https://doi.org/10.33307/entomon.v46i4.646
Entomon 46(4): 343-348 (2021)
Short Communication No. ent. 46409

Morphological and biochemical traits in chickpea resistance against *Helicoverpa armigera* Hubner (Lepidoptera: Noctuidae)

Manish K. Yadav*, Lipsa Das, V. Ramalakshmi, Nihal R. Sunil, Sudhanshu Bala Nayak and Deepayan Padhi

Department of Agricultural Entomology, M. S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi 761200, Odisha, India
Email: maish.yadav@cutm.ac.in; arpansfour@gmail.com

ABSTRACT: Investigation undertaken with eight chickpea genotypes (Vallabh Kallar Channa 1, Ankur (CSJ 140), JGK-2, Ganguar (GNG 1581), Jawahar Gram-1 (JGK 1), WCG-10 (Pant G-10), Avrodhi and ICC 506-EB as resistant check) for their morphological and biochemical traits of resistance to *Helicoverpa armigera,* indicated trichome number, length and density, and nitrogen, total chlorophyll and potassium content as influencing the resistance/ susceptibility levels in chick pea.

KEYWORDS: Pod borer, trichome, chlorophyll

Chickpea *(Cicer arietinum* L.), which is commonly known as gram plays an important role in the vegetarian diet as a major source of protein. Pulses are almost an essential component of the vegetarian diet in Indian sub-continent, besides in rich source of protein. Insect-pests are challenge in gram cultivation. NCIPM study has recorded pod borer, *Helicoverpa armigera* Hubner (Lepidoptera: Noctuidae) in gram to cause 30-90% loss in Madhya Pradesh, Karnataka, Rajasthan, Maharashtra, Uttar Pradesh, Gujarat and Telangana (Kumar *et al*., 2021a, b; Shah *et al*., 2021). This polyphagous pest cause economic loss to chickpea, pigeonpea, cotton, sunflower, tomatoes, chillies, tobacco and many other crops (Vikram, 2021). Among several insect pests attacking chickpea, gram pod borer, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) is the major pest of chickpea which feeds on every stage of the crop from seedling to maturity and is known to cause 50 – 60 per cent pod loss (Sonawane and Chaudhary, 2021). Morphological namely plant height, stem thickness, number of branches, leaf trichome density and trichome length and biochemicals namely nitrogen, protein, potassium, phosphorus and total chlorophyll contents are the important traits in contributing resistance or otherwise. Therefore, the present investigation was undertaken to calibrate the influence of various traits and their impact on gram pod borer infestation on chick pea.

Experiment was conducted during the *Rabi* 2020-2021 with a total number of eight genotypes (Table 1). The ICC 506-EB genotype was selected as

* Author for correspondence

Table 1. Morphological traits, biochemical contents of the chickpea genotypes and their *Helicoverpa armigera* infestation

Genotypes	Morphological characters					Biochemical content				*Helicoverpa armigera* infestation		
	Plant heigh (cm)	Stem thickness (mm)	Branches (no.)	Trichome density (leaf^{-1})	Trichome length (im)	N (%)	Protein (%)	K (%)	Chlorophyll (mg /ml)	Larvae/ plant	Leaf (%)	Pod (%)
Vallabh Kallar Channa 1	54.34	3.67	5.67	43.61	7.34	3.61	22.56	0.91	1.51	3.67	67	61
Ankur (CSJ 140)	52.67	4.34	6.34	47.00	7.11	3.36	21.00	0.94	1.46	2.34	46	51
Avrodhi	56.34	4.34	5.34	48.34	6.67	3.19	19.93	1.01	1.44	2.00	39	41
Ganguar (GNG 1581)	54.67	4.67	4.67	47.67	7.18	3.34	20.87	0.96	1.46	2.34	48	48
Jawahar Gram-1 (JGK 1)	52.34	4.00	6.00	49.34	7.34	3.21	20.06	0.97	1.42	1.67	37	41
WCG-10 (Pant G-10)	56.67	3.67	5.67	46.67	7.67	3.41	21.31	0.91	1.39	2.67	51	53
JGK-2	54.34	4.34	5.34	41.67	6.91	3.47	21.68	0.92	1.53	3.34	59	53
ICC 506-EB (Check)	51.34	4.34	5.34	51.34	6.41	3.09	19.31	1.03	1.37	1.34	36	38
Sem±	0.73	0.36	0.43	0.95	0.54	0.36	0.43	0.11	0.19	0.39	0.8	0.9
CD @0.05%	2.14	1.03	1.21	2.81	1.54	0.93	1.21	0.29	0.49	1.09	2.3	2.7
CV	3.68	2.51	2.66	3.43	2.37	2.31	1.63	1.09	1.21	2.17	3.6	3.5

resistant check as it showed resistance against *H. armigera* on the basis of Malic acid content in leaves (Bhagwat *et al*., 1995). CRBD has been utilized with all the recommended agronomic practices, sown in rows (10 X 35 cm) with three replications. Number of larvae per plant, mean leaf infestation and mean pod infestation were recorded in all the replications by selecting five random plants at the time of pod formation stage. Morphological parameters viz., plant height, stem thickness, number of branches, leaf trichome density and trichome length were recorded. For trichome extraction, leaf chlorophyll was erased with the help of organic solvents (dimethyl sulpho-oxide and ethanol) kept for 12 hours at 60^0C in BOD. Later on, the trichomes were extracted with help of fine forceps, needle and surgical blades and length has been taken by placing over the measuring ocular under the microscope.

For the estimation of biochemical (nitrogen, phosphorus, potassium and protein) samples have been prepared by selecting a total number of five plants from each replication of each treatment randomly and cut from the base at root. These samples should be composited, washed with running water and then chopped into very small pieces by mixing stem and leaves at the rate of 80:20. Later on, the chopped material was mixed thoroughly and dried in air for 1 day and later in the oven at 70^0C for a total period of 22-28 hours. These dried samples were again ground upto finer dust. From these, 5 g material was taken for estimation of N, K and protein. Nitrogen content was calculated as per AOAC (1970).

$$\text{Nitrogen (\%)} = \frac{\text{(Sample TV-Blank TV) } 0.00007 \times \text{Volume of digation}}{\text{weight of sample} \times \text{Adiquot taken}} \times 100$$

The protein calculated as = Nitrogen (%) × 6.25; potassium by Flame Photometer (Upadhyay and Sahu, 2012) and total chlorophyll by spectrophotometer method (Arnon, 1949). One gram leaf samples were taken, homogenized in a pre-cooled mortar and pestle using 80 per cent acetone. A pinch of calcium carbonate was added while grinding. Later the extract was centrifuged at 3000 rpm for 15 min and made up to 25 ml with 80 per cent acetone. The clear solutions were transferred to a colorimeter tube and the optical density was measured at 645 nm and 663 nm, against an 80 per cent acetone blank in Shimadzu 35 Double Beam spectrophotometer (UV 240). The levels of chlorophyll 'a' and chlorophyll 'b' were determined using the equation given below:

$$\text{Chlorophyll-a [mg ml}^{-1}\text{]} = 12.7\ A_{663} - 2.69\ A_{645}$$

$$\text{Amount of Chlorophyll-b [mg ml}^{-1}\text{]} = 22.9\ A_{645} - 4.68\ A_{663}$$

where:

A_{645} = absorbance at a wavelength of 645 nm

A_{663} = absorbance at a wavelength of 663 nm.

Total Chlorophyll (mg/ml) = Chlorophyll a + Chlorophyll b.

The data were analysed for ANOVA and correlation to establish the relationship of traits with the levels of pod borer infestation.

Plant heights ranged from 51.34 to 56.67cm and maximum height was recorded in WCG-10 (Pant G-10) followed by Avrodhi with 56.34 and Ganguar (GNG 1581) with 54.67cm while minimum was recorded in ICC 506-EB (Check) with 51.34. Stem thickness was maximum in Ganguar (GNG 1581) with 4.67 mm followed by Ankur (CSJ 140); JGK-2; Avrodhi and ICC 506-EB (Check) and minimum was recorded in WCG-10 (Pant G-10) and Vallabh Kallar Channa 1 with 3.67 mm. Number of branches were maximum in Ankur (CSJ 140) with 6.34 followed by Jawahar Gram-1 (JGK 1), Vallabh Kallar Channa 1 and WCG-10 (Pant G-10). Trichome density was maximum in the leaves of ICC 506-EB (Check) with 51.34 trichomes per leaf, followed by Jawahar Gram-1 (JGK 1). Trichome density was minimum in JGK-2 with 41.67 and Vallabh Kallar Channa 1 with 43.61. The trichome length was maximum in WCG-10 (Pant G-10) with 7.67 ìm followed by Vallabh Kallar Channa 1 and Jawahar Gram-1 (JGK 1) with 7.34 ìm. Minimum trichome length was recorded in ICC 506-EB (Check) with 6.41 µm and Avrodhi with 6.67 µm (Table 1).

Nitrogen content was maximum in Vallabh Kallar Channa 1 (3.61%) followed by JGK-2 and WCG-10 (Pant G-10), while minimum was recorded in ICC 506-EB (Check) (3.09 %) and Avrodhi (3.19%). In the case of protein, it was maximum in Vallabh Kallar Channa 1 (22.56 %), followed by JGK-2 (21.68%) and WCG-10 (Pant G-10) (21.31%). Potassium was maximum in ICC 506-EB (Check), while minimum was in Vallabh Kallar Channa 1 and WCG-10 (Pant G-10). The total chlorophyll was maximum in JGK-2 (1.53 mg ml^{-1}) followed by Vallabh Kallar Channa 1 and Ankur (CSJ 140); Ganguar (GNG 1581), while it was minimum in ICC 506-EB (Check) (1.37 mg ml^{-1}) (Table 1).

The number of pod borer larvae was maximum in Vallabh Kallar Channa 1 (3.67) followed by JGK-2 and WCG-10 (Pant G-10), while minimum in ICC 506-EB (Check) (1.34). The infestation on leaf was maximum in Vallabh Kallar Channa 1 (67%) followed by JGK-2 (59%) and WCG-10 (Pant G-10) (51 %), while it was minimum in ICC 506-EB (Check) (36%). The mean per cent of pod infestation (Table 1) was found maximum in Vallabh Kallar Channa 1 (61%) followed by WCG-10 (Pant G-10); JGK-2 (53%) and Ankur (CSJ 140) (51%). It was minimum in ICC 506-EB (Check) (38%).

Significant positive correlation was noted between trichome length, total chlorophyll, nitrogen and pod infestation (Table 2). Plant height is an important character of plant, in case of all the agricultural crops, it deals with the productivity of the crop. All the selected genotypes under this experiment had showed different degree of variation among the height parameter. As per the correlation values, height is found to be positively correlated with the various infestation parameters. Dinesh *et al*. (2017), Pandey *et al*. (2021) and Yadav *et al*. (2021) support these findings. The stem thickness can be considered as a major factor in case of stem borers but the defoliators have not found to be correlated with the stem thickness that much. In case of other morphological parameters, trichome density and trichome length was found to the major infestation governing factor in case of this pest. The correlation of trichome density with various traits of infestation was maximum and negative and it was noted that genotypes having shorter trichomes with higher density, was found to be very less infested with the chickpea pod borer (Shahzad *et al.*, 2005; Vanambathina *et al*., 2021).

Nitrogen, potassium and chlorophyll were noted as the more influencing factors to the infestation and survival of chickpea pod borer on selected genotypes. The maximum correlation was seen in case of mean per cent of pod infestation and nitrogen content in plants. The correlation between nitrogen; chlorophyll and infestation traits suggested the more nitrogen content in plants will leads to more infestation of *H. armigera* (Gyawali *et al*.,

Table 2. Correlation between the morphological and biochemical factors of chickpea genotypes and *Helicoverpa armigera* infestation

Character	Larvae/ plant	Leaf infestation (%)	Pod infestation (%)	Correlation
Plant height	0.439	0.346	0.361	Positive
Stem thickness	-0.390	-0.407	-0.478	Negative
Branches (no.)	-0.010	-0.046	0.142	NS
Trichome density	-0.952	-0.904	-0.840	Negative
Trichome length	0.449	0.440	0.604	Positive
Nitrogen	0.972	0.922	0.987	Positive
Potassium	-0.852	-0.834	-0.918	Negative
Chlorophyll	0.804	0.758	0.665	Positive

2021; War *et al.*, 2021). The potassium found to be negatively correlated with all traits of infestation and genotypes richer in K content, were slightly resistant against the chickpea pod borer infestation (Keshan *et al*., 2021; Gayatri and Kumar, 2021; Sai *et al*., 2021**).** The results indicate trichome density and lengths as the major influencing factors while in biochemical, nitrogen, potassium and chlorophyll content were identified in influencing the susceptibility levels of the genotypes.

REFERENCES

A.O.A.C. (2015) Official methods of analysis. Association of Official Analytical Chemists, Washington.

Arnon D.L. (1949) Copper enzyme in isolated chloroplast and polyphenol oxidase. Plant Physiology 24: 71-80.

Bhagwat V.R., Aherkar S.K., Satpute U.S. and Thakare H.S. (1995) Screening of chickpea (*Cicer arietinum* L.) genotypes for resistance to gram pod borer, *Helicoverpa armigera* (Hubner) and its relationship with malic acid in leaf exudates. Journal of Entomological Research 19(3): 249-253.

Dinesh K., Anusha S., Singh R.B. and Dangi N.L. (2017) Estimation of avoidable yield losses caused by *Helicoverpa armigera* (Hubner) on chickpea. Journal of Entomology and Zoology Studies 5(2): 1476-1478.

Gayathri L. and Kumar A. (2021) Field efficacy of certain insecticides against pod borer, *Helicoverpa armigera* (Hubner) on chick pea in Prayagraj. Journal of Entomology and Zoology Studies 9(3): 280-283.

Gyawali P., Hwang S.Y., Sotelo-Cardona P. and Srinivasan R. (2021) Elucidating the fitness of a dead-end trap crop strategy against the tomato fruitworm, *Helicoverpa armigera*. Insects 12 (6): 506.

Keshan R., Singh I.K. and Singh A. (2021) Genome wide investigation of MAPKKKs from *Cicer arietinum* and their involvement in plant defense against *Helicoverpa armigera*. Physiological and Molecular Plant Pathology 115:101685.

Kumar T., Hamwieh A., Swain N. and Sarker A. (2021a) Identification and morphological characterization of promising Kabuli chickpea genotypes for short-season environment in central India. Journal of Genetics 100 (2): 1-8.

Kumar U., Patel G.A., Patel H.P., Chudhari R.P. and Darji S.S. (2021b) Impact of frontline demonstration programme on the yield of chickpea (*Cicer arietinum* L.) in Patan District of Gujarat, India. Legume Research: An International Journal 44(2): 27-32.

Pandey A., Yadav R., Kumar S., Kumar A., Shukla P., Yadav A. and Sanyal, I. (2021). Expression of the entomotoxic *Cocculus hirsutus* trypsin inhibitor (ChTI) gene in transgenic chickpea enhances its underlying resistance against the infestation of Helicoverpa armigera and Spodoptera litura. Plant Cell, Tissue and Organ Culture (PCTOC), 1-16.

Sai K.P., Tayde A.R., Reddy R.D. and Srivastava V.K. (2021) Management of gram pod borer *Helicoverpa armigera* (Hubner) in chickpea with bio-pesticides and combination. Journal of Entomology and Zoology Studies 9(1): 561-563

Shah U., Chaturvedi S.K., Dixit G.P., Singh N.P. and Gaur P. (2021) Organized farmers towards chickpea seed self-sufficiency in Bundelkhand region of India. In: Enhancing Smallholder Farmers' Access to Seed of Improved Legume Varieties Through Multi-Stakeholder Platforms, Springer, Singapore. pp. 113-123.

Shahzad K., Iqbal A., Khalil S.K. and Khattak S. (2005) Response of different chickpea, Cicer arietinum genotypes to the infestation of pod borer, Helicoverpa armigera with relation to trichomes. Research Journal of Agriculture and Biological Sciences 1:120-124.

Sonawane V.K. and Chaudhary S. (2021) Insect pest of chickpea and their Management-A Review. Journal of Emerging Technologies and Innovative Research (JETIR) 8 (1): 1-25. JETIR2101123.

Upadhyay S. and Sahoo B.B. (2012) Mercury induced phytotoxicity and oxidative stress in wheat (*Triticum aestivum* L.) plants. Physiology and Molecular Biology of Plants 18: 21-31.

Vanambathina P., Rachaputi R.C., Sultanbawa Y., Phan A.D.T., Henry R.J. and Brier H. (2021) Biochemical basis of resistance to pod borer (*Helicoverpa armigera*) in Australian wild relatives of pigeonpea. Legume Science 2021: 1–13. doi.org/10.1002/leg3.101

Vikram P.K. (2021) Status of Chickpea (*Cicer arietinum*) Cultivation in India-An Overview. Biotica Research Today 3(1): 49-51.

War A.R., Hussain B., Mishra S.P., Munghate R.S. and Sharma H.C. (2021) Nutritional indices and biochemical profile of Helicoverpa armigera [Hübner (1808)] on different groundnut genotypes. Acta agriculturae Slovenica 117(1): 1-9.

Yadav M.K., Dash L. and Rout S. (2021) Evaluation of host plant resistance traits in certain genotypes of maize (*Zea mays* L.) against maize spotted stem borer, *Chilo partellus* Swinhoe. International Journal of Botany Studies 3(13): 64-69.

(Received August 11, 2021; revised ms accepted October 11, 2021; printed December 31, 2021)