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FACULTY OF AGRICULTURE SCIENCES AND ALLIED INDUSTRIES

(Crop Improvement I (Kharif))

For

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INSECT RESISTANCE

Global average loss due to insect pests is 14%. Estimated losses in individual crops vary from 5% in wheat to 26.7% in rice and still more in crops like cotton & sugarcane.

Insect Resistance :

1. The ability of a plant to withstand, oppose or overcome the attack of an insect in known as insect resistance.
2. It is the property of a variety or a host crop due to whic h it is attacked by an insect pest to a significantly lower degree than are other varieties of the same host.

Biotypes : Strains of a species of an insect pest, differing in their ability to attack different varieties of the same host species (syn: Physiological races)

Host Habitation :

1. Polyphagy 3. Seasonal Oligophagy
2. Oligophagy 4. Monophagy

1. Polyphagy : Insects feed on a vide range of hosts avoiding few plant species. Eg. Scales & moths.
2. Oligophagy : Live on one taxonomic unit only. Eg. Hessianfly on wheat
3. Seasonal oligophagy : Insects may live on many species in one part of the year and on few in another part of the year. Eg : Aphids.
4. Monophagy : Avoid all hosts except one particular species or variety Eg. Boll weevil on cotton.

Mechanism of Insect Resistance :

Insect resistance is grouped into four categories :

1. Non preference
2. Antibiosis
3. Tolerance
4. Avoidance

1. **Non preference** : Host Varieties exhibiting this type of resistance are unattractive or unsuitable for colonization, oviposition or both by an insect pest. This type of resistance in also termed as non-acceptance and anti-xenosis. Non preference involves various morphological and biochemical features of host plants such as – color, hairness, leaf angle, taste etc.

2. **Antibiosis** : Antibiosis refers to an adverse effect of feeding on a resistant host plant on the development and/or reproduction of the insect pest. In severe cases, it may even lead to the death of the insect pest. Antibiosis may involve morphological, physiological or biochemical features of the host plant; some cases of insect resistance involve a combination of features. Eg. Resistance to BPT is due to antibiosis & non preference.

3. **Tolerance** : An insect tolerant variety is attacked by the insect pest to the same degree as a susceptible variety. But at the same level of infestation, a tolerant variety produces a higher yield than a susceptible variety. Ability of the host plant to withstand the insect population to a certain extent which might have damaged a more susceptible host. Tolerance is mainly a host character and it may be because of greater recovery from pest damage. Eg. Rice varieties tolerant to stem borer/gall midge produce additional tillers to compensate yield losses (as in stem borer in sorghum) or due to the ability of host to suffer less damage by the pest eg. aphid tolerance in Sugarbeet & Brassica sps. And green bugs tolerance in cereals. Inheritance of tolerance is complex in many cases and is supposed to be governed by polygenes.

4. **Avoidance** : Pest avoidance is the same as disease escape , and as such it is not a case of true resistance Mostly insect avoidance result from the host plants being at a much less susceptible developmental stage when the pest population is at its peak. Eg. 1. Early maturing cotton varieties escape pinkboll worm infestation, which occurs late in the season.

Nature of Insect Resistance / Factors for insect -resistance

Insect resistance may involve :

1. Morphological
2. Physiological (or)
3. Biochemical features of the host plant

1. **Morphological features** : Morphological factors like, hairiness, colour, thickness and toughness of tissues etc. are known to confer insect resistance.

a) Hairiness of leaves is associated with resistance to many insect pests leaf beetle in cereals, in cotton to Jassids , in turnip to turnip aphid.

b) Colour of plant : Color may contribute to non preference in some cases. For example : Red cabbage, Red leaved brussel's sprouts are less favored than green varieties by butterflies and certain Lepidoptera for oviposit ion. Boll worms prefer green cotton plants to red ones.

c) Thickness and Toughness of plant – Tissues prevent mechanical obstruction to feeding and oviposition and thereby lead to non-preference as well as antibiosis.

Eg.

1. Thick leaf lamina in cotton contributes to Jassid resistance
2. Solid stem in wheat confers resistance to wheat stem sawfly
3. Thick and tough rind of cotton bolls makes it difficult for the boll worm larve to bore holes and enter the bolls.

Other characters : also contribute to insect resistance.

Eg. 1. *Gossypium arboretum* varieties with narrow lobed and leathery leaves are more resistant to Jassids than are those with broad lobed and succulent leaves.

2. Cotton varieties with longer pedicels are more resistant to boll worms.

2. **Physiological Factors :** Osmotic concentration of cell sap, various exudates etc; may be associated with insect resistance.
Eg.
1) Leaf hairs of some *solanum sps*. secrete gummy exudates. Aphids and coloradobeetles get trapped in these exudates.
2) Exudates from secondary trichomes of *Medicago disciformis* leaves have antibiotic effects on alfalfa weevil.
3) Cotton- High osmotic concentration of cell sap is associated with Jassid resistance.

3. **Biochemical Factors**: Several biochemical factors are associated with insect resistance in many crops. It is believed that biochemical factors are more important than morphological and physiological factors in conferring non-preference and antibiosis.
Eg.
1) High concentrations of gossypol is associated with resistance in several insect pests in cotton.
2) In rice – high silica content in shoots gives resistance to shoot borer

Genetics of Insect Resistance

Insect resistance is governed by -
1. Oligogenes
2. Polygenes
3. Cytoplasmic genes

1. **Oligogenic Resistance** : Insect resistance is governed by one or few major genes or oligogenes, each gene having a large and identifiable individual effect on resistance. Oligogenic resistance may be conditioned by the dominant or the recessive allele of the concerned gene. The differences between resistant and susceptible plants are generally large and clear-cut. In several cases, resistance is governed by a single gene (monogenic resistance)
Eg. In wheat to green bugs In cotton to Jassids In apple to woolly aphis In rice to plant & leaf hopper.
2. **Polygenic Resistance** : It is governed by several genes, each gene producing a small and usually cumulative effect. Such cases of resistance.
1) Involve more than one feature of the host plant
2) Are much more durable than the cases of oligogenic resistance.
3) Difference between resistance & susceptible plants are not clear cut
4) Transfer of resistance is much more difficult

Examples for polygenic resistance
1) In wheat to cereal leaf beetle
2) In alfalfa to spotted aphid
3) In rice to stem borer
4) In maize to ear worm and leaf aphid Evolution of resistance breaking biotypes is almost rare.

3. **Cytoplasmic Resistance :** governed by plasmagenes
Eg. 1. Resistance to European corn borer in maize
2. Resistance to root aphid in lettuce

Sources of Insect Resistance

1. A cultivated variety 3. A related wild species
2. Germplasm collections. 4. An unrelated organisms

1. Cultivated variety : Resistance to many insect pests may be found among the cultivated varieties of the concerned crop. Varieties SRT 1, Khand waz ; DNJ 286 and B 1007 of *G. hirsuturn* are good sources of resistance to Jassids.
2. Germplasm collection :
Eg.
1) In apples for rosy apple aphid, green apple, apple maker and apple saw-fly.
2) In cotton, several strains resistant to Jassids.
3. Related wild species :
Eg.
1) Resistance to both the species of potato nematodes has been transferred fro *Solanum vernei* to potato
2) Jassid resistances is known in wild relatives of cotton *G. tomentosum; G.anomalum* and *G.armourianum*
4. An unrelated organism : It is done through recombinant DNA technology
a) T he 'Cry' gene of *Bacillus thuringiensis* is the most successful example.

Other genes of importance are the
b) Protease inhibitor encoding genes found in many plants eg. the cowpea pea, trypsin inhibitor (cp TI) gene.

Breeding Methods for Insect Resistance

1. Introduction 2. Selection
3. Hybridization 4. Genetic Engineering

1. Introduction :
Eg. *Phylloxera vertifoliae* resistance grape root-stocks from U.S.A. into france.

2. Selection :
Eg.
1) Resistance to potato leaf hopper
2) Resistance to spotted alfalfa aphid
3. Hybridization : Pedigree oligogenic characters Back cross Polygenic characters
4. Genetic Engineering : *B.theningiensis* (cry gene) resistance in maize, soybean, cotton etc.

Screening Techniques for determining resistance

The most crucial and, perhaps , the most difficult task in breeding for insect resistance is the identification of insect resistant plant during segregation generations. There are two types of screenings.
1. Field Screening
2. Glass house screening

Field Screening :
The techniques designed to promote uniform infestation by an insect pest in the field are
1. Inter planting a row of known susceptible variety between two rows of testing material.
2. Screening in highly prone areas
3. in case Soil insect pests to be tested in sick plots only
4. Testing in a particular season when the infestation is very high. Eg. Rice stem borer in off season.
5. Transferring manually equal number of eggs or larvae to each test plant.

Glass house screening
Result from glass house tests are much more reliable than those from field tests since both the environment and the initial level of infestations are more or less uniform for all the plants being tested.
Problems in Breeding for Insect Resistance :
1. Breeding for resistance to are insect pest may leads to the susceptibility to another pest. Eg. Glabrous strains of cotton are resistant to bollworms but susceptible to Jassids.
2. Reduction is quality or make unfit for consumption.
3. Linkage between desirable & undesirable genes. Inter specific varieties are generally low yielding and their produce is often of inferior quality.
4. Screening for resistance is the most critical and difficult step is a breeding programme it necessitates a close co-ordination among scientists belonging to different disciplines.
5. It is a long term programme.

Achievements
INDIA
1. India – cotton varieties – G 27, MCU 7, LRK 516 – resistant to boll worms.
2. Rice – variety vijaya – resistant to leaf hopper
Rice – TKM 6, Ratna – Stemborer
Rice –Vajram, chaitanya, Pratibha – BPH