## CONCEPT OF HOST PLANT RESISTANCE

Since host plant resistance is the result of interactions between the plant and the insect, it is therefore, assumed that optimum conditions under which a plant species is grown are also favourable enough for the growth and development of the insect so that the insect accepts the plant species. The concept of host plant resistance should therefore, be viewed by comparing the performance of a variety under optimum conditions for the growth and development of the plant in the absence and presence of insect population capable of causing maximum loss to the host plant.

Snelling (1941) defined plant resistance as 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 (1951) described plant resistance as the relative amount of heritable qualities that influence the ultimate degree of damage done by the insect. In practical agriculture, resistance represents the ability of a certain variety to produce a larger crop of good quality than do ordinary varieties at the same level of insect population.

Beck (1965) defined resistance as collective heritable characteristics by which a plant species, race, clone or individual may reduce the probability of successful utilization of that plant as a host by an insect species, race, biotype or individual. This definition restricts the spectrum of insect-plant interactions to the extent of successful use by the insect of a plant as host, but excludes the possible ability of plant to recover or repair the loss after injury occurs.

Maxwell *et al.* (1972) extended the definition of Painter (1951) by considering level of insect infestation and environmental conditions. According to them, resistance is those heritable characteristics possessed by the plant, which influence the ultimate degree of damage done by the insect. From a practical point of view, resistance is the ability of certain variety to produce larger yield of good quality than other varieties at the same initial level of infestation and under similar environmental conditions.

According to Kogan (1994) resistance to insects is the inheritable property that enables a plant to restrain the growth of insect populations or to recover from injury caused by populations that were not restrained. Inhibition of population growth generally derives from the biochemical and morphological characteristics of a plant which affect the behaviour or the metabolism of insects so as to reduce the relative degree of damage these insects can potentially cause.

Most of the attempts to explain the concept of host plant resistance are from farmer's point of view, that too ignoring different heritable potentialities of the host plant in the absence of insect infestation. In order to overcome this limitation, Dhaliwal et al (1993) proposed the following definition:

'Host plant resistance refers to the heritable qualities of a cultivar to counteract the activities of insects so as to cause minimum per cent reduction in yield as compared to other

cultivars of the same species under similar conditions'. The emphasis here is not on the absolute yield pattern but on the proportional decrease in yield among the cultivars in the presence of insect vis-a-vis the yield obtained in its absence. It means that a cultivar may yield poor but carries the genes for resistance and, on the contrary, a cultivar may yield good without having any genes for resistance. Moreover, it is not always true that resistance is manifested only in the form of greater yields because there can be stage or age specific characteristics imparting resistance.

## CHARACTERISATION OF RESISTANCE

There are four major characteristics by which resistance can be assessed (Panda and Khush, 1995):

- Resistance is heritable and controlled by one or more major genes.
- Resistance is relative and can be measured only by comparing with a susceptible cultivar of the same species.
- Resistance is measurable and its magnitude can be determined quantitatively (by insect establishment) and qualitatively (by analysis of the standard scoring systems).
- Resistance is variable and can be modified by abiotic and biotic components of the environment.

Various parameters have been employed to characterize host plant resistance to insects.

## Types of Resistance

### I. Intensity of Resistance

Interactions between host plants and insects are spread over a wide spectrum of intensity. In terms of the host plant, lesser the population of the insect and or lesser the damage they cause to the plant, more resistant the plant is likely to be. On the other hand, from the point of view of the insect, interaction varies from totally unsuitable host to completely suitable for growth and development of insect. Therefore, intensity of resistance is a relative term and should be discussed in relation to a susceptible cultivar of the same species. Painter (1951) used the following scale to classify degree of resistance based on intensity:

1. **Immunity:** An immune variety is one which a specific insect will never consume or injure under any known conditions. There are thus, few, if any, cultivars immune to the attack of specific insects which are otherwise known to attack cultivars of the same species
2. **High resistance:** A variety with high resistance is one, which possesses qualities resulting in small damage by a specific insect under a given set of conditions.
3. **Low resistance:** A low level of resistance indicates the possession of qualities, which cause a variety to show lesser damage or infestation by an insect than the average for the crop under consideration.

4. **Susceptibility:** A susceptible variety is one, which shows average or more than average damage caused by an insect.
5. **High susceptibility:** A variety shows high susceptibility when much more than average damage is done by the insect under consideration.

These terms are relevant to express resistance vis-a-vis screening of varieties under field conditions and have nothing to do with the mechanism of resistance. An intermediate level of resistance is sometimes, referred to *as moderate resistance.*

**II. Ecological Resistance**

Sometimes, a plant or a variety may be classified as resistant due to unfavourable environmental conditions for the insect and no heritable trait is involved. In this case, there may be differential impact of the environment on the host plant and on the insect, which affects the expression of resistance. Painter (1951) called this type of resistance as *pseudoresistance,* which refers to apparent resistance resulting from transitory characters in potentially susceptible host plants. Pseudoresistance is generally classified into three broad categories:

1. **Host evasion.** Under some circumstances, a host may pass through the most susceptible stage quickly or at a time when number of insects is less. Some varieties evade injury by early maturing. Late planting of an early maturing variety or other special experiments will indicate whether true resistance is present or not.
2. **Induced resistance.** This term may be used for 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 the soil (Kogan, 1994). Such induced resistance may be of great significance especially in the field of horticulture, but should not be confused with inherent differences in resistance which exist between varieties or individual plants.
3. **Escape.** Escape refers to the absence of infestation or injury to the host plant because of transitory circumstances such as incomplete infestation. Thus, an uninfested plant located in a susceptible population does not necessarily mean that it is resistant. Even under very heavy infestation, susceptible plants will occasionally escape and only studies of their progenies will establish their true expression of resistance or susceptibility.

The term host evasion and escape seem to be synonyms but critical analysis reveals that host evasion pertains to whole population of the host and insect is absent or insignificant while escape pertains to one or a few individuals in the presence of insects causing damage to other plants.

**III. Evolutionary Concept**

Resistance to an insect is evolved either due to long host plant and insect association at the gene centers or due to pleiotropic effects of genes which are present as a result of selective forces unrelated to the insect (Harm, 1975). Based on these factors host plant resistance to insects can be divided into sympatric and allopatric resistance.

1. **Sympatric resistance:** Sympatric resistance may be defined as those heritable qualities possessed by an organism, which influence the ultimate degree of damage

done by a parasitic species having a prior continuous, co-evolutionary history with that species of organism. This type of resistance evolves at original home of plants and insects. Association of the gene centres results in natural selection for resistance in plants. The resistance is evolved as a result of gene for gene nature of co-evolution of plant and herbivores.

2. **Allopatric resistance:** Allopatric resistance may be defined as those heritable qualities possessed by an organism, which influence the ultimate degree of damage done by a parasitic species having no prior continuous revolutionary history with that species of organism. The resistance to insects in plants is evolved in the absence of insects to which the host is resistant. Allopatric resistance is not the result of coevolution, but rather due to fortuitous, pleiotropic effects of genes, which are present as a result of selective forces unrelated to the pest insect.

Though not essential, in general, sympatric resistance is governed by major genes and allopatric resistance is polygenic in nature.

**IV. Trophic Levels**

Interaction among host plants, insect pests and their natural enemies (tritrophic interaction) leads to effective defense and attack at each level (Fig. 6.1). On this basis, two types of plant resistance or plant defense have been recognized (Price, 1986).

1. **Intrinsic resistance:** Here the plant alone produces defense through physical means (trichomes or toughness) or through production of chemicals (toxins or digestibility reducers) or both (glandular trichomes or resins).
2. **Extrinsic resistance:** Here the natural enemies (third trophic level) of insect pests (second trophic level) benefit the host plants (first trophic level) by reducing the pest abundance.

**It has** now been established that intrinsic resistance of the host may affect positively or negatively the third trophic level and the factors associated with extrinsic resistance.

**V. Crop Stage**

Resistance at different growth stages of the crop has been assigned different terminology.

1. **Seedling resistance:** This is also often referred to as ***juvenile resistance.*** It is measured at the seedling stage of the crop.
2. **Adult plant resistance:** This is also referred to as *mature plant resistance* or *age resistance.* This type of resistance is manifested in older plants which have been found to be susceptible at the seedling stage. Adult plant resistance is detected by sowing the plants at different dates. This type of resistance may involve horizontal resistance but all types of horizontal resistance are not concerned with the adult plant.

**VI. Screening Conditions**

1. Greenhouse resistance. This is the resistance detected under greenhouse conditions by exposing the varieties to insect populations. This may involve seedling resistance as well as mature plant resistance.
2. **Field resistance.** This is the resistance observed under field conditions due to the exposure of plants to natural populations of insects. It may also involve seedling resistance and adult plant resistance with respect to all locally occurring insect biotypes. Field resistance is also called *moderate* resistance.

**VII. Genetic Resistance**

Genetic resistance may be grouped under various categories.

**A. Number of Genes**

1. **Monogenic resistance.** When resistance is controlled by a single gene, it is called monogenic resistance.
2. **Oligogenic resistance.** When resistance is governed by a few genes, it is called oligogenic resistance.
3. **Polygenic resistance.** When resistance is governed by many genes, it is referred to as polygenic resistance. The term *horizontal resistance* has also been used to denote the resistance governed by polygenes.

**B. Major or Minor Genes**

1. **Major gene resistance:** The resistance controlled by one (monogenic) or a few (oligogenic) major genes is called major gene resistance. This is also called *vertical resistance.* Major genes have a strong effect and these can be identified easily.
2. **Minor gene resistance:** When resistance is controlled by a number of minor genes, each contributing a small effect, it is called minor gene resistance. This is also referred to as ***horizontal*** *resistance.* In certain crops, the cumulative effect of minor genes is termed as *adult resistance, mature resistance* or *field resistance.*

**C. Biotype Reaction**

1. **Vertical resistance:** This type of resistance is effective against certain specific biotypes of the insect but not against others. It is also called *specific resistance.* Vertical resistance is qualitative as the frequency distribution of resistant and susceptible plants is discontinuous

2. **Horizontal resistance:** This type of resistance is effective against all the known biotypes of the insect. It is also called *nonspecific resistance*. Horizontal resistance is quantitative as the degree of resistance depends on the number of minor genes each contributing a small effect.

**D. Population/Line Concept**

1. **Pure line resistance.** The resistance exhibited by a line which is phenotypically and genotypically similar, is called pure line resistance. In other words, resistance in all the plants is conveyed to the same degree.

2. **Multiline resistance.** When a number of pure lines phenotypically similar and genotypically dissimilar are mixed, the resistance conveyed is called multiline resistance. The component lines differing genotypically usually involve vertical resistance.

**E. Miscellaneous Categories**

1. **Cross resistance:** When a variety with resistance incorporated against a primary pest, confers resistance to another insect, the phenomenon is referred to as cross resistance.
2. **Multiple resistance:** Multiple resistance refers to the protection provided to a variety against different environmental stresses like insects, diseases, nematodes, heat, drought, cold, etc. The genes conferring resistance to various stresses are incorporated in a variety.