INTEGRATED PEST MANAGEMENT OVERVIEW

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A philosophy of pest control founded on the principles of ecology.

Definitions of IPM:

> "Selection, integration, and implementation of pest control based on predicted economic, ecological, and sociological consequences".
>
> "A comprehensive approach to pest control that uses combined means to reduce the status of pests to tolerable levels while maintaining a quality environment".
>
> "The optimization of pest control in an economically and ecologically sound manner, accomplished by the coordinated use of multiple tactics to assure stable crop production and to maintain pest damage below the economic injury level while minimizing risks to man and the environment".
>
> "A sustainable approach to manage pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health and environmental risks". (National Coalition on IPM)

IPM is not implemented in isolation from other management activities; rather, it is **one component of the total crop production system** of physical, biological, and management functions all interacting to determine the yield of a cultivated crop. Thus, IPM, like nutrient management, is a component of integrated crop management (ICM).

Integrated means that a broad interdisciplinary approach is taken using scientific principles of crop protection to combine into a single cropping system a variety of management strategies and tactics to reduce pest populations. **Strategies** are the general approaches used to implement coordinated systems of multiple tactics. Examples are containment, preventive, corrective or remedial, and eradication. **Tactics** are the specific methods used to achieve pest control. These include cultural, biological, physical, genetic, chemical, and regulatory procedures.

Management implies a process by which information is collected and used to make good management decisions to reduce pest populations in a planned, coordinated way. IPM requires a more tolerant management approach than traditional pesticide-based programs. Eliminating all pests from a crop is the not the objective - IPM emphasizes pest suppression rather than annihilation. This approach allow for the conservation of natural control factors and the establishment of a pest refuge for resistance management.

Pests include insects, mites, nematodes, weeds, bacteria, fungi, viruses, vertebrates, etc. Any plant or animal whose activities interfere with human health, convenience, comfort, or profits. Broadly defined to include pests affecting food, fiber, and shelter; pests of public health importance; and nuisance pests.

How do plants and animals become pests?

*Introduction of foreign pests
*Host shifts in native organisms
*Changes in cropping systems
*Changes in food quality standards

Four general types of insect damage which affect why, how, and when control actions are used.

Indirect Damage - Feeds on nonmarketable portion of plant, causing yield loss.
(i.e. potato beetles, root and seed maggot, aphids)

Direct Damage - Feeds on marketable portion of plant, causing primarily quality loss. (i.e. earworm in sweet corn ears, cabbage worms)

Vector Diseases - Insect transmits organism that causes plant disease, causing yield and quality losses. (i.e. cucumber beetles/bacterial wilt, flea beetles/Stewart's wilt)

Contamination - Presence of insects, insect parts, or insect products makes produce less valuable, causing quality loss. (i.e. ECB in snap beans and peppers, thrips in asparagus and sauerkraut)

Justification for IPM:

A unilateral approach using pesticides has limitations; thus a socially acceptable and economically practical approach to crop protection is needed.

What are the problems with pesticides?

*Economic and energy costs
*Resistance to pesticides
*Disruption of natural control
*Target pest resurgence
*Induced secondary pest outbreaks
*Human health hazards - acute and chronic effects - user and consumer risks
*Environmental pollution and effects on wildlife
*Effects on pollinators

Goals of IPM (and ICM):

Increase Farm Profitability (increase net profit)

*Prevent or avoid crop and pest problems before economic losses occur.
*Eliminate crop input expenses by avoiding unnecessary management actions.
*Improve the efficiency of management actions by adopting better application practices.

Improve Environmental Quality

*Judicious use of pesticides and fertilizers based on identified needs.
*Use selective chemicals or application methods where possible to reduce risk to non-target organisms.

Improve Public Image of Agriculture

*Far-reaching "side benefits" of reducing further regulatory and societal restrictions on the use of pesticides.

Major Underlying Principles of IPM:

The **management unit is the agroecosystem** and any management action may produce unexpected and undesirable effects – this notion forms the basis of the systems or holistic approach to IPM.

Any pest exists at some tolerable level – this notion forms the basis of the economic injury level concept.

Natural control factors regulate pest populations.and are maximized in IPM as the primary means of management; if this strategy fail to maintain pests below economic levels, then pesticides in combination with other tactics are used as a last resort.

Less than 100% control is desirable to leave a permanent pest residue for natural enemies and as a refuge for susceptible pests to reduce the chances of resistance development.

> *Do these principles conflict with the attitudes and practices of traditional
> pesticide-based pest control programs?

Key Components or Steps in the Implementation of IPM:

1. Correct pest Identification - what pests and stages are causing the damage. This is foundation of all decisionmaking.

2. Understanding of pest and crop dynamics - must have enough information about the biology of the pest encountered to assess the potential risk that the pest poses and determine the best possible management strategy.

*When does the pest inflict feeding injury?
*How much injury is tolerable?
*What are the expected losses of the pest if controls are not used?
*What is the most vulnerable stage for management?
*Two concepts of importance: window of vulnerability and treatment window

3. Planning Preventive Strategies as the preferred management strategy in IPM; a careful examination of field history and all aspects of the crop production system should be made to determine if the crop can be grown or treated to prevent pest populations from exceeding economic levels.

*Can any cropping practice, such as time of planting, crop rotation, or tillage, be manipulated to reduce pest attack?
*Are the chances of economic pest losses great enough to justify a preventive pesticide strategy?
*What are the benefits and risks of soil insecticides?
*What are the existing natural control agents that can be augmented or conserved?

4. Monitoring - involves periodic assessment of pests, natural control factors, crop characteristics, and environmental factors to the need for control and the effectiveness of any management action. Different methods and sampling frequencies are used, depending on the type of pest and monitoring objective. Involves direct and indirect means: field scouting to make visual counts or assessment of damage, use of trapping devices (pheromone traps, light traps).

5. Decisionmaking - involves an evaluation of the monitoring information to assess the relevant economic benefits versus the risks of pest management actions. What will I lose if I do nothing? What will I gain?

*Is there enough natural control agents present to reduce the pest population below economic levels?

*Is the damage potential of the pest more costly than the control?

Estimates of pest population size are compared to "economic thresholds" or "action thresholds" which serve as references for loss potential at particular crop growth stages or sets of crop conditions.

6. Selection of Optimal Pest Control Tactics to manage the problem while minimizing economic, health and environmental risks.

*Are there opportunities to integrate nonchemical tactics?
*How well will the control option fit into the total management system?
*How well will the tactic control the pest? What effects will this action have on the user, society as a whole, and the environment?
*Will this action impact, either positively or negatively, the other insect pest species or natural enemies present in my crop?

For chemical controls, important questions at this step are: What is the best insecticide for the target pest? What is the optimal rate? Is it legal? What are the safety requirements and use restrictions?

7. Implementation - Once the management options are selected, they should be deployed on a timely manner with precision and completeness. Concept to remember for chemical control: Proper timing and placement is often more important than the rate.

*What can be done to improve effectiveness of the management tactics?
*Is the pesticide application equipment calibrated properly and in good working condition?
*If pesticides are used, what is the appropriate chemical and rate for the target pest?
*Can the pesticide be applied in a manner that will be least disruptive on natural enemies while still provide effective control?
*In certain situations, it may be desirable to leave small non-treated areas to evaluate control effectiveness.

8. Evaluation - Always take time to follow-up and evaluate pest control actions to determine if you got your money's worth. Review what went wrong but more importantly what went right.

*Was the choice of control action appropriate?

*Was the management action implemented on time and according to recommen dations?
*What changes to the management tactics can be made to improve control if the same pest problem occurs in the future?
*What future changes in the production system can be made to achieve more permanent suppression of the pest problem?

Use of the Economic Threshold in IPM

Complete control of pests is neither necessary in most cases for maximum yields nor appropriate for IPM. Nearly all crops can tolerate a certain amount of pest damage without appreciable effects on vigor and yield. For most of the key pests, quantitative studies of the amount of damage versus reduction in crop yield have established allowable levels of damage or population density. These measures of tolerable damage or density are referred to economic injury levels" or "economic thresholds", which are fundamental to the goals of IPM. Without an estimate of the pest density that can be tolerated, there can be no reasonable safeguard against either overtreatment with pesticides or unacceptable crop damage.

Economic Injury Level (EIL) - the lowest pest population level that will cause economic damage or the critical population density where the loss caused by the pest equals in monetary value to the cost of management.

Economic Threshold or Action Threshold (AT) - the point at which management actions should be taken to prevent an increasing pest population from exceeding the economic injury level. The ET always represents a pest density or level of pest damage lower than the EIL.

General Equilibrium Position (GEP) - the average population density of a pest over a long period of time, unaffected by interventions of pest management. This level fluctuates about a mean level as a result of biotic and abiotic regulating factors.

The position of the EIL in relation to the GEP defines the status of a pest

The economic injury level concept is flexible and may vary from area to area, crop variety to crop variety, and even between to adjacent fields, depending on crop growth stage and specific agronomic practices.

$$EIL = C / VIDK$$

where:
C = Management costs
V = Market value of crop
I = Injury per pest
D = Crop damage per unit injury
K = Reduction in injury or percent control

*How do these factors influence the EIL?

Most actual thresholds used in IPM today are more complicated and dynamic than a simple fixed level. Many are presented as decisionmaking guidelines or rules which give variable levels, depending on a number of factors in addition to the pest population density or damage. Action thresholds can be expressed as the number of pest stages in the crop, pest damage, or a relative measure of pest activity by trapping or other indirect sampling methods.

Monitoring in IPM

IPM can not be implemented effectively without accurate estimates of pest and natural enemy population densities, or without reliable assessments of crop damage and its effects on yield. .

The amount and frequency of monitoring required for decisionmaking depends upon the crop and its pests. Almost invariably, uniformity of pest infestations does not occur, so it is essential to take a representative sample that overcomes the lack of uniformity. Also. it is important to make a representative survey of a field in the least amount of time.

Field scouting is the primary means of obtaining information to make management decisions. Upon entering any field there are certain general procedures that must always be followed:

Make certain you are properly equipped with the tools you may need once in the field.

*Identify the field on the scouting report form by the farmer's name and number, the
field name and number, and the county.
*Record date and time of day.
*Record weather conditions.
*Record the stage of growth of the crop.
*Record general soil and crop conditions.
*Sample the field using the method and pattern recommended for the particular
pest(s).
*Record the scouting results using the recording units for the particular pest(s).
*If so required, collect samples of pests and/or their damage for later identification.

*Make a recommendation as to whether or not some type of control action is required
for each pest. *Report the scouting results to the grower, the agent and the pest
management office at the university.

Frequency of Scouting Visits

Generally, each field should be scouted at least once a week. Although the incidence of pest problems may not require that all fields be scouted each week, some fields may require checking more than once per week when infestations are borderline and may be approaching economic levels. It is important not to waste time making detailed counts when pest problems are not present. Efficient use of time will come with experience.

Scouting Pattern

Samples must be taken from representative areas of the field. There are many sampling patterns that may be used when scouting a field. Generally, one should move about 50 feet beyond the end rows before making counts. Border rows should be avoided unless there are special reasons for surveying these areas. For example, certain pests invade fields move from outside areas and thus may be expected in these areas first.

There are three basic patterns for pest infestations in a field and sampling should be arranged accordingly.

*Pattern 1 - Pests expected to be uniformly spread over the field. When scouting for a pest with this distribution, the sample sites are chosen so as to be evenly distributed over the field, excluding obvious influencing factors such as field edges. In a square field this might mean one sample in each corner and one in the center. Pests fitting into this pattern are the alfalfa weevil, potato leafhopper, European corn borer, corn rootworm adults, corn leaf aphids, corn earworm, most foliar diseases, etc.

*Pattern 2 - Pests expected to be concentrated in particular areas of a field. Examples: many annual and perennial weeds, early season infestations of Mexican bean beetles, black cutworm, white garbs, Phytophthera root rot or other root diseases may be distributed in high or low spots, or other distinguishable features of the field. If pests are detected in one spot and not in others, subsamples should be made in that region to determine the extent and severity of the problem more accurately.

*Pattern 3 - Pests expected to appear at field edges first. Examples are spider mites, common stalk borer, armyworm, grass sawfly, and grasshoppers. Sample for these pests by walking fields borders or waterways.

It may be necessary to combine 2 or more patterns on one sampling date. For example, scouting corn for armyworms and stalk borers can be accomplished by walking the field borders followed by sampling throughout the field for weeds, European corn borer, and other pests.

Sampling Unit

Once the patternfor sampling has been established, the method of selecting a subsample or sampling unit then becomes important. A sampling unit consists of a speak number of plants, a specific number of feet of row, or a specific area in square feet. Regardless of the sampling unit used, the first plant or site to be examined is chosen at random, i.e., wherever the trowel falls when thrown, etc. The number and size of the sampling units are dependent upon the pests being sampled, their distribution patterns, and other factors.

If the sampling unit involves a specific number of plants at each subsample site, two methods to select those plants are used. Consecutive plants are examined when the pest will not be disturbed by your action to adjacent plants. For example, with European corn borer, cutworms, stalk rot or seedling diseases, a series of consecutive plants are examined. Random plants are examined when mobile insects are being surveyed. In this case, the next plant to be examined will not be adjacent to you but will be some distance away. For example, random sampling would be used with corn rootworm adults.

Scouting and Field Size

Most recommended scouting procedures are designed to provide an accurate assessment of pest activity in 40 acres of a crop field. Many fields will be much larger or smaller than 40 acres. Small fields should be scouted using the full sampling plan. Larger fields should be divided into smaller units of approximately 40 acres for scouting. For example, an 80 acre field can be broken into two 40-acre sections for scouting purposes and a complete sample should be taken in each section.

Fields should be divided into smaller units if parts of the field are under different management systems. For example: 20 acres of corn and 20 acres of soybeans last year planted as one 40-acre corn field this year should be scouted as two 20-acre sections because weed, insect, and disease problems may differ, depending on the preceding crop.

Types of Pest Monitoring Methods

Monitoring techniques fall into three types: absolute methods, relative methods, and population indices.

Absolute methods - estimates of pest population density are expressed as a level per unit of crop area or as a percentage of the sampling units affected. Examples are direct visual counts per plant or per foot of row or per unit of area.

> *Advantages: broad range of applicability, less influenced by spatial patterns and changes in pest behavior and sampling efficiency, easier to predict potential crop damage.
> *Disadvantages: More time-consuming

Relative methods - estimates of pest population activity per unit of effort or time but not expressed with units of the crop area. Examples include visual searches, sweep net sampling, beating or shake cloth estimates, blacklight traps, pheromone traps, visual sticky traps, and bait traps.

> *Advantages: yield more data given the same effort, less time-consuming, easier to implement.
> *Disadvantages: efficiency is affected by pest behavior, diurnal activity, weather conditions, the crop habitat being sampled, and variations in the way the methods are deployed; requires more information to relate relative estimates to potential crop damage.

Population Indices - estimates of crop damage or the frequency of pest infestations which indirectly reflect the size of the pest population. Examples are percentage of plants infested or diseased, percentage of defoliation, percentage of damaged fruits, visual ratings of root or foliage injury, etc.

> *Advantages: less time-consuming and easy to implement, more directly related to crop yield losses.
> *Disadvantages: Can not be used alone to make control decisions, may not allow enough time to take management actions.

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