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ANTIXENOSIS IN CULTIVARS OF TOMATO AGAINST *HELICOVERPA ARMIGERA* (HUBNER)

Keshav K[1], Yendrembam K. D[1]*, I Yimjenjang Longkumer[1], Sumedh B[1], Abhinash B[1], Anshu G[2] and Richard N[2]

[1]Department of Entomology; [2]Department of Plant Pathology,
Lovely Professional University, Phagwara 144411, Punjab, India
*Email: krishna.23363@lpu.co.in (corresponding author): ORCID ID 0000-0003-3184-0347

ABSTRACT

This study on the effect of antixenosis in relation to resistance against *Helicoverpa armigera* in tomato was carried out at the Entomological Research Farm, LPU, Phagwara during 2020 and 2021. The result showed that the antixenosis effect of four tomato cultivars on plant morphological characters revealed that Rahul cultivar with maximum trichome density in lamina (181 and 183 cm^{-2}), vein (89 and 93 cm), trichome length (132.43 and 136.21 µm) and leaf lamina thickness (0.21 and 0.23 mm). Correlation analysis between morphological character and larval incidence revealed significant negative correlation with trichome density (lamina and vein), trichome length, leaf area and leaf lamina thickness.

Key words: Tomato, morphological, antixenosis, cultivars, Trichome density, *Helicoverpa armigera*, correlation, leaf lamina, trichome length, population, resistance, relationship

The tomato, *Solanum lycopersicum* L. (Solanaceae), is one of the most widely planted vegetables in India because of its high nutritional content and ability to provide income for farmers. A variety of insect pests damage the crop, the most harmful of which, is the fruit borer *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) (Haralu et al., 2018). One of the main causes of its pest status is the capacity of gravid females to find and use a variety of hosts for oviposition (Kriticos et al., 2015). Crop losses have been reported to range from 20 to 60% despite improved tomato cultivars and other agronomic practises (Herald and Tayde, 2018). The primary cause of the difficulties in managing this pest species is the emergence of resistance to various insecticide classes (Hussain et al., 2015). This has made it necessary to implement substitute techniques in order to lessen dependency on these pesticides. The introduction of resistant cultivars is one such environmentally and economically sound technique of controlling this species. Host plant resistance can be a vital component of integrated pest management because of its relative ease of incorporation into an IPM strategy and its low impact on non-target species and the environment. Plant defense against insect pests includes the formation of a physical barrier and the formation of a waxy cuticle and the development of spines, setae, and trichomes. Mostly trichomes are present in the abaxial and adaxial surfaces of the leaf and petiole (Muthukumaran 2016). Several morphological traits of the tomato plant such as trichome density, leaf area, leaf thickness and fruit pericarp thickness influence oviposition and larval feeding behavior of *H. armigera* (Ashfaq et al., 2012; Amin et al., 2016; Bisht et al., 2022). An economic and ecologically safe method of lowering crop losses is the development of enhanced cultivars resistant to *H. armigera*. Understanding the many related characteristics and the nature of their interaction with host plant resistance is essential in selection for resistance. In light of these observations, 4 distinct cultivars were chosen in order to evaluate the biophysical characters of resistance to *H. armigera* in tomato.

MATERIALS AND METHODS

The seeds of tomato cultivar namely Roma, Sioux and Marglobe were collected from the Indian Agricultural Research Institute Regional Station Katrain, Kullu Valley, Himachal Pradesh. Rahul variety was collected from local KVK Jalandhar Punjab. The crop was grown for two continuous seasons during 2019-2020 and 2020-2021 at the Entomology Farms of Lovely Professional University (LPU), Phagwara, Punjab. Crop was raised as per the recommended package practices from Punjab Agricultural University, Ludhiana. Observation on larval incidence of *H. armigera* was done by selecting five plants randomly from each plot with total area of 638 m^2. The plants were tagged and larvae count was recorded at 30, 60 and 90 days after sowing. The randomized block design was with 3 replications was followed. The morphological parameters were recorded from three fully formed leaves/ plant/ cultivars. The leaf hairiness parameters, namely trichome density, trichome length and angle of insertion of trichome were analyzed and imaged under JSM-7610F Plus Field emission scanning electron microscope (FESEM) from Centre of Excellence, Central Instrumentation Facility, Lovely Professional University, as per standard protocol given by Bozzola and Russell (1999). Statistical analysis was done by ANOVA (p=0.01) using SPSS software. Simple correlation analysis between morphological characters and incidence of *H. armigera* was worked out.

RESULTS AND DISCUSSION

The analysis of characters at the vegetative and reproductive stages of tomato showed that the mean trichome density exhibit significant differences (Fig. 1-5; Table 1). Significantly highest trichome density is found in cultivar Rahul (181/ cm^2) during 2020 with similar result in 2021 (183/ cm^2). Significantly highest trichome length was recorded in Rahul during 2020 with similar result in 2021. However, significantly highest trichome angle was recorded from Marglobe. Highest leave lamina thickness was recorded in cultivar Rahul, Sioux and Marglobe (Table 1). The correlation analysis between larval incidence with length of the trichome, leaf area, trichome density in lamina and vein showed negatively significant correlation (r= -.0585*,-0.972*,-0.964*, -0.697*) and (r= -0.855*, 0.577, -0.948*, -0.866*), respectively during the two years (p=0.05).

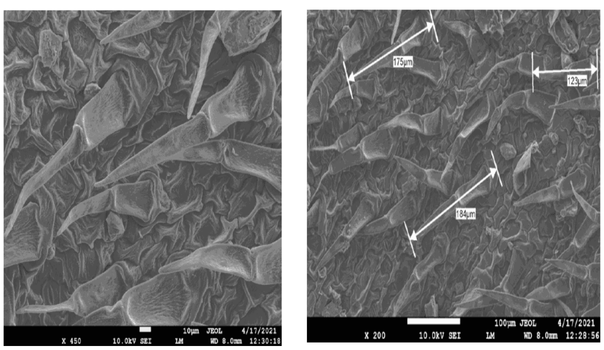

Fig. 1. Trichome of tomato cultivar, Rahul

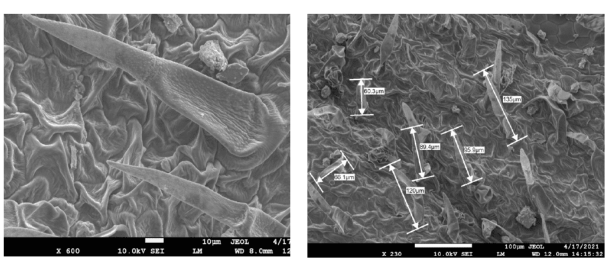

Fig. 2. Tomato cultivar, Roma

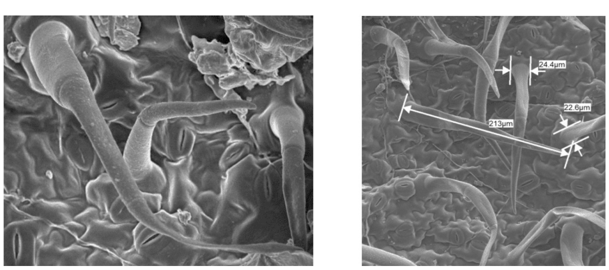

Fig. 3. Tomato cultivar Sioux

One of the most significant physical characteristics linked to insect resistance is pubescence or trichome density. One of the reported mechanisms of tomato resistance to insect pests is ovipositional non-preference because of the presence of trichomes (Firdaus et al., 2013). The present findings on trichome density in lamina and vein showed that cultivar Rahul recorded the highest mean density of trichomes/ cm^2 of leaf lamina and trichome vein/ cm with a significant negative correlation (Fig. 1). The results denote that the growth stages of tomato may affect the oviposition behaviour as the various cultivars of tomato presented resistance characteristics in the category non-preference for oviposition. This resistance was probably due to a morphological characteristic such as trichomes. Similar result was obtained by Muhammad et al. (2024); and Muthukumaran and Selvanarayanan (2016). Trichome density on the adaxial surface recorded a significant negative correlation with the larval incidence. Ghosh et al. (2023) and Ongaratto et al. (2021) also showed the effect of non-glandular and glandular trichomes.

Brar and Singh (2017) reported that trichome density on leaves of chickpea was significantly and

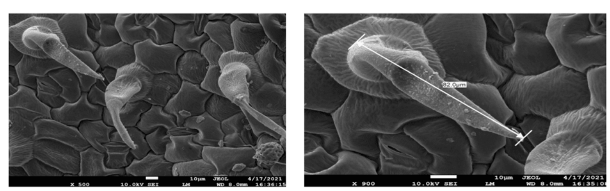

Fig. 4. Tomato cultivar, Marglobe

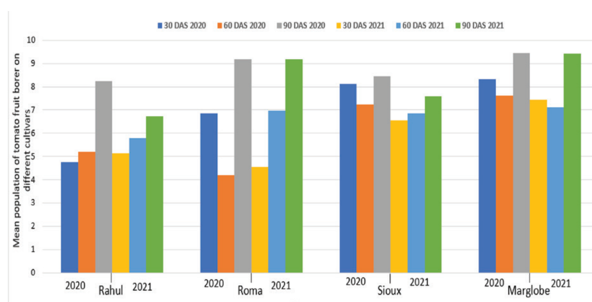

Fig. 5. Incidence of *H. armigera* on tomato cultivars (2020, 2021)

Table 1. Antixenosis- plant morphological characters in tomato cultivars

Year	2020						2021					
Cultivar	Trichome density in lamina (cm^{-2})	Trichome density in vein (cm^{-2})	Trichome length (µm)	Trichome angle (°)	Leaf area (cm^{-2})	Leaf lamina thickness (mm)	Trichome density in lamina (cm^{-2})	Trichome density in vein (cm^{-2})	Trichome length (µm)	Trichome angle (°)	Leaf area (cm^{-2})	Leaf lamina thickness (mm)
Rahul	181^{a}	83 NS	132.43± 26.82^{a}	73.67± 12.77^{b}	11.55NS	0.21^{a}	183^{a}	93 NS	136.21 ± 27.32^{a}	75.69± 13.22^{b}	11.89 NS	0.23^{a}
Roma	176^{ab}	77 NS	105.60± 13.38^{b}	69.14± 8.36^{c}	11.48NS	0.17^{b}	178^{ab}	81 NS	107.78 ± 14.16^{b}	68.45± 8.18^{c}	10.23 NS	0.19^{b}
Sioux	170^{ab}	89 NS	130.98± 19.43^{a}	73.44± 4.55^{b}	11.15NS	0.21^{a}	172^{b}	88 NS	133.56± 17.54^{a}	77.67± 5.35^{b}	10.18 NS	0.22^{a}
Marglobe	160^{c}	72 NS	77.82± 9.42^{c}	80.44± 2.04^{a}	11.15NS	0.18^{a}	156^{c}	79 NS	80.27± 8.32^{c}	82.34± 3.43^{a}	11.32NS	0.23^{a}
R value*	-0.964*	-0.697*	-0.585	0.669*	-0.972*	-0.186	-0.948*	-0.866*	-0.855*	0.497	-0.577	-0.870*

*Incidence vs. morphology; NS-non-significant; values mentioned with different ... are significantly different

negatively correlated with larval incidence, egg counts, larval survival and pod damage by *H. armigera.* This report is in very close approximation with the present findings. Golla et al. (2018) and Roshan and Raju (2018) also revealed that incidence of *H. armigera* was negatively correlated with trichomes. Maximum leaf area was recorded in Rahul cultivar which showed significant negative correlation with the incidence of larvae. Mean trichome length was observed maximum in Rahul cultivar (132.43± 17.26). Kalyani et al. (2017) confirmed that trichome length was significant and negatively correlated (r = -0.833) with larval infestation. Shabbir et al. (2014) also reported that genotypes with higher trichome length are more resistant. The present results are closely supported by the findings of Karthik and Vastrad (2018). Similar result was recorded by Rasheed et al. (2018) that the lowest leaflet thickness of 0.18 mm recorded low incidence of *H. armigera.* Genotypes having higher trichome density and length resulted less feeding damage by *H. armigera* as these two characters were significantly and negatively correlated with pod damage (Bisht et al., 2022).

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AUTHOR CONTRIBUTION STATEMENT

Conceptualization of research (YKD, KK); Designing of the experiments (YKD, AB); Contribution of experimental materials (YKD, IYL); Execution of field/lab experiments and data collection (KK, YKD, AG, SB); Analysis of data and interpretation (IYL, YKD, RN); Preparation of the manuscript (YKD, IYL).

CONFLICT OF INTEREST

No conflict of interest.

REFERENCES

Amin M R, Chakma A, Alam M Z, Hossain M M, Ge F. 2016. Screening of tomato varieties against tomato fruit borer and associated plant characters. SAARC Journal of Agriculture 14: 150-161.

Ashfaq M, Sajjad M, Noor ul Ane M, Rana N. 2012. Morphological and chemical characteristics of tomato foliage as mechanisms of resistance to *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) larvae. African Journal of Biotechnology 11: 7744-7750.

Bisht K, Yadav S K, Bhowmik S, Singh N N. 2022. Morphological and biochemical resistance to *Helicoverpa armigera* (Lepidoptera: Noctuidae) in tomato. Crop Protection 162: 106080.

Bozzola J J, Russell L D. 1999. Electron microscopy: principles and techniques for biologists. Jones and Bartlett Publishers, Inc; 2nd edition (25 November 1998); CBS Publishers & Distributors-1149344934. Jones & Bartlett Learning. Quartely Review of Biology. p. 208-238.

Brar H S, Singh R. 2017. Role of trichomes on leaves and pods for imparting resistance in chickpea *Cicer arientinum* (L.) genotypes against *Helicoverpa armigera* (Hübner). Journal of Applied and Natural Science 9: 2193-98.

Firdaus S, van Heusden A W, Hidayati N, Supena E D J, Mumm R, de Vos R C H, Vosman B. 2013. Identification and QTL mapping of whitefly resistance components in *Solanum galapagense*. Theoretical and Applied Genetics 126: 1487-1501.

Ghosh P, Jagadish K S, Purushothama M G, Hanson P, Rakha M, Sotelo-Cardona P, Vaddi S, Srinivasan R. 2023. Performance of wild tomato accessions and elucidation of resistance against invasive pest *Phthorimaea absoluta* damage under tropical conditions. Horticulturae 9: 143.

Golla S K, Rajasekhar P, Sharma S P, Prasad H K V, Sharma H C. 2018. Antixenosis and antibiosis mechanisms of resistance to pod borer, *Helicoverpa armigera* in wild relatives of chickpea, *Cicer arietinum*. Euphytica 214: 88.

Haralu S, Karabhantanal S S, Naidu G K, Jagginavar S B. 2018. Biophysical and biochemical basis of resistance to pod borer, *Helicoverpa armigera* (Hubner) in chickpea. Journal of Entomology and Zoology Studies 6: 873-878

Herald K P, Tayde A R. 2018. Biology and morphology of tomato fruit borer, *Helicoverpa armigera* (Hubner) under Allahabad conditions. Journal of Entomology and Zoology Studies 6: 1734-1737.

Hussain D, Saleem M, Ghouse G, Abbas M. 2015. Insecticide resistance in Ffield populations of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae). Journal Entomological Science 50: 119-128.

Kalyani Y, Chavan A P, Holay P U, Patil S K. 2017. Correlation of biophysical attributes on *Helicoverpa armigera* infestation in Chick pea. Annals of Plant Protection Sciences 25: 217-218.

Karthik G S, Vastrad A S. 2018. Morphological characterization of chickpea genotypes and their influence on *Helicoverpa armigera* (Hübner) population and its natural enemies. Journal of Entomology and Zoology Studies 6: 1220-25.

Kriticos D J, Ota N, William D H, Beddow J, Walsh T, Tay W T, Daniel M B, Silvana V P M, Czepak C, Zalucki M P. 2015. The Potential Distribution of Invading *Helicoverpa armigera* in North America: Is It Just a Matter of Time?. PLOS ONE 10: e0133224.

Muhammad B Y H, Yasin M, Ali H, Naveed K, Riaz A, AlGarawi A M, Hatamleh A A, Shan Y. 2024. Evaluation of different Kabuli chickpea genotypes against *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) in relation to biotic and abiotic factors. PeerJ 12:e16944 DOI 10.7717/peerj.16944

Muthukumaran N, Selvanarayanan V. 2016. Role of trichomes in tomatoes against fruit worm as influenced by nutrient sources and external. International Journal of Entomological Research 1: 39-42

Muthukumaran N. 2016. Biophysical and biochemical factors of resistance in tomato accessions as influenced by selected bioinoculants against fruit worm *Helicoverpa armigera* (Hubner). International Journal of Current Microbiology and Applied Science 5: 252-262.

Rasheed V A, Rao S K, Babu T R, Murali T, Krishna B V, Naidu G M. 2018. Biophysical parameters of different tomato genotypes responsible for resistance/susceptibility to South American tomato leaf miner, *Tuta absoluta* (Meyrick). Journal of Pharmacognosy and Phytochemistry 7: 1130-1136.

Roshan D R, Raju S V S. 2018. Influence of morphological characters of chickpea varieties on damage by gram pod borer *(Helicoverpa armigera* Hübner). International Journal of Current Microbiology and Applied Science 7: 2025-33.

Shabbir M Z, Arshad M, Hussain B, Nadeem I, Ali S, Abbasi A, Ali Q. 2014. Genotypic response of chick pea (*Cicer arietinum* L.) for resistance against *Helicoverpa armigera*. Journal of Biological Science 2: 23 -30.

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