Morpho-physical Characteristic in Tomato Imparting Resistance to Sucking Pest Whitefly, *Bemisia tabaci* (Gennadius) Aleyrodidae: Hemiptera: A Review

Keshav Kumar[1], Sumant Pal[2] and Yendrembam K. Devi[3]

[1,2] Master Scholar [3]Assistant Professor,

Department of Entomology, Lovely Professional University, Jalandhar-144411 India.

Abstract

Plants have several natural defenses that offer resistance to number of insect pests as well as non-insect pests that attack them. In tomato, plant defense include trichome length, trichome density leaf lamina thickness etc., offers defense mechanism to the insects. Plant use various strategies to defend against insect pest of tomato. At a time when the chemical insecticides do not offer the defense to insect attack, these plant morphological characters do the work.

Keyword: Morphological characters, Resistance, Trichome, Thickness, Whitefly.

1. Introduction:

Host plant resistance is one of the important and eco-friendly approaches of keeping the pest populations below the (EIL) economic injury levels. Improving host plant protection against insects and reduced losses due to herbivores, reduced use of insecticides, increased crop production and safer environment (Howe and Jander 2008). Host plant resistance is one of the main basic components of IPM, and the use of resistant plants has long been known to be one of the most effective components of insect control (Russell 1978). The phenomenon of plant resistance can be defined as a relative reduction in the size of the pest population compared to standard varieties due to the genetic characteristics of the host plant (Ponti et al. 1990). The defenses mechanism of plants can be direct or indirect method. Direct ones are those in which only the plant and its aggressor are engaged in antagonistic interactions (Home and Jander 2008). Herbivores affect the integrity of plant tissues in order to acquire nutrients from foliage, seeds, pollen, nectar, roots or stems that need to survive and breed Walling (2008). Antibiotic and antixenosis terms are clearly defined Antibiotic adverse effects caused by a resistant plant on the life, growth or reproduction of the arthropod. Antixenosis there is no preference for arthropod reactions in a resistant plant when allelochemicals or biophysical factors adversely affect the behaviour of the arthropod, causing late acceptance or rejection of the plant as a host (Smith and Clement 2012). A significant factor in managing agricultural pests is plant resistance. The resistance may be due to plant physicomorphic characteristics (Raza et al. 2000). The first line of defence against herbivory is plant structures, and insects play a significant role in HPR. The first line of plant defence against insect pests is to create a physical barrier by forming a waxy cuticle (Hanley et al. 2016, and

Agrawal et al. 2009). Recent studies show that trichomes can act as sensors to detect insect movement on the surface of the leaf (Peiffer et al. (2009)

In general, the resistance mechanisms that have been studied in tomatoes, usually are identified in two groups

(1) Those concerned with the presence of leaf trichomes (glandular and non-glandular) and the secreted substances.
(2) Associated with lamella leaf, fruit or growth habit of the plant (Diez and Nuez 2008). There are various low-yield causes and one of the most important is sucking a pest complex (Kennedy 2003, Shakoor et al 2010).

The infestation of sucking pests, results in changing leaf morphology that falling of leaves and earlier fruit dropping which ultimately affect the yield and quality of tomato fruit (Lange et al. 1981). The most common sucking pests of tomato damage are aphid, jassid, whitefly, mites and thrips (Costa and Brown 1991). He reported that gossypol gland on lamina showed negative correlation with thrips population. Hair length on lamina, hair density on vein and hair density on lamina showed positive correlation with thrips population which is the conformation of the morphological parameters (Tahir 2013). The white fly impacts the tomato plants in three ways direct injury due to puncture, sap removal sugary and other then Secretion that causes sooty mould formation, which eventually interferes with photosynthesis and vectoring of leaf curl and yellow vein mosaic viruses (Sarkar et al. 2018). The attraction and ovipositional preference of *Bemisia tabaci* played important roles in morphological leaf characters such as density of leaf trichome, thickness of leaf lamina (Hasanuzzaman et al. 2015).

Integrated pest management (IPM) using strategy effectively to control insect pests and the pest resistant varieties of planting is the key of IPM parts to control pests. HPR is an economically sound and environmentally friendly strategy for the management of insect pests (Smith 2005).

2. Effect of morphological character of tomato on sucking pest

In general resistance mechanisms are the defense against of herbivory, and play an important role in insects. Trichomes present in the abaxial and adaxial surfaces of the leaf and on the petiole were estimated (Muthukumaran 2016). To build themselves on the host plant, insect herbivores from all feeding associations must make contact with the plant surface. The plant surfaces are important factors of resistance. It is not surprising for physical and chemical features. All plant components provide some kind of resistance to herbivory. They range from tissue toughness to the presence of very complex trichomes and spines of the glandular. The cover of cuticle most vascular plants with in Epicuticular wax films and crystals. The physical mechanisms of the wax layer as well as its chemical composition are important features of preformed to resistance (Howe and Schaller 2008).

The formation of a physical barrier through the making of a waxy cuticle and the development of spines, setae, and trichomes is the primary function of plant defence against insect pests. It has been reported to protect the plants against many insects. Pubescence consists of the hair layer (trichomes) that spreads from the epidermis of parts of the above ground plant, including stem, leaves, and even fruits, and occurs in various forms such as linear, spiral, stellate, hooked, and glandular (Chamarthi et al. 2011).

Whitefly adults and nymphs showed positive correlations with hair density and length of hair on leaf lamina, midrib and vein (Raza et al. 2000; Bashir et al. 2001; Aslam et al. 2004). A less studied phenomenon is the induction of plant resistance to or by phloem-feeding insects, such as whiteflies, which maintain a longer interaction with their host plant but causing only limited direct damage to the plant tissues with their stylets (Walling, 2000).

2.1 Mechanisms of Resistance.

The three important mechanisms of resistance are described, viz. Non-preference (antixenosis) antibiosis and resistance (Host plant have the ability to with stand insect population that are sufficient to damage the susceptible plant) Painter (1951). Therefore, both antibiosis and antixenosis, which may arise from whitefly repellence or attraction (Baldin and Beneduzzi 2010).

2.2 Antixenosis

Host plant characters that are responsible for insect non-preference for shelter, oviposition, feeding, etc. It denotes the presence of a morphological or chemical factor that alters the behaviour of insects, resulting in poor insect formation.

Pests using controlling for technique varieties of host plants with behavioural resistance (antixenosis) can also be an important, economic and ecofriendly (Berlinger (1986). Host Plant Resistance using three functional types antibiosis, no preference (antixenosis), and tolerance. Antibiosis describes the negative impact of the plant on the biology of an insect attempting to use that plant as a host (Painter 1951).

2.3 Antibiosis

The biochemical and biophysical factors present in it, the adverse effect of the host plant on the biology (survival, development and reproduction) of insects and their progeny. Presence of toxic substances and absence of sufficient amount of essential nutrients - Nutrient imbalance and improper utilization of nutrient.

Antibiosis in resistant plants, hunger resulting from chemical compounds such as secondary metabolites in tomatoes, cotton and cassava, identified as a mechanism of resistance to several types of phloem feeding and piercing insects, may cause mortality of whitefly (Heinz and Zalom 1995; Bellotti and Arias 2001; Jindal et al. 2008).

The host use of the plant explains the negative impact of the plant on the biology of an insect attempt and can be explained after decreased body size and mass, extended growth cycles in the immature stages and decreased insect fecundity (Smith 2005).

2.4 Tolerance

Tolerance is unique from both antibiosis and antixenosis in respects to the absence of plant and arthropod interaction. 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.

Tolerance in an insect plant interaction sense, tolerance is the response of plants to insect attack, and it demonstrates the ability of plants to withstand or compensate for insect damage and produce significantly higher dry mass than a susceptible plant under similar infestation conditions (Pedigo 1999 and Smith 2005).

Thus, recognizing the resistant mechanisms in chilies is the best way to reduce the population of whitefly and chilli leaf curl disease (ChiLCD) (Moshe and Michael 2002).

2.5 Trichomes

Trichomes are hair-like structures that can consist of several different forms, including non-glandular, glandular, curly, straight, single, multicellular, hooked, and simple (Werker 2000). Trichomes are tiny hairs that are found in most plant species on the epidermis of stems, leaves, flowers and fruits. (Roy et al. 1999 and McDowell et al. 2011). Trichomes, based on their morphology and cellular metabolism, also contribute to plant defence against pathogens and herbivores through physical and chemical (Levin 1973; Gurr 2005; Tian et al. 2012; Oney and Bingham 2014; Avery et al. 2015; Bergau et al. 2015).

Depending on the type of trichomes, plant and insect involved, trichomes can have both positive and negative effects on insect locomotion, feeding and reproduction (Gallo et al. 2002). High glandular trichome density has shown resistance to other sucking pest like white flies (Rakha et al. 2017 and Sridhar et al. 2019).

Trichome The density of trichomes present in the leaf and petiole abaxial and adaxial surfaces was estimated. The leaf and petiole of the accessions were cut from a one mm long transverse segment (Muthukumaran 2016). In addition to raising the thickness of the epidermis, plant trichomes serve as a physical defense against external attack. (Kang et al. (2010).

Trichomes are specific cells present on the tomato plant surfaces and are capable of producing and either storing or secreting large amounts of specific metabolites (Schilmiller et al. 2008). The plant epidermis is mostly covered by trichomes, called outgrowths. They are present in all major terrestrial plant groups. They derive from epidermal tissue and then develop and discern to produce hair-like structures (Johnson 1975).

The leaf texture also affects the predatory mite population. It affects the growth and reproduction of predatory mites of the Stigmaeidae and Phytoseiidae families (Saber and Momen 2005). In plant protection against many insect pests, trichomes play an important role, involving both toxic and deterrent effects. The density of Trichomes adversely affects the ovipositional nature, feeding and larval feeding of insect pests. Glandular trichomes secrete secondary metabolites that can be poisonous, repellent, or trap insects and other organisms, including flavonoids, terpenoids, and alkaloids, forming a combination of structural and chemical defence. Insect damage after Increase in trichome density has also been recorded in *Lepidium virginicum* L. and *Raphanusra phanistrum* (Belete 2018). The glandular trichomes of alfalfa can secrete chemicals to kill pests that attack its leaves and stems (Elad, Y and Shtienberg, D 1995). Correlation among trichomes density in eggplant leaves Negative and resistance to *B. tabaci* (Oriani et al. (2011).

2.6 Leaf trichome density and length

Samples were taken from the intermediate location between the leaf lamina midrib and the leaf margin and between the leaf top and base, avoiding any dominant secondary veins. To measure trichome length, only the most abundant star type trichomes were measured. A cover slip on the trichome was put under a stereomicroscope and squeezed slightly to make the hair straight. The length of trichome hairs was then measured using a compound microscope of high definition fitted with an internal micrometer. All hairs from each trichome were measured and compared among all varieties of eggplant (Zhang Y et al. (2020)

3. Influence of maturity stages and storage on the antioxidant composition of tomatoes

The colour and composition of the fruit are important during maturation. Immature fruits, green colour associated with chlorophylls, poor carotenoid content. The biosynthesis of carotenoids is active in these fruits, but the carotenoids are immediately broken down due to photo-protective and antioxidant properties (Giulano et al. 1993and Fraser et al. 1994).

4. Effect of Morphological character on tomato and incidence of sucking pest, whitefly

Whitefly, *Bemisia tabaci* (Gennadius) (Aleyrodidae: Hemiptera) is a cosmopolitan insect pest of many agriculturally important crops grown in the world. Certain plant characteristics including biochemical or morphological factors or a combination of both may promote resistance (antibiosis, antixenosis, or both antibiosis and antixenosis) to whitefly. The incidence of whitefly, *Bemisia tabaci* Gennadius started in month of December, three weeks after transplanting in the second week of (50^{th} SMW) 2018. The population of whitefly increased gradually and reached to its peak (15.00 whiteflies per three leaves) Kumar, P et al. (2019). Whitefly resistance dependent on Plant age has also been observed in tomato plants that harbour the Mi-1.2 gene mm (Nombela et al. 2003). Population of whiteflies decreased and observed as to 3.40 whiteflies per three leaves in the second week of April. Tomato crop the population of Whitefly, *Bemisia tabaci* are fluctuation (Chevan et al. 2013). Aleyrodes proletella, a cabbage whitefly, is a specialised insect that uses its mouth parts (styluses) to feed on the phloem of its host plants located between the Brassicaceae and Asteraceae. Female whiteflies lay their eggs on vulnerable plants in circular patterns embedded in wax on the underside of the leaves (Broekgaarden et al. 2012). A peak population of *B. tabaci* during second week of January observed (Senfu et al. 2013).

Recorded during the last week of February the peak population of white fly, jassid and winged aphid was showed that the peak incidence of white flies varied seasonally from year to year (Srinivasan et al 2012). Sucking pest of tomato whitefly is another important in patriotic region of Birbhum. Population of aphid was started on or before the first week of February but increased gradually and reached the crop Maximum population peak during the fruiting stage (6.21whitefly / leaf / plant) was reported during the 2nd week of March. Population of white fly declined at regular interval. Correlations of white fly population with weather parameters is negatively no significant effect of maximum rainfall (r = -0.007) temperature (r = -0.010) and Whereas, minimum temperature (r

=0.113) and relative humidity (r = 0.311) showed a positive correlation but non-significant correlation with population build-up of the whitefly (Mondal et al. 2019).

The highest population density was observed during mid-February in month (1.68 white flies per plant). From mid-February to mid-March, when temperature, relative humidity, sunshine and precipitation were 17.07-22.13 degrees Celsius, 65.29-72.78 percent, 7.79-8.9 hours a day and 5 mm respectively, high infestation levels were maintained (Chaudhuri et al. 2001). Kharpuse, (2005) recorded maximum white fly population on tomato during first week of March.

5. Conclusion

This paper provides a thorough analysis of Host Plant Resistance (HPR) research activities for whiteflies. For tomato breeders worldwide, knowledge on insect resistance levels among a large number of accessions and their underlying resistance mechanisms would be very helpful. Many facets of the use of host-plant resistance in pest control are demonstrated by the use of plant resistance for the management of arthropod pests. However, while hair density on midrib and gossypol glands on veins was positive and highly significantly correlated to whitefly population, the length of hair on leaf lamina was negatively and highly significantly correlated. A low-cost, realistic long-term solution for sustaining lower whitefly populations and reducing crop losses is provided by host plant resistance. In future utilizing the plant morphological as defense mechanism for insect pest attack would reduce the insecticide application.

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