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Feeding Preference and Damage Potential of *Helicoverpa armigera* (Hübner) on Different Promising Cotton Genotypes/Hybrid

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ABSTRACT

The larval feeding preference and damage potential of *Helicoverpa armigera* (Hübner) on promising cotton genotypes/hybrid were studied during 2004 under laboratory and field conditions at CCS Haryana Agricultural University, Hisar, Haryana, India. Third and fifth instar larvae were allowed to feed on different types of fruiting body (squares, flowers and young bolls) of various genotypes/hybrid in the laboratory to determine the relative feeding preference by the larva. For studying damage potential, the larvae were allowed to feed individually up until pupation on a single or all types of fruiting body of different genotypes/hybrid, both under laboratory and field conditions. The mean number of fruiting bodies damaged by a larva was determined. The results indicated that the *arboreum* genotypes (HD-123 and HD-324) and the *hirsutum* genotype, H-1226, were preferred by neither third nor fifth instar larvae for feeding. The order of preference of the remaining genotypes/hybrid was HS-6> H-1117> HHH-223 (hybrid)> H-1098 with respect to third instar and HHH-223> H-1098> H-1117> HS-6 for fifth instar larvae. Among different fruiting bodies, the third instar larvae exhibited greater preference for flowers while the fifth instar for young bolls, irrespective of genotypes. Under laboratory conditions, a larva damaged more squares, followed by flowers and young bolls. Larvae caused significantly greater damage to fruiting bodies in the *arboreum* than the *hirsutum* genotypes/hybrid during the course of development. The hybrid generally recorded significantly lower square and boll damage. Under field conditions, a larva from hatching till pupation required on average 9.00 squares, 7.88 flowers or 4.20 bolls of H-1098 when restricted to feeding on a single type of fruiting body but 1.25 squares, 2.75 flowers and 2.12 bolls when all types of fruiting bodies were available to.

Keywords: Cotton genotypes, Damage potential, Feeding preference, *Helicoverpa armigera.*

INTRODUCTION

Resistant plant genotypes/hybrids play an important role in managing populations of various species of crop pests. However, it is often difficult to develop a genotype/hybrid which is highly resistant to a number of insect-pests, without sacrificing yield. Nevertheless, it is significant to identify varieties/hybrids which could tolerate pest pressure and/or are the least preferred by the pests. On cotton, apart from spotted bollworms, *Earias* spp., and pink bollworm, *Pectinophora gossypiella* (Saunders), cotton bollworm, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) is a serious pest causing 14-56 per cent damage (Kaushik *et al*., 1969; Manjunath *et al*., 1989; Jayaraj 1990). Under the agroclimatic conditions of Haryana, this pest completes its life cycle in the cotton season in about one month with larval and pupal durations of 15-20 and 9-13 days, respectively, from July to September.

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Thus, it completes 3 or 4 generations on cotton before the onset of winter when a proportion of the population enters winter pupal diapause (Kumar, 2005). A number of promising genotypes/hybrids of cotton have already been recommended for cultivation in Haryana (Anon., 2004) and some are in the final stages of evaluation. Little information on the severity of damage inflicted on these genotypes/hybrids by *H. armigera* and their relative preference by this pest is currently available. The present studies were undertaken to assess the feeding preference and damage potential of this pest to some promising genotypes and a hybrid in the laboratory as well as under field conditions so that a better assessment of losses in relation to the severity of this pest could be made.

MATERIALS AND METHODS

The studies were conducted at the Research Farm as well as in the laboratory of the Department of Entomology, CCS Haryana Agricultural University, Hisar (29°10'N, 75°46'E, 215.2 m m.s.l.), Haryana, India during the 2004 cotton crop season. The following genotypes were evaluated against *H. armigera*: H-1117, HS-6, H-1098 and H-1226 (*hirsutum* genotypes); HD-123 and HD-324 (*arboreum* genotypes); and the intra-*hirsutum* hybrid, HHH-223. These were sown one week before May, except HHH-223, which was sown in the first week of June, in plots of 13×16.5 m each and replicated three times. A row-to-row and plant-to-plant spacing of 0.675×0.300 m was kept for the genotypes and 1.0×0.3 m for the hybrid. Recommended agronomic practices were followed, except for the spraying of insecticides (Anon., 2004).

Insect Culture

The culture of this pest was initiated during August by collecting about 50 grown up larvae from cotton fields. These were brought to the laboratory and reared on cotton fruiting bodies (flowers, squares and young bolls) of variety H-1098 in a B.O.D. incubator to obtain pupae. The respective temperature, relative humidity and photoperiod of the incubator were maintained at 27±1°C, 80% and 14:10 hr (L:D). Freshly emerged males and females were paired and confined in glass jars (20×15 cm) for mating at the rate of 5 pairs per jar with the help of muslin pieces fastened with elastic bands. The moths were fed with a 10 per cent sucrose solution through cotton swabs. The muslin used for covering the open ends of the jars also served as an egg laying substrate. The next morning muslin pieces bearing *H. armigera* eggs were carefully removed and replaced with fresh ones for further egg laying. Eggs so obtained were utilized for further multiplication of culture and experimentation.

Feeding Preference

The feeding preference of *H. armigera* was studied in the laboratory in a free choice test. For this, fresh twigs from different genotypes/hybrid bearing fruiting bodies of different types (i.e. squares, flowers and young bolls of 2-3 cm diameter) were detached from the plants and their cut ends were wrapped in wet cotton. Care was taken that each twig had three fruiting bodies of each type. These twigs from seven genotypes/hybrid were kept together in glass jars (20×15 cm) and third instar larvae were released per jars. The open tops of the jars were covered with muslin fastened with elastic bands. Fresh twigs of different genotypes were offered to the larvae daily for three days. The number of fruiting bodies damaged by the larva after 24, 48 and 72 hours of initial release was counted. There were six replications and the experiment was repeated three times in completely randomized design. A similar test was conducted for the fifth instar larvae. The feeding preference of that larva was determined on the basis of number of fruiting bodies damaged in different genotypes. The higher the num-

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ber of fruiting bodies of a genotype damaged by the larva signified a greater preference for that genotype.

Damage Potential

The potential of the larvae to cause damage to fruiting bodies of different genotypes/hybrid was studied using two methods in the laboratory: a) larvae offered a single type of fruiting body i.e. either squares or flowers or young bolls of a particular genotype/hybrid; and b) larvae offered all types of fruiting body of a particular genotype/hybrid collectively. Since the first and second instar larvae posed a difficulty in locating them in fruiting bodies in the laboratory, and since the damage caused by them was of little importance, the third instar larvae were selected for the studies. In the first method, a larva was daily provided with either three fresh flowers or three bolls or 10 squares of a genotype in perforated plastic specimen tubes (10×4.5 cm). In the second method, three fruiting bodies of each type were offered to the larva till it pupated. The experiment was carried out in completely randomized design. These larvae were kept in a B.O.D. incubator at 27±1°C. There were 10 replications for each type of fruiting body and daily observations on the number of fruiting bodies damaged by a larva were recorded.

Under field conditions, the damage potential was studied from first instar till pupation on cotton variety H-1098 only as this is the most widely grown variety in the state. The experiment was carried out in a randomized block design. The average temperature and relative humidity during the study period ranged from 21.1-36.8°C and 52.3-75.0%, respectively. The fruiting bodies were offered to the larva by two methods. In the first method, 3-4 healthy squares or flowers or young bolls (of 2-3 cm diameter) were retained on the selected branch while others were clipped off. The fruiting bodies on the branch were examined and cleared of the eggs or larvae of bollworms, if present already. A portion of the branch bearing a particular type of fruiting body was confined in muslin cage supported by an aluminium frame (25 cm×10 cm diameter). A newly hatched *H. armigera* larva from laboratory culture was released on the caged branch using a wet, soft camel hairbrush. There were 10 replications for each type of fruiting body. Observations on the number of fruiting bodies damaged by each larva were made on alternate days till pupation of the larva. During this period, the larvae were transferred to freshly caged branches, initially after one week and subsequently after 2-3 days depending upon the food requirement of the larvae. In the second method, a similar procedure was followed as above, except that different types of fruiting bodies were provided to the larva collectively in a cage. In this case, sometimes 2-3 branches were caged to keep the number of fruiting bodies offered to the larvae constant. The mean number of fruiting bodies of different types damaged by the larva during its course of development was worked out. The data thus obtained were analyzed statistically for analysis of variance (ANOVA) using a completely randomized design for the laboratory experiment and a randomized block design for the field experiment (Cochran and Cox, 1957).

RESULTS AND DISCUSSION

Feeding Preference of *H. armigera* Larvae

Among the different genotypes/hybrid, the third instar larva did not prefer to feed on fruiting bodies of H-1226, HD-123 and HD-324 as no fruiting body was found damaged during the three observation times (Table 1). The next least preferred genotype was H-1098 where only the flowers were damaged. In the remaining genotypes/hybrid, the highest number of fruiting bodies was damaged in HS-6 (19), followed by H-1117 (17) and HHH-223 (15). Comparison of feeding preferences among different types of fruiting bodies, irrespective of genotype/ hybrid, in-

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Table 1. Feeding preference of *H. armigera* larvae for fruiting bodies of different genotypes/hybrid offered simultaneously in the laboratory.

Genotype/ hybrid	Number of fruiting bodies[a] damaged by different instars at different intervals after release																							
	Third instar												Fifth instar											
	24h			48h			72h			Total			24h			48h			72h			Total		
	S	F	B	S	F	B	S	F	B	S	F	B	S	F	B	S	F	B	S	F	B	S	F	B
H-1117	--	6	1	1	3	2	1	1	2	2	10	5	--	2	2	--	--	3	--	--	2	--	2	7
HS-6	--	4	1	--	3	3	1	2	5	1	9	9	--	1	2	--	--	2	--	--	2	--	1	6
H-1098	--	2	--	--	1	--	--	--	--	--	3	--	--	--	5	--	--	5	--	--	4	--	--	14
HHH-223	--	4	--	--	4	1	--	2	4	--	10	5	1	1	4	--	--	8	--	--	10	1	1	22
Total										3	32	19										1	4	49
Mean										0.75	8.00	4.75										0.25	1.00	12.25

[a] F: Flower, S: Square, B: Boll.
-- No damage
Note: In H-1226, HD-123 and HD-324 damage by larvae was nil
n=18

dicated a main preference of the third instar larva for flowers, followed by young bolls and squares when observed after 24 hours of release. However, after 48 and 72 hours, the larva exhibited an increasing tendency to attack young bolls. During the observation period, a larva damaged on average 8.00 flowers, 4.75 young bolls and 0.75 square.

Fifth instar larva showed a similar non-preference for feeding with respect to H-1226, HD-123 and HD-324. The highest feeding preference was shown for HHH-223, followed by H-1098, H-1117 and HS-6 wherein a total of 24, 14, 9 and 7 fruiting bodies were found damaged by the larvae, respectively. The higher the number of fruiting bodies consumed by a larva signified greater preference as the single larva in a jar was free to move to the shoot of any genotype. It did not feed on the least preferred genotypes but consumed a few fruiting bodies of moderately preferred genotypes. However, when it encountered the shoot of most preferred genotype it settled on it and consumed the most of the fruiting bodies of that genotype. This is in contrast to the common perception that insects that are on less preferred host will damage a greater number of fruiting bodies but feed little. However, in the present study whenever a larva encountered the shoot of most preferred genotype it fed on the fruiting bodies of that genotype sparing the other ones. This type of non-preference can be said to be the one which is exhibited in the presence of most preferred host. Comparison among different types of fruiting bodies, irrespective of genotype/hybrid, revealed that the larvae preferred young bolls over either flowers or squares at all the observation intervals. During the period of observation, a fifth instar larva damaged an average of 12.25 young bolls, one flower and 0.25 square.

It was concluded that *H. armigera* did not prefer to feed on *arboreum* genotypes in the laboratory when *hirsutum* genotypes were available. Under field conditions, Kumar and Saini (2005) recorded quite a low population of this pest on *arboreum* genotypes in comparison to *hirsutum* ones, supporting our laboratory findings. The lesser preference of *arboreum* genotypes might be due to their inherent genetic characters and biochemical composition (Singh, 1988) which made them less suitable for larval development as there was poor survival of *H. armigera* larvae on *arboreum* cotton genotype, LD-327, as compared to *hirsutum* genotypes (Singh *et al*., 1992). In the present studies, the lesser preference of H-1226 by this pest against other *hirsutum* genotypes/hybrid may be due to differences in various morphological and biochemical attributes of these genotypes. Kulkarni (2001) observed that H-1226 had higher hair density and length, greater boll rind thickness, higher amounts of total phenol, gossypol, tannin and potassium, and lower amounts of total sugar, protein and nitrogen as compared to H-1098, HS-6 and H-1117; in addition, the rind thickness, total phenol, gossypol, tannin and potassium were negatively correlated while total sugar, protein and nitrogen positively correlated with the bollworms infestation in cotton. Kumar and Saini (2005) also recorded a significantly lower bollworm incidence in H-1226 as compared to H-1117 and HS-6 in the field. A higher gossypol content in the fruiting bodies of cotton is known adversely to affect larval growth of bollworms (Shvetsova *et al*., 1989; Kamboj, 1991; Mohan *et al*., 1996). Phogat *et al*. (2000) observed that gossypol content had a negative correlation with bollworm incidence.

Damage Potential of *H. armigera* Larvae under Laboratory Conditions

The average number of squares damaged in the different genotypes/hybrid by the third instar larva up to pupation when a larva was offered only a single type of fruiting body (i.e. squares or flowers or young bolls) of a genotype separately was, in decreasing order, 31.00, 29.71, 18.66, 17.66, 16.66, 15.88 and 14.10 in HD-324, HD-123, HS-6, H-1117, H-1226, H-1098 and HHH-223, respectively (Table 2).

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Square damage was significantly higher in the *arboreum* as compared to the *hirsutum* genotypes, and was significantly higher in HD-324 than HD-123. Among the *hirsutum* genotypes/hybrid, significantly lower square damage was recorded in the hybrid (HHH-223). Comparative flower damage was significantly lower in the hybrid than in the genotypes. It was significantly higher in the *arboreum* than the *hirsutum* genotypes. This may probably be due to differences in the nutritional status of hybrid and genotypes as larva need to consume a greater number of fruiting bodies of a genotype to complete its feeding requirements when there was no choice for any other genotype/hybrid. Between the two *arboreum* genotypes, significantly more flowers were damaged in HD-123 as compared to HD-324. All the *hirsutum* genotypes recorded comparable damage to flowers. With respect to young bolls, the hybrid showed significantly lower damage than all the genotypes. The relative order of boll damage in different genotypes was HD-123> H-1117> H-1226> H-1098= HD-324> HS-6. A significantly higher number of bolls of HD-123 were damaged as compared to HS-6, H-1098 and HD-324.

On the other hand, when all types of fruiting bodies of a genotype were offered to the larva simultaneously, significantly higher square damage was observed in HD-123 than in the other genotypes/hybrid. The hybrid recorded significantly lower square damage than the genotypes. Square damage in different *hirsutum* genotypes was comparable. The highest number of flowers of HD-324 (5.50) were damaged, followed by HHH-223 (3.77), H-1117 (3.37), HD-123 (3.33), H-1226 (3.22), H-1098 (3.12) and HS-6 (2.57). Further, a significantly lesser number of bolls were damaged in the hybrid (1.66) than in H-1117 (3.25), HD-123 (2.44) and HD-324 (2.37). In all the genotypes, a larva generally caused damage to a greater number of squares or flowers than the bolls.

Under Field Conditions

A single *H. armigera* larva from hatching to pupation required on an average 9.00 squares or 7.88 flowers or 4.20 bolls of H-1098 to complete its duration under field conditions when only a single type of fruiting body was offered (Table 3). However, when a larva was allowed to feed on all types of fruiting body of this genotype, it damaged 1.25 squares, 2.75 flowers and 2.12 bolls. Garcia (1980) reported that a single larva of *Heliothis* consumed 6.00-6.26 fruiting bodies of cotton during its larval stage. Damage to fruiting bodies was more in some genotypes over the others; this variation was probably due to the differences in their morphological and biochemical characters as reported by Kulkarni (2001).

It was inferred that both under laboratory and field conditions, a larva damaged more squares, followed by flowers and bolls when restricted to feeding on a particular fruiting body, though in some genotypes a greater number of flowers than the squares were damaged. Similarly, Kumar and Thontadarya (1980) observed that a single *Heliothis armigera* larva per plant damaged 8.75 squares and 3.00 developed bolls. Damage to fruiting bodies was highest in the *arboreum* genotypes over *hirsutum* ones. Greater damage in the former could be ascribed to their smaller size as well as to the poor nutritional status of fruiting bodies, particularly squares. Farrar and Bradley (1985) observed that larvae which were fed on cotton squares and leaves grew slower and smaller than those on flowers or bolls. Likewise, Braga *et al*. (1991) reported a lower survival rate of *Helicoverpa zea* (Boddie) larvae when fed on cotton squares.

The number of fruiting bodies damaged by a larva under field conditions was lower than that under laboratory conditions. The possible reason could be that under field conditions the larva generally consumed the whole contents of a fruiting body before it shifted to a new one as it remained fresh

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Table 2. Assessment of damage by *H. armigera* (from third instar up to pupation) on fruiting bodies of different cotton genotypes/hybrid by different methods in the laboratory.

Genotype/hybrid	Mean number of fruiting bodies damaged(±SE) per larva		
	Squares	Flowers	Young bolls (2-3cm diameter)
a. Larvae offered a single type of fruiting body of a genotype			
H-1117	17.66±0.88 (11-26) [a]	10.88±0.54 (8-14)*	4.71±0.24 (3-7)*
HS-6	18.66±0.93 (15-22)	11.50±0.57 (10-14)	4.12±0.21 (3-5)
H-1098	15.88±0.80 (14-20)	11.50±0.57 (11-13)	4.30±0.22 (3-5)
H-1226	16.66±0.83 (13-20)	11.20±0.56 (9-13)	4.70±0.24 (4-5)
HHH-223	14.10±0.70 (13-16)	9.30±0.46 (9-10)	3.70±0.18 (3-4)
HD-123	29.71±1.49 (27-36)	13.33±0.67 (11-15)	5.22±0.26 (4-6)
HD-324	31.00±1.55 (26-34)	12.34±0.62 (9-14)	4.30±0.22 (3-6)
Mean	20.52±1.02	11.44±0.57	4.44±0.22
b. Larvae offered all types of fruiting body of a genotype			
H-1117	3.12±0.15 (1-8)	3.37±0.17 (1-7)	3.25±0.16 (2-4)
HS-6	3.28±0.16 (0-6)	2.57±0.13 (1-4)	2.14±0.10 (2-3)
H-1098	3.37±0.17 (1-5)	3.12±0.15 (2-4)	1.87±0.09 (1-3)
H-1226	3.00±0.15 (0-6)	3.22±0.16 (2-5)	2.22±0.11 (2-3)
HHH-223	1.66±0.08 (1-3)	3.77±0.19 (3-5)	1.66±0.08 (1-2)
HD-123	4.55±0.23 (3-7)	3.33±0.17 (1-6)	2.44±0.12 (2-3)
HD-324	2.55±0.13 (1-6)	5.50±0.27 (3-9)	2.37±0.12 (2-3)
Mean	3.08±0.15	3.55±0.18	2.28±0.11

[a] Figures in parentheses indicate range.
Sample size: 10 larvae for each category of each genotype/hybrid.
CD ($p \leq 0.05$) for: Genotypes: 0.70; Fruiting bodies: 0.45, Genotype × Fruiting bodies: 1.20.

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Table 3. Assessment of damage by *H. armigera* (from first instar up to pupation) on fruiting bodies of H-1098 under field conditions.

Parameter	Mean number of fruiting bodies (±SE) damaged per larva		
	Squares	Flowers	Young bolls (2-3cm diameter)
Single type of fruiting body offered to the larva	9.00±0.45 (7-10) [a]	7.88±0.40 (7-10)*	4.20±0.21 (3-5)*
All types of fruiting body offered to the larva	1.25±0.06 (0-2)	2.75±0.14 (2-4)	2.12±0.11 (1-3)

[a] Figures in parentheses indicate range.
Sample size: 10 larvae for each category.
CD ($p \leq 0.05$): 1.05.

also. However, under laboratory conditions, either the larva abandoned the fruiting body after damaging it partially or a fresh fruiting body was offered to it before it consumed the whole contents of a fruiting body while changing the food. Thus, some of the fruiting bodies which could still support larval feeding were removed and were accounted for by damaged ones.

CONCLUSION

It was concluded from the studies that field losses due to *H. armigera* attack were likely to be low in the genotypes HD-123, HD-324 and H-1226; moderate in H-1098, H-1117 and HHH-223, and high in HS-6. Third instar larvae prefer to feed more on flowers while fifth instars on bolls.

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ترجیح تغذیه‌ای و توان خسارت زائی پروانه (Hübner) *Helicoverpa armigera* بر روی ژنوتیپهای امید بخش پنبه

س. کومار، و ر. ک. ساینی

چکیده

طی مطالعه‌ای که در سال ۲۰۰۴ در دانشگاه کشاورزی هاریانا هند انجام گردید، ترجیح تغذیه‌ای و توان خسارت‌زایی مرحله لاروی پروانه *H. armigera* در شرایط آزمایشگاهی و مزرعه‌ای بررسی شد. به منظور تعیین ترجیح تغذیه‌ای نسبی لاروها در شرائط آزمایشگاه ، لاروهای سنین سوم و چهارم بر روی اندامهای مختلف بارده (غنچه‌ها، گلها و غوزه‌های جوان) ژنوتیپهای مختلف تغذیه شدند. برای مطالعه توان خسارت زایی، لاروها بر روی اندامهای بارده ژنوتیپهای مختلف به‌صورت مجزا و یا تمامی اندامها تا مرحله شفیرگی پرورش یافته و میانگین تعداد اندام بارده خسارت دیده به وسیله یک لارو در شرایط آزمایشگاهی و مزرعه‌ای محاسبه شد. نتایج نشان داد که لاروهای سنین سه و چهار ترجیحی برای تغذیه از ژنوتیپهای *arboretum* و *hirsutum* ندارند. ترتیب ترجیح سایر ژنوتیپها برای لارو سن سوم به صورت HS-6 > H-1117> HHH-223> H-1098 و در مورد لارو سن چهار HHH-223> H-1098> H-1117> HS-6 بود. در میان اندامهای بارده، بدون توجه به ژنوتیپ لاروهای سن سوم گلها و لاروهای سن چهار غوزه‌ها را بیشتر ترجیح می‌دهند. خسارت وارده به اندام بارده توسط لاروها طی رشد و نمو در رقم *arboretum* بطور معناداری بیشتر از رقم *hirsutum* می‌باشد. عموما" خسارت وارد شده به غنچه‌ها و غوزه‌ها کمتر بود. در شرایط مزرعه لاروها از مرحله تفریخ تا شفیرگی به تعداد ۹ غنچه یا ۷/۸۸ گل و یا ۴/۲ غوزه از رقم H-1098 نیاز دارند، اما در صورت وجود تمامی اندامهای بارده این مقدار ۱/۲۵ غنچه، ۲/۷۵ گل و ۲/۱۲ غوزه می‌باشد.

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