Lecture 16 : HOST PLANT RESISTANCE - DEFINITION - TYPES AND MECHANISMS ECOLOGICAL AND GENETIC RESISTANCE

Host Plant Resistance (HPR)

Definition

"Those characters that enable a plant to avoid, tolerate or recover from attacks of insects under conditions that would cause greater injury to other plants of the same species" (Painter, R.H., 1951).

"Those heritable characteristics possessed by the plant which influence the ultimate degree of damage done by the insect" (Maxwell, F.G., 1972).

Types of Resistance

Ecological Resistance or Pseudo resistance

Apparent resistance resulting from transitory characters in potentially susceptible host plants due to environmental conditions.

Pseudoresistance may be classified into 3 categories

a**. Host evasion**

Host may pass through the most susceptible stage quickly or at a time when insects are less or evade injury by early maturing. This pertains to the whole population of host plant.

b. Induced Resistance

Increase in resistance temporarily as a result of some changed conditions of plants or environment such as change in the amount of water or nutrient status of soil

c. Escape

Absence of infestation or injury to host plant due to transitory process like incomplete infestation. This pertains to few individuals of host.

Genetic Resistance

A. Based on number of genes

- Monogenic resistance: Controlled by single gene
  Easy to incorporate into plants by breeding
  Easy to break also
- Oligogenic resistance: Controlled by few genes
- Polygenic resistance: Controlled by many genes
- Major gene resistance: Controlled by one or few major genes (vertical resistance)
- Minor gene resistance: Controlled by many minor genes. The cumulative effect of minor genes is called adult resistance or mature resistance or field resistance. Also called horizontal resistance

B. **Based on biotype reaction**

- Vertical resistance: Effective against specific biotypes (specific resistance)
- Horizontal resistance: Effective against all the known biotypes
  (Non specific resistance)

C. Based on population/Line concept

- Pureline resistance: Exhibited by liens which are phenotypically and genetically similar
- Multiline resistance: Exhibited by lines which are phenotypically similar but genotypically dissimilar

D. Miscellaneous categories

- Cross resistance: Variety with resistance incorporated against a primary pest, confers resistance to another insect.
- Multiple resistance: Resistance incorporated in a variety against different environmental stresses like insects, diseases, nematodes, heat, drought, cold, etc.

E. Based on evolutionary concept

- Sympatric resistance: Acquired by coevolution of plant and insect (gene for gene) Governed by major genes
- Allopatric resistance: Not by co-evolution of plant and insect. Governed by many genes

Mechanisms of Resistance

The three important mechanisms of resistance are

- Antixenosis (Non preference)
- Antibiosis
- Tolerance

Antixenosis: Host plant characters responsible for non-preference of the insects for shelter, oviposition, feeding, etc. It denotes presence of morphological or chemcial factor which alter insect behaviour resulting in poor establishment of the insect. e.g.

Trichomes in cotton - resistant to whitefly

Wax bloom on carucifer leaves - deter feeding by DBM

Plant shape and colour also play a role in non preference

Open panicle of sorghum - Supports less Helicoverpa

Antibiosis

Adverse effect of the host plant on the biology (survival, development and reproduction) of the insects and their progeny due to the biochemical and biophysical factors present in it.

Manifested by larval death, abnormal larval growth, etc.

Antibiosis may be due to

- Presence of toxic substances
- Absence of sufficient amount of essential nutrients
- Nutrient imbalance/improper utilization of nutrients

Chemical factors in Antibiosis - Examples

	Chemicals present in plants	Imparts resistance against
1.	DIMBOA (Dihydroxy methyl benzoxazin)	Against European corn borer, *Ostrinia nubilalis*
2.	Gossypol (Polyphenol)	*Helicoverpa armigera* (American bollworm)
3.	Sinigrin	Aphids, *Myzus persicae*
4.	Cucurbitacin	Cucurbit fruit flies
5.	Salicylic acid	Rice stem borer

Physical factors in antibiosis
Thick cuticle, glandular hairs, silica deposits, tight leaf sheath, etc.

c. Tolerance

Ability to grow and yield despite pest attack. It is generally attributable to plant vigour, regrowth of damaged tissue, to produce additional branches, compensation by growth of neighbouring plants.

Use of tolerance in IPM

- Tolerant varieties have high ETL - require less insecticide
- Apply less selection pressure on pests. Biotype development is less

HPR in IPM

- HPR is a very important component of IPM
- Selection and growing of a resistant variety minimise cost on all other pest management activities

Compatibility of HPR in IPM

a. Compatability with chemical control

- HPR enhances efficacy of insecticides
- Higher mortality of leaf hoppers and plant hoppers in resistant variety compared to susceptible variety
- Lower concentration of insecticide is sufficient to control insects on resistant variety

b. Compatibility with biological control

- Resistant varieties reduce pest numbers - thus shifting pest: Predatory (or parasitoid) ratio favourable for biological control. e.g. Predatory activity of mirid bug *Cyrtorhinus lividipennis* on BPH was more on a resistant rice variety IR 36 than susceptible variety IR 8
- Insects feeding on resistant varieties are more susceptible to virus disease (NPV)

c. Compatibility with cultural method

- Cultural practices can help in better utilization of resistant varieties. e.g. Use of short duration, pest resistant plants effective against cotton boll weevil in USA.

Examples of resistant varieties in major crops

	Pest	Resistant varieties
Rice	Yellow stem borer	TKN 6, Paiyur 1
	Brown planthopper (BPH)	CO 42, IR 36, IR 64
	Green leaf hopper (GLH)	IR 50, Ptb 2, CO 46
Sugarcane	Early shoot borer (ESB)	CO 312, CO 421, CO 661,
	Internode borer	CO 975, CO 7304
	Top shoot borer	CO 745, CO 6515
Cotton	American bollworm	Abhadita
	Spotted bollworm	Deltapine
	Stem weevil	MCU 3, Supriya
	Leaf hopper	MCU 5, K 7, K 8
Sorghum	Earhead bug	K tall
Jasmine	Eriophyid mite	Pari Mullai

Advantages of HPR as a component in IPM

Specificity: Specific to the target pest. Natural enemies unaffected

Cumulative effect: Lasts for many successive generations

Eco-friendly: No pollution. No effect on man and animals

Easily adoptable: High yielding insect resistant variety easily accepted and adopted by farmers. Less cost.

Effectiveness: Res. variety increases efficacy of insecticides and natural enemies

Compatability: HPR can be combined with all other components of IPM

Decreased pesticide application: Resistant varieties requires less frequent and low doses of insecticides

Persistence: Some varieties have durable resistance for long periods

Unique situations: HPR effective where other control measures are less effective

e.g. a. When timing of application is critical

b. Crop of low economic value

c. Pest is continuously present and is a single limiting factor

Disadvantages of HPR

Time consuming: Requires from 3-10 years by traditional breeding programmes to develop a res. variety.

Biotype development: A biotype is a new population capable of damaging and surviving on plants previously resistant to other population of same species.

Genetic limiation: Absence of resistance genes among available germination