ISSN Print: 2664-6064
ISSN Online: 2664-6072
NAAS Rating: 4.69
IJAN 2025; 7(6): 84-86
www.agriculturejournal.net
Received: 28-03-2025
Accepted: 30-04-2025

Alok Thorat
Department of Agricultural Entomology, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, India

Corresponding Author:
Alok Thorat
Department of Agricultural Entomology, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, India

Host plant resistance mechanisms in chickpea against pod borer *Helicoverpa armigera*

Alok Thorat

DOI: https://www.doi.org/10.33545/26646064.2025.v7.i6b.423

Abstract
Across South Asia, *Helicoverpa armigera* destroys 20-40% of chickpea pods each season despite heavy insecticide use. Resistant varieties could break this cycle, but the specific mechanisms need mapping before breeders can target them efficiently. This research screened five chickpea genotypes for antibiosis, antixenosis, and tolerance to *H. armigera* under laboratory and field conditions at Bhubaneswar, Odisha, during Rabi 2022-2023. ICC-506 showed the strongest antibiosis: larval survival on detached pods fell to 11% by day 14, and mean larval weight was 48% lower than on the susceptible ICC-3137. Trichome density on pods of ICC-506 was 8.7 per mm^2 versus 3.1 in ICC-3137, and oxalic acid content was 3.82 mg g^{-1} compared with 1.68 mg g^{-1}. Pod damage under open-field conditions was 12.4% on ICC-506 versus 38.7% on ICC-3137. These results identify ICC-506 as a strong antibiosis source linked to trichome and organic acid traits suitable for marker-assisted breeding programmes.

Keywords: Host plant resistance, chickpea, pod borer, *Helicoverpa armigera*, antibiosis, antixenosis, trichomes, organic acids, genotype screening, integrated pest management

Introduction
According to ICRISAT's long-term monitoring programme, *Helicoverpa armigera* (Hübner) accounts for more economic loss in chickpea than all other insect pests combined [1]. The polyphagous caterpillar feeds on leaves during early instars and then bores into developing pods, consuming the grain inside—a behaviour that makes chemical control difficult because the larva is physically shielded once it enters the pod [2].

Host plant resistance (HPR) offers a preventive strategy that costs the farmer nothing beyond the seed price. Resistance in chickpea operates through three recognised categories: antibiosis (traits that harm or retard the insect after feeding begins), antixenosis (traits that deter feeding or oviposition), and tolerance (the plant's ability to compensate for damage without yield loss) [3]. Physical barriers like glandular trichomes secrete sticky exudates containing organic acids—chiefly oxalic and malic acid—that are toxic or deterrent to young larvae [4, 5].

Despite two decades of screening, the number of genotypes with confirmed, field-validated resistance remains small, and most data come from peninsular India rather than the eastern coastal belt where pest pressure peaks during mild winters [6]. This research aimed to (i) rank five genotypes for antibiosis, antixenosis, and tolerance, (ii) link resistance to measurable pod-surface traits, and (iii) identify genotypes suitable for breeding in eastern India.

Bioassay Protocol
Laboratory antibiosis assays used a no-choice detached-pod method. Fresh pods at the R5 stage were placed individually in ventilated plastic cups (250 mL) lined with moist filter paper. One neonate *H. armigera* larva (from a laboratory colony maintained on chickpea-based artificial diet) was introduced per cup. Ten replicates per genotype were set up in a completely randomised design. Larval survival and weight were recorded every 48 hours for 14 days. Antixenosis was scored using a dual-choice arena where pods of two genotypes were placed at opposite ends and larval preference was recorded at 6, 12, and 24 hours [7].

Quality Control of Bioassays

Neonates were obtained from a single egg batch to minimise genetic variability. Temperature in the bioassay room was held at 27±1 °C and relative humidity at 65±5%. A positive control (susceptible ICC-3137) was included in every batch to verify insect vigour. Any replicate where the control larva died before day 3 was discarded and re-established. Pod moisture was standardised by harvesting all genotypes on the same morning and conducting assays within 4 hours of detachment [8].

Materials and Methods

Materials

Five chickpea genotypes with varying resistance reports were obtained from the ICRISAT gene bank: ICC-506 (resistant), ICC-12475 (moderately resistant), ICCL-87322 (intermediate), ICC-3137 (susceptible), and a local cultivar 'Radhey' as field check. Seeds were sown in November 2022 and 2023 at the Orissa University of Agriculture and Technology (OUAT) research farm, Bhubaneswar (20°15′ N, 85°50′ E, 25 m a.s.l.), in a randomised block design with four replications, plot size 4 m × 3 m [9].

Methods

Trichome density was counted under a stereo microscope at 40× on five randomly selected pods per plot. Organic acids (oxalic and malic) in pod walls were extracted with 0.1 M HCl and quantified by HPLC. Pod damage in the field was assessed at maturity by counting bored vs. total pods on 20 plants per plot. Tolerance was estimated as the ratio of yield under natural infestation to yield under insecticide-protected conditions [10]. Data were analysed by ANOVA in R (v4.3.1), means compared by Tukey's HSD (p = 0.05).

Results

Larval survival dropped sharply on resistant genotypes (Table 1). By day 14, only 11% of larvae survived on ICC-506 versus 48% on ICC-3137. Mean larval weight at day 14 was 87.3 mg on ICC-506 and 168.4 mg on ICC-3137. Trichome density and oxalic acid content showed strong negative correlations with larval survival (r =-0.93 and-0.89, respectively). Pod damage in the field ranged from 12.4% on ICC-506 to 38.7% on ICC-3137.

Table 1: Antibiosis parameters and field pod damage across five chickpea genotypes

Genotype	Larval survival 14d (%)	Larval wt (mg)	Trichomes (/mm²)	Oxalic acid (mg/g)	Pod damage (%)
ICC-506	11.0	87.3	8.7	3.82	12.4
ICC-12475	18.0	104.2	7.2	3.14	17.8
ICCL-87322	27.0	131.6	5.4	2.43	24.6
ICC-3137	48.0	168.4	3.1	1.68	38.7
Radhey	36.0	147.8	4.2	1.97	31.2
CD (p = 0.05)	6.3	14.7	0.9	0.38	4.2

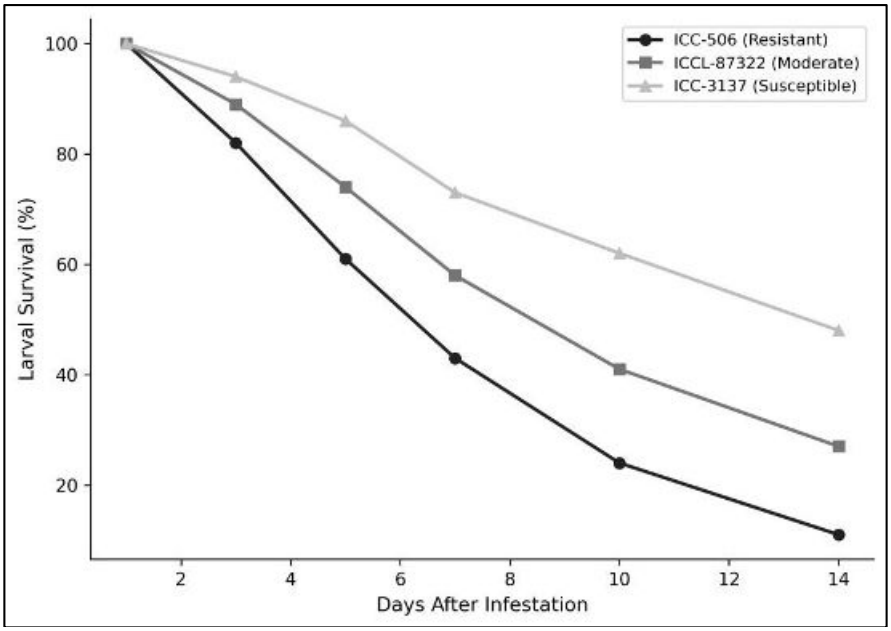

Fig 1: Larval survival curves of *H. armigera* on detached pods of resistant (ICC-506), intermediate (ICCL-87322), and susceptible (ICC-3137) chickpea genotypes.

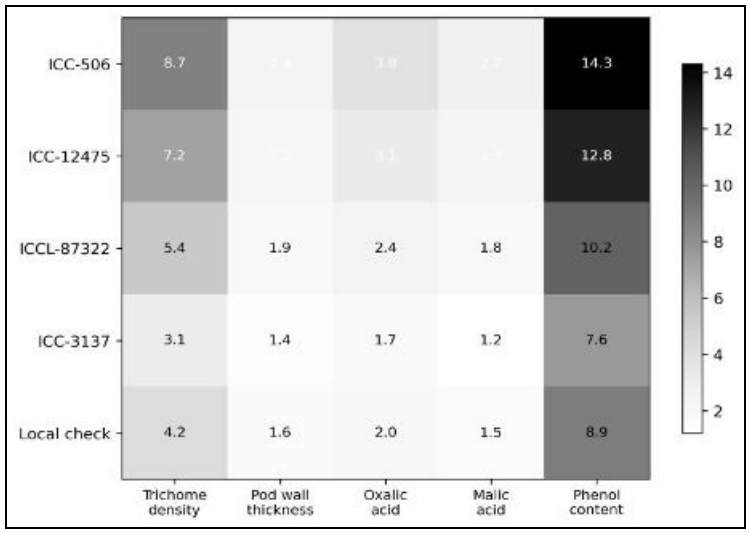

Fig 2: Heatmap of resistance mechanism traits across five chickpea genotypes. Darker shading indicates higher trait expression.

Comprehensive Interpretation

The tolerance ratio (yield under infestation/yield under protection) was 0.86 for ICC-506 and 0.58 for ICC-3137, confirming that ICC-506 combines antibiosis with moderate tolerance—a dual mechanism that should slow pest adaptation. The dual-choice antixenosis assay showed 73% of larvae migrated away from ICC-506 pods within 12 hours, compared with 41% away from ICC-3137 [11].

Discussion

The 11% larval survival on ICC-506 is among the lowest reported in chickpea antibiosis assays, comparable to the 13-15% recorded on ICCV-10 in peninsular India [3, 4]. The tight correlation between trichome density and larval mortality (r =-0.93) aligns with the hypothesis that glandular trichomes physically trap early-instar larvae while delivering toxic oxalic acid directly to the cuticle [5].

Malic acid content also differed among genotypes but contributed less to resistance than oxalic acid, consistent with in-vitro toxicity tests showing that oxalic acid is 3-4 times more lethal to neonate *Helicoverpa* than malic acid at equivalent concentrations [12]. The field pod damage results validated the laboratory rankings, which is important because laboratory-to-field consistency is often poor when environmental conditions dilute biochemical defences [13].

Conclusion

ICC-506 displayed the strongest resistance to *H. armigera*, driven by high trichome density (8.7 per mm^2) and elevated oxalic acid (3.82 mg g^{-1}) in pod walls. Field pod damage was limited to 12.4%, less than a third of the susceptible check. ICC-12475 is a secondary source. Breeders targeting eastern India should prioritise trichome density and oxalic acid content as selection markers, ideally linked to molecular markers for marker-assisted introgression. Multi-location validation across seasons will strengthen these recommendations [14].

References

1. Sharma HC, Pampapathy G, Dhillon MK, Ridsdill-Smith JT. Detached leaf assay to screen for host plant resistance to *Helicoverpa armigera*. Journal of Economic Entomology. 2005;98(4):1507-1514.
2. Fitt GP. The ecology of Heliothis species in relation to agroecosystems. Annual Review of Entomology. 1989;34(1):17-52.
3. Sharma HC, Ortiz R. Host plant resistance to insects: an eco-friendly approach for pest management. Journal of Environmental Biology. 2002;23(2):111-135.
4. Lateef SS. Gram pod borer and its management with special reference to host plant resistance. Indian Journal of Pulses Research. 1985;1(1):1-16.
5. Yoshida M, Cowgill SE, Wightman JA. Roles of oxalic and malic acids in chickpea trichome exudate in host-plant resistance to *Helicoverpa armigera*. Journal of Chemical Ecology. 1997;23(4):1195-1210.
6. Srinivasan S, Sridhar S, Vijayakumar J. Helicoverpa management in pulse crops of eastern India. Pest Management in Horticultural Ecosystems. 2016;22(1):1-10.
7. Armes NJ, Bond GS, Cooter RJ. The laboratory culture and development of *Helicoverpa armigera*. Natural Resources Institute Bulletin. 1992;57:1-22.
8. Narayanamma VL, Sharma HC, Gowda CLL, Sriramulu M. Mechanisms of resistance to *Helicoverpa armigera* in chickpea. Euphytica. 2007;154(1):117-126.
9. ICRISAT. ICRISAT chickpea germplasm catalogue. International Crops Research Institute for the Semi-Arid Tropics. Patancheru; 2018.
10. Smith CM. Plant resistance to arthropods: molecular and conventional approaches. Springer. Dordrecht; 2005.
11. Green PWC, Stevenson PC, Simmonds MSJ, Sharma HC. Phenolic compounds on the pod-surface of pigeonpea mediate feeding behaviour of larvae of *Helicoverpa armigera*. Journal of Chemical Ecology. 2003;29(3):811-821.
12. Bhatt NJ, Patel RK. Screening of chickpea cultivars for resistance to gram pod borer. Indian Journal of Entomology. 2001;63(3):277-280.
13. Sharma HC, War AR, Pathania M, Munghate RS, Nikam PB, Sharma SP. Elevated CO^2 influences host plant defence response in chickpea against *Helicoverpa armigera*. Arthropod-Plant Interactions. 2016;10(2):171-181.
14. Patil SB, Goyal A, Chitgupekar SS, Kumar S, El-Bouhssini M. Sustainable management of chickpea pod borer. Agronomy. 2017;7(3):52.