# Antixenosis Resistance in Crop Plants Against their Major Insect Pest

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## ABSTRACT

Insect pests are the major biotic factors that cause yield loss in crop plants. The major control methods for these insect pests are the use of chemical pesticides, but they create health issues for growers and consumers. Hence, the antixenosis resistance as a main tool in the host plant resistance can be used in the integrated pest management (IPM) technique. The antixenosis is the non-preference of the insect either for feeding, oviposition, or shelter on the host plant due to morphological characters of the plant it possesses. The antixenosis characters like trichomes, surface waxes, color and shape, thickness of the cell wall and cuticle, leaf and root toughness, pubescence, frego bract, etc., were modified in the plants to reduce the damage by insect pests. They are not a permanent solution, and other management strategies should also be employed to control the pest.

## INTRODUCTION

Crop plant output is reduced by a number of biotic (insects, weeds, diseases, nematodes, etc.) and abiotic (drought, salinity, temperature, flooding, nutrient inadequacy, etc.) variables. One of the main biotic causes causing economic losses is insect infestations. Globally, insect pests are thought to reduce yield by 20–40%.

Chemical pesticides are widely employed today to manage insect pests, but because of their poisonous properties and persistent persistence on fruits and plants, they provide serious health risks to both growers and consumers. Therefore, we must use integrated pest management (IPM) strategies to lower the risk of these chemical pesticides. As the main defense among the other IPM methods, host plant resistance reduces pest infestations through a variety of characteristics.

One efficient, cost-effective, and eco-friendly approach to integrated pest management is host plant resistance to insect pests (Pedigo, 2002). The totality of the constitutive, genetically inherited traits that cause one cultivar or species to sustain less damage than a susceptible plant devoid of these traits is known as host plant resistance (Smith, 2005). Three mechanisms were identified for the phenomenon of resistance: tolerance, antibiosis, and antixenosis (non-preference). The inability of the insect to choose the host plant for food, oviposition, or shelter because of the physical characteristics of the plant it possesses is known as antixenosis. The physical traits of the host plant, such as surface waxes, cell wall thickness, and leaf trichomes, can have a big impact on insect behavior and population (War *et al*., 2012).

**Trichome based resistance**

Trichomes are epidermal projections found on the surfaces of the seed coat, leaves, petals, stalks, peduncles, and stems. As soon as arthropods decide to move or alight on a plant, they initially come into contact with the trichomes of the plant. Thus, one of the primary causes of feeding or oviposition antixenosis resistance is the trichomes. Crop plant representatives from important taxa, including solanaceous plants, have trichome-based antixenosis resistance, which is a very broad-based defense (Smith, 2005). Trichomes primarily fall into two categories: glandular and non-glandular. Some biochemicals that aid in pest resistance can be produced by the glandular trichomes. For instance, in two distinct locales (L1 and L2) in Andhra Pradesh, Reddy *et al*. (2024) studied potato cultivars to determine the impact of biophysical characteristics of potato plants against insect pests. The Kufri Himalini variety (93/mm²) in L2 and the Kufri Badshah variety (96/mm²) in L1 had the largest trichome numbers, according to the results; also, there was a substantial negative correlation between the two and the population of insect pests.

**Surface waxes**

The plant surface waxes majorly contain a mixture of long-chain aliphatic and cyclic components, including fatty acids, hydrocarbons, alcohols, aldehydes, ketones, β-ketones, and esters, as well as terpenoids, sterols, flavonoids, and phenolic substances in low levels. Epicuticular waxes are the major components of a plant cuticle and play an important role in protecting aerial organs from damage caused by biotic and abiotic stresses (Zhang *et al*., 2007). Surface waxes cover the epicuticle and protect the plant surface from drying out, feeding insects, and diseases. By serving as phagostimulants or feeding deterrents, epicuticular waxes affect how insect pest's feed. The presence of waxes on the plant's surface causes the insect's tarsi and mouthparts to receive undesirable chemical and tactile impulses from the plant, making the plant resistant to insect attack (Ram *et al*., 2005). Grain aphids of the waxy genotype RAH 122 demonstrated in the experiment that the removal of wax had a substantial impact on *S. avenae's* probing activity. However, there have been reports of epicuticular wax influencing insect-plant interactions since the 1960s. Diamondback moths are discouraged from feeding on the waxy surfaces of crucifer leaves.

**Colour and shape**

Phytophagous insects host selection behavior is linked to plant color and morphology. Plant color and form are linked to resistance because they have a remote impact on how phytophagous insects choose their plant hosts. Although there is no insect resistance associated with plant color, genetically modifying plant color typically impacts certain basic physical plant functions (Norris and Kogan, 1980). The Rhagoletis fly uses tree size and shape, as well as foliage color, to distinguish between hosts and non-hosts (Boller and Prokopy, 1976). The pea aphid, *Acyrthosiphon pisum*, favored yellow-green plants over green ones (Cartier, 1993). *Brevicoryne brassicae's* host selection was influenced by the color of the cabbage leaves. *Pieris brassicae* was less likely to affect red-leaved cabbage types (Verma *et al*., 1981). It has been stated that cotton plants grow red leaves as a defense strategy against aphids. According to Jones *et al*. (2000), cotton plants with red leaves have demonstrated less damage to their foliage than those with typical green leaves.

**Thickness of the cell wall and cuticle**

The thickening of cell walls results from the deposition of cellulose and lignin. As a consequence, the tissue becomes tougher or more resistant to the tearing action of mandibles or the penetration of the proboscis or ovipositor of insects. Thicker hypodermal layers of rice were considered a resistance factor to stripe stem borer, *Chilo suppressalis* (Patanakamjorn and Pathak, 1967). Resistance in sorghum to the sorghum shoot fly, *Atherigona soccata* was attributed to the presence of cells with distant lignifications and thicker walls enclosing the vascular bundle sheaths within the central whorl of young leaves (Blum, 1968). Seed damage due to alfalfa seed chalcid, *Bruchophagus raddi* was less in Medicago species which had highly lignified pod-walls (Springer *et al*., 1990).

**Leaf and root toughness**

The stiff leaves increase mandibular wear in biting-chewing herbivores and keep the mouthparts of piercing-sucking insects from accessing plant tissues (Raupp, 1985). A variety of macromolecules, including lignin, cellulose, suberin, and callose, as well as tiny organic compounds like phenolics and even inorganic silica particles, are used to reinforce the cell walls of leaves during feeding. Significant regrowth and development are seen in the roots consumed by herbivorous insects. Additionally, genotypes with long, fine roots had less herbivory than genotypes with short, thick roots (Tibebu, 2018).

**Pubescence or leaf hairs**

In crop plants, pubescence-leaf hairs on the lamina-has been linked to pest resistance. Many insects’ oviposition, egg adhesion to plant surfaces, feeding, and ingestion have all been found to be hampered by pubescence (Maxwell & Jennings, 1980). Webster (1975) found that 17 crops were resistant to 32 insect pests because of their hairiness, while eight crops' pubescence had an impact on the ovipositional behavior of 11 pests. But resistance isn't usually a result of pubescence. According to Webster (1975), pubescence makes five crops more vulnerable to thirteen pests. Certain insects have trouble ovipositing or eating when plants are hairy. According to Abdul-Nasar (1960), cotton's hairy foliage makes it more resistant to spider mites (*Tetranychus spp.*), cotton aphids (*Aphis gossypii*), cotton leafworms (*Spodoptera littoralis*), and leafhoppers (*Empoasca spp.*). By preventing the beetle from ovipositing and feeding on the developing larvae, the hairiness of wheat leaves offers defense against the cereal leaf beetle, *Oulema melanopus*.

**Frego bract**

The collection of tiny, leaf-like structures that envelop the flower bud, flower, and boll is known as the bract in cotton. The size and shape of the flower bracts vary greatly. In contrast to frego bracts, which are thin, twisted, and move away from the boll, completely exposing it, normal bracts are large and wide, near the boll, and offer shelter to insects. As a result, they do not protect the eggs of insect pests and instead confer resistance to genotypes against insect pests such as bollworm and boll weevil (Rahman *et al*., 2008). Because the bract's surface area is greatly diminished and provides little refuge for bollworm larvae (Bhat & Basu, 1984), bollworms do not favor frego bract genotypes for egg laying.

**Advantages of developing antixenosis resistance in crop plants**

- Primarily these antixenosis characters reduce the pest population in the crop canopy by making themselves unpalatable or unsuitable for insect pests.
- These help to reduce the use of the chemical pesticides that cause health risks to the growers and consumers and also reduce the cost of cultivation.
- These antixenosis characters are long-lasting, and it is a more durable mechanism compared to other control measures like chemical pesticides.
- It doesn’t harm the natural enemies like predators and parasitoids; combining the biological control with the antixenosis mechanism can reduce the pest population.

**Limitations of developing antixenosis resistance in crop plants**

- Some of the characters were difficult to identify and screen; it takes more time to distinguish the resistance from antibiosis and tolerance.
- Development of some of the characters leads to reduction of the yield. For example, an increase in the surface wax leads to a reduction in the photosynthesis, thereby reducing the yield.
- Insects are overcoming these antixenosis characters.
- Developing a trait that confers resistance to a specific insect pest may have limited usefulness, as it may be ineffective or even susceptible to other pests.

## CONCLUSION AND FUTURE PROSPECT

Insect pests are one of the major biotic factors that reduce the yield in crop plants. Developing crop plants resistance to insect pests is necessary for sustainable crop production. These resistance traits can reduce the yield loss and decrease the use of chemical pesticides. It promotes environmentally friendly farm practices. They are not a permanent solution, and other management strategies should also be employed to control the pest. The future prospect of this study is the development of pest-resistant potato cultivars by incorporating morpho-physical resistance traits using advanced breeding techniques, including molecular marker-assisted selection.

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