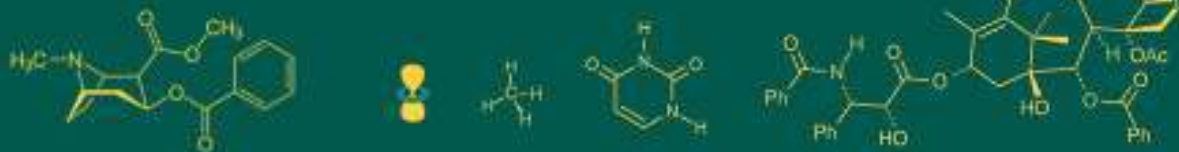


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Manisha Chamoli
 Department of Entomology,
 G.B. Pant University of
 Agriculture and Technology,
 Pantnagar, Uttarakhand,
 India

Meena Agnihotri
 Department of Entomology,
 G.B. Pant University of
 Agriculture and Technology,
 Pantnagar, Uttarakhand,
 India

Vaishnavi Sharma
 Department of Agronomy, Shri
 Guru Ram Rai University,
 Dehradun, Uttarakhand, India

Corresponding Author:
Manisha Chamoli
 Department of Entomology,
 G.B. Pant University of
 Agriculture and Technology,
 Pantnagar, Uttarakhand,
 India

Impact of morphological antixenotic resistance on the establishment of *H. armigera* on different chickpea germplasms

Manisha Chamoli, Meena Agnihotri and Vaishnavi Sharma

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Abstract

This research was carried out in 2020-2021 during *rabi* season at Norman E. Borlaug Crop Research Centre (CRC) of G.B. Pant University of Agriculture and Technology, with the objective to identify the source of resistance in 11 chickpea germplasms against pod borer *Helicoverpa armigera*. The study revealed that trichomes play a crucial role in imparting resistance against *Helicoverpa armigera* in chickpea germplasms. This study evaluated the length of glandular and non-glandular trichomes on leaves and pods across different chickpea genotypes. Results indicated that the minimum glandular trichome length was (225.60 μ m) observed on GJG 1801 and the maximum glandular trichome length (300.50 μ m) was recorded on NBeG 810. Similarly, the length of non-glandular trichomes on upper surface of the leaf varied from 180.35 μ m to 245.10 μ m. The lowest glandular trichome length (220.70 μ m) on GJG 1801 and the maximum glandular trichome length in NBeG 810 (297.10 μ m). The length of the glandular trichome on pods varied significantly between the germplasm. The highest length of glandular trichomes (311.05 μ m) on DMHC 18-1664 whereas the lowest glandular trichome length (240.71 μ m) on GJG 1801. Results showed that germplasms with higher trichome length on leaves and pods are least preferred by *H. armigera*. These findings highlight the potential of trichome-based antixenotic resistance in chickpea breeding programs for pest management.

Keywords: Antixenosis, chickpea, *Cicer arietinum*, crop morphology, *Helicoverpa armigera*

Introduction

Chickpea (*Cicer arietinum* L.) is one of the most economically important pulse crop in India (Farooq *et al.*, 2018) [3] and it accounts for 40 per cent of total pulse production followed by pigeon pea (16%), mungbean (13%), lentil (7%) and other legumes (20%) (Mann *et al.*, 2020) [4]. Pod borer, *Helicoverpa armigera* is one of the most damaging pests of chickpea, *Cicer arietinum*. To develop insect-resistant cultivars with durable resistance, it is important to understand the contribution of different components of resistance, and therefore, we studied antixenosis mechanisms of resistance to *H. armigera* in a diverse array.

Plant resistance can be classified as antixenosis (non-preference) and antibiosis (how a plant is unsuitable for an herbivore). It has been demonstrated that these mechanism of plant resistance can be inferred from the behavior of *H. armigera*. These plant-insect pest interaction refer to two different phenomenon, namely the search for the plant and its acceptance (antixenosis). Antixenosis is based on behavioral avoidance of a host due to feature or set of feature that deter the insect from settling and feeding. (Smith, 2005) [8]. The expression of antixenosis in genotype may be consequence of both biochemical and morphological characteristic in plant and mainly effects the visual and olfactory stimuli involved in the host finding behavior. Antixenosis occurs when morphological or chemical factors of plants adversely effect insect behavior leading to delayed acceptance or rejection of a plant as a host (Shoorooei *et al.*, 2018) [7]. Among the cause of antixenosis, morphological and biochemical characteristics of chickpea germplasm can influence female behavior by decreasing the feeding and oviposition and seeking shelter for a host plant (Painter, 1951) [6]. Different chickpea germplasms possess several morphological characteristics that can provide resistance against *H. armigera*. Among these, pubescence in chickpea crop which refer to the density of trichomes, is considered one of the most important factor for imparting resistance against *H. armigera*. In chickpea, trichome exudates contains oxalic, malic and

citric acid which also imparts resistance against *H. armigera* (Narayanamma, 2013) [5]. Therefore there is need to explore plant defence mechanism for developing chickpea cultivars with high level of resistance to *H. armigera*.

Materials and Method: To check the impact of trichome length on feeding of *Helicoverpa armigera* in chickpea germplasm using Scanning electron microscopy: To access the antixenosis mechanism of resistance towards *H. armigera* on the basis of trichome length, growth and development of *H. armigera* on eleven promising chickpea germplasms. Germplasm RSGD-834, BG4017, DMHC 18-1664, GJG 1803, GJG 1801, NBeG 1635, NBeG 810, RLBGMH-G, JG 2020-60, NBeG 857, RSGD 926 were taken along with checks ICCL3137, ICCL86111, PG3 for the estimation of leaf trichome length using Scanning electron Microscopy (SEM) at the Electron Microscopy Laboratory, College of Veterinary, GBPUA&T, Pantnagar in accordance with the standard protocol established by (Bozzola and Russell, 1999) [1].

Standard protocol for imaging leaf under scanning electron microscopy for Trichome density and length

Fresh leaves from each genotype were collected, cut into 5mm² sections, and immediately placed in separate vials containing 2.5% glutaraldehyde for primary fixation, followed by overnight storage at 4°C. The samples were then rinsed three times with phosphate buffer solution (pH 7.2-7.4) for 15 minutes each. Dehydration was carried out using a graded ethanol series (30, 50, 70, 90, and 100%) for 15 minutes each, with a final 30-minute dehydration step in absolute ethanol. The specimens were dried at the critical point in CO₂ at 5°C and affixed to aluminum stubs using double-sided carbon tape. Each specimen was mounted with the lower epidermal surface facing upward for examination. The mounted samples were sputter-coated with a thin gold layer using an automated JAF 1600 sputter coater. Finally, the specimens were analyzed and imaged using a JASM 6610LV Scanning E



Plate 1: Counting trichomes on upper leaf surface

Result and Discussion

Impact of morphological antixenotic resistance on the establishment of *H. armigera* on different chickpea germplasms

Antixenotic resistance of promising chickpea germplasm against *H. armigera* was carried out under laboratory conditions on the basis of morphological features viz., mean trichome density, length of glandular and non-glandular trichomes on upper side, lower side of the leaf and pod.

Trichome density on leaves and pods of promising germplasm of chickpea

In case of pods, the numbers of non-glandular trichomes were few even completely absent in most of the

germplasms. On the upper surface of the leaf, the minimum glandular trichome length was recorded on NBeG1635 (225.60 µm), whereas the maximum glandular trichome length was observed on NBeG 810 (300.50 µm). Similarly, the maximum and minimum non-glandular trichome length was recorded in NBeG 810 (245.10 µm) and RLBGMH-4 (180.35 µm), respectively. On the lower surface of leaf maximum trichome length was observed in germplasm NBeG 810 (297.10 trichomes per mm²) whereas the mean glandular trichome length on pod ranged from 241.71µm to 312.05 µm. The highest glandular trichome length on pod was recorded on DHMC 18-1664 (311.05 µm) whereas lowest trichome length was recorded on GJG 1801 (240.71µm) respectively.

Table 1: Length of Glandular and Non-Glandular trichomes on upper and lower leaf surface of chickpea leaves and pods

Germplasm	Trichome length on upper leaf surface (µm)		Trichome length on lower leaf surface (µm)		Trichome length on pods (µm)	
	Glandular	Non-glandular	Glandular	Non-glandular	Glandular	Non-glandular
RSGD-834	247.20 ^d	209.50 ^f	244.80 ^d	220.60 ^b	281.10 ^e	181.66 ^b
BG4017	250.70 ^e	185.50 ^b	239.10 ^c	196.60 ^d	275.19 ^d	126 ^{ab}
DMHC 18-1664	270.40 ^h	234.30 ^g	275.06 ^h	230.90 ⁱ	311.05 ^g	176.33 ^b
GJG 1803	234.90 ^b	185.80 ^b	230.60 ^b	194.60 ^d	257.06 ^c	0 ^a

GJG 1801	225.60 ^a	196.30 ^c	220.70 ^a	188.80 ^c	240.71 ^a	179.66 ^b
NBeG 1635	256.7 ^f	180.35 ^a	257.20 ^f	187.40 ^c	276.420 ^d	0 ^a
RLBGMH-G	258.45 ^f	205.50 ^e	260.80 ^g	204.65 ^f	255.70 ^c	0 ^a
NBeG 810	300.50 ^k	245.10 ^h	297.10 ^k	243.34 ^j	300.33 ^f	191 ^b
JG 2020-60	246.80 ^d	196.20 ^c	241.40 ^c	200.32 ^e	247.80 ^b	0 ^a
NBeG 857	283.90 ^j	206.40 ^e	281.60 ⁱ	212.15 ^g	303.1 ^f	123.33 ^{ab}
RSGD 926	246.30 ^d	180.3 ^a	251.80 ^e	184.41 ^b	245.64 ^b	0 ^a
ICCL3137	263.40 ^g	179.60 ^a	253.70 ^e	180.12 ^a	333.66 ^h	195 ^b
GL26016	289.30 ^j	250.60 ⁱ	281.20 ⁱ	248.91 ^k	363.53 ⁱ	59.33 ^{ab}
ICCL86111	282.86 ⁱ	257.30 ^j	294.50 ^j	262.97 ^l	375.4 ^j	0 ^a
PG3	242.06 ^c	200.40 ^d	242.80 ^d	202.18 ^{ef}	254 ^c	0 ^a
SEm±	0.481	0.517	0.457	0.467	0.672	25.389
CD @ 5%	1.393	1.496	1.322	1.353	1.946	75.438

*Means in a column followed by the same letter(s) do not differ significantly at the 5% level by Tukey's HSD test

Graphical representation of trichome length on chickpea germplasm

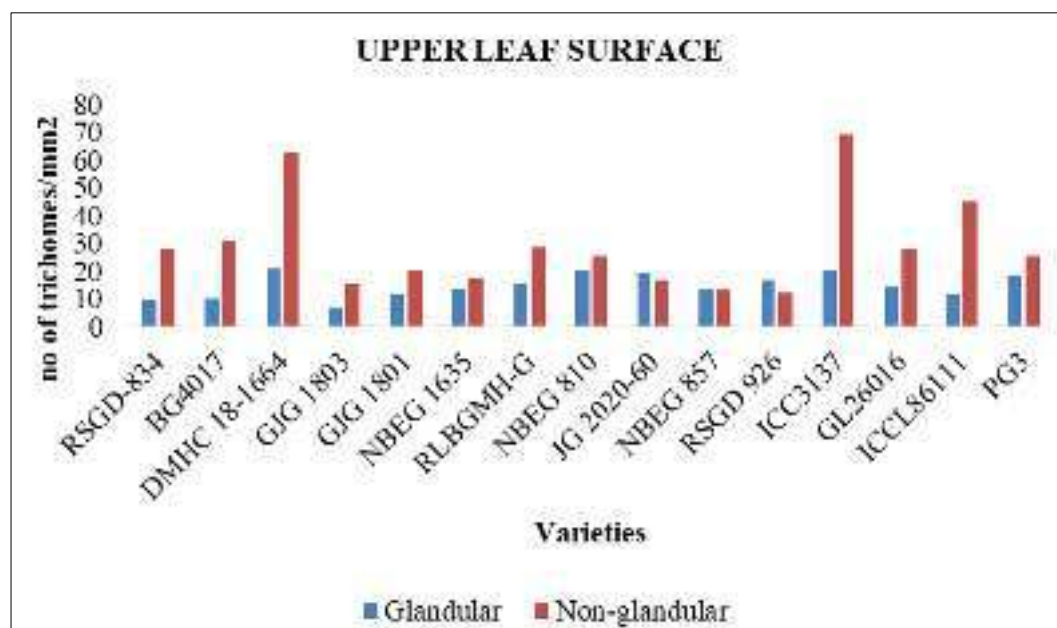


Fig 1: Glandular and Non-Glandular trichome length on upper leaf surface of chickpea

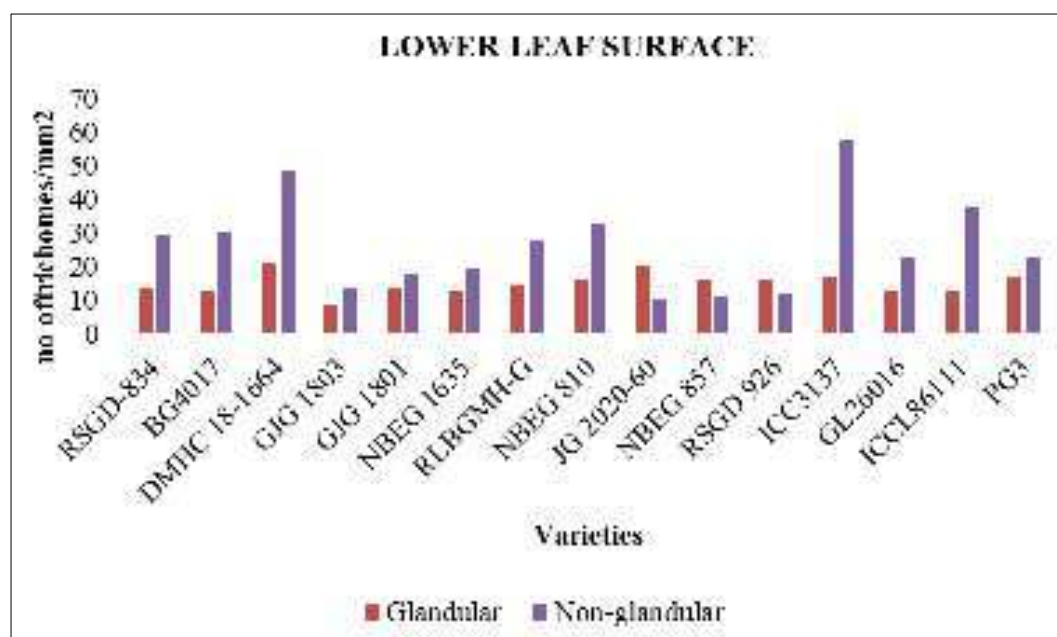


Fig 2: Glandular and Non-Glandular trichome length on lower leaf surface

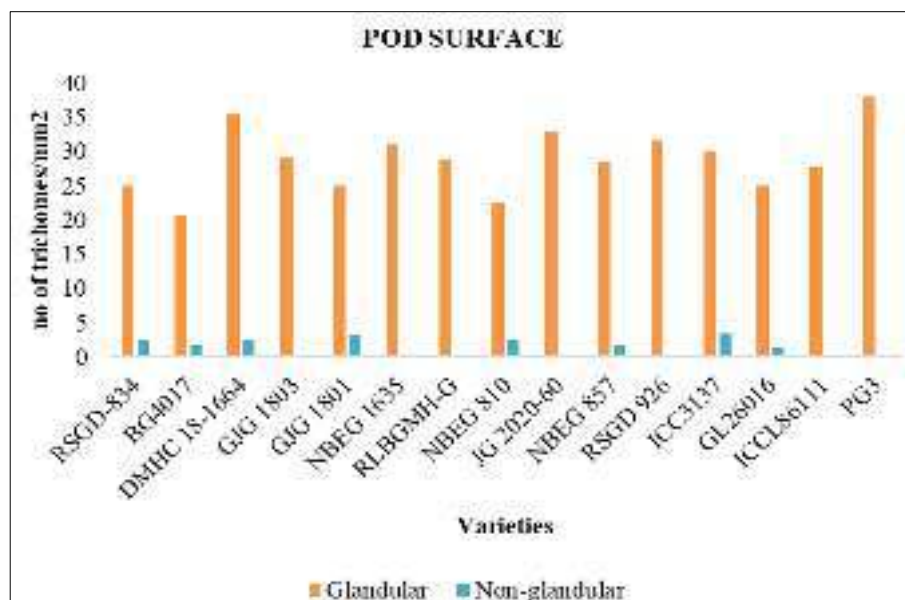


Fig 3: Glandular and Non-Glandular trichome length on pods surface

Correlation between morphological characteristics of leaves and pods of promising chickpea germplasm and population of *H. armigera* during 2020-21

The data pertaining to the correlation between morphological characteristics of leaves and pods of promising chickpea germplasms with *H. armigera* population are presented below.

Glandular trichome length on leaves showed non-significant negative correlation with number of eggs, larval population and per cent pod damage ($r = -0.166^{NS}$, -0.490^{NS} , and -0.226^{NS} , respectively). On the other hand, the length of the non-glandular trichomes on leaf had a non-significant correlation with egg, larval population and pod damage ($r = -0.022^{NS}$, -0.419^{NS} and -0.346^{NS} , respectively). Whereas in case of pods also, the length of the trichomes (glandular and non-glandular) had non-significant negative correlation with the population of *H. armigera*, indicating that more the trichome length, lesser would be the number of *H. armigera* eggs, larval population and pod damage. The above findings are well supported by Brar *et al.* (2017) [2] who recorded non-significant negative correlation between length of non-glandular and length of glandular trichome on pod with egg, larval population of *H. armigera* and pod damage.

Conclusion

The study revealed significant variation in trichome density and length among chickpea germplasms, influencing their antixenotic resistance to *Helicoverpa armigera*. DHMC 18-1664 and NBeG 810 exhibited the highest glandular trichome length on leaves, while DHMC 18-1664 had the maximum glandular trichomes on pods. NBeG 810 showed the longest glandular and non-glandular trichomes. These traits likely contribute to resistance by deterring insect feeding. Overall, DHMC 18-1664 and NBeG 810 emerged as promising resistant germplasms against *H. armigera*.

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