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ZO- 351 PEST MANAGEMENT

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CHAPTER VI INTEGRATED PEST MANAGEMENT (IPM)

6.1. PRINCIPLES AND ITS COMPONENTS

Definition: Integrated Pest Management is an effective and environmentally sensitive approach against pest using common practices.

Integrated Pest Management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. The major components of IPM in increasing order of complexity are as under:

6.1.1 Cultural practices:

Cultural methods of pest control consist of regular farm operations in such a way which either destroy the pests or prevent them from causing economic loss. The various cultural practices are as under.

- Preparation of nurseries or main fields free from pest infestation by removing plant debris, trimming of bunds, treating of soil and deep summer ploughing which kills various stages of pests.
- Testing of soil for nutrients deficiencies on the basis of which fertilizers should be applied.
- Selection of clean and certified seeds and treating seeds with fungicide or bio-pesticides before sowing for seed borne disease control.
- Selection of seeds of relatively pest resistant/tolerant varieties which play a significant role in pest suppression.
- Adjustment of time of sowing and harvesting to escape peak season of pest attack.
- Rotation of crops with non-host crops. It helps in reduction of incidence of soil borne diseases.

- Proper plant spacing which makes plants more healthy and less susceptible to pests.
- Optimum use of fertilizer. Use of FYM and bio-fertilizers should be encouraged.
- Proper water management as the high moisture in soil for prolonged period is conducive for development of pests especially soil borne diseases.
- Proper weed management. It is well-known fact that most of weeds beside competing with crop for micro nutrients also harbor many pests.
- Setting up yellow pan sticky traps for white flies and aphids at far above canopy height.
- Synchronized sowing. Here community approach is required to sow the crops simultaneously in vast area so that pest may not get different staged crops suitable for its population build up and if pest appears in damaging proportion, control operation could be applied effectively in whole area.
- Growing trap crops on the borders or peripheries of fields. There are certain crops which are preferred more by a pest species are known as trap crops for that pest. By growing such crops on the border of the fields, pest population develop there which can be either killed by using pesticides or its natural enemies are allowed to develop there for natural control.
- Inter-cropping or multiple cropping wherever possible. All the crops are not preferred by each pest species and certain crops act as repellents, thus keeping the pest species away from preferred crops resulting in reduction of pest incidence.
- Harvesting as close as to ground level. This is because certain developmental stages of insect pests/diseases remain on the plant parts

which act as primary inoculum for the next crop season. Hence, harvesting crops at ground level will lessen the incidence of pests in next season.

- Before planting, nursery plants be sprayed/dipped in copper fungicide/ bio pesticide solutions to protect the plants from soil borne diseases.
- While pruning fruit trees, remove crowded/dead/broken/diseased branches and destroy them. Do not pile them in the orchards which may act as source of pest infestation.
- Large pruning wounds should be covered with Bordeaux paste/paint to protect the plants from pest/disease attack.
- Keeping bee hives or placing flower bouquets of pollinizer cultivars facilitate better pollination and subsequent fruit set.
- Selection of high yielding varieties for different crops.
- Selection of comparatively pest resistant/tolerant varieties.

6.1.2 Mechanical practices:

- Removal and destruction of egg masses, larvae, pupae and adults of insect pests and diseased parts of plants wherever possible.
- Installation of bamboo cage cum bird perchers in the field and placing parasitized egg masses inside them for conservation of natural enemies and withholding of pest species wherever possible.
- Use of light traps and destruction of trapped insects.
- Use of rope for dislodging leaf feeding larvae e.g. caseworm and leaf folders.
- Installation of bird scarer in the field where required.
- Installation of bird perchers in the field for allowing birds to sit and feed on insects and their immature stages viz., eggs, larvae and pupae.
- Use of pheromones for mating disruption and kill zone creation.

- Use of pheromone traps for monitoring and suppression of pest population.
- Use of pheromone traps for mass trapping.

6.1.3 Regulatory practices:

In this process regulatory rules framed by Govt. are brought into force under which seeds and infested plant materials are not allowed to enter the country or from one part to other parts of the country. These are known as quarantine methods and are of two types i.e. domestic and foreign quarantine.

6.1.4 Biological practices:

Biological control of insect pests and diseases through biological means is most important component of IPM. In broader sense, biocontrol is use of living organisms to control unwanted living organisms (pests). In other words, deliberate use of parasitoids, predators and pathogens to maintain pest population at level blow those causing economic loss either by introducing a new bioagent into the environment of pest or by increasing effectiveness of those already preset in the field.

6.1.4.1 Parasitoids:

These are the organisms which lay eggs in or on the bodies of their hosts and complete their life cycles on host bodies as a result of which hosts die. A parasitoid may be of different type depending on the host developmental stage in or on which it completes its life cycle. For example, egg, larval, pupal, adult, egg-larval and larval pupal parasitoids. Example are different species of *Trichogramma, Apanteles, Bracon, Chelonus, Brachemeria, Pseudogonotopus* etc.

6.1.4.2 Predators:

These are free living organisms which prey upon other organisms for their food. Examples are different species of spiders, dragon flies, damsel flies, lady bird beetles, Chrysopa species, birds etc.

6.1.4.3 Bio-pesticides:

These are micro-organisims which infest and cause diseases in their hosts as a result of which hosts are killed. Major groups of pathogens are fungi, viruses and bacteria. Some nematodes also cause diseases in some insect pests. Important examples of fungi are different species of Hirsutella, Beauveria, Nomurae and Metarhizium which have been reported to infest and kill large number of insects (upto 90%) in the fields. Among viruses, most important examples are of nuclear polyhedrosis virus (NPV) and granulosis viruses. Outbreak of viruses in armyworms, cut worms, leaf folders, hairy caterpillars and plant hoppers have been reported many times. Among bacteria, Bacillus thuringiensis (B.t.) and B. popillae are very common examples.

Diseases of pests can be mass multiplied in the laboratory at a low cost in liquid or powdered formulations that can be sprayed like ordinary chemical pesticides. These formulations are known as bio-pesticides. The different types of biocontrol practices are grouped as under:-

- **Introduction**

In this process, a new species of bio-agent is introduced into a locality for its establishment against its host. This is done only after thorough laboratory examination and field trials for its efficacy.

- **Augmentation**

In this process, the population of natural enemies already present in the area is increased by releasing either laboratory reared or field collected

bio-agents of same species in such number as would require to suppress the pest population in that area.

- **Conservation**

This is most important component of biological control and plays a major role in pest suppression. In this process, natural enemies present in the nature are protected from being killed. The different practices required to protect the natural enemies are as below:

- Collection of parasitised egg masses and placing them in bamboo cage-cum-bird perchers for allowing emergence of parasitoids and withholding of pest larvae.
- Educating farmers through field days, radios & TV to differentiate pests and defenders and sparing the defenders during field sprays
- Chemical spray should be adopted as last resort and that too after observing pest defender ratio.
- Use of broad spectrum pesticides should be avoided.
- Only selective and relatively environmental friendly (REF) pesticides should be used where necessary.
- As far as possible strip or spot application of pesticides be carried out.
- Adjustment of time of sowing and harvesting to avoid the peak season of pest attack.
- Growing trap crop on the borders of main fields before the actual sowing of crop to trap pest and develop natural enemies.
- Root dip/seedling treatment for gall midge prone area.
- Crop rotation and inter-cropping also help in conservation of defenders.
- Recommended dose and concentration of pesticides should be used.

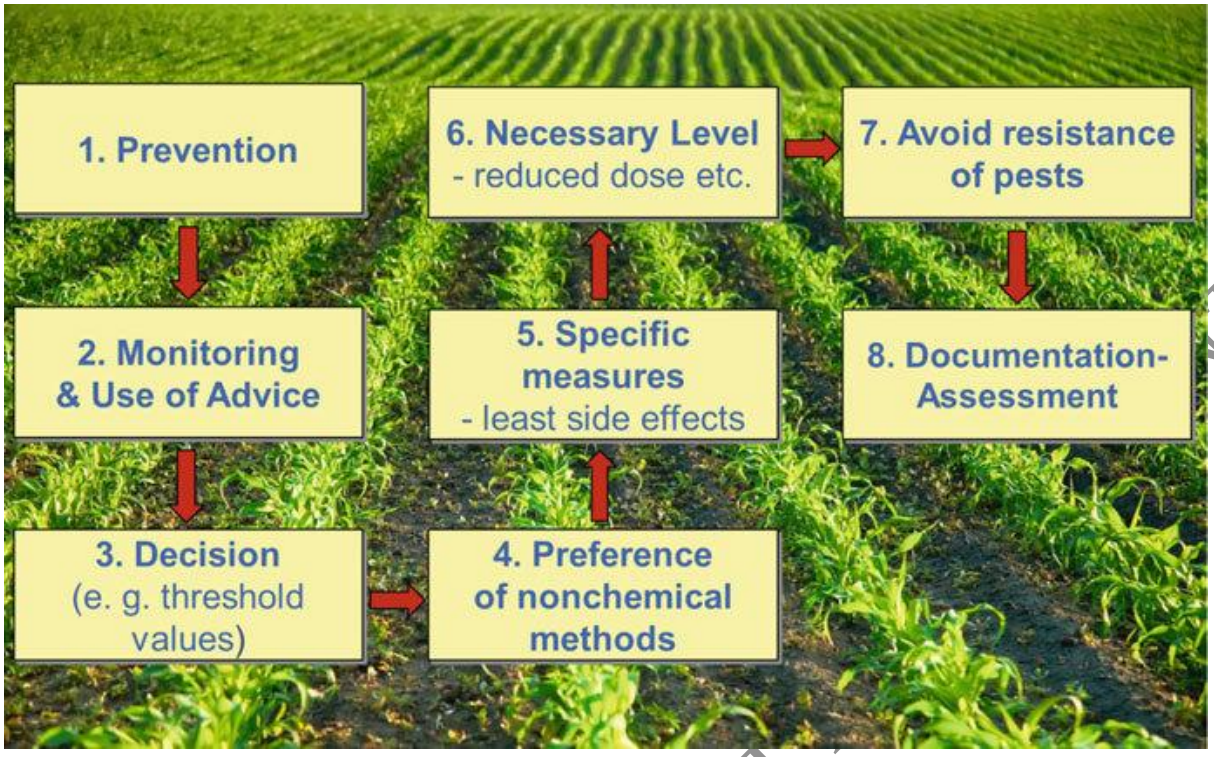
6.1.5 Chemical practices:

Use of chemical pesticides is the last resort when all other methods fail to keep the pest population below economic loss. Although there is a

great advancement in pest management research, yet pesticides would continue to play an important role in crop protection in view of complexity of pest problems. Therefore, use of pesticides should be need based, judicious, based on pest surveillance to minimise not only the cost involved, but also to reduce associated problems. While going for chemical control, we must understand thoroughly what to spray, when to spray, where to spray and how to spray, keeping in mind the following points.

- Pest defender ratio must be observed.
- Relatively safer pesticides should be selected e.g. neem based and biopesticides.
- If pest is present in strips or isolated patches, whole field should not be sprayed.

Relevance of IPM practices are more important in vegetable and fruit crops because of their unique mode of consumption by human being. CIB&RC approved pesticides should be used against target pest for recommended crops. Farmers should not use another pesticide until waiting periods of first pesticides completes and crop should be harvest after completion of waiting period. We have to be more careful and cautious in applying pest control practices in field crops.



1. Prevention and Suppression

- Prevention is adoption of measures to reduce the chance of occurrence of pest. Suppression is reducing the impact of the pests.
- Prevention and suppression can be done by applying the different techniques.
- It is a method of preventing the spreading of harmful organisms by hygiene measures (e.g. by regular cleansing of machinery and equipment)
- One of the methods of prevention and suppression is crop rotation where it would break the life cycle of the pests.
- Prevention and suppression also include use of adequate cultivation techniques (e.g. stale seedbed technique, sowing dates and densities, under-sowing, conservation tillage, pruning and direct sowing).

2: Monitoring

- Harmful organisms must be monitored by adequate methods and tools, wherever available.
- Monitoring can be done through observations, use of scientifically sound warning, forecasting and early diagnosis systems, advice from professionally qualified advisers, etc.
- Many countries like France, Denmark have adopted this monitoring and forecasting technique

3: Decision making

- Decision making is done based on the results of the monitoring
- IPM focuses on threshold-based intervention in most of the cases. Threshold is the defined pest density, or population level, which when exceeded, management should occur.
- However, threshold is difficult to define in most of the cases and in case of tolerant species, decision of intervention is based on the general observations.
- We should also be aware that specific crops, pest life cycle, climatic condition, etc., should be considered before making any kind of decisions.

4: Non-Chemical Methods

- Non-chemical methods are prioritized over chemical methods if they can produce satisfactory results.
- As chemical methods are often not sustainable and creates more pest problems, non-chemical methods are always preferred at first hand as they are more sustainable with less biological and environmental hazards.

- Examples of non-chemical methods include soil-solarization or biological control.
- Use of live natural enemies is one of the major non-chemical (biological) intervention method.
- Other non-chemical methods include biological, physical and ecological methods.

5: Pesticide Selection

- IPM doesn't totally avoid the use of the pesticides
- When the alternative methods are not properly used then the pesticides are used for pest control.
- The pesticides used however needs to be as specific as possible for the target
- The pesticides shouldn't possess any threat to the health of human, non-target humans and environment.

6: Reduced Pesticide Use

- Reduced pesticides use refers to the reduction in the frequency and doses of the pesticides
- This method needs to be supported by the other means of intervention
- It helps in reducing the side effects of the pesticides

7: Anti- resistant Strategies

- IPM focuses on the anti-resistance activities as:
- Unmanaged and haphazard use of the pesticides have created the problem of resistance and
- Pests have developed the resistance and the use of pesticides have less effect on them

- This is also the major reason for the IPM.
- Anti-resistant strategies include use of combination of different pesticides that has different mode of action, applied in different time.

8: Evaluation

- Evaluation is the important aspect of the IPM program.
- Evaluation is done based on the records of the use of the pesticides, its effects and many more.
- Evaluation is necessary in studying the effectiveness of the plan protective measures and plan further.

6.2 ADVANTAGES AND DISADVANTAGES OF IPM

ADVANTAGES

1. Lower cost intervention

- Traditionally, the use of the pesticides to control the pest invasion would account to lots of cost.
- Also, these pesticides need to be imported as well
- The application of IPM would lessen the financial burden.
- Moreover, different techniques involved in IPM are more sustainable with long lasting benefits

2. Benefits to the environment

- Use of the pesticides are often linked degradation of the environment causing some more additional problems
- IPM is an eco-friendly approach and the effects on the environment is always considered before the application of any interventions
- Less use of pesticides won't affect the fertility of soil

3. Minimizes residue hazards of pesticides

- It is obvious that in an IPM schedule the use of pesticides will be considerably reduced, hence the pesticide residue hazards will also get automatically minimized.

4. Anti-Resistance

- The IPM model in itself is the anti-resistant mode for pest control.
- It discourages the use of chemicals and thus creates less cases of anti-resistance.
- Pesticides are used only when the other alternatives are not satisfying.

5. Useful and best intervention for the general public

- Assurance of safe, reliable and low-cost pest control
- The pest control will not affect the crops
- Moreover, it is safe and affordable for the general public as well

DISADVANTAGES

1. More involvement in the technicalities of the method

- IPM needs to be planned
- IPM demands more attention and dedication
- Requires expertise of various field
- All those involved in the IPM needs to be educated and trained which often requires much time.

2. Time and energy consuming

- Application of IPM takes time. Much time is needed in planning itself.
- As IPM strategies differs from region to region, a separate plan is required for each region.
- The expected results of intervention may take long time to be achieved.

6. 3 BIOLOGICAL CONTROL AGENTS

Predators

- Predators are mainly free-living species that directly consume a large number of prey during their whole lifetime. Given that many major crop pests are insects, many of the predators used in biological control are insectivorous species.
- Lady beetles, and in particular their larvae which are active between May and July in the northern hemisphere, are voracious predators of aphids, and also consume mites, scale insects and small caterpillars.
- The spotted lady beetle (*Coleomegilla maculata*) is also able to feed on the eggs and larvae of the Colorado potato beetle (*Leptinotarsa decemlineata*).

Parasitoids

- Parasitoids lay their eggs on or in the body of an insect host, which is then used as a food for developing larvae. The host is ultimately killed.
- Most insect parasitoids are wasps or flies, and many have a very narrow host range.
- The most important groups are the ichneumonid wasps, which mainly use caterpillars as hosts; braconid wasps, which attack caterpillars and a wide range of other insects including aphids; chalcidoid wasps, which parasitize eggs and larvae of many insect species; and tachinid flies, which parasitize a wide range of insects including caterpillars, beetle adults and larvae, and true bugs.
- Parasitoids are most effective at reducing pest populations when their host organisms have limited refuges to hide from them.
- Parasitoids are among the most widely used biological control agents. Commercially, there are two types of rearing systems: short-term daily output with high production of parasitoids per day, and long-term, low daily

output systems. In most instances, production will need to be matched with the appropriate release dates when susceptible host species at a suitable phase of development will be available.

- Larger production facilities produce on a yearlong basis, whereas some facilities produce only seasonally.
- Rearing facilities are usually a significant distance from where the agents are to be used in the field, and transporting the parasitoids from the point of production to the point of use can pose problems.
- Shipping conditions can be too hot, and even vibrations from planes or trucks can adversely affect parasitoids.

Entomopathogens

- Entomopathogens are microorganisms that pathogenic to insect pest. Several species of naturally occurring viz; fungi, bacteria, viruses and nematodes, infect a variety of insect pests and play an important role in agricultural crops controlling insect pest management.
- This kind of biopesticide has many advantages and alternative to chemical insecticides, highly specific, safe, and environmentally sustainable.
- Pest problems are an almost inevitable part of agriculture. They occur largely because agricultural systems are simplified and modifications of natural ecosystems.
- Viruses, bacteria are host specific and fungi generally have broader host range and can infect both underground and aboveground pests, soil-dwelling nature nematodes are more suitable for managing soil pests.
- Growing crops in monoculture provides concentrated food resource that allows pest populations to achieve higher densities in natural environments. Some of the most important problems occur when pests develop resistance to chemical pesticides.

- These cause highly significant damage to crops, there are also threats from emerging new strains of pests. Crops cultivation can make the physico-chemical environment more favourable for pest activity.
- Agricultural pests are reducing the yield and quality of produce by feeding on crops, transmitting diseases. Agricultural production significantly loss crop yields, suggest that improvements in pest management are significant forward for improving yields.
- Crop growers are under immense pressure to reduce the use of chemical pesticides without sacrificing yields, but at the same time manage of pests is becoming difficult due to pesticide resistance and the decreasing availability of products.
- Alternative methods are needed urgently. These need to be used as part of Integrated Pest Management safety and environmental impact.

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