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Relation of gossypol gland density with bollworm *(Helicoverpa armigera)* incidence in parents and hybrids of American cotton *(Gossypium hirsutum L.)*

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Abstract : An experiment was conducted to study the effect of gossypol gland density in different plant parts in relation to bollworm incidence *(Helicoverpa armigera)* and seed cotton yield in 10 bollworm donor lines and their 45 F1's obtained in 10 x 10 diallel fashion (without reciprocals). A wide range of variability was observed for gossypol gland number, size and volume per unit area on leaf, bract and calyx surfaces both in parents and hybrids. The present study revealed that both in parents and hybrids, the nature of relationship between gland density in different plant parts and bollworm incidence in reproductive parts did not follow similar trend. The study also revealed the scope for utilisation of high gossypol gland density on leaf, bract and calyx in future breeding programmes for development of high yielding cotton cultivars with inbuilt mechanism for bollworm tolerance especially for *H. armigera*. (*Key Words : Gossypol gland. Bollworm and American cotton*)

Gossypol glands play a significant role in host plant resistance to insect pests in cotton Hedin *et al.*, 1992. In view of the recent pest outbreaks in Andhra Pradesh due to excessive reliance on chemical pesticides, development of inbuilt bollworm tolerant lines may help to save plant protection costs besides maintaining eco-friendly environment. Such cultivars can fit well in IPM programmes. Hence, the present study was undertaken to study the pattern of variability and density of gossypol glands on various plant parts of different breeding materials of the Regional Agricultural Research Station Farm at Lam, Guntur.

Materials and Method

Ten bollworm tolerant lines were crossed in 10 x 10 diallel fashion (without reciprocals) during 1992-93 kharif. The 45 F1's along with their 10 parents were sown in randomized block design with two replications during kharif 1993 under cage conditions. Each line was sown in a single row of six meters length spaced at 120 x 60 cm apart and were separated by nylon nets. At peak flowering stage, the plants in each polt were bombarded by artificial release of I, II and III instar larvae of H. armigera and infestation counts on square damage, green boll damage, open boll and locule damage were recorded at regular intervals. At peak flowering stage samples of leaf, bract and calyx were collected from five randomly selected plants in each replication and were fixed in FAA (Formaldehyde Acetic Acid) and alcohol solution mixture. Observations were recorded on gossypol gland density per unit area, size, glandular area and distribution pattern under binocular microscope from middle leaf and calyx using graphical transperency grid. From each unit, five samples were taken and length and breadth of gossypol glands were measured from upper surface of leaf, bract and calyx. Data on yield per plant were also recorded. The genotypic correlation coefficients were computed as per Johnson *et at.*, (1955).

Results and Discussion

The differences were highly significant among the parents and hybrids for gossypol gland density per unit area on leaf, bract and calyx surfaces. This revealed the existence of exploitable genetic variability among the genotypes for gossypol gland density on upper plant parts. The gossypol glands were spherical on leaf and bract, while spherical and oval on calyx surface.

A wide range of variability (Table 1) was observed for gossypol gland density per unit area on leaf from 67.80 (JK 276-4) to 92.35 (AET 5) in parents; 48.05 (AET 5 x JK 276-4) to 112.60 (Frego x Glabrous) in hybrids. For bracts, it ranged from 8.40 (ANL) to 51.10 (HG) in parents; 10.85 (AET 5 x ANL) to 39.65 (HG x Glabrous) in hybrids.. In calyx, it varied from 26.30 (ANL) to 62.50 (HG) in parents; 23.60 (Frego x AET 5) to 60.00 (HG x JK 276-4) in hybrids.

Size of the gland (m) in leaf ranged from 103.35 (ANL) to 120.35 (m) (9-1487) in parents; 117.05 (HT x ANL) to 154.75 (m) (AET 5 x ANL) in hybrids, while in bracts, it ranged from 98.70 (9-1487) to 119.25 (m) (ANL) in parents; 118.35 (Okra x AET 5) to 158.35 (m) (HG x 9-1487) in hybrids, whereas in the case of calyx, it ranged from 119.20 (Okra) to 141.15 (m) (9-1487) in parents; 121.50 (Okra x HG) to 174.40 (m) (Glabrous x 9-1487) in hybrids.

Table 1. Statement showing the range of variability for glanded nature on different plant parts and bollworm incidence *(Helicoverpa armigera)* in cotton

Character	Range				General Mean		C.D. at 1%	
	Minimum		Maximum					
	Parents	Hybrids	Parents	Hybrids	Parents	Hybrids	Parents	Hybrids
No. of gossypol glands/cm² in leaf	67.80 (JK 276-4)	48.05 (AED 5 x JK 276-4)	92.35 (AET 5)	112.60 (Frego x Glabrous)	86.53	84.18	10.63	7.74
No. of gossypol glands/cm² in bract	8.40 (ANL)	10.85 (AET 5 x ANL)	51.10 (HG)	39.65 (HG x Glabrous)	21.70	20.43	1.26	2.17
No. of gossypol glands/cm² in calyx	26.30 (ANL)	23.60 (Frego X AET 5)	62.50 (HG)	60.00 (HG x JK 276-4)	41.77	43.15	8.31	6.74
Size of the gossypol glands (μ) in leaf	103.35 (ANL)	117.05 (HT x ANL)	120.35 (9-1487)	154.75 (AET 5 x ANL)	108.31	134.10	8.36	7.83
Size of the gossypol glands (μ) in bract	98.70 (9-1487)	118.35 (Okra x AET 5)	119.25 (ANL)	158.35 (HG x 9-1487)	110.60	130.37	10.64	7.40
Size of the gossypol glands (μ) in Calyx	119.20 (Okra)	121.50 (Okra x HG)	143.15 (9-1487)	174.40 (Glabrous x 9-1487)	131.15	142.77	7.76	8.19
Glandular area mm²/cm² in leaf	0.61 (JK 276-4)	0.77 (AET 5 x JK 276-4)	0.94 (9-1487)	1.89 (AET 5 x HG)	0.80	1.19	0.19	0.20
Glandular area mm²/cm² in bract	0.08 (9-1487)	0.13 (AET 5 x HT etc)	0.48 (HG)	0.60 (HG x JK 276-4)	0.21	0.28	0.06	0.05
Glandular area mm²/cm² in calyx	0.31 (ANL)	0.39 (Frego x AET 5)	0.92 (HG)	1.00 (JK 276-4 x B 1007)	0.57	0.69	0.10	0.13
Square damage	35.80 (36.70) (9-1487)	25.00 (29.94) (Okra X 9-1487)	60.40 (50.99) (ANL)	66.70 (54.71) (HT x JK 276-4)	41.33	40.69	2.82	3.87
Green boll damage	44.60 (41.85) 13.1007	36.10 (36.89) (Okra x 9-1487)	56.20 (48.52) (ANL)	65.30 (40.32) (Glabrous x ANL)	44.28	43.18	3.25	2.23
Open boll damage	33.60 35.41 (JK 276-4)	23.80 (29.17) (Okra X 9-1487)	68.80 (55.99) (HG)	61.90 (51.85) (HG x Glabrous)	46.61	39.76	4.84	3.85
Open locule damage	20.90 (27.179) (JK 276-4)	14.40 22.30 (Okra x AET 5)	43.10 41.01 (ANL)	34.40 35.87 (HG x Glabrous)	34.47	29.04	3.77	3.26

Figures in parenthesis are angular transformed values

Table 2. Relationship of glandular density with bollworm incidence in parents and hybrids of cotton

Character		X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	SCY
X1 No. of glands (L)	P	-0.13	0.59	-0.18	-0.00	-0.18	-0.14	-0.58	-0.12	0.27	0.23	0.31	0.30	-0.14
	H	-0.03	0.60**	-0.00	0.01	0.01	-0.06	-0.11	-0.12	0.01	0.04	-0.15	-0.11	-0.00
X2 Size of the gland (L)	P		0.72*	-0.17	-0.35	-0.20	-0.20	0.43	-0.04	-0.33	0.21	-0.05	-0.09	-0.02
	H		0.76**	-0.20	0.26	-0.06	0.17	-0.18	0.00	-0.30	-0.03	-0.27	-0.24	0.28
X3 Glandular area/cm² (L)	P			-0.26	-0.28	-0.29	-0.08	-0.04	-0.11	-0.06	0.34	0.19	0.15	-0.13
	H			-0.14	0.22	-0.02	0.07	-0.21	-0.09	-0.25	-0.01	-0.31	-0.25	0.23
X4 No. of glands/cm2 (B)	P				-0.01	0.98**	0.57	0.30	0.68	-0.11	-0.63*	0.45	0.26	-0.36
	H				0.08	0.92**	0.30	-0.07	0.23	0.11	0.07	0.25	0.25	-0.15
X5 Size of the gland (B)	P					0.17	-0.06	-0.12	-0.06	0.09	-0.12	0.16	0.28	-0.04
	H					0.44**	0.09	-0.16	-0.06	0.24	0.20	0.08	0.16	-0.14
X6 Glandular area/cm² (B)	P						0.56	0.32	0.68*	-0.13	-0.64*	0.47	0.31	-0.35
	H						0.32*	-0.13	0.20	0.18	0.14	0.26	0.29	-0.18
X7 No. of glands/cm2 (C)	P							0.06	0.90**	-0.63	-0.42	0.22	0.08	0.00
	H							-0.28	0.71**	0.01	-0.19	0.07	0.08	0.14
X8 Size of the gland (C)	P								0.47	-0.51	-0.29	-0.19	-0.11	-0.08
	H								-0.46**	0.00	0.16	0.02	-0.11	-0.07
X9 Glandular area/cm² (C)	P									-0.72*	-0.50	0.16	0.07	-0.08
	H									0.03	-0.07	0.06	-0.03	0.09
X10 Square damage/pl	P										0.28	0.21	0.21	-0.27
	H										0.06	0.38**	0.31*	-0.34*
X11 Green boll damage/pl	P											0.04*	0.14	-0.28
	H											0.38**	0.40**	-0.65**
X12 Open boll damage /pl	P												0.91**	-0.62*
	H												0.87**	-0.60**
X13 Open locule damage/pl	P													-0.70*
	H													-0.54**

L=Leaf, B = Bracts, C = Calyx; *,** Significant and P=0.05 and 0.01 respectively; SCY = Seed Cotton Yield P = Parents; H = Hybrids Pl = Plant.

Glandular area per unit area in leaf ranged from 0.61 (JK 276-4) to 0.94 mm^2 (9-1487) in parents; 0.77 (AET 5 x JK 276-4) to 1.89 mm^2 (AET 5 x HG) in hybrids, whereas in bracts, it varied from 0.08 (9-1487) to 0.48 mm^2 (HG) in parents; 0.13 (AET 5 x HT etc.) to 0.60 mm^2 (HG x JK 276-4) in hybrids. In calyx, it ranged from 0.31 (ANL) to 0.92 mm^2 (HG) in parents; 0.39 (Frego x AET 5) to 1.00 mm^2 (JK 276-4 x B 1007) in hybrids. Kadapa (1980) also reported the variation for number of gland per unit area of the cotton leaf in *G. hirsutum*. Kadapa (1980), also observed wide range of variability for gossypol glands per unit area on different plant parts.

The minimum and maximum variations observed for square damage caused by *H. armigera* ranged from 35.80 (9-1487) to 60.40 (ANL) in parents; 25.00 (Okra x 9-1487) to 66.70 (HT x JK 276-4) in hybrids. For green boll damage, variations observed ranged from 44.60 (B 1007) to 56.20 (ANL) in parents; 36.10 (Okra x 9-1487) to 65.30 (Glabrous x ANL) in hybrids. The variation recorded in case of open boll damage ranged from 33.60 (JK 276-4) to 68.80 (HG) in parents; 23.80 (Okra x 9-1487) to 61.90 (HG x Glabrous) in hybrids, while the range of variation observed for open locule damage ranged from 20.90 (JK 276-4) to 43.10 (ANL) in parents; 14.40 (Okra x AET 5) to 34.40 (HG x Glabrous) in hybrids.

Correlation analysis (Table 2) in parents revealed that number of glands and glandular area per unit area in bracts are found to be positively associated with glandular area per unit area in calyx, while they showed negative relationship with green boll damage per plant. Number of glands and glandular area per unit area in calyx are found to be negatively associated with square damage per plant. Close relationship was observed between open boll and locule damage both in parents and hybrids. Open locule damage per plant showed significant negative association with seed cotton yield both in parents and hybrids.

In contrast, size of the gland in leaf exhibited strong negative association with square damage per plant, while glandular area per unit area in leaf showed significant negative association with open boll damage per plant. Seed cotton yield was found negatively and significantly associated with bollworm incidence in hybrids. Similar trend was also observed in parents but not at significant level. This could be due to differences in insect pest activity, reproductive efficiency and rejuvenation potential. In parents, high gossypol gland density in bracts and calyx and for hybrids in leaf may be effective to reduce the bollworm damage to some extent. Hedin *et al.*, (1992) also reported relationship between gland density on different plant parts viz., leaf, bract, calyx and ovary and bollworm incidence in cotton.

The present study suggested to go for improvement of gland density in calyx region of the square which is the most preferred feeding site of early instar larvae. Since gossypol glands are genetically controlled, they can be manipulated both in size and density. If selection for these characters is made in breeding material by visual scoring, the lines which show resistance to bollworms can be isolated. Further, in such lines, biochemical basis of resistance can be established.

Hence, it is suggested that by studying segregating progenies in bi-parental fashion or any form of recurrent selection with visual scoring on gland density in clayx region of the square bud and other plant parts may help to achieve desired level of resistance in genotypes.

Reference

Hedin, P.A. Parrott, W.L. and Jenkins, J.N. (1992). Relationship of glands, cotton square terpenoid aldehydes and other Allelochemical to larval growth of *Heliothis virescence* (Lepidoptera : Noctuidae). *J. Econ. Ent.* **85** : 359-364.

Johnson, H.W., Robinson, H.G and Camstock, R.E. (1955). Estimates of genetic and environment variability in soybean. *Agron. J.* 47:324-318.

Kadapa, S.N. (1980). Identifying and assessing the genetic sources of bollworm tolerance / resistance and incorporating desirable attributes in the Agronomic base varieties of cotton *(G. hirsutum). 6th Annual Rep. 1979-80, ASPEE,* Bombay.

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