https://doi.org/10.33307/entomon.v48i1.844
ENTOMON 48(1): 63-68 (2023)
Article No. ent. 48107

Morphological and biochemical basis of resistance against the pod borers *Maruca vitrata* F. and *Helicoverpa armigera* (Hübner) in cowpea

D.V. Muchhadiya*, **J.J. Patel**, **N.H. Garaniya**[1] **and D.R. Patel**[2]

Department of Entomology, College of Agriculture, Navsari Agricultural University, Bharuch 392 012, Gujarat, India.
[1]*Department of Soil Science and Agricultural Chemistry, College of Agriculture, Navsari Agricultural University, Bharuch 392 012, Gujarat, India.*
[2]*Regional Cotton Research Station, Navsari Agricultural University, Bharuch 392 012, Gujarat, India.*
Email: dvmuchhadiya@nau.in

ABSTRACT: For determination of morphological and biochemical basis of resistance in cowpea against the pod borers (*Maruca vitrata* F. and *Helicoverpa armigera* (Hübner)), ten cowpea cultivars were evaluated during *kharif* 2017 and 2018. Results revealed that cultivars having indeterminate growth, yellow flower, light green and short pods as well as long peduncle recorded lower pod borer population. Correlation between different plant morphological characters and the larval population were found non-significant. The cultivars having low protein, high phenol and low total soluble sugars in flowers and immature pods recorded lower larval population. The correlation between biochemical components of flowers and larval population were found to be non-significant. Biochemical components of immature pods revealed that phenol exhibited significant negative relationship with larval population, whereas, correlation of total soluble sugars of immature pods exhibited significant positive association with larval population. Among the cultivars screened, GC-6 and GC-1605 were found to be consistently resistant based on different morphological and biochemical factors and pod borer infestation. Relatively GC-1609, GC-1611 and GC-2 showed lesser pod borer infestation. GC-1606 was found to be highly susceptible.

KEY WORDS: Flower, immature pod, phenol, total soluble sugars, larval population

INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp.] is an important legume crop grown in tropical and sub-tropical habitats both for vegetable and pulse. Cowpea is one of the most important pulse crops, native to central Africa, belongs to family Fabaceae. Cowpea is well adapted to the drier regions of the tropics because of its drought tolerance capacity. In terms of area, it is the second most important food legume crop in the world. Production of cowpea is limited by large number of biotic and abiotic constraints and the productivity remains very low in India. The main reason attributed for the low productivity is the extensive damage caused by insect pests. Among different insect pests, pod borers (spotted pod borer *Maruca vitrata* F. (Lepidoptera, Crambidae) and gram pod borer *Helicoverpa armigera* (Hübner) (Lepidoptera, Noctuidae) damaging the reproductive parts cause

* Author for correspondence

maximum reduction in yield. Pod borers damaging the reproductive parts cause maximum reduction in yield. Gubbaiah *et al.* (1975) observed 42 to 56 per cent damage to cowpea pods due to pod borer complex. Kumar (1978) observed the damage as high as 94.67 and 78.93 per cent on pods and seeds, respectively by pod borers. The avoidable losses in yield due to insect pests have been recorded in the range of 66 to 100 per cent in cowpea (Pandey *et al.,* 1991). Extensive use of insecticides and pesticides cause serious problems of pesticide residues, pest resurgence and also cause environmental pollution. Therefore it is necessary to use resistant varieties against pod borers. An investigation was carried out to determine the morphological and biochemical factors responsible for resistance in cowpea cultivars against the pod borers.

MATERIALS AND METHODS

An experiment was conducted for two years (kharif 2017 and 2018) to evaluate the basis of resistance in cowpea genotypes/cultivars against the pod borers infesting cowpea, at College of Agriculture, Navsari Agricultural University, Campus Bharuch, Gujarat. Ten genotypes/ cultivars were sown (Table1). The basis of resistance in various cowpea genotypes/ cultivars was determined based on various morphological characters and biochemical parameters. Data on morphological characters such as plant growth habit (determinate/ indeterminate), flower colour (yellow/ violet), pod colour (light green/ dark green) as well as peduncle and pod length of 25 peduncles/ pods of each genotypes/ cultivars were recorded from ten uniformly developed plants. Peduncle and pod length was measured. Biochemical analysis of flowers and immature pods for parameters such as protein, phenols and total soluble sugar were done by following the methods developed by Sadasivam and Manikkam (1996). The data on morphological characters and biochemical components of flowers and immature pods were statistically analyzed using statistical procedure (Steel and Torrie, 1980).

Table 1. Morphological and biochemical parameters of cowpea genotypes/ cultivars

Cultivar/ Genotype	Peduncle length (cm)	Pod length (cm)	Flower			Immature pod		
			Protein (%)	Phenol (mg/g)	sugar (%)	Protein (%)	Phenol (mg/g)	sugar (%)
GC-1605	17.68	9.44	11.75	0.51	1.19	12.40	0.60	1.15
GC-1606	12.68	10.80	11.19	0.46	4.80	20.30	0.21	4.32
GC-1607	19.70	10.10	6.68	0.43	1.65	10.81	0.32	4.42
GC-1609	28.90	8.50	11.64	0.64	1.70	12.99	0.19	4.13
GC-1611	16.90	8.40	10.13	0.45	2.89	13.11	0.42	1.92
GC-2	19.14	11.20	12.45	0.93	4.58	24.22	0.70	1.67
GC-3	16.56	11.90	6.60	0.48	1.43	11.22	0.35	2.96
GC-4	20.04	10.60	11.58	0.37	2.19	10.62	0.26	3.07
GC-5	18.44	9.80	7.18	0.62	2.03	7.34	0.63	4.42
GC-6	23.12	9.60	4.14	0.37	1.45	12.95	0.70	1.20
Mean	19.31	10.03	9.33	0.53	2.39	13.60	0.44	2.93

RESULTS AND DISCUSSION

Morphological characters

The results revealed that determinate genotypes/ cultivars recorded higher larval population of *M. vitrata* and *H. armigera* than indeterminate ones. The genotypes/cultivars having violet coloured flower recorded more larval population than yellow coloured genotypes/cultivars. The genotypes/ cultivars having dark green coloured pods recorded more larval population than light green coloured pods. Genotypes/cultivars having long peduncle recorded lower larval population than short peduncle whereas genotypes/cultivars having long pod recorded more larval population than short pod genotypes/cultivars. Cultivar GC-6 was found to be consistently resistant to the pod borer infestation (Table 1, 2).

Table 2. Impact of different morphological characters on the pod borers in cowpea genotypes/cultivars (Mean of two years)

Plant characters/ Genotypes		Mean larvae /plant	
		M. vitrata	*H. armigera*
Plant growth	Determinate - GC-1607, GC-3, GC-4, GC-5	1.30 ± 0.09	1.13 ± 0.13
	Indeterminate - **GC-1605**, GC- 1606, GC-1609, GC- 611, GC-2, GC-6	**1.05 ± 0.50**	**0.75 ± 0.42**
Flower colour	Yellow - GC-1605, GC-1606, GC-1607, GC-1609, GC-1611, GC-4, **GC-6**	**1.12 ± 0.48**	**0.87 ± 0.45**
	Violet - GC-2, GC-3, GC-5	1.21 ± 0.09	0.97 ± 0.21
Pod colour	Light green – GC-1607, GC-1609, GC-3, **GC-6**	**1.02 ± 0.37**	**0.88 ± 0.41**
	Dark green - GC-1605, GC-1606, GC-1611, GC-2, GC-4, GC-5	1.23 ± 0.42	0.92 ± 0.40
Peduncle length (cm)	Long >19.31* GC-1607, GC-1609, GC-4, **GC-6**	**1.04 ± 0.40**	**0.89 ± 0.42**
	Short <19.31 GC-1605, GC-1606, GC-1611, GC-2, GC-3, GC-5	1.21 ± 0.41	0.91 ± 0.39
Pod length (cm)	Long >10.00* GC-1606, GC-1607, GC-2, GC-3, GC-4	1.40 ± 0.30	1.15 ± 0.23
	Short <10.00 **GC-1605**, GC-1609, GC-1611, GC-5, GC-6	**0.89 ± 0.31**	**0.65 ± 0.34**

*Mean values refer Table 1

Findings in the present investigation are in accordance with the findings of Reddy *et al*. (1983), Lal *et al*. (1986), Kushwaha and Malik (1987), Sharma *et al*. (1999) and Bhadani (2019) who reported higher larval population in determinate genotypes than indeterminate genotypes and more larval population in long pod length genotypes/ cultivars than short pod length.

Correlation of morphological characters and larval population

Plant morphological characters and larval population of *M. vitrata and H. armigera* did not show any significant correlation between them, indicating that the impact of morphological characters on larval population as well flower and pod damage is negligible. These results are in accordance with findings of Anusha (2013) who reported that the morphological characters did not exhibit any significant relationship with the flower and pod damage in relation to resistance or susceptibility. Singh and Singh (2014) also reported that there were no significant relationship between larval densities and morphological characters of genotypes/cultivars.

Biochemical parameters - Flowers

Flowers with high protein content (> 9.33%) recorded higher larval population of *M. vitrata* than the flowers of cultivars having low protein (<9.33%). However, the protein content did not affect the larval population of *H. armigera.* The genotypes/ cultivars having low phenol content (< 0.53 mg/g) recorded higher larval population (*M. vitrata* and *H. armigera*) than genotypes/cultivars having high

Table 3. Influence of different biochemical components of flower and immature pods on the larval population of pod borers (Mean of two years)

Biochemical components	Category	Genotypes/ cultivars	Larvae /plant	
			M. vitrata	*H. armigera*
Flower				
Protein (%)	High>9.33*	GC-1605, GC-1606, GC-1609, GC-1611, GC-2, GC-4	1.20 ± 0.43	0.90 ± 0.40
	Low <9.33	**GC-1607**, GC-3, GC-5, **GC-6**	**1.06 ± 0.38**	**0.90 ± 0.41**
Phenol (mg/g)	High >0.53*	**GC-1605**, GC-1609, GC-2, GC-5	**1.00 ± 0.26**	**0.71 ± 0.31**
	Low <0.53	GC-1606, GC-1607, GC-1611, GC-3, GC-4,GC-6	1.25 ± 0.46	1.03 ± 0.39
Total Soluble Sugars (%)	High >2.39*	GC-1606, GC-1611, GC-2	1.38 ± 0.46	1.02 ± 0.33
	Low <2.39	**GC-1605**, GC-1607, GC-1609, GC-3, GC-4, GC-5, **GC-6**	**1.05 ± 0.35**	**0.85 ± 0.41**
Immature pods				
Protein (%)	High >13.60*	GC-1606, GC-2	1.51 ± 0.56	1.09 ± 0.44
	Low <13.60	**GC-1605**, GC-1607, GC-1609, GC-1611, GC-3, GC-4, GC-5, **GC-6**	**1.05 ± 0.33**	**0.86 ± 0.38**
Phenol (mg/g)	High >0.44*	**GC-1605**, GC-1611, GC-2, GC-5, **GC-6**	**0.91 ± 0.33**	**0.63 ± 0.33**
	Low <0.44	GC-1606, GC-1607, GC-1609, GC-3, GC-4	1.38 ± 0.33	1.17 ± 0.20
Total Soluble Sugars (%)	High >2.93*	GC-1606, GC-1607, GC-1609, GC-3, GC-4,GC-5	1.35 ± 0.30	1.13 ± 0.20
	Low <2.93	**GC-1605**, GC-1611, GC-2, **GC-6**	**0.84 ± 0.32**	**0.56 ± 0.32**

*Mean values refer Table 1

phenol content (> 0.53 mg/g). The genotypes/cultivars having high total soluble sugar (> 2.39%) recorded higher larval population (*M. vitrata* and *H. armigera*) than genotypes/cultivars having low total soluble sugar content (< 2.39%) (Table 3).

Biochemical parameters - Immature pods

Immature pods with high protein content (> 13.60%) recorded higher larval population (*M. vitrata* and *H. armigera*) than the cultivars having low protein content (< 13.60%). The genotypes/cultivars having low phenol content (< 0.44 mg/g) recorded higher larval population (*M. vitrata* and *H. armigera*) than genotypes/cultivars having high phenol content (> 0.44 mg/g). The genotypes/cultivars having high total soluble sugar (> 2.93%) recorded higher larval population (*M. vitrata* and *H. armigera*) than genotypes/cultivars having low total soluble sugar content (< 2.93%). Among the cultivars screened, GC-6 and GC-1605 were found to be consistently resistant based on different biochemical characters and pod borer infestation. Relatively GC-1609, GC-1611 and GC-2 cultivars also showed resistance to the pod borer infestation. GC-1606 was found highly susceptible cultivar (Table 3).

Cultivars GC-6 and GC-1605 recorded lower pod borers and found to be consistently resistant. Relatively GC-1609, GC-1611 and GC-2 cultivars showed low pod borer infestation indicating these are also have the resistance to the pod borers. GC-1606 was found to be highly susceptible cultivar. The results revealed that genotypes/cultivars having low protein, high phenol and low total soluble sugar in flowers and immature pods recorded lower larval population than genotypes/cultivars having high protein, low phenol and high total soluble sugar in flowers and immature pods. These constituents played vital role in determining the resistance in cowpea genotypes/cultivars against pod borers. These findings are in complete agreement with findings of Jaydeep *et al.* (2006) and Haider and Srinivasan (2007) who reported that susceptible cultivars of mung bean and urd bean had high amount of total sugar, reducing sugar, non-reducing sugar, amino acids and protein where resistant cultivars had high amount of phenol. Singh and Singh (2014) also recorded lower concentration of phenol and higher concentration of total sugar and protein from flowers and immature pods of the susceptible genotypes/varieties of cowpea.

Correlation of biochemical parameters with larval population

Different biochemical components of flowers like protein (%), phenol (mg/g) and total soluble sugars (%) and larval population non-significant correlation between them, indicating there are no significant relationship between pest population and biochemical components of flower. However, the correlation of biochemical components of immature pods with larval population revealed that phenol (mg/g) exhibited significant negative relationship with larval population of *M. vitrata* (r = - 0.650*) and *H. armigera* (r = - 0.728*). Correlation of total soluble sugars of immature pods exhibited significant positive association with larval population of *M. vitrata* (r = 0.688*) and *H. armigera* (r = 0.752*).

According to Jaydeep *et al*. (2006), significant positive correlation exist between total sugar, reducing sugar, non reducing sugar, amino acids and proteins with pod damage, whereas negative correlation existed between phenol contents in pods with pod damage by spotted pod borer in mungbean. Haider and Srinivasan (2007) also reported significant positive correlation between total sugar, reducing sugar, non reducing sugar, amino acids and proteins with pod damage by pod borer, whereas negative correlation prevailed between phenols contents in pod with pod damage in urd bean. Singh and Singh (2014) also reported that phenol content in flower and immature pods have negative correlation with per cent flower and pod damages and larval densities. However, amount of total sugar and protein in flowers and immature pods were correlated positively with infestation of legume pod borer. Based on different biochemical characters and pod borer infestation the cultivars GC-6 and GC-1605 were found to be consistently resistant. Relatively GC-1609, GC-1611 and GC-2 cultivars also showed resistance to the pod borer infestation. GC-1606 was found highly susceptible cultivar.

REFERENCES

Anusha C. (2013) Varietal screening, loss estimation and management of cowpea pests. M.Sc. (Agri.) Thesis, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka, India.

Bhadani D.J. (2019) Morphological and biochemical basis of resistance against pod borer complex in pigeonpea, *Cajanus cajan* (L.) Millspaugh. Ph.D. Thesis, Navsari Agricultural University, Navsari, Gujarat, India

Gubbaiah M., Rajanna T.V. and Kulkarni K.A. (1975) *Cydia ptychora* Meyr as a pest of cowpea (*Vigna sinensis*). Current Research 4: 46.

Haider J. and Srinivasan S. (2007) Biochemical basis of resistance against *Maruca vitrata* (Geyer) in urd bean. Annals of Plant Protection Sciences 15(2): 287–290.

Jaydeep H., Srinivasan S. and Muralikrishna T. (2006) Biochemical basis of resistance to spotted pod borer, *Maruca vitrata* (Geyer) in mungbean. Journal of Entomological Research 30(4): 313–316.

Kumar N.G. (1978) Studies on the potentiality of the pod borer, *Cydia ptychora* M. (Lepidoptera: Tortricidae) as a pest of pulses, its bio-economics and control by insecticides. M. Sc. (Agri.) Thesis, University of Agricultural Sciences, Bangalore, Karnataka, India. 167p.

Kushwaha K.S. and Malik B.P.S. (1987) Effect of sowing time and plant type on pod borer incidence and grain yield in some pigeonpea genotypes. International Pigeonpea Newsletter 6(5): 65-66.

Lal S.S., Yadava C.P. and Chandra S. (1986) Suppression of pod flies damage through varietal selection. International Pigeonpea Newsletter 5(3): 42–43.

Pandey S.N., Singh R., Sharma V.K. and Kanwat P.W. (1991) Losses due to insect pests in some *kharif* pulses. Indian journal of Entomology 53: 629–631.

Reddy A.R., Singh O.N. and Misra G.C. (1983) Flushing behaviour and pest incidence in indeterminate and determinate pigeonpea. Madras Agricultural Journal 70(11): 701–704.

Sadasivam S. and Manikkam A. (1996) Biochemical Methods, 2nd Edition, New Age International (P) Limited Publisher, New Delhi.

Sharma H.C., Saxena K.B. and Bhagwat V.R. (1999) The legume pod borer, *Maruca vitrata*: bionomics and management. ICRISAT Information Bulletin 55**:** 37.

Singh C. and Singh N.N. (2014) Occurrence of insect-pests infesting cowpea (*vigna unguiculata* Walpers) and their natural enemy complex in associations with weather variables. Legume Research 37(6): 658–664.

Steel R.G.D. and Torrie J.H. (1980) Principle and procedures of statistics. 2nd Edition, Megraw Hill Book Company, Inc., New York. 20–90.

(Received September 23, 2022; revised ms accepted January 19, 2023; published March 31, 2023)