pest management. application of pesticides using chemicals. All inputs from the bio-intensive IPM module were used in the TNAU technique, although with different quantitative values. Chemical insecticides, NPV, and neem oil were all used by farmers. Two different kinds, LRA5166 and MCU5, were tested. Northern Europe began to recognize cotton as an imported material in the late medieval era, albeit no one knew how it was made, other than that it was a plant. It was supposed that the plant was a tree rather than a shrub since Herodotus claimed that in India, trees grew wild and produced wool in his Histories, Book III, 106. Numerous Germanic languages maintain this feature in the names for cotton, such as Baumol in German, which means "tree wool" (Baum is the German word for tree and Wolle is the word for wool). People in the area could only assume that cotton was generated by plant-borne sheep because of its resemblance to wool. "There grew there [India] a wonderful tree which bore tiny lambs on the ends of its branches," wrote John Mandeville in 1350. These branches were so flexible that they could bend to allow the hungry lambs to eat.

The Tartar Vegetable Lamb

During the Muslim invasion of Sicily and the Iberian Peninsula, cotton manufacturing was brought to Europe. Figure 1 Following the Norman conquest of Sicily in the 12th century, cotton weaving techniques were later introduced to northern Italy and the rest of Europe. Around 1350, the spinning wheel was introduced to Europe, speeding up the spinning of cotton. Venice, Antwerp, and Haarlem were significant ports for cotton trade by the 15th century, and the exchange of cotton fabrics for other commodities was now a highly lucrative business [1], [2].

Figure 1: The Tartar Vegetable Lamb

The most crucial metric for evaluating the effectiveness of a pest management system is yield loss prevented. The difference between the yield of the plot with the best protection and the yield under 132 natural infestation is typically used to determine yield loss. Technology performs better when the loss is lower. When comparing yields with and without protection, the yield loss is frequently underestimated because a sizeable amount of the yield is lost even when the crop is protected using the finest available technology. This implies calculation of the yield that could be produced in the absence of pest infestation. To calculate the yield loss, the actual yield gained using various pest management technologies and methodologies is [3]–[6] compared. The prospective yield has recently been estimated using an econometric method. It assumes that yield or yield loss and the degree of pest infestation have a functional connection.

The association between yield or yield loss and pest infestation is then established using the regression approach, and the prospective yield or yield loss is estimated by extending the regression line up to the coordinate. The potential yield or yield loss is shown by the junction point. In other words, the regression equation's intercept term calculates the prospective yield or yield loss. The method has the advantage of include several technological options in the model and may be utilized for both single and multiple cultivation cycles. By regressing the actual yield (Yi) on the severity of the insect infestation (Ii), one may determine the potential yield. Yi = f (I i) (1) can be used to express the relationship. Equation 1 is applicable when there is only one technology or approach for controlling pests. When comparing technologies or procedures, which reflect the link between pest infestation and the technology (Ti), are estimated simultaneously. Dummies are used to symbolize technologies; when used, a technology has the value 1 and when not, it has the value 0. It is desirable to include this as a variable on the right-hand side since the level of pest control effort differs between technology and methodologies. I i = f (T i, C i) can be used to depict this as the cost of pest control (Ci). (2) 133 To negate the time influence on the amount of pest infestation, a time variable was introduced to the right-hand side. These connections were developed using time series averages of trial data. Crop varieties were altered over the course of tests, and as different varieties have varied potential yields, variety dummies (DVD) were added to the right side to calculate the potential yield of various varieties. Finally, we used the SURE approach to estimate the following equations.

DISCUSSION

If a technology produces net benefits comparable to those of its rival options, potential users will accept it. So, in order to determine the relative profitability of various pest management strategies, a cost-benefit analysis was carried out. Over the costs and returns from no crop protection, changes in the costs and returns for each pest management technique were calculated. It was calculated how the use of a method changed net revenue [7], [8].

Forecasts for Yield Loss

Findings from the Regression

In Gujarat, the connection between pest infestation and various pest management techniques is unfavourable. IPM and biological control coefficients are highly significant, indicating that they have greater potential than chemical control. The relationship between the cost of protection and the amount of infestation is favourable and significant at the 10% level, suggesting that as the level of infestation rises, more pest management activities are required. There is a negative and strong relationship between yield and boll damage. Positive and significant intercept term that offered an estimate of the potential yield of variety CH6. The coefficient for the CH8 variant is favourable and high important, demonstrating that it has a larger production potential than respectively, of CH6 and CH8 have a potential yield. In Punjab, there is a negative correlation between the amount of insect infestation and the various pest management techniques [9]–[12].

Estimates of yield loss1 related to various pest management techniques. Since Crispello is an expensive input and its integration substantially raises the cost of protection, it has been further classified as biological control and IPM with and without it. The suffix I represents the method without chrysoberyl, whereas the suffix II represents the method with Crispell. For both the CH6 and CH8 cultivars in Gujarat, biological control and IPM were more successful in preventing yield loss. More than half of the CH6 production was lost to insect pests using chemical treatment. The loss was 31% with biological control-I IPM applications made with and without chrysoberyl caused yield losses of 23% and 43%, respectively. By keeping the crop unprotected, the loss may have reached 58 percent. Under conditions of natural infestation, the yield loss of the CH8 variety was estimated to be 37%. It was decreased to 27% by chemical control, and to roughly 10%–11% by biological control and IPM. With chemical pest control, the variety F846's potential yield loss in Punjab was projected to be 43%; with biological pest control, it was 58%; and with IPM, it was estimated to be 53%. Loss without protection was nearly equivalent to loss with IPM in place.

For F414, the loss without protection was 44 percent, and chemical control may lower this to 16 percent. The loss with the use of IPM was somewhat larger than that without protection, whereas biological control decreased it to 39 percent. In the absence of pest management practices, more than half of the variety F1054's potential output was lost. Chemical control and IPM without crespelle could reduce it to 34% and 36%, respectively. Integration of chrysoberyl was unsuccessful, in contrast to Gujarat. More than two thirds of the variety LH1134's potential output might have been lost due to natural infestation. It was reduced to 11% with chemical pesticide protection. The effectiveness of IPM and biological control was lower. In the example of variety LRA5166, where yield loss was estimated to be around 21%, Tamil Nadu yield loss calculations imply that maximum protection against insect pests can be achieved with application of a moderately chemical-intensive IPM. The second-best choice was biointensive IPM (32%). Biological control was anticipated to cause the most yield loss2. With a yield loss of roughly 25 percent on the variety MCU5, bio-intensive IPM was shown to be the optimum technique of control.

Financial viability

It's not necessary for a yield-saving technology to be more profitable than its rivals. The cost of technology application (kind of inputs, their application rates, and pricing) impacts the profitability of technology given the crop output and its price. Below is a technology-by-technology assessment of the costs and returns3 related to various pest management strategies. In Gujarat, regardless of the crop variety, the costs of biological control and IPM were higher than those of chemical control. After crespelle was included into these, the cost of protection through biological control and IPM significantly increased. Under natural infestation, the variety CH6's net yields were assessed at Rs. 11132/ha. These weren't any different from using IPM-I and chemical control. Crespelle's integration into IPM and biological control had a negative net return. With the use of biological control and IPM without chrysoberyl, net gains (added returns minus new costs) over natural control were positive. Despite the application of chrysoberyl, biological control and IPM on CH8 were profitable. This suggests that (i) only high yielding varieties should use expensive inputs like crisper and (ii) research should focus on lowering the cost of Crispell production [13]–[16].

Regardless of the types on which it had been used, chemical control seemed to be the best option in Punjab. On F846, the price of chemical control was more expensive than the price of biological control but less expensive than the price of IPM. Chemical control also produced higher gross returns, which translated into higher net returns. Net benefits were somewhat negative when chemical control was used, and they were extremely negative when biological control and IPM were used. When compared to the other two options, chemical control of F414 was less expensive. In comparison to biological control and IPM, net returns from the use of chemical control were almost twice as high. Even no protection produced larger returns than IPM and biological control. The use of these techniques did not yield any money. Comparing chemical control on LH1134 to biological and IPM control, chemical control was more affordable and produced greater net returns.

Net benefits were favourable in all circumstances, although chemical control produced the highest net benefits. The least expensive method of control for F1054 was biological, which was then followed by chemical. Chemical control was used to achieve the highest net returns. IPM and biological control had no net advantages. When compared to moderately chemical-intensive and chemical-intensive IPM in Tamil Nadu, the cost of safeguarding the variety LRA5166 with biological control and bio-intensive IPM was five to six times higher (Table 9). The use of Crysoperla in these techniques led to a greater cost. Net returns were negative as a result of this. All approaches, with the exception of the moderately chemical-intensive IPM, had negative net advantages above chemical-intensive IPM. When applied to MCU5, bio-intensive IPM produced higher gross returns than moderately chemical-intensive IPM, but the higher cost of protection (caused by Crysoperla) made it unprofitable to use.

CONCLUSION

The results show that there are regional/locational differences in the technical and financial performance of biological control and IPM. This may be a result of the various agroclimatic conditions found in the chosen regions, which have a significant impact on insect populations. Crop variety, which differs in its yield potential and pest resistance, is thus a key element in pest management. In Gujarat and Tamil Nadu, the yield-saving potential of biological and IPM is superior to that of chemical control. The use of these technologies has also increased net economic advantages, especially in Gujarat. On the other side, Punjab has benefited economically and from enhanced protection as a result of chemical management. The inputs employed have an impact on how profitable various techniques are. For instance, even though C. crane is effectively protected against insect pests when integrated into biological control and IPM, the benefits are not usable because of the increased cost of treatment. This suggests the requirement for application standardization.

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CHAPTER 11

COST-EFFECTIVENESS OF INTEGRATED PEST MANAGEMENT IN PUNJAB'S RICE AND COTTON

Deepak Kumar, Assistant Professor, Department of Agriculture and Environmental Sciences,
Shobhit University, Gangoh, Uttar Pradesh, India,
Email Id- deepak.kumar@shobhituniversity.ac.in

ABSTRACT:

One of the states in India that uses the most pesticides is Punjab. Rice and cotton make up more than half of the state's gross cropped area, hence agriculture there faces a variety of insect pest issues. The main pest issues with rice in Punjab are insects/pests such plant hoppers, leaf folders, rice stem borer, etc. and diseases like bacterial leaf blight, blast, sheath blight, etc. In the case of cotton, in addition to Jassi's and whiteflies, bollworms are the most significant insect pests. Among the significant cotton diseases include bacterial blight, leaf blight, wilt, etc. Farmers in Punjab use a combination of cultural and mechanical control methods together with chemical control to defend their crops from insect pest attacks. Recently, Integrated Pest Management (IPM)-based pest control techniques have also been deployed in a few Punjabi areas. The IPM program in Punjab is evaluated in this essay.

KEYWORDS:

Adoption, Cotton, Farmers, Pesticide, Technology.

INTRODUCTION

The study is based on primary data gathered from a sample of 60 farmers from Punjab's rice- and cotton-growing regions who had attended Farmers' Field Schools (FFS) and 60 farmers who had not. While Bathinda district was chosen for the study on cotton, Jalandhar district was chosen for the study of the IPM-program on rice. For a thorough analysis, data were gathered on the use of pesticides on farms, the adoption of IPM methods, obstacles to IPM adoption, consequences of pesticide use on the environment, etc. IPM has been around for a while, but in many areas of the study region, it is a very recent development. The majority of FFS-farmers had little, often less than two years, of experience with the lPM. In a strict sense, not enough time had passed to allow for a thorough impact evaluation of the program and an assessment of its long-term influence. While interpreting the data and making generalizations about their robustness, it is important to keep this component of the impact evaluation in mind.

The effectiveness of the program was assessed by contrasting specific defined criteria between FFS and non-FFS farmers, as well as by examining the attitudes, perceptions, and experiences of the FFS farmers and the degree to which the program was successful in raising awareness among non-FFS farmers. Continuity in IPM use after its initial adoption, general experience with technology, impact on cropping pattern, crop yields, reduction in pesticide consumption, impact on cost of production, perceived impact on soil, environment, and people, and skill development were some of the crucial impact parameters. Based on the opinions of the user farmers, the sustainability of the IPM technology was assessed.

Oryza sativa (Asian rice) or, less frequently, O. Liberia African rice are grass species that produce rice as their seed. Although the phrase may sometimes be used to refer to wild or uncultivated variants of Oryza, wild rice is typically used to refer to species of the genera Zizania and Porters. Domesticated rice is the most popular staple food consumed by more than half of the world's population, especially in Asia and Africa. After maize and sugarcane, it is the agricultural product with the third-highest global production. Rice is the most significant food crop with regard to human nutrition and caloric intake, delivering more than one-fifth of the calories consumed by humans globally. This is because significant portions of sugarcane and maize crops are used for reasons other than human consumption. There are numerous types of rice, and regional differences in cuisine are common.

Annual supply per person Wind-pollinated miniature blooms

Rice is traditionally grown by flooding the fields before or after the young seedlings are planted. This straightforward technique necessitates good irrigation planning, yet it inhibits rodent activity and stunts the growth of weaker weed and pest plants that lack a submerged growth condition. Rice cultivation does not require floods, but all other irrigation techniques necessitate greater effort in weed and insect control during growth phases as well as a different means of nourishing the soil [1], [2].

Brown rice, Nepal, cooked Jamil Marshi, brown rice, under hand-made microscope

Although monocot rice is often produced as an annual plant, it can persist as a perennial in tropical climates and can yield a ratoon crop for up to 30 years. Given that it requires a lot of effort and a lot of water to nurture, rice is best grown in nations and areas with low labor costs and heavy rainfall. However, with the use of water-controlling terrace systems, rice may be cultivated almost anywhere, even on a steep hill or mountain environment. Despite the fact that its parent species is indigenous to Asia and some regions of Africa, centuries of commerce and exports have made it a staple in many different cultures around the world. According to estimates, the production and consumption of rice contributed to 4% of the world's greenhouse gas emissions in 2016.

FFS-farmers' experiences with IPM

It was required to know about farmers' experiences with IPM to manage pests in order to assess the program's effectiveness, and this information was obtained from the sampled FFS-farmers. The findings imply that IPM adoption in Punjab is a relatively recent development. While over two-thirds of rice farmers claimed to have shifted to IPM around a year ago, only about a fifth of them had been doing so for more than a year.

Contrarily, in the case of cotton, one-third of the farmers had only recently made the transition to IPM, whilst the others had been doing so for two to four years. The findings indicate that many FFS-farmers had only recently made the move to IPM. However, compared to rice farmers, cotton farmers had a greater level of IPM usage experience. Interesting findings on IPM adoption rates in various years were found in a study broken down by farm size. Larger farmers were the first to use the IPM method in the case of rice, and more than 50% of them had been doing so for more than three years. On the other hand, practically all of the farmers who work on small and medium-sized farms claimed to have only begun using IPM a year ago. This pattern of adoption suggested that small and medium farmers may have been inspired to use IPM technology as a result of large farmers' use of the technology demonstrating its benefits [3].

Although the sample size in the first two size categories of farms small and medium is too small to make any firm generalizations from the results in the case of cotton, they have not lagged behind the large farmers in converting to IPM. The pattern of IPM adoption by various size groups of cotton and rice farmers may differ based to the severity of the pest problems in the respective rice and cotton regions. IPM program adoption may have been influenced by the severity of the insect problem in cotton growing regions, the high cost of pesticides, the rise in pesticide resistance, etc., regardless of farm size. On the other hand, a less severe pest problem in rice would have persuaded only larger farmers to test out IPM at first, and the success of their use on the bigger farms might have persuaded smaller farmers to make the move as well. Farmers who initially adopted IPM may have done so due to a variety of reasons, including a desire to cut costs associated with pesticide use, the incapability of currently available pesticides to control specific pests, their participation in the IPM training program, the persuasion of the extension staff, or simply a desire to give the new strategy a try.

However, this one-time adoption of IPM does not automatically mean that the user farmers have continued to do so going forward. It's likely that some of the user farmers have gone back to employing conventional pest control techniques after utilizing IPM for one or more seasons. On the basis of a single adoption, it can be inaccurate to draw any clear conclusions about the level of technological adoption and acceptance by farmers. We obtained the necessary data from the sampled farmers in order to determine if they have been utilizing IPM continually since making the initial switch. IPM has been continuously used by about 83% of rice farmers and 93% of cotton growers since they shifted to this approach to pest management. These findings, however, need to be interpreted with some caution because a significant portion of farmers, particularly rice growers, have only recently made the switch to IPM. As a result, even while the current results do show positive indicators of IPM technology's sustainability, this would need to be evaluated again, perhaps after two to three years. We also made an effort to determine how the FFS-farmers generally felt about using IPM technology. Approximately 77% of rice FFS farmers and 90% of cotton FFS farmers rated their IPM experience as "good". The bulk of the farmers whose use of IPM had not been "good" in the instance of rice farmers belonged to the small size group of farms. Further investigation is required to determine the precise causes of their unfavourable experience with IPM.

DISCUSSION

In order to evaluate the effectiveness of the lPM program, the study compared a number of parameters between FFS and non-FFS farmers. Farmers who have attended Farmers' Field Schools are, by definition, FFS-farmers. The adoption of the technology by farmers or the adoption of every aspect of the IPM technology by those farmers, however, is not always guaranteed by participation in the training school. As was previously mentioned, IPM technology for pest management employs a multi-pronged strategy that integrates the usage of existing pest control strategies and approaches based on cultural, mechanical, biological, and chemical methods. Adoption of various IPM method elements and activities is necessary to reap the full benefits of the approach. It's possible that the FFS-farmers aren't using all of these techniques or maybe just certain parts of them [4]–[6].

Thus, the effectiveness of IPM would vary depending on which elements or methods the farmers actually use. We gathered data on the IPM practices being employed by the FFS-farmers in order to determine the level of their adoption of IPM technologies. The findings imply that while these farmers adopted a variety of cultural and mechanical approaches widely, they hardly ever adopted biological practices. Most FFS-farmers practiced timely crop sowing in accordance with cultural customs. percent and more than 74 percent of rice growers.

One or more of the cotton growers was also engaging in deep ploughing. The FFS-farmers used the mechanical methods that comprise the three essential components hand picking and killing of insects, pheromone trapping, and usage of rope though the degree of their utilization varied. Because of this, only 43% of rice farmers utilized pheromone traps, compared to 73% of cotton FFS growers. Similar to this, only 33% of cotton farmers reported manually picking and destroying insects, compared to 57% of rice farmers. With a few exceptions, biological methods were hardly ever used. Almost one-third of FFS farmers admitted to using pesticides when insect populations reached a certain economic threshold. Due to the lack of neem-based pesticides on the market, not a single farmer reported using them. Due to the partial adoption pattern, the impact of the various IPM adoption components would vary, depending on which lists the IPM technology components that FFS farmers utilize.

Timely sowing Choosing and destroying insects by hand. Using pheromone traps for capture, relying on the rope approach biological practices Predators are protected, and parasites are controlled using biocontrol fauna. installing bird perches in the field 4 installing egg masses in perforated cages 1 releasing Trichogrammatid/NPV* 1 releasing eggs and larvae 1 chemical control Using pesticides in accordance with ETL. Using insecticides using neem as a basis 151 parts of the technology used by the farmers are exclusively used in cotton. We did not categorize the farmers according to the various IPM technology components utilized to evaluate its impact because the sample size was too small. However, we would like to emphasize that when making conclusions and interpretations about the effectiveness of IPM technology in general, it was necessary to keep this finding of partial adoption of the IPM technology by the FFS-farmers in mind.

IPM's Effect on Pesticide Use

IPM's effect on pesticide use is one of the key measures of its effectiveness. We questioned the farmers who were already using IPM about whether the move to IPM had changed how often they used pesticides. After switching to IPM, nearly 75% of the farmers in the rice and cotton regions reported a decrease in pesticide use. Thirty respondents in the rice industry and seven in the cotton industry indicated no decrease in pesticide use after implementing IPM. Even a cotton farmer claimed to have increased pesticide use. The fact that this trend of reduced pesticide use has affected all farmer size groups was a significant aspect of it. The number of pesticides used fluctuated from year to year based on the weather, the type and severity of pest attacks, etc. As a result, determining the degree of drop in pesticide usage by comparing the "before" and "after" condition could result in some inaccurate conclusions, aside from any memory bias-related errors. However, in a given year, both IPM users and non-users encountered a similar pest problem; hence, a comparison of their pesticide usage may be able to provide a clearer picture of the degree to which pesticide consumption was reduced [7].

The average number of pesticide applications made by FFS and non-FFS farmers as well as the cost of pesticides per acre for various size groupings of farmers. The findings imply that FFS-farms use fewer pesticides than non-FFS farms, both in terms of quantity sprayed and dollar value. All size groups of farmers and for both of the crops under study indicated a decrease in pesticide use, albeit the degree of the decline varied between farms and between crops. The average reduction in pesticide usage in rice was about 15%, which was a bit greater than the average reduction in cotton, which was about 10%. A 10 to 15% decrease in pesticide use is not a trivial amount, especially considering that the majority of farmers have only switched to IPM in the previous one or two years. Farmers' trust in the technology is sure to grow once the whole IPM technology package is implemented and biopesticide availability is guaranteed. This will probably lead to a higher decrease in pesticide use.

Influence on the Pattern and Intensity of Cropping

There was no discernible difference between FFS and non-FFS farmers in the results regarding cropping pattern and intensity. Therefore, there has not been a major change in these two variables as a result of the transition to IPM for pest management. impact on cultivation costs lists the gross value of output produced per acre, the cost of cultivation, and the net returns on various size groups of farms for the cultivation of paddy and cotton by FFS and non-FFS farmers. It is challenging to link the adoption of IPM to the resulting disparities in gross value of output and cost of production, as was noted in the discussion on the differences in their crop yields [8]–[10].

IPM's Effect on Other Factors

Crop yield1, crop quality, soil quality, and human health data were collected in order to evaluate the effects of IPM. The outcomes are displayed. Crop yield might be considered a non-quantifiable variable and, as such, shouldn't be included with the other three qualitative factors, according to one argument. However, it would not be proper to attribute the observed differences in crop yields between the two kinds of farms to IPM alone. It is true that crop yields on FFS and non-FFS farms may be quantified. It would be necessary to take into consideration variations in other inputs, cultural practices, and crop yields, as well as any potential interactions between IPM and some of these variables. Though the quantitative data on the variations in crop yields between FFS and non-FFS farmers have also been given elsewhere in the study, the qualitative information presented here represents the perception of the user farmers.

In the instance of rice, 60% of the user farmers claimed that switching to IPM had enhanced their crop yield, while the other 40% claimed that there had been no change. In the case of cotton, over 30% of the farmers claimed an improvement in crop yield after using IPM; yet, a significant portion of them (50%) reported "no effect" of IPM. About 75% of rice farmers reported higher crop quality after implementing IPM, which is good news on the quality front. On the other hand, only around 25% of the cotton producers agreed with this viewpoint. About 40% of cotton producers claimed that the use of IPM had had "no significant change" on crop quality. Seventy-five percent of rice farmers reported an improvement in soil quality after using IPM, both in terms of crop quality and the perceived influence on soil quality. In the case of cotton, only 30% of respondents saw a rise in soil quality, while roughly 45% said they 'do not know' if there had been any changes. More than 80% of rice farmers and roughly 57 percent of cotton farmers reported a positive impact on human health after switching to IPM, respectively, in terms of the perceived impact of employing IPM on human health. However, only 16% of cotton and 16% of rice producers saw any improvement in the way their crops affected people's health.

Farmers as IPM Instructors

The capacity of less experienced farmers to pass on their newly gained information to their fellow farmers is another crucial indicator, but not necessarily of the IPM program per se. More than 90% of the FFS-farmers who grow rice and cotton indicated that they would be willing to provide the necessary training. The outcome has significant implications for the IPM program's extension plan going forward. Only a few farmers have received training in the Farmers' Field Schools thus far. The government and other agencies can rely on some of these farmers to provide colleague farmers with training in order to spread the IPM quickly [11].

IPM awareness levels among non-FFS farmers

One would not anticipate a significant multiplier effect in terms of the IPM program's widespread acceptance by non-FFS farmers given how recently it was launched. However, one may anticipate some program awareness to be raised. Through the use of several awareness measures, the degree of IPM program awareness among non-Affirmers was investigated. The results show that the IPM program was sufficiently known to non-FFS farmers as a result of the prior efforts. The IPM program was known to around two-thirds of the farmers in both the rice and cotton growing zones. Nearly all of the remaining people who were unaware of the initiative showed a desire to learn more about it. Additionally, it was shown that between 70 and 80 percent of these farmers got their knowledge from other farmers rather than from any formal organizations or print or electronic media. According to reports, fellow farmers in both crop study locations were the most reliable sources of knowledge for all sizes of farms.

IPM Application Restrictions

After receiving formal instruction in the application of IPM, the FFS-farmers are required to employ it in their fields. There are no organized follow-up training courses. However, because the majority of farmers only recently had this training, it is possible that they may run into some difficulties implementing it on their farms. The outcomes paint a slightly different picture. About 87 percent of cotton FFS farmers and about 63 percent of rice FFS farmers reported no issues with IPM. The remaining farmers sought help from the extension agencies for solutions to their issues when using IPM. In the case of rice, a few farmers from all size groups experienced some difficulty, however in the case of cotton, it was the farmers from the largest size group who reported experiencing some issues with the application of IPM.

The longevity of IPM

We cautioned against taking any clear conclusions regarding the long-term viability of the technique based on such an indicator because the IPM technology was only recently launched. We gathered the necessary data from the FFS-farmers in order to evaluate the long-term viability of the IPM technology. More than 93 percent of FFS farmers who grow rice and cotton agreed that the IPM had the potential to be sustainable in the long run. All farmers shared this opinion, although the small and medium-sized farms were particularly adamant about its viability. IPM has advantages over pesticides for managing pests: FFS-farmers Only if the benefits of utilizing the new strategy outweigh the drawbacks of the old one would a farmer decide to adopt it. These benefits may come in the form of quantifiable factors (cost savings or increased crop yields), perceived factors (better soil quality, less detrimental to human health, etc.), or a mix of quantitative and qualitative factors. We questioned the FFS-farmers about the relative benefits they had noticed in using IPM as opposed to solely depending on pesticides. It presents the outcomes. More than 60% of the user farmers in the instance of rice felt that IPM pest control was less hazardous to the land, the environment, and people. IPM (50%) was also strongly supported by the fact that it lowers pest control costs. The most significant benefit of IPM, cited by two-thirds of the farmers, was that it protected the beneficial insects in the environment, thereby reducing the need for pesticide applications in the cotton crop, where the pest problem is much more severe and the farmers use pesticides very heavily. IPM is preferred by cotton farmers for the same two reasons as rice farmers did: it is less destructive to the soil, environment, and people, and it also results in cost savings on inputs [12]–[14].

CONCLUSION

Although the IPM program in Punjab was only recently established, the study reveals that farmers have accepted it and have had "good" experiences with it. The IPM as it is currently used only applies a small portion of the technology, and the majority of farmers do not apply the entire package of activities. The usage of pesticides by farmers has decreased by 10 to 15 percent as a result of technology adoption, even at the current level. The use of pesticides may decrease much further once farmers implement the entire IPM technology bundle. The findings, however, do not demonstrate with certainty that IPM technology is more cost-effective than conventional pest control methods. The farmers believe that the adoption of IPM technology has improved the quality of their crops, soil, and human health.

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CHAPTER 12

ANALYZING THE HARYANA'S IMPORTANT INTEGRATED PEST MANAGEMENT SCHEMES

Deepak Kumar, Assistant Professor, Department of Agriculture and Environmental Sciences,
Shobhit University, Gangoh, Uttar Pradesh, India,
Email Id- deepak.kumar@shobhituniversity.ac.in

ABSTRACT:

The two main crops grown in the irrigated portions of Haryana, one of India's most developing states, are rice and wheat. Wheat and rice are not the only crops grown in the less-irrigated areas; other important crops include pulses, oilseeds, coarse cereals, cotton, and sugarcane. However, throughout time, a trend toward wheat and rice monoculture has emerged in several regions of the state. The natural resources have suffered significant harm as a result of this combined with the excessive and careless use of irrigation, fertilizers, and pesticides. Due to decreasing returns from using more inputs, the growth in agricultural productivity has begun to slow down. Pesticide usage has significantly increased in Haryana over the last quarter of the 20th century. Its percentage of the nation's overall pesticide use rose from 3 percent in 1975–1976 to 9 percent in 1997–1998. The amount consumed per hectare also grew, from 278 to 828 g. When the per hectare usage of pesticides in the majority of the other states was declining in the 1990s,

KEYWORDS:

Agricultural, Crops, Irrigation, Pesticides.

INTRODUCTION

Haryana it stayed essentially constant. The stalling of agricultural productivity increase in the face of heavy pesticide use suggests the beginning of the process of diminishing returns to additional input utilization. In light of this, the state government has begun to advocate the use of alternative pest control methods, such as the IPM strategy and the use of bio-agents, biopesticides, and plant-based insecticides. However, there is a very low rate of new technology uptake. Examining the use of integrated pest management and its effects on significant Haryanan crops is the goal of this article. A.K. Dixit and K.N. Rai1 1 Department of Agricultural Economics, CCS Haryana Agricultural University, Hisar the viability of developing technologies from an economic perspective and barriers to adoption. Methodology and Data Three zones can be identified within Haryana based on the agro-climatic parameters and pesticide use intensity. Districts having a high pesticide use rate are located in Region I, including Yamuna Nagar, Kurukshetra, and Sonepat. It is the most developed and has the best irrigation systems.

The least amount of irrigation infrastructure and pesticides are used in the districts of Bhiwani, Mahendragarh, Rohtak, Gurgaon, Hisar, Jind, and Rewari. Between these two are the medium-use pesticide-using districts of Sirsa, Karnal, Kaithal, Ambala, and Panipat. One district from each region was picked for this study, keeping in mind the area devoted to crops that require more plant protection. Sonepat, Hisar, and Karnal were the districts that were picked. Additionally, there were different agricultural patterns in these districts. 15 farmers were chosen at random from each of the four villages that were randomly chosen from each district. For the agricultural years data were gathered from these chosen farmers using interview method and pretested schedules. We obtained information from the chosen farmers about their cropping practices, input-output breakdowns by crops, and other factors. Additionally, the Regional Research Station, Uchani (Karnal), of the CCSHAU, Hisar was contacted for experimental data on various techniques of controlling pests in cotton and paddy. The information on cotton pest management was gathered from the Hisar district's Parbhuwala hamlet as part of the project's Development of Integrated Pest Management (IPM) packages under selected crop conditions.

IPM adoption

Paddy Farmers in the village of Baraunda (Karnal) were taught by professionals how to manage pests rather than exterminate them in order to promote the use of biopesticides and other environmentally friendly ways of pest control. provides information on the adoption of various 163 IPM practices. Farmers were unaware of the use of cultural measures including deep summer plowing, resistant cultivars, balanced fertilization, and bund raising to restrict and minimize the appearance of various insect-pests prior to the adoption of IPM. In the second year of the IPM program, a significant number of farmers who had received IPM training, however, adopted these cultural practices. The rope method of eradicating leaf folder infestation was used by 15% of the instructed farmers in the first year alone. Only 30% of people continued this behavior in the years that followed. This approach requires a lot of labor, which is why adoption has been minimal.

Only 40% of the farmers used light traps, however 100% of them implanted sex pheromone traps. By using these procedures, the yellow stem borer was found and kept below the threshold level. None of the farmers used mechanical methods, including trimming or pruning seedlings or rouging out infested plants, etc. Eco-friendly pesticides and biopesticides should be used, farmers were urged. The majority of farmers applied neem products, and around half of them used Bt. Before the introduction of the IPM program, the majority of farmers used to apply pesticides without first checking the population of pests on the area being controlled chemically, which covered around 95% of the entire area. But in the first and second years when IPM was implemented, only 35 and 10% of the area were subject to chemical control, respectively. It was interesting to discover that the majority of farmers did not use pesticides in 1996–1997 and 1997–1998 and that this had no impact on the production.

Sugarcane

In 1996–1997 and 1997–1998, the university's experts worked with the Indian Farmers' Fertilizer Cooperative (IFFCO) to train thirty farmers in the village of Snakehead (Yamuna Nagar). the adoption rate for various pest management techniques is listed. Based on the findings, 30% of the area in the first year and 80% in the second year were treated with urea solution (2%), enemas, or both in place of the pesticide endozoan. The second year of the program saw a very satisfactory level of adoption of cultural and mechanical pest control methods. Light trap usage was not very widespread, though. A large portion of the chemical pesticides were replaced with biological control, which covered 10% of the land. And, the yield of sugarcane increased from 50 to 57 t/ha with the introduction of IPM programme. Cotton The specialists of CCSHAU instructed 35 farmers through the Farmers' Field School in the village of Parbhuwala (Hisar).

The program's goal was to convince the farmers to apply chemicals depending on necessity in conjunction with other management measures. Table 3 provides information on the selection of cotton growers' level of use of IPM measures in 1996–1997 and 1997–1998. The results showed that before the introduction of the IPM program, no farmers used the economic threshold level (ETL) as a criterion for pest management. However, following its implementation, 20% of farmers in the first year and those to whom these were provided under the program did so. For avoiding the usage of pesticides, a 2:1 pest-defender ratio has been demonstrated to be helpful. Nevertheless, due to a lack of knowledge, none of the skilled farmers had established the pest-defender ratio.

DISCUSSION

Paddy Table 4 displays the costs and returns related to IPM and farming techniques. The main insect pests of the paddy crop might be controlled effectively with biopesticides, mechanical controls, and cultural measures. Farmers observed that while rope shaking and concurrent use of biopesticide might stop the attack of leaf folder, chemical control techniques had little impact on the leaf-folder. The benefit of this approach is that it minimizes health concerns and the negative impact of residues on microorganisms, even though it is slightly more expensive than the chemical application alone [1]–[3].

According to the regions where they are most suitable, farming systems are strategically used in India. Subsistence farming, organic farming, and industrial farming are the farming techniques that make up a considerable portion of India's agricultural output. The forms of farming used in various regions of India vary; some are based on horticulture, ley farming, agroforestry, and many other practices. India's geographic location causes certain of its regions to experience various climates, which in turn affects how productively each region's agriculture is. India's monsoon cycle is crucial to achieving high crop yields. India's agricultural history is broad and dates back at least 9,000 years. The ancient cities of Mohenjo-Daro and Harappa in Pakistan and India both experienced the apparent emergence of a structured farming urban civilization. The Harappan or Indus civilization, which was significantly more extensive than the cultures of Egypt or Babylonia and first arose before equivalent societies in northern China, thrived until just after 4000 BC.

The nation currently ranks second in the world for agricultural production. In 2007, more than 16% of India's GDP came from agriculture and other businesses. Agriculture is the largest industry in the nation and is crucial to the socioeconomic development of the nation, despite the fact that its share of the GDP has been steadily declining. India is the world's second-largest producer of groundnuts, rice, cotton, sugarcane, wheat, and many more crops. It is also the second-largest producer of fruits and vegetables, accounting for 8.6% and 10.9%, respectively, of global production. Mangoes, papayas, sapotas, and bananas are among of India's most important fruit exports. With 281 million animals, India is the country with the most livestock in the entire globe. With 175 million cattle, the nation had the second-highest number of cattle in the world in 2008.

Agriculture and climate change

Each location in India has unique soil and a climate that are only suitable for particular farming techniques. The farming techniques are constrained to cultivate crops that can resist drought conditions, and farmers are typically only allowed to plant one crop in many places of western India where the annual rainfall is less than 50 cm. This climate is present in Gujarat, Rajasthan, Punjab, and northern Maharashtra, where jowar, bajra, and peas are grown as appropriate crops. In contrast, the eastern part of India receives 100–200 cm of rain yearly on average without irrigation, allowing these areas to produce two times as much food. This climate is common on the West Coast, West Bengal, parts of Bihar, the U.P., and Assam, where crops including jute, sugarcane, and rice are grown [4]–[6].

India's climate regions

All over India, there are three major kinds of crops that are grown. Depending on how well they adapt to a particular climate, each kind is grown in a different season. Kharif crops are raised from the beginning of the monsoon season to the colder months, generally from June to November. These crops include rice, corn, millet, groundnuts, moong, and urad, as examples. Winter crops called rabi are sown in October and November and harvested in February and March. Examples of this type of food include wheat, boron paddy, jowar, almonds, etc. Summer crops known as Zaid crops are the third category. The crop is harvested in May or June after being sowed in February or March. Vegetables, jute, and augh paddy are a few examples.

Farming using irrigation

When crops are cultivated using irrigation systems, water is supplied to the land by rivers, reservoirs, tanks, and wells. The population of India has tripled in the last century. Water is essential for agricultural productivity due to a growing population and rising food demand. India has the enormous burden of boosting its food output by almost 50% over the next two decades, and water is essential to achieving the aim of sustainable agriculture. According to empirical data, irrigation is largely to blame for India's surge in agricultural production; about three-fifths of the country's grain crop is produced on irrigated land. From 22.6 million hectares in FY 1950 to 59 million hectares in FY 1990, more land was irrigated. The primary approach for these irrigation systems is on public investments in surface systems, such as sizable dams, lengthy canals, and other sizable projects that demand sizable sums of money. Nearly 1,350 major and medium-sized irrigation projects were started between 1951 and 1990, and about 850 of those projects were finished [7].

Irrigation issues

Many projects, notably the Indira Gandhi Canal project, advanced slowly due to a lack of resources and technical know-how. The massive water transfers from Punjab to Rajasthan and Haryana by the national government during the 1980s and early 1990s fuelled discontent in Punjab. Depletion of groundwater resources utilized for irrigation has also led to problems. When irrigation is poorly managed or poorly planned, the outcome is frequently too much water and water-logged areas that are unable to produce. Drawing water from one area to irrigate another frequently increases salinity.

India's geography of irrigation

In areas with sporadic or low rainfall, irrigation farming is crucial for agricultural cultivation. Irrigation is essential to the prosperity of the Western U.P., Punjab, Haryana, portions of Bihar, Orissa, AP, Tamil Nadu, Karnataka, and other regions, which frequently engage in triple or double cropping. A wide variety of crops, including rice, sugarcane, wheat, and tobacco, can be grown with irrigation [8]–[10].

Changing one's cultivation

Shifting cultivation is a form of subsistence farming in which a piece of land is farmed for a short period of time until the crop production decreases as a result of soil depletion and the effects of pests and weeds. When crop yield reaches a plateau, the area is abandoned and removed using slash-and-burn techniques, allowing the soil to regenerate. Most often grown crops include yarn, cassava, maize, and potatoes. On hill slopes and in forested areas, this style of farming is most common in the eastern and north-eastern regions, including Assam, Meghalaya, Nagaland, Manipur, Tripura, Mizoram, Arunachal Pradesh, Madhya Pradesh, Orissa, and Andhra Pradesh. In this technique, crops like vegetables, corn, buckwheat, small millets, root crops, and rain-fed rice are cultivated. In northeast India, shifting cultivation accounts for 85% of all agriculture. The cycle of agriculture followed by leaving land fallow has decreased from 25 to 30 years to 2-3 years due to the rising demand for land for cultivation. The land doesn't have enough time to revert to its natural state because of this huge decrease of uncultivated area. As a result, the ecosystem's resilience has been compromised, and the condition of the land is rapidly declining.

The focus of the intensive and IPM module is on the use of bio-agents and biopesticides in combination with chemical pesticides that are safer and are based on economic threshold levels. IPM, on the other hand, has little to no focus on mechanical control and mostly relies on chemical control based on ETL. Given that bioagents and bio-pesticides are volatile by nature and necessitate frequent application, the comparison clearly shows that IPM is expensive in cotton. Net returns were contrasted in order to determine the most economical technique. At the current market rates, the cost of pesticides and their application was evaluated, and total returns were computed at Rs 18.55 each quarter.

Costs of Pesticide Externalities

In addition to contaminating the environment, pesticides harm the human immune system, as well as the kidney, liver, and nervous systems. They can also cause tumors, memory loss, skin allergies, behavioural abnormalities, and a number of other known and unknow ailments in humans, animals, and other living things. In Table 8, the societal cost of pesticide use has been calculated. The findings indicate that the overall cost for treating humans was Rs 73,885 and treating animals was Rs 22,350. Two people perished in the Karnal district from the inhalation of exceedingly harmful pesticides among the chosen farmers. Three cattle worth Rs 52,500 in the Sonepat area were reported to have perished after consuming fodder that had been sprayed with pesticides. Therefore, the societal cost associated with externalizing pesticides' negative effects in the research area was Rs 170,235.

Farmers' Views on the Environmental Impact of Pesticides

the perspectives of farmers regarding the effects of pesticides on the environment. The indicators covered the effects on air, water, soil, animals, edible agricultural products, and human labor. Frequencies of the response suggested that the insecticides had a considerable impact on the labor involved in spraying. It was discovered that the influence on soil and water, as shown by the crops cultivated in adjacent fields or the following crop in the same area, was rather low. They were thought to have a significant impact on the air, though. Farmers believed that pesticides contaminated the land around the treated area. Some of them claimed that fumes are released by pesticides like furadan, thimet, carbofuran, etc. The farmers believed that pesticides also contributed to water contamination and decreased soil fertility. In Sonepat district, the impact of pesticides on edible goods was thought to be moderate, but much higher in Hisar district [11]–[13].

Response of Farmers to IPM

presents the data about knowledge, use, and opinions regarding the efficacy of various pest management techniques. In the Sonipat district, there was little knowledge of the cultural methods for weed and insect management. In all the districts, the usage of cultural practices that discourage insect control was likewise minimal. However, a small number of farmers in the Hisar district have embraced traditional techniques including deep plowing and stubble burning. Quite a few people were aware of manual weed management; 61 percent of farmers said it worked. Because weeds are used as animal feed and for food, such as bathu, cholai, and other plants, manual weed management was also widely used. Farmers believed that removing the diseased and dead paddy shoots would considerably lessen damage from pests and diseases. Crop rotation's importance was widely understood, but little of it was actually practiced. In the districts of Karnal, Hisar, and Sonepat, respectively, 60%, 25%, and 20% of the farmers who were chosen for the program realized its usefulness. Although seed treatment was well known, it was rarely used. On the other hand, there existed a lot of knowledge regarding chemical control. In three districts, respectively, 52, 13 and 49% of farmers said that insecticides, fungicides, and weedicides were effective. Because of its immediate and visible outcomes, chemical treatment was found to be the most effective form of pest management.

CONCLUSION

IPM has been found to be efficient in controlling the main insect pests of rice and sugarcane crops. Need-based pesticide applications, along with other options like mechanical and bioagents, have been demonstrated to be cost-effective in cotton crops. Without incurring any additional costs, IPM results in a 16 percent increase in sugarcane output over conventional farming. Under IPM practice, a higher cost-benefit ratio is seen in both cotton and paddy. Pesticides' adverse effects on human and animal health are projected to have a social cost of Rs 945 per family per year. Farmers are also very aware of the negative impact that pesticides have on both human and animal health. They are not particularly conscious of their impact on natural resources like soil and water, though. the greatest region in India that is used for shifting farming. Locally, shifting agriculture is referred to as podium cultivation. It covers an area of more than 30,000 square kilometers, or nearly 1/5 of Odisha's total land area. In Kalahandi, Koraput, Phulbani, and other western and southern districts, shifting farming is common. This technique is practiced by several tribal groups, including the indigenous people consider podium agriculture to be more than simply a source of income, they see it as a way of life, many festivals and other kinds of rituals are centered around the podium fields. Tribal people sow Kandan in the first year of podium farming. When employed in the pre-monsoon season and with sufficient protection, sowing refers to spraying seeds.

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CHAPTER 13

A CASE STUDY OF FARMER'S KNOWLEDGE OF RICE FARMING

Deepak Kumar, Assistant Professor, Department of Agriculture and Environmental Sciences,
Shobhit University, Gangoh, Uttar Pradesh, India,
Email Id- deepak.kumar@shobhituniversity.ac.in

ABSTRACT:

The Andhra Pradesh state in India's West Godavari district is referred to as the "rice bowl of India." As a result of the very intensive rice-based cropping system, most farmers produce two crops of rice each year. The area is irrigated by canals to a greater than 90% extent. More than 5 t/ha of rice are produced on average. Utilizing high-yielding rice varieties and advanced agronomic techniques including fertilizer application, water management, pest management, etc., farmers in this region engage in intensive agriculture. Due to a multitude of technological, social, economic, and environmental limitations, research and development in pest management haven't always led to the adoption of better approaches. Furthermore, the farmers' methods for controlling pests are a reflection of their capacity for decision-making, which is largely influenced by their perceptions.

KEYWORDS:

Biological Control, Farmers, Pesticides, Rice.

INTRODUCTION

The farmers pick pest management strategies that seem to fit their needs. Their views and opinions about technology also have an impact on the technology they choose. The development of effective management strategies therefore requires an awareness of the variables influencing their views, knowledge, and practices farmers' survey is a crucial data collection process for assessing the needs of intended beneficiaries and determining their level of knowledge. Their perspectives on the pest issues, as well as their attitudes toward pest control. These surveys, if thoughtfully created and carried out, can aid both research and extension workers in locating knowledge gaps, false beliefs, or improper behaviours. Heung and Escalada (1997) have provided documentation of these findings in relation to Asian rice growers. In India described the methods used by Tamil Nadu rice farmers to handle pests. The goal of the current study is to ascertain the attitudes, practices, and knowledge of farmers in the West Godavari region about pest control (AP). This research was done in response to an earlier survey conducted in 1998 which found that the majority of farmers in this area had seen high yields, which they mostly attributed to heavy pesticide use. Nevertheless, despite using fewer pesticides, some farmers were still able to produce great harvests. With these inconsistencies in mind, the current study was conducted to ascertain the farmers' views and pest management techniques (pesticide use, frequency, timings, and goals), as well as to contrast the variations between high and low pesticide users' beliefs and practices.

Resources and Procedures

Area of study and data gathering In the West Godavari district's 21 villages, the study was conducted. In the region, double rice farming is common, and the entire crop is transferred. The skilled enumerators used standardized questions to get the data. The questionnaire was pre-tested on a sample of 50 farmers, and some of the questions were changed to obtain more precise data. Interviews were conducted with 512 farmers who were chosen at random.

Pest control procedures

Regulation or management of a species that is considered a pest, such as any animal, plant, or fungus that negatively affects human activities or the environment, is known as pest control.

The human response varies depending on the severity of the harm caused and might include tolerance, deterrent, and control measures, as well as attempts to totally eliminate the pest. An integrated pest management approach may include the use of pest control methods. Pests are controlled in agriculture using mechanical, cultural, chemical, and biological methods. Crop rotation and soil preparation prior to planting serve to lessen the pest burden and prevent the emergence of some pest species. Limiting the use of pesticides in Favor of other techniques is a sign of environmental concern. This can be done by keeping an eye on the crop, using pesticides only when necessary, and cultivating pest-resistant plant varieties and crops. When using biological methods, it is best to support the pests' natural enemies and introduce the right predators or parasites.

The pests in houses and urban settings are rats, birds, insects, and other creatures that live in the same habitat as people and eat or damage property. Exclusion or quarantine, repulsion, physical removal, or chemical methods are all tried to control these pests. Alternatives include sterilizing programs and other biological control strategies. Since there has always been a need to maintain crops free of pests, pest control is at least as ancient as agriculture. Cats have been used to keep rodent pests out of grain bins since 3000 BC in Egypt. By 1500 BC, ferrets had been tamed in Europe and were being used as macers. Most likely by the ancient Egyptians, mongooses were introduced into households to manage vermin and snakes. Since it is very simple to kill larger competing animals and eradicate weeds by burning them or plot them under, the usual method was presumably used first. Crop rotation, companion planting, intercropping, and the selective breeding of pest-resistant cultivars are a few methods with a lengthy history.

Red weaver ants, seen here eating a snail, have long been utilized in China, Southeast Asia, and Africa to eradicate pests. Around 2500 BC, the Sumerians utilized sulphur compounds as insecticides, which led to the development of the earliest chemical pesticides. The Colorado potato beetle's rapid expansion throughout the United States served as an impetus for modern pest control. Arsenical compounds were finally utilized to suppress the beetle, and unlike what was anticipated, the human population was not poisoned. This paved the path for insecticides to be widely accepted across the continent. Chemical pest control spread as a result of the industrialization and mechanization of agriculture in the 18th and 19th centuries, as well as the invention of the insecticides pyrethrum and derris. This progress was accelerated by the discovery of various synthetic herbicides and pesticides during the 20th century, including DDT.

The development of innovative strategies, such as the use of biological control to eradicate the ability of pests to reproduce or to alter their behaviour to make them less bothersome, has been prompted by the detrimental side effects of pesticides on humans. Around 300 AD, weaver ant colonies, Ascophyllan Sharadini, were purposefully planted in citrus groves to control beetles and caterpillars, marking the beginning of biological management. As depicted in prehistoric cave art, ducks were used in paddy fields in China approximately 4000 BC to eat pests. In order to control locusts, an Indian Meenah was imported to Mauritius in 1762. Around the same time, bamboos were used to connect citrus trees in Burma so that ants could walk between them and assist control caterpillars. In California citrus farms in the 1880s, ladybirds were used to control scale insects, and other biological control trials followed. The development of DDT, a low-cost and efficient substance, effectively ended research in biological control. By the 1960s, issues with chemical resistance and environmental harm were starting to surface, and biological control was experiencing a comeback. Even though a revived interest in conventional and biological pest control emerged near the end of the 20th century and is still present now, chemical pest control is still the most common method of pest control used today.

DISCUSSION

A biopesticide is a biological agent that harms, eliminates, or deters creatures thought to be pests. A biological pest management strategy may use chemical, parasitic, or predatory interactions. They come from a variety of living things, such as plants, bacteria and other microorganisms, fungus, nematodes, and others. Needs page They are part of integrated pest management (IPM) programs and have attracted a lot of interest in the real world as alternatives to synthetic chemical plant protection products (PPPs). There are currently 299 registered biopesticide active ingredients and 1401 active biopesticide product registrations, according to the U.S. Environmental Protection Agency. Biopesticides are "certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals. In addition, the EPA notes that biopesticides "include naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants containing added genetic material (plant-incorporated protectants) or PIPs.

A biopesticide, according to the European Environmental Agency, is "a pesticide made from biological sources, which are toxins that occur naturally. - Naturally occurring biological agents used to kill pests by causing specific biological effects rather than by inducing chemical poisoning." A biopesticide is also a pesticide whose "active ingredient is a virus, fungus, or bacteria, or a natural product derived from a plant source," according to the EEA. The mechanism of action of biopesticide is based on particular biological effects rather than chemical toxins [1]–[3].

Typically, photosynthesis, growth, or other fundamental components of plant physiology are not known to be affected by biopesticides. Antifeedants are a class of chemical substances that plants make to defend themselves against pests. These materials are renewable and biodegradable, making them cost-effective for usage in real world applications. This strategy of pest management is supported by organic farming techniques.

Biopesticides can be categorized as follows

Microbial pesticides are made up of bacteria, entomopathogenic fungi, viruses, or (in some cases) the metabolites that the bacteria or fungi create. Despite being multicellular, entomopathogenic nematodes may be categorized as microbial insecticides. Page not found Chemicals made from biological sources. Pyrethrum, rotenone, neem oil, and other essential oils are four types of naturally occurring compounds that control or monitor, in the case of pheromones pests and microbial disease. These compounds are used commercially. Plant-incorporated protectants (PIPs), such as GM crops, contain genetic material from other species. Their use is debatable, particularly in European nations. RNAi insecticides, some of which are applied topically and others which the crop absorbs [4]–[6].

Interference with RNA

Companies like Syngenta and Bayer are researching RNA interference for use in spray-on pesticides (RNAi insecticides). Such sprays do not alter the target plant's genetics. As the target species adapt to the original, the RNA can be changed to preserve its efficacy. RNA is a relatively delicate molecule that often breaks down after a few days or weeks. Monsanto calculated costs to be around $5/acre. Weeds that tolerate Roundup have been the target of RNAi. It is possible to combine RNAi with a silicone surfactant, which enables the RNA molecules to penetrate air-exchange holes in the surface of the plant. For long enough for the herbicide to operate, this interfered with the gene for tolerance. This approach would permit the ongoing use of pesticides based on glyphosate.

They can be manufactured with sufficient accuracy to target particular bug species. To eradicate Colorado potato pests, Monsanto is creating an RNA spray. Making it stay on the plant for a week when it's raining is one difficult task. More than 60 common insecticides no longer work on the potato beetle. In addition to the general restrictions that apply to all pesticides, Monsanto pushed the U.S. EPA to exempt RNAi pesticide products from testing for residual environmental effects, allergenicity, and rodent toxicity. A 2014 EPA advisory panel found scant evidence of a harm associated with RNA consumption.

The Australian Safe Food Foundation asserted in 2012, though, that the RNA trigger intended to alter the starch content of wheat might obstruct the gene for a liver enzyme in humans. Supporters responded that RNA did not seem to withstand stomach acids or human saliva. The US National Honey Bee Advisory Board warned the EPA that employing RNAi would pose "the epitome of risk" to natural systems. The beekeepers issued a warning that pollinators might suffer from unintended consequences and that many insects' genomes are yet unknown. Ecological concerns since herbicides must be present continuously and potential RNA drift across species boundaries are further unrecognized dangers. For their expertise in RNA, Monsanto made investments in a number of businesses, such as Biologics for RNA that kills a parasitic mite that infests hives and for manufacturing technology and Precures, as well as obtained technical licenses from Alnylam and Tekmira. Devgn, an RNA partner in Europe, was purchased by Syngenta in 2012. Startup Forest Innovations is looking into RNAi as a treatment for the citrus greening disease, which in 2014 led to the falling off of 22 percent of Florida's orange trees.

Mucopeptide

Mucopeptides contain fungi and elements of fungal cells. Hydrolytic enzyme mixes and several types of propagules, including conidia, blastospores, chlamydospores, oospores, and zygospores, have been studied. The primary research areas include the function of hydrolytic enzymes, particularly chitinases, in the killing process and the potential application of chitin production inhibitors [7]–[9].

Nanotechnology

Some biological substances have been proven to be more effective against pests, less harmful to people and the environment, and less susceptible to physical degradation (such as volatilization and leaching) when they are enclosed in nanoparticulate structures. The development of less toxic biopesticides with acceptable safety profiles, increased active agent stability, improved efficacy against the targeted pests, and higher end-user acceptance may thus benefit from the application of nanotechnology. When nanoparticles are used to protect neem oil, the desired pests are more efficiently targeted for a longer period of time. This type of formulation's biodegradable polymers allows for continual delivery of the active component without harming the environment. Future research must concentrate on ways to reduce the risks connected with the use of nanoparticles because there is currently a lack of comprehensive understanding regarding risk assessment factors and the subsequent toxicity of nanoparticles towards components of agroecosystems after their release into the environment.

Practices and attitudes of high and low pesticide users in terms of pest management

For a comparison of their pest management strategies and attitudes, farmers were divided into high and low pesticide users based on the quantity of pesticide applications. Farmers who adopted the recommended practice of using pesticides for the control of both insect pests and illnesses were among the low pesticide users. Farmers made up a significant portion of the pesticide user group with more than four applications. About 44% of farmers fell into the low pesticide user category, whereas 56% used pesticides more than four times per year. Pesticides were used on average 3.4 times during the season by low users, compared to 6.2 times by high users, according to a comparison of attributes associated to pesticide use.

Insecticide expenditures were somewhat greater in the high user group than in the low user group. Fungicide costs were lower for the high usage group than for the low use group. Additionally, the high user group experienced a greater perceived loss than the low user group. Additionally, the low user group had a yield level that was one tonne/ha lower on average [10]–[12].

Views and convictions on crop output and pest management

contain the mean belief ratings for characteristics relating to how pesticides and cultural management techniques affect rice productivity. The comparisons were made using mean scores. A score of 3 denoted neutrality, a score of 3+ denoted strong beliefs, and a score of 3 denoted weak beliefs. High users firmly believed that pesticide mixes were more effective and that more sprays were required to boost the yield. The low user group likewise felt that additional sprays were necessary to boost the yield, but they did not have a strong opinion regarding the efficiency of pesticide mixes. Neither group believed that utilizing pesticides in high concentrations was more effective. While the higher user group expressed their willingness to apply pesticides on the calendar, the low user group believed that calendar spraying was not necessary. Both parties firmly believed that beneficial insects might reduce pest populations, that using more pesticides might be bad for human health, and that using pesticides indiscriminately was bad for non-target organisms. Additionally, both groups concurred that the government's information.

Comparative Analysis Comparative analysis

The disparities between the high and low user groups' views and beliefs. The findings showed that while experience and farm holding size did not significantly affect the outcome, the farmers' age and level of education did. Data indicated that all farmers used insecticides to prevent illnesses. Various chemicals, including recently developed ones, were employed, particularly in the fight against illnesses. This demonstrated that farmers were prepared to utilize the freshly advertised chemicals if they proved to be successful in addition to being aware of them. This was especially clear when newer drugs like acephate, bipvin, and cartap were used to combat insect pests like planthoppers, stem borer, and leaf folders, as well as hexaconazole and propicanozole against sheath blight. Interestingly, no rodenticide was discovered in use, despite the fact that farmers believe rats to be a significant nuisance. Some farmers utilized phorate to control the rat population in the hopes that the rats would flee owing to the chemical's stench, while others used rat traps that were readily available nearby. According to the farmers' belief scores and the relationship between beliefs and decision-making behaviours, farmers' decisions about pest control were influenced by their views of the target pest, the magnitude of their perceived losses, the usage of pesticides, the time and frequency of application, among other factors. There were more high pesticide users than low pesticide users. This suggested that local farmers thought more pesticides were necessary to boost harvests. Additionally, calendar-based applications were more frequently used than need-based sprays. These two characteristics showed that the farmers were driven to succeed and were eager to save the harvest at all costs.

CONCLUSION

According to Rajagopalan (1983), farmers typically adopted plant protection practices out of a desire to preserve their harvest. Sheath blight was ranked as the number one enemy of farmers, but it appeared that insect pests were their top priority as seen by the greater amount of insecticide applications made in a season. The considerable effect of the neighbors (other farmers) on the decisions of the farmers seemed to imply that the use of pesticides is the standard in society. However, the greater impact of plant protection technicians made it clear that by providing farmers with information, knowledge, and skills through appropriate and consistent training as well as awareness programs, it would be possible to develop a new belief and value system. Mechanical/physical, cultural, biological, and pharmacological interventions are all possible. Picking pests off plants and employing netting or other materials to keep pests out like birds from grapes or rodents from buildings are examples of mechanical/physical controls. Using disease-resistant crop types, flooding, sanding, and the removal of dead or diseased plants are just a few cultural measures that can be used to keep a region free of breeding grounds. There are a lot of biological controls. They include sterile insect technique (SIT), the enhancement or conservation of natural predators.

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