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Course No: - PATH-232

Course:- Path - 232

Define IPM, describe basic principles and advantages of IPM

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Integrated pest management [IPM]

IPM also known as integrated pest control (IPC) is a broad-based approach that integrated practices for economic control of pests

IPM aims to suppress pest populations below the economic injury level (EIL).

(FAO, 1967): Integrated pest management is a system that, in the context of associated environment and population dynamics of the pest species, utilized all suitable technique and method as compatible manner as possible and maintain levels below those causing economic injury

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Pest

- Pest :- A pest is any organism which occure in large numbers and which is noxious destructive or troublesome to plant as well as to man or his conflict with man's welfare, convenience and profit [Insect, Pathogen, weeds etc]

Based on Occurrence of Pest :-

1) Regular pest :- Occuring more frequently on a crop having close association with the crop.
eg :- Brinjal Fruit borer

2) Occasional pest :- Occuring infrequently with no close accociation with a particular crop.
eg :- Mango stem borer

3) Seasonal pest :- Occuring during a particular part of the year.
eg :- Mango hopper.

Endemic pest
sporadic pests

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4) Persistent pest: Persistent pest are those that do not breakdown in the environment but remain toxic to fish, animals and humans for many year.
eg: Chilli thrips.

Based on level of infections:-

1) Pest Epidemic :- sudden out break of a disease in a severe form in a region at a pertaicular time. These disease occure incidently and occasionally in a particular locality.

Endemic pest:- Endemic means prevalent in and confined to a particularly locality. These disease are more or less constantly present in a particular area.

Sporadic disease:- These occure at very irregular intervals and location.

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- Economic threshold level (ETL) :-
Population density at which control measure should be implemented to prevent an increasing pest population from reaching the ETL eg:- Tomato fruit borer one egg/one larvae/one damaged fruit per plant. Whitefly 4 adults/leaf (as a sucking pest). Root-knot reniform Nematode 1-2 larvae/g soil

- Economic injury level (EIL) :-
The lowest population density that will cause economic damage

Define Plant disease, economic important of P D

- Plant disease :- A plant disease is any abnormal condition that alters the appearance or function of a plant. It is a physiological process that affects some or all plant function. Disease may also reduce yield and quality of harvested product.

Disease is a process or a change that occurs over time. It does not occure instantly like injury

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- Symptoms :- Visiable effects of disease on plants are called as symptoms. Any dectectable changes in colour, shape, and functions of the plant in response to a pathogen or disease causing agent is a symptom.

- Signs :- Signs of plant disease are physical evidence of the pathogens. eg:- fungal fruiting bodies, bacterial ooze, or nematode cyst. Signs also can help with plant disease identification.

Causes of plant disease :-

1) Abiotic factors :- These are the resultants of deficiencies or excess of ~~nutrition~~ nutrients, light, moisture, aeration adverse soil cond^n, atmospheric cond^n, temp. heat etc. These are generally refered to as disorder.

2) Mesobiotic factors :- The causal agent is neither living thing nor a

non - living thing. The disease caused by viroids and viruses are of this category.

- Biotic factor: This category includes disease caused by living or cellular organization.

1) Eukaryotes :- Fungi, Protozoa, Algae, Nematodes, parasites.

2) Prokaryotes :- Mycoplasma, Rickettsia, Bacteria.

Causes of Plant disease?
Infectious plant diseases are caused by living organisms that attack and obtain their nutrition from the plant they infect.

The parasitic organism that causes a disease is a pathogen.

Numerous fungi, bacteria, viruses and nematodes are pathogens

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The plant invaded by the pathogen and serving as its food sources is referred to as a host.

Classification of Plant disease:-

1) Endemic diseases :- Endemic means prevalent in and confined to a particular locality. These disease are more or less constantly present in a particular area.

2) Epidemic diseases :- Sudden outbreak of a disease in a serve form in a region at a particular time. This diseases occure incidently and occasionally in a particular locali

3) Sporadic disease :- These occure at very irregular intervals and location.

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Modes of spreading of diseases-

1) Soil borne disease: are caused by microorganisms that survive and move about in the soil. Most cannot be seen by the eye and go undetected until the plant becomes ill.
eg:- Root rot, wilt

2) Seed borne disease:-
- Seed borne disease assumed a great importance to seed industries.
- Seed borne pathogens results in seed rots, seedling decay, pre and post emergence mortalities abnormalities, discoloration, reduced seed size and shrivelledness of seed
- The seed borne pathogen not only affect the market value but also nutritive value of the product.
eg:- Damping off.

3) Air borne diseases :-
An air borne transmission is disease transmission through small particulates that can be transmitted through the air over time and distance.
eg: Blight rust, powdery mildew

4) Disease spread by insect :- The viral disease are spread by insects. The insects which carry the viruses are known as vector.

Terminology :-

1) Pathogen :- It is an entity usually micro-organism that can cause disease.

2) Inoculum :- It is any part of the pathogen that can initiate the infection (Primary, secondary).

Any part of the pathogen that contacts with the plant at certain site to initiate the infection process, such as spores, sclerotia or fragment of mycelium of fungi.

a) Primary inoculum :- It is the one that survives during unfavorable condition and causes original infection or primary infection.

b) Secondary inoculum :- The primary infection that produces disease symptoms is the primary symptom. that which produces next crop inoculum is known as secondary inoculum.

3) Propogule :- One unit of inoculum of any pathogen.

4) Pathogencity :- It is the capability of the pathogen to cause the disease.

5) Pathogenesis :- is the chain of events leading to disease development in the host.

Inoculation → Penetration → Invasion / Colonization → Infection

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The concept of IDM / IPM

The concept has evolved into holistic multidisplinary management system that integrates control methods on the basis of ecological and economic principles of pests.

Development of diseases is essential for econnomic and effective control:

- Causes of the disease
- Mode of survival and spread of the pathogen
- Host pathogen relationship and mode of secondary spread
- Effect of environment on pathogenis and effective disease
  i.e Epidemiology knowledge

- The central idea of IDM / IPM is the tactical management of the host, the pathogen and the environment so as to keep the damage or loss below the economic threshold level [ETL.

Disease Triangle :-

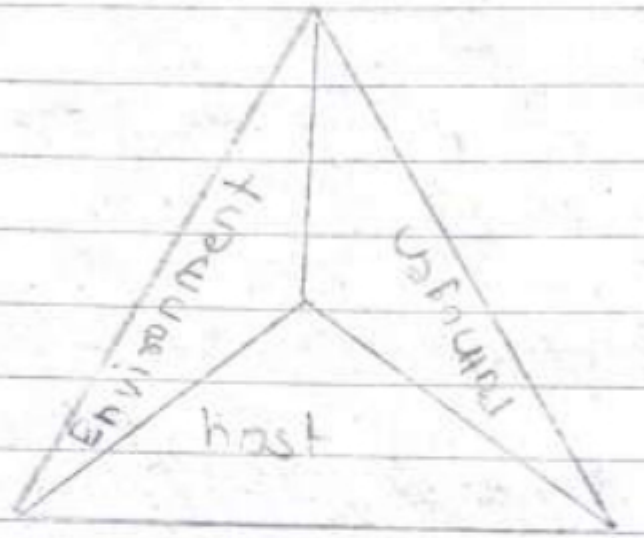

Fig :- Disease triangle

1) Management of Host :- (Sutible)
Involves the practises adopted to improve plant vigour and host resistance through nutrition, induction of genetic resistance through conventional plant breeding and through genetic enginering and providing protection againt attack by chemical means

2) Management of pathogen :- (virulent)
involving avoiding contact betn the pathogen and the host through eradication (inculdecultural,

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physical, mechanical method etc) and protective application of chemicals to prevent infection by reducing initial inoculum or reducing infection rate of pathogen.

3) Management of Environment: (suitable involves water management (improving drainage, changing irrigation practise), soil management (culture method inculding slope, bunds, sun solaization etc) and crop mana. (changing time of sowing reduce plant density etc).

4) Time dimension :- Although time dimension is imp in the epidemic development of most disease not much be done to manage this component except the use of early maturating varieties

Principles of Integrated Pest Management :

Integrated plant disease management: Defined as a decision-based process involving co-ordinated use of multiple tactics for optimizing the control of pathogen in an ecologicaily and economically

Implication :-

- Simultaneous management of multiple pathogen.
- Regular monitoring of pathogen effects, and their natural enemies and antagonists as well
- Use of economic or treatment thresholds when applying chemicals.
- Integrated use of multiple suppressive tactics.

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Principles of IPM

4 - Principles:

1) Consideration of Ecosystem:
Insect pest population.
Natural enemies and other factors.

- Essential to an understanding of population phenomenon.

- The study of individuals is of prime importance. their biology behaviour response to other members of the same species and to other organisms and to biotic factors in the environment

- The study of individuals offers a potent method for this analysis of population change.

- The most effective system for controlling pest can be derived only after understanding the priciples responsible for the population fluctuation in the ecosystem

determining the need a pest control measure surveillance - determine the feasibility of a pest control programme.

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2) Pest surveilance :
Constant observation i.e a crop or pest and recording the factors observed. compilation of information obtained and prediction of future events about pest population. Hence pest surveilance comprises of 3 basic.

a) Determination of the level of incidence of the pest species.

b) Determination of what loss the incidence will cause.

c) Determination of economic benefits or other benefits the control will provide.

3) Utilization of Economic Threshold Levels [ETL] :-
- The level of pest population is very imp. consideration for taking up control measures.

- Pest population must be maintained at level below those causing economic injury.

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- The economic threshold is the pest density at which control measure should to be determined to prevent an increasing pest population from reaching economic injury level.

- The determination of these threshold is a pre-requisite to the development of any pest management strategy

4) Application of minimum selective hazards :-

- The application of chemical measures to pest population has to be in such a manner that target pest populations are just kept below economic injury threshold.

- By observation of this priciple the development of resistant populations of pest is avoided or delayed, the possibility of resurgence of treated population is decreased adversed effect on one target organism and amount of environment contamination are reduced and the cost of control is also lowered.

- When insecticide treatment are deemed necessary special consideration should be given to
1) Effectiveness of the insecticide against most vulnerable life stage of the pest.
2) Employing an insecticide that will cause least disturbance in the ecosystem.
3) Applying the insecticide in such a way that it will restrict its distribution to the area where it is needed.

Advantages and Importance of IPM :-

1) Fits better in National Economy.

2) More efficient and cheaper method.

3) Avoid upsetting the balance of nature

4) minimizes residue hazards of pesticides

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1) Fits better in National Economy :-
Pest control activities at present are mainly based on the application of chemical pesticides, quite a large ~~pop~~ proportion of which has to be imported

- The expenditure envisaged for plant protections run into crores of rupees even when only one or at the most two pesticide applications are envisaged per crop.

2) More efficient and cheaper method:
Mechanical method like destruction of egg masses of some pests or collecting the caterpillar stages

- saving of money and saving of foreign exchange and also the destruction of the pest before it has been able to inflict damage

3) Avoid upsetting the balance of nature:-
chemical control has often been reported by upset the balance of nature at time

leading to upsurge of new type of pest problem which did not exist before. The seriousness of mites in many parts of the world has occured by the use of DDT. It is confidently expected that such adverse side effects will be much less as a result of integrated pest management schedule.

4) 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.

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- Advantages of IPM:

1) Promotes sound structures and healthy plants.

2) Promotes the sustainable bio based disease management alternatives.

3) Reduce environmental risks associated with mana. by encouraging the adoption of more ecologically benefits control practices

4) Reduce or eliminates issues related to pesticide residue.

5) Decrease worker and public exposure to chemical.

6) Reduce the need of pesticides and fungicides by using several mana. method.

7) Reduce the potential for air and ground water contamination

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- Disadvantages of IPM :-

1) Requires more time to understand and implements than tradition pest mana even if implementation

2) May initially be more expensive

3) sometimes the bio-agents may become crop pests

4) It cannot be used for all pests.

5) It can be hard to determine when to use sprays.

6) It doesn't work with all environment

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3 Lecture

Tools and components of Intergrated Pest Management

1) Cultural method or agronomic practise.
a) Use of resistant varieties
b) Crop rotation
c) Eradication / crop residues destruction
d) Tillage of soil
e) Variation in time of planting or harvesting
f) Pruning or thinning and proper spacing
g) Judicious and blananced use of fertilizers
h) crop sanitation
i) water management
j) planting of trap crops etc.

2) Mechanical method :-
a) Hand destruction
b) Exclusion by barriers, screens
c) Uses of traps, suction devices collecting machine
d) Crushing and grinding

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3) Physical Method:-

a) Application of heat :- Hot air treatment

- Hot water treatment :- pasteurization of godown
- Exposing of infested grain to sun
- Super heating of empty godowns at 50 degree c to kill hibernating stored grain pest. sugarcane chewing sun - exposure to grain reduce moisture content in storage condition

b) Manipulation of moisture:

- Reduction of moisture content of grains helps to prevent from the attack of stored grain pest.

c) Energy :-

- Light traps, irradication, light regulation change the resistance of plants

d) Sound :-

- Ultrasonic sound to control rats, sound for birds

4) Biological method:-

a) Protection and encouragment of natural encemies.

b) Introduction, artificial increase and colonization of specific parasitoids

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and predators.
conservation of natural enemies
Parasites and parasitoids
- Egg Parasitoids
larval Parasitoids
- Pupal Parasitoids

c) Propagation and dissemination of specific bacterical, viral fungal and protozan disease
d) Use of botinical like Neem, pongam

5) Genetic method
- Use of sterile male technique
- Release of genetically incompatible/ sterile pests
- Trangenic plants.

6) Regulatory / Legal method:-
Plant quarantine.
a) Foregien quarantine
b) Domestic quarantine (state)

7) Chemical method:-
a) Use of attractants
b) Use of repellents

germ plasm

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c) Use of growth inhibitors
d) Use of insecticides
e) Use of chemosterilents.

8) Hot plant resistance:-
develop the favorable for biological control
Antixenosis, Antibiosis, tolerance etc.
eg. Bt cotton for manage Helocirpa

9) Behavioral methods:
a) Pheromones - chemical release by female insect which attract male insects
b) Allelochemicals - are the natural chemical which is living patmogen which is harmful for other insects

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Economic Importance of Plant Diseases

- Plant disease may limit the kinds of plants and industries in an area.

- Plant diseases reduces the quantity and quality of the plant produce

- Plant disease may make plant or plant product poisonous to human and animals

- Plant disease may cause financial losses

- The cost of controlling plant disease is also a direct loss due to diseases

Q. Define plant disease and explain economic impoolant of plant disease

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What is pest risk analysis. Describe all stage of pest risk analysis

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Pest Risk Analysis

Pest risk analysis :- PRA is a form of risk analysis conducted by regulatory plant health authorities to identify the appropriate phyto sanitary measures required to protect plant resources against new or emerging pest and regulated pest of plants or plant products

- commonly applied for different purpose

1) Analysis risk for organism
2) Analysis risks for pathways
3) Analysis risks for commodities
4) Supporting new publicies or changes to existing policies
5) Prioritizing resources

The PRA process consists of 3 stages
Stage 1 = Initiation
Stage 2 = Pest risk assessment
Stage 3 = Pest risk management

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Stages within a pest risk analysis:-
The initiation stages involves 4 steps
1) determination whether an organism is a pest
2) defining the PRA area
3) evaluating any previous PRA
4) conclusion

Stage I: Initiation :-
The aim of the initiation stage is to identify the pest(s) and pathways which are of quarantine concern and should be considered for risk analysis in relation to the identified PRA area.
- common reasons for initiating a pest risk analysis includes
1) The identification of a pest that may require phytosanitary measures.
2) The identification of a pathways that present a potential pest hazard.
3) The review or revision of phytosanitary policies and priorities.

m - 1
n - 2
1 - 3
D - 4

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Disease Management:

To know the prevalence and extent of damage caused by a disease

To develop effective management strategies

3 categories of disease damage:-

1) The whole plant is killed/damaged.

2) Localized part of plant or the field is affected

3) The effect of disease outbreak persists over several seasons

Disease incidence:

It is the percentage of diseased plants or parts in the sample or population of plants.

It can be the proportion or percentage of diseased leaves in a plant. diseased stalks or a tiller or diseased seedling in a field

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$$D.I = \frac{\text{No. of infected plant}}{\text{Total no. of plant assessed}} \times 100$$

Disease evaluation according to the incidence is suitable for:-

1) most disease in the early stage of their epidemic

2) It applies mainly to disease which affects whole plants such as systemic virus disease wilts, smuts, fruit rots etc.

3) It generally tell about the prevalence of the disease in a given area or host population

Disease Severity:-
Disease severity is the percentage of relevant host tissues or organ covered by symptom or lesion or damaged by the disease. Severity results from the number and size of the lesions

It is more appropriate in disease like rust, downy and powdery mildews, leaf spots and other similar disease.

It tells about the extent of damage cause by the disease

Disease severity or Infection Index

$$= \frac{\text{Sum of all disease rating}}{\text{Total no. of rating} \times \text{maximum disease grade}} \times 100$$

Standard Area diagram:
It allow estimation of intermediate levels of disease severity by comparing a disease plant with diagrams showing both more and less disease

These diagram have been prepared for various disease

(A) Bacterial pustule / Rhizoctonia Aerial Blight / Fungal Leaf Spot.

Rating	Decription
0	No lesions / spot.
1	1 % leaf area covered with lesions / spot.
3	1.1 - 10 % leaf area covered no defoliation little damage
7	25.1 - 50% leaf area covered, some leaves drop. death of a few plants. damage conspicuous.
9	More than 50% area covered, lesions / spot very common on all plant, defoliation common. death of plant common damage more than 50%.

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$$D.S = \frac{\text{Sum of all disease rating}}{\text{Total no of rating} \times \text{maximum disease grade}} \times 100$$

$$= \frac{186}{34 \times 9} \times 100$$

$$= \frac{186}{204} \times 100 = 60\%$$

Fungal | Bacterial disease

(B) Charcoal Rot | collar Rot | Rhizotonia Root Rot.

Rating	Description
0	No mortality
1	1% mortality
3	1.1 - 10% mortality
5	10.1 - 25% mortality
7	25.1 - 50% mortality
9	more than 50%

Disease grade	Total Rating	No. of Rating
0	5	0
1	5	5
3	8	24
5	4	20
7	8	56
9	4	36
	34	186

sum of all rating : 186
Total rating : 34

Descriptive scales:-

1) For assessing the disease severity the descriptive keys have also been standardized for various diseases.

2) Here the pictorial diagram of the plants with varying amount of types of disease symptoms are categorized with description.

These are widely used and are

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many type ranging from disease rating on numerical scale to subjective.

methods of detection and diagnosis of various plant disease

7 - step plan for basis plant disease diagnosis :-

1) Identify the affect plant.

2) Determine what disease have been reported on plant being examine

3) Determine what to look for to confirm suspicion.

4) Determine the distribution of the disease within a field

5) Cropping history

6) Check for root rot.

7) Inspect all parts of the plants.

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Diagnosis = Diagnosis of plant disease is to identify the disease nature of illness / problem by examination of symtom.

Detection: Detection of plant disease is to determine the casual agent whether living or non-living by observation / noticing / recognition.

Plant pathogen types:
Fungal: round leaf spot, Stem rots with dry / papery texture, concentric rings, discoloration with

Biotic plant Problems.
living disease factor - Infectious and transmissible.

- fungal
- Bacteral.
- Nematodes
- Phytoplasma
- Parasitic higher plant.

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Abiotic plant problems:-
non-living disease factor - non-infectious and non-transmissible

- Environment extreme - temp, light moisture.

- Nutrient imblance - mobile elements N, P, K, mg and Cl.
Immobile element - Fe, Mn, Cu, Mo

- Toxic chemicals - nutrients pesticide pollutants, fertilizer

- Mechanical injury - frost, hail, wind, equipment.

- water imblance.

- Genetic variable.

Bacterial diseases:- Galls (swollen areas) irregularly shaped leaf spots, wilting (then yellowing and drying) or rot (often a wet rot).
eg:- Black leg on potato.

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Methods of Plant Disease Management

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1) Host Plant Resistance:

Disease resistance = It is the ability of a plant to overcome completely or in some degree the effect of a pathogen or damaging factors

Susceptibility - The inability of a plant to resist the effect of a pathogen or other damaging factor.

Advantages of resistant variety:

1) Resistant varieties can be the most simple practicals, efficitive and economical method of plant disease management.

They not only ensure protection against plant disease

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Disadvantages:-

1) Breeding of resistant varities is a slow and expensive process.

2) Resistance of the cultivator may be broken down with the evolution of the pathogen.

[m imp] Types of resistance:-

1) Vertical Resistance - when a variety is more resistant to one or some races of the pathogen than other known as vertical resistance. It is usually governed by single gene and is unstable

2) Horizontal Resistance - when the resistance is uniformly spread against all the races of a pathogen then it is called as horizontal. It is usually governed by several gene and is more stable.

3) monogenic resistance:- When the defence mechanism is controlled by a single gene pair.

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4) Oligogenic resistance = when the defence mechanism is governed by a few gene pairs.

5) Polygenic resistance = When the defence is controlled by many gene or more groups of supplymentary gene.

Difference betn vertical and horizontal resistance:-

Feature	Vertical	Horizontal
Pathotype specificity	Race specific	Race non-specific
Nature of gene reaction	Oligogenic	Polygenic.
Response to pathogen	Hypersensitive	Resistant response.
Phenotypic expression	Qualitilative	Quantitative.
Stage of expression	Seedling to maturity	Expression increase as plant matures

selection & evaluation	Relatively easy	Relatively difficult
Risk of boom and b rust	Present	Absent.
Suitable for Host	Annual but not perennials	Both annuals & perennials.
b. pathogen	Immobile eg. soil pathogen	All pathogen
Need for specific development of resistant	Critical for success with mobile pathogen	None.
Need for other control measure.	Likely	much less likely
Host-pathogen interaction	Present	Absent
Efficiency	Highly efficient against specific race.	Variable but operate against all race

Methods of breeding disease resistance

1) Introduction
2) Selection
3) Hybridization
4) Back cross method
5) Induced mutagenis
6) Development of multilines
7) Tissue culture techinque.

2) Biotechonlogical methods of Plant disease management:

The use of genetically modified organism and or modern techniques (genetic engineering, tissue culture etc) with biological system for disease control is known as biotechonology.

Genetic engeering is the techonology by which it is possible to isolate particular gene from one organism plant, insert them into the genome of another organism/plant and make them to express at right time.

meristem and shoot tips culture are used to eliminate virus from infected germplasm.

Vectors for transfer of genes:

- For transfer of genes to plants vectors are needed in which the gene to be transfered will multiply several folds

- The most effective gene developed in the Tumour inducing plasmid of Agrobacterium tumefaciens from which the Tumour induced genes have been removed.

- A tumefaciens induced tumors (crown galls) through Ti plasmid (tumor inducing) which is a circular double stranded DNA molecules containing up to 2,00,000 base pairs organised into several genes.

- The Ti- plasmid is transferred

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from the bacterium into the cell.
A specific region of the plasmid.
the t-DNA is transferred from the plasmid to the nucleus of the plant cells. It become integrated into plant nuclear genome and is transcribed.

DNA construction:-
- Messenger RNA (mRNA) is extracted and exposed to an enzyme reverse transcriptase which synthesis a complementary single stranded DNA.

- The complementary DNA (c-DNA) is exposed to another enzyme, DNA polymerase, which produces the double stranded cDNA.

The cDNA are inserted into the plasmid of Agrobacterium tumefaciens

Coat - Protein expression in transgenic plant :-
examples :-
Transformation using a gene encoding

the viral nucleocapsid protein of tomato spotted wilt virus [TSWV] has yeild transgenic tabacco plant that are resistant to TSWV.

Transgenic tabacco plant expressing coat protein gene protected the plant against TMV.

Transgenic tabacco plant showing resistance to alfalfa mosaic virus and tabocco rattle virus have also been developed.

Tissue Culture :-
Cells of plants can be cultured special nutrient medium and whole plant can be regenerated from cultured cells. This technique of growing plant in invitro is called tissue culture.

a) Somaclonal variation :-
When plants are regenerated from cultured cells, they exhibit

new phenotype sometimes at high frequencies. If these are heritable and affecting desirable traits. such somaclonal variation can be incoperated into regular breeding programmes.

Disease resistance plants from tissue culture:-

Plant	culture system	selection	Resistance
Potato	Protoplast	SCV	Phytophthora infestans, Alternaria solani.
	callus	CF	Fusarium oxysporum.
Tomato	callus	Fusaric acid	Fusarium oxysporu.

b) Anther culture:-
In these method, the plants are produce directly from microspore [immature pollen grain].
Through anther or micro-spore culture one has immediate access to unique and rare combination of gene representing the recombination of the genetic material contributed by the parents of the cross.

Through anther culture, followed by chromosome doubling, such gene combinations can be fixed in their homozygous state as instant inbreds in a single steps.

c) Protoplasmic fusion:-
This generates hybrid cells by merging the total cellular component of somatic cells from which the cell walls have been removed to produce protoplast.

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Advantages of biotechnology in IPM:

1) Slow development of resistance against transgenic Bt, protease Inhabitor lectin.

2) All plant parts express toxin and so no need for insecticide spray.

3) No need for continuous monitoring

4) No environmental pollution, safe to natural enemies, not-target organism.

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Cultural Methods of Plant Disease management

Cultural method:- Manipulation of different cultural practises for reducing pest damages is called as cultural control of pest

1) Eradication :-

a) Host Eradication:

1) When a plant pathogen enters into new area despite quarantine a plant disease epidemic may occur
2) All the host plants infected by pathogen may have to be removed and burnt to prevent such epidemics
3) This eliminates the pathogen and prevent greater losses from the spread of pathogen to additional plant.

b) Eradication of alternate hosts:- Some pathogens that infects plants of one or a few specie or even families of plant can sometimes be reduced in the soil by planting non-hos-

crop for 3 or 4 years.

b) Eradication of alternate hosts:-
some pathogen require alternate host to complete their life cycle.
eg:- Puccinia graminis tritici requires wheat and barberry.

c) Eradication of collateral and self sown overwintering host:-
There are many weed hosts or wild species of cultivated plants acts as collateral host or volunteer plants of an economic crop which act as reservoirs of pathogens of annual crop.

d) Eradication of the affected plants or trees:-
i) Citrus canker (Xanthomonas axonopodis pv. citri) is an example of success of an eradication programme.

ii) Peach yellow and peach rosette were also controlled by removal

and destruction of disease tree

e) Eradication of pathogen from infected plant parts by surgery.
i) Lesions caused by fire blight bacterium (Erwinia amylovora) on pear and apple trees are removed during winter months

ii) Tree surgery is also practised in coconut tree affected by stem bleeding disease.

f) Eradication of culled out plant materials debris etc, through different cultural practises.

2) Crop Rotation :-
Soil borne pathogens that infect plants of one or a few species or even families of plant can sometimes be reduced in the soil by planting non-host crop for 3 or 4 years.
Crop rotation can reduced population of pathogens.

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eg:- Crop rotation with sugarcane or paddy is effective in the control of 'Panoma wilt' (Fusarium oxysporum f. sp cubense).
crop rotation with paddy or green manures is effective in the control of red rot of sugercane. (colletobrichum falcutum).

3) Fallowing:-
1) The field is tilled and left fallow for a year or part of year in some cases.
2) During, fallowing, pathogens debris and incolum are distroyed by micro organism with little or no replacement
3) Flood fallowing is to a depth of 0.6-1.5 m for 4 to 6 months markedly reduced the panoma wilt pathogen Fusarium oxysporum f. sp cubense inoculum in balance.
4) Soil inoculum of phytophthora parasitica var. nicotianae the casual organism of black shank of tabacco w w destroyed by flooding the field for 3-4 months and by raising swamp rice in a 2 year rotation with tabacco in tara.

4) Summer Ploughing :-

1) Deep ploughing during summer periods buries the inocula of fungi of soil borne nature.

2) Groundnut blight (corticum rolfsii) is controlled by ploughing the soil to a depth of 20 cm.

3) Bunt and smut spores of wheat, smut spores of sugarcane and sorghum and microsclerotia of verticillium in cotton are buried deep into the soil by deep ploughing.

5) Application of organic manures:

1) Addition of organic manures like farm yard manure or green manures or oil cakes to the soil increases the antagonistic micro-organisms in the soil.

2) Application of FYM at the rate of 12.5 tonne/ha reduced the incidence of macrophomina root rot of citrus and coconut

3) Application of 5 kg of neem cake / tree three times in a

year reduces the basal stem rot [Ganoderma incidum] of coconut.

6) Use of pathogen free seeds and propagative materials:-
Seed may carry internally one or few fungai such as those causing anthracnose and smuts, certain bacteria causing bacterial wilts, spot and blights and certain viruses (Tobacco ring spot virus in soyabean, Lettuce mosaic virus, Barley strip mosaic virus, Prunus nectrotic ring virus.

7) Growing of seed crops in isolated place or use of resistant varieties:-
1) Obtaining seed from disease-free localities has been very successfully resorted to the elimination of many seed borne diseases
2) In India, seed potatoes are annually imported in southern states from Shimla hills for control of virus disease and bacterial ring.

8) Depth of Sowing:-
Depth of sowing greatly influences seed transmission of smuts

Deep planting may cause delay in the emergance of seedling which may be vulnerable to pre-emergence damping off

9) Avoiding injury:-
Injury of plants parts should be avoided in order to check the entry of pathogen.

10) Avoiding ratoons:
Ratooning is a general practise in sugarcane when the incidence of grassy shoot disease and red rot are very high, hence, ratooning should be avoided.

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Physical Methods of Plant disease Management:-

Reduction of pest population by using device which affect them physically or alter their physical environment.

Manipulation of temperature, humidity, light is used for this purpose.

Physical methods are employed for reduction or elimination of primary inoculums that may be present in seed, soil or planting material.

1) Hot water treatment:-
Hot water treatment of certain seeds, bulbs and nursery stock is done to kill many pathogens present in or on the seed and other propagating material.

2) The seeds are soaked in cold

water at 20-30°c for 5 hrs to induce the dormant mycelium to grow. Then the seeds are immersed in hot water at 50-5 for 10 min to kill the mycelium. It is very effectively used to eliminates loose smut of wheat.

The setts of sugarcane can be treated at 50°c for 2 hrs to eliminate whip smut, grassy shoot and red rot of sugarcane. Also hot water treatment to the sugarcane prevent damage by scale insect

The main drawback in the hot water treatment is that the seeds may be killed or loose th germinability, if the period of treatment exceeds the specified time

2) Hot air treatment :-
sugarcane setts are treated with hot air at 50°c for 2 hrs to eliminate mosic virus Treatment of certain storage organs with warm air (curing) removes excess moisture from their surface and hasten the healing of wounds. thus preventing their infection by certain weak pathogens.

a) Aerated steam thearpy (AST) :-
Sugarcane setts are also exposed to aerated steam at 50°c for 3 hrs to eliminate mosaic virus.

b) Moist hot air treatment :-
This method is effectively used in sugarcane to eliminate grassy shoot disease. Initially the setts are exposed to hot air at 54°c for 8 hrs then exposed to aerated steam at 50°c for 1 hrs and finally to moist hot air at 54°c for 2 hours

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3) ~~Hot~~ Solar Heat treatment:-
A simplest treatment has been deviced in India at eliminated the pathogen of loose smut of wheat. Previously the hot water treatment was followed to eliminated loose smut. As the thermal death point of the fungus and the embroy are very close. The extensive care should be taken to avoid killing of the embryo.

Sun drying can easily controlled stored grain pest.

4) Soil solarization:-
Soil solarization is generally used for controlling soil borne pathogen like pythium, verticillum Rhizoctonia etc and nematodes in small area like nurseries.

5) Burning: Flame thrower are used for pest like locust.

6) Moisture:- Reducing the moisture content of stored grain to 10% reduces the infection of pests.

7) Use of sound:- Ultrasonic sound is used to control rats. Also sound used to manage birds

8) Use of light trap:- Light trap is used for many phototropic insects like red hairy caterpiller, stem borer etc.

Mechanical Methods of Plant Disease Management:

Reduction of pest population by means of manual devices is called as mechanical method

1) Hand destruction:-

i) Larvae of cutworm, leaf eating caterpillar, red pumpkin beetle are very sluggish so they can be easily collected and destroyed

ii) Beating with stick to swarms of locust

iii) Adults of white grubs gather on neem or babul tree so by shaking the branches of the tree they can be collected and distroy

iv) Pest of stored grains can be seperately by seiving and winnowing

v) Destruction of diseased plants parts (eg Dried branch of citrus) or plants (uproot and burn) also prevent plant disease.

2) Uses of traps
Pheromone traps :-
Effective For Fruit fly in citrus Helicoverpa, spodoptera and spotted ball worm in cotton.

Yellow cards:
Yellow card with oil or sticky material is effective for white fly

Traps or cage:
Traps or cages For rats also very economic to control the rats.

3) Exclusion by barriers (physical and chemicals).

1) Banding the trees: mealy bugs on mango crawl down and lay the eggs in the soil which can be prevented by putting sticky bands on stem.

2) Bagging the fruits: fruit sucking moth on citrus or pomegranate suck the juice with the help of proboscis which can be prevented by bagging the fruits

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3) Use of packaging material:-
Packaging material is also helps to prevent the post harvest pests incidence in many Fruits and Field crops.

4) Water as a barrier (water Force):
various pest like ants, mites and powdery mildew disease can be prevented by spolashing the plant with water at a great speed

5) Trenching around the Field:
Pest like army worm, grasshopper march from one Field to other which can be prevented by digging trenches around the field.

6) Tin sheets around the base of the trunk:-
Rat can climb on coconut tree and damage the fruit. when we put the tin sheets around base of the trunk they cannot climb.

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Legislative Method of Plant Disease Management:

Plant quarantine regulation:-
Quarantine can be defined as a legal restriction on the movement of agricultural commodities for the purpose of exclusion, prevention or delay in the spread of plant pests and disease in uninfected area.

Quarantine measure are of 3 types:
1) Domestic quarantine
2) Internal quarantine.
3) Total embargoes

1) Domestic quarantine:-
i) Rules and regulations issued prohibiting the movement of insects and diseases and their hosts from one state to another state in India is called as domestic quarantine.

ii) Domestic quarantine in India exists for two pests - a) Rooted scale
b) Sanjose scale.
and for 4 diseases

a) Bunchy top of banana
b) Banana mosaic
c) Apple scab
d) wart of potato (synchytrium endobiotic

iii) wart (synchytrium endobiotcum of potato from 1959

iv) Bunchy top (virus) of banana from 1959.

v) mosaic virus of banana from 1961

vi) Apple scab (venturia inaequalis) from 1979.

2) Foreign Quarantine:
i) Rules and regulations issued prohibiting the import of plants, plant materials, insects and fungi into India from foregin countries by air, sea and land

ii) The Government of India has also approved other national institution

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to act as official quarantine agencies especially for research materials.

1) ICAR Research Institutes

2) National Bureau of plant Genetic Resource [NBPGR]

3) Forest Research Institute [FRI] Dehra Dun, for forestry plants

4) Botanical survey of India [BSI] for other plants

5) The Directorates of Agriculture of all states

3) Total embargoes:-
Total restriction on import and export of agricultural commodities.

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Import Regulations:

1) 1914 - Destructive Insects and Pest Act.

2) 1936 - Import Regulation

3) 1972 - Regulations to import cotton

4) 1984 - PFS order 1984

5) 1988 - National Policy on seed Development.

6) 1989 - PFS order 1989 (revised)

7) 1992 - Amendement to DIP Act - for levying import inspection fee.

8) 2003 - Plant Quarantine (Regulation of Import into India) Order

Botanicals - Plant products occuring from nature

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Biological Methods of Plant disease management:

Biological control is the reduction of inoculum density or disease producing activity of a pathogen or a parasite in its active or dormant state by one or more organisms accomplished naturally or through manipulation of the environment of host or antagonist by mans introduction of one or more antagonists

Biological control of plant pathogens refers to the total or partial destruction of pathogen populations by other organism.

Biological Methods of AEPDM

1) **Use of cross protection:-**
Cross protection indicates when a mild or avirulent strain or pathotype of the pathogen is introduced into the host, its induced resistance to a virulent strain or pathotype of the same or serologically related pathogens

In viruses cross protection is proved in citrus tristeza virus where surplus of coat protein made by the mild virus prevents uncoating of the virulent virus and prevent its multiplication.

2) Use of suppressive soil.
In certain soils, soil borne disease like root rot of fruit trees caused by phytophthora cinnamoni vascular wilts caused by Fusarium oxysporum, damping off caused by pythium spp etc are found to cause much milder effect on their hosts, such soils are reffered to as suppressive soils

3) Introduction of new antagonists
The new antagonists can be introduced in a particular place where its population is very limited.
eg: use of different formulation

of Trichoderma Bacillus sp.

4) Use of hypo-virulent strain:-
Hypovirulence is the phenomenon of reduced virulence of a pathogen strain than normal ones developed as a result of its infection by double-stranded RNA (ds RNA).

5) Use of hyperparasities:-
Some fungal bioagents like Trichoderma spp can parastize the other fungi like Rhizoctonia, sclerotium and fusarium spp they are known as hyperparasitism and can be effectively used to control these soil inhabitants.

6) Use of plant growth promoting rhizobacteria [PGPR]:-
Rhizosphere bacteria that favorable affect plant growth and yield of commercially important crop are known as plant growth promoting rhizobacteria.

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The growth promoting ability of PGPR is due to their ability to produce phyto-harmones siderophore, hydrogen cyanide [HCN] chitinase, volatile compounds or antibiotics which will reduce infection of host through phyto-pathogic micro-organisms

7) Bacteriophages:-
Bacterophages are viruses which kill the bacteria. A number of phages have been discovered for many phytopathogic bacteria such as Agrobacterium tumefaciens Erwinia amylovora. E. carotovora. Psedomonas glycinea.
this was brought about by inoculation with a mixture of the phage and the bacterium or by plant or seed treatment with phage before challenge with bacteria.

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Plant Products (Botanical) in plant disease management:

Plant products play an important role in evolving an ecologically sound and environmentally acceptable disease managment system.

Neem products
Neem seed kernel Extract
Neem oil solution
Neem cake extract
Neem cake

Biopesticides:

Biopesticides are crop protection products derived from naturally source that are used to control pest pathogen and weeds by a variety of mean.

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Chemical Methods of Plant disease Managements:

1) Fungicides: The word Fungicides originated from two latin words Fungus and caedo. The word Caedo means to kill. Thus, the fungicides is a chemical which is capable of killing fungi.

2) Fungistat: Some chemicals do not kill the fungl pathogens But they simply arrest the growth of the fungus temporarily. These chemical are called fungistat and the phenomenon of temporarily inhibiting the fungal growth is termed as fungistatis.

3) Antisporulant: some other chemicals may inhibit the spore production without affecting the growth of vegetative hyphae and are called as Antisporulant.

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Fungicides can be broadly grouped based on their

I) mode of action.
i) Protectant
ii) Therapeutant
iii) Eradicant

II) Based on general use
i) seed protectant
ii) soil fungicides (preplant)
iii) Foliage and blossom
iv) fruit protectants
v) Eradicants
vi) Tree wound dressers
vii) Antibiotic
viii) General purpose

III) Based on chemical composition.
i) Copper fungicides
ii) Sulphur fungicides
iii) Heterocyclic Nitrogeous compounds
iv) Mercury fungicides
v) Benzene compounds
vi) Quinone fungicides
vii) Organo Tin compounds

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Antibiotics : Antibiotics is defined as a chemical substance produced by one micro-organism which is low concentration can inhibit or even kill other micro-organism.

They can be grouped into 2
i) Antibacterial antibiotics
ii) Antifungal antibiotics.

i) Antibacterial antibiotics
Streptomycin sulphate
Tetracyclines

ii) Antifungal antibiotics
Aureofungin
Griseofulvin
Cyclohexmide
Blaticdin
Antimycin
Kasugamycin
Thiolution
Endomycin
Bulbiformin
Nystatin
Furocidin

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Fungicide Formulation:-

Emulsifiable concentrates [EC]:-
These are liquid formulation which can be diluted with water before application

Wettable Powders [WP]:-
Wettable powders is a very common formulation for most of the fungicides which is used for spray mixture.

Dust [D]:-
Dust formulation usually contain 1-10% active ingredient for direct application in dry form.

Granules (Pellets):-
Pellets are the formulations of the fungicide with inert material formed into particles about the size of coarse sugar.

Solution:-
True solutions are formulations in which active ingredient or a combination

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of active ingredients and a solvents is dissolved in water solutions have the advantage of requiring no agitation after formulation is added in water.

Adjuvants:
The fungicides can be commonly applied either as spraying or dusting.

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General Safty guidelines:

1) preparation of pesticides:
select suitable pesticides, purchase registered pesticides read and follow label instructions, pay close attenstion to the dilution and application, rate, we proper measuring cylinders. measure carefully and mix only the amount needed, mix pesticides in a well ventilated location, we a stick to stir the mixture.

2) Equiments:
wear appropriate personal protective equipment when mixtiing and applying pesticides, we seperate sprayers for insecticides and herbicides proper calibration, maintanance and regular checking of leakages from joints / pipes and nozzles do not blow out a clogged nozzle with mouth Fill and rinse tank with clean water, Store in a dry place with lid open, drain fuel tank and leave

3) Field application:
Sensitized persons should not apply pesticide post warning notices do not smoke eat or drink when spraying do not spray when crop are wet from rain or dew. In a strong wind, when flowers are in bloom do not inhale the mist, aviod contact with mouth eye and skin clothing, stop spraying immediately if feeling ill, medical attention. Do not harvest crop for at least 2 week after the last treatment. washing of equiments and cloths

4) Storage and disposal:
Purchase and keep only the amount of pesticides required for operational needs. Alway store pesticides under lock and key in their original, labeled container all containers should be tightly closely stored pesticides away from food, feed and out of reach of children and livestock animals

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Do not use the empty container for other purposes. Dispose obsolete or unwanted pesticides properly.