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A SIMPLE LOW COST ARTIFICIAL DIET AND SOME MASS REARING TECHNIQUES OF GRAM POD-BORER, HELIOTHIS ARMIGERA (HUBN.) (LEPIDOPTERA: NOCTUIDAE)

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The study presents a detailed account of apparatii, procedures and artificial diet used in mass rearing of gram pod-borer, *Heliothis armigera* (Hubn.). Data on biology of *H. armigera* reared on artificial diet up to six successive generations reveal that the pupal recovery percentage ranged from 22.16 ± 3.06 to 80.95 ± 13.92; the larval and pupal periods varied from 16.57 ± 1.13 to 70.85 ± 1.63 days and 10.18 ± 0.87 to 53.85 ± 5.44 days respectively. The maximum egg yield/female was recorded to be 326.65 ± 163.51 in the third generation and maximum logevity 17.27 ± 3.38 days.

INTRODUCTION

The ever-increasing demand for a large number of laboratory reared insects has necessitated the development of a more efficient and economical method of production. The shifting emphasis in insect control utilizing biological entities such as male sterilization, pathogen production, hormone and pheromone manipulation, biological and intergrated pest control programmes has also created a demand for constantly reliable sources of such insects.

Adkisson [1] conducted studies on fecundity and logevity of the adult pink bolloworm and reared this insect on natural and synthetic diets. Berger [2] conducted laboratory studies and described techniques for rearing the fall armyworm, *Heliothis virescens* (Fabr.) and *Heliothis zea* (Boddie) and reared these insects upto 5 and 18 consecutive generations respectively on a laboratory prepared medium. Shorey and Hale [3] developed a simple low-cost artificial medium for rearing a variety of noctuid species. Chippendale and Beck [4] conducted extensive studies on the biochemical requirements of plant feeding lepidopterans. Burton [5] recorded a-low cost artificial diet for rearing the corn earworm, *Heliothis zea* (Boddie). Burton and Perkins [6] reared the corn earworm, *Heliothis zea* (Boddie) and fall armyworm, *Spodoptera frugiperda* (Smith.) on a new laboratory diet. Mulder and Showers [7] reared black cutworm upto 1,12 and 24 generations on corn. Nadguada and Pitre [8] studied development, fecundity and lengevity of tobacco budworm fed on soybean cotton and artificial diet.

The present study and its results elaborate upon the development of a diet, tools and techniques perfected and applied successfuly to maintain healthy insect colony of Heliothis armigera (Hubn.) on artificial diet with all the ingredients locally available.

MATERIAL AND METHODS

Contents and preparation of the diet: The ingredients and the quantities used in preparation of two litres batch of the diet are: tap water (2000 ml), agar (50 g), coarse bean powder *(Vigna unguiculata* (L. Walp) (400 g), ascorbic acid (3 g), dried active yeast (baking granule) (20 g), methyl-*p*-hydroxy-benzoate (7g) and formaldehyde (10%, 6 ml).

The dry ingredients of the diet were carefully weighed and taken into separate vessels. The entire quantity of agar was suspended in the total amount of water in a 2-litre capacity conical flask and brought to boil. The boiled agar was poured into a container and allowed to cool down to approximately 85°. Then the total quantity of coarse bean powder of *Vigna unguiculata* (L. Walp) was added and mixed. Thereafter all the dry and liquid ingredients were added to this mixture and the entire mass was thoroughly mixed. Thus prepared diet was then poured into a container and allowed to cool.

Description of the rearing apparatii and procedures. lamp glass mating-oviposition cage (Fig. 1): A medium-sized lamp glass 10.2 cm high having a 7.9 a lower end and a 6.6 cm upper end dia. was fashioned into an oviposition cage. Both ends of the lamp glass were covered with a nylon

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net which was held in position by rubber bands. A small hole was made in centre of nylon net at the upper end which became the top of the cage and the end opposite to it was the bottom. The bottom of the cage was placed on a 9.5 x 1.6 cm pertri-dish containing a 2.5 cm thick absorbent cotton pad which lay between the petri-dish and the nylon net serving as the oviposition site. A 2.0- sq. cm piece of cotton wool soaked in 10% sucrose solution was placed on a piece of polyethylen sheet just below the bottom nylon net for providing adult feed.

Two or three pairs of adults of *H. armigera* (Hubn.) were released into the cage through the nylon net hole. Another oviposition pad like that of the bottom was prepa-

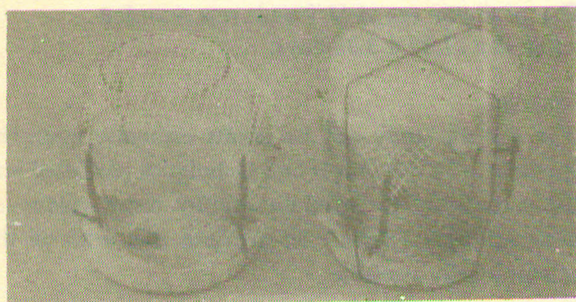

Fig. 1 Lamp glass mating-oviposition cage.

ed and placed on top of the cage covering it with another petri-dish. The top and bottom petri-dishes were fixed tighly to the lamp glass by rubber bands. The absorbent cotton wool oviposition pads were checked on each or alternate day. The eggs deposited on pads were counted by placing the detached eggs bearing layer of pad against light.

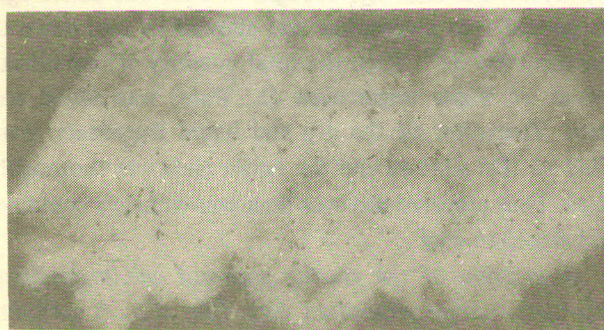

Fig. 2 Eggs of *H. armigera* (Hubn.) laid on cotton wool oviposition pad.

Egg incubation (Fig. 2 and 3). The egg bearing layers of cotton wool oviposition pads were enclosed in a polyethylene bag. The eggs were allowed to undergo incubation at room temperature. After incubation the first-stage larvae started hatching and were transferred to glass vials containing diet.

Larval development technique: (Fig. 4): A standard-size glass capsule vial having 2.5 cm dia. and 5.5 cm height

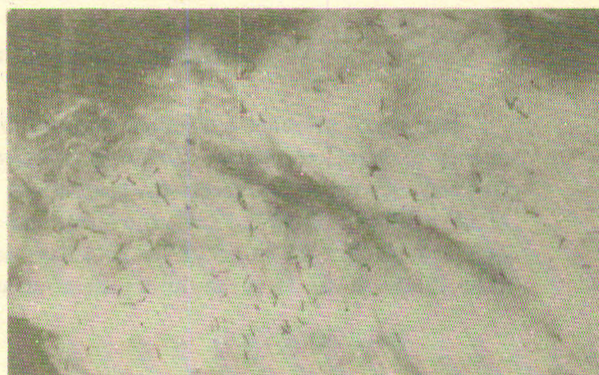

Fig. 3 First stage larvae of *H. armigera* (Hubn.) hatched from eggs laid on oviposition pad.

was used in this technique. Nearly 7 g of the diet were placed in an sterilized vial. The vial was then infested with newly hatched first stage larva with the help of a soft camel hair brush and its mouth was tightly closed by and sterilized cotton wool plug. Cotton wool plug provided a little exchange of air and did not allow the diet to get completely dried out till the developing larva reached pupal stage. Several sets comprising hundreds of vials containing diet (one larva/vial) were used for mass larval development.

Fig. 4 *H. armigera* (Hubn.) larval development in capsule vials (one larva/vial).

Adult emergence technique (Fig 5). A plastic jar having 11.5 cm dia. and 10 cm height was used for adult emergence. The larvae which pupated in the capsule vial were taken out and placed in a circular piece of blotting

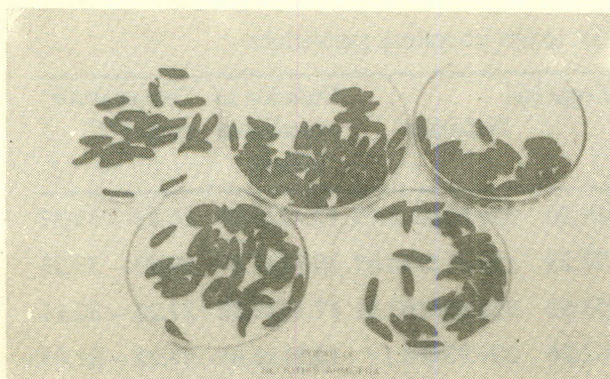

Fig. 5 Pupae of *H. armigera* procured from the rearing facility.

paper in the plastic jar (10 to 13 pupae/jar) The jar mouth was closed by a muslin cloth held in position by rubber bands. The adults after emergence were removed through glass test tubes and released in lamp glass mating-oviposition cage.

RESULTS AND DISCUSSION

The detailed results on continuous mass rearing of *Heliothis armigera* (Hubn.) from 1st to 6th successive laboratory generations are presented in Tables 1–3).

The results indicate that minimum larval mortality percentage 19.05 ± 13.92 was recorded in the 2nd generation and maximum 77.84 ± 3.06 in the 6th. Variation in mortality from the 1st to 6th generation may be attributed to factors like larval entanglement in the cotton plug, larval injury inflicted during the transfer of first-stage larvae into the vials, and fungal contamination. The maximum survival of larvae noted was 80.95 ± 13.92 in the 2nd generation.

The maximum larval period (70.85 ± 1.63 days) was observed in the 6th generation at 19.61 to 25.11°C the lowest temperature range) and as the temperature increased, the larval period decreased, thereby indicating that the length of this period is directly related to temperature. The highest pupal recovery of 80.95 ± 13.92 was obtained in the second generation at 27.22 to 33.88° and the lowest recovery 22.16 ± 3.06 was noted in the 6th generation. The decrease and increase in temperature appeared to have no impact on the pupal recovery.

The pupal mortality in the 3rd and 6th generations was recorded to be the highest (62.88 ± 13.21 and 55.77 ± 8.16

Table 1. Mean ± S.E. of larval development data from 1st to 6th laboratory generations

Generation	No. of larval batches observed	Larvae/batch developed on diet	Larval mortality %	Pupal recovery %	Larval period (days)	Temperature range (°C)
1	5	47.60 ±32.11	33.26 ±14.09	66.74 ±14.09	27.40 ±1.34	18.88 – 30.0
2	4	42.75 ±20.16	19.05 ±13.92	80.95 ±13.92	16.00 ±0.82	27.22 – 33.88
3	8	46.63 ±8.91	40.48 ±17.68	59.52 ±17.68	20.13 ±2.17	27.27 – 33.16
4	7	41.71 ±8.18	33.25 ±18.34	66.75 ±18.34	16.57 ±1.13	26.66 – 31.11
5	7	29.43 ±12.42	41.11 ±26.26	58.89 ±26.26	24.39 ±4.42	25.5 – 29.11
6	2	41.00 ± 5.66	77.84 ±3.06	22.16 ±3.06	70.85 ±1.63	19.61 – 25.11

Table 2. Mean ± S.E of pupal development and adult emergence data from 1st to 6th laboratory generations

Generation	No. of pupal batches observed	Pupae/ batch	Pupal mortality (%)	Adult emergence (%)	Pupal period (days)	Temperature range (oC)
1	8	20.00 ±13.38	34.89 ±19.94	65.11 ±19.44	12.00 ±0.53	25.44 – 32.83
2	8	13.50 ±5.26	31.63 ±10.54	68.37 ±10.54	10.25 ±0.71	27.83 – 33.38
3	11	17.00 ±9.73	62.88 ±13.21	44.40 ±21.96	10.18 ±0.87	28.0 – 32.22
4	14	13.64 ±5.92	29.03 ±21.42	70.97 ±21.42	10.43 ±0.65	27.1 – 31.0
5	10	9.90 ±2.96	38.18 ±22.56	61.82 ±22.56	11.77 ±2.87	22.0 – 26.33
6	2	9.50 ±4.95	55.77 ±8.16	44.23 ±8.16	53.85 ±5.44	14.38 – 18.72

Table 3. Mean ± S.E. of oviposition data from 1st to 6th laboratory generations

Generation	No. of observations	Adults released in cage Male	Female	No. of eggs laid Total	Perfemale	Duration of experiment in days	Temperature range (°C)
1	12	2.08±1.44	2.17±1.53	383.00±319.30	225.62±228.79	12.42±5.09	26.83 – 32.27
2	11	2.36±0.92	2.36±0.92	436.27±278.23	190.31±130.07	10.91±1.87	29.83 – 33.33
3	11	2.91±1.22	3.09±1.14	1016.73±553.52	326.65±163.51	17.17±3.38	27.22 – 32.11
4	13	2.69±1.49	2.69±1.49	535.77±282.26	207.92±83.17	13.31±2.81	27.22 – 31.83
5	11	1.91±0.30	2.09±0.30	544.09±289.74	263.19±146.47	16.09±8.58	20.27 – 25.27
6	2	1.50±0.71	1.50±0.71	220.00±113.14	145.00±7.07	12.00±5.66	18.94 – 23.72

respectively), while in the rest of the generations it remained approximately the same. The high pupal mortality in the 3rd and 6th generations was noted to be due to incomplete chitinization of the 1st three abdominal segments on the ventral surface and its cause could not be determined.

The data indicated that the pupal period ranged from 53.85 ± 8.16 days (maximum) to 10.18 ±0.87 days (minimum). It was also observed that the pupal period decreased as the temperature increased or vice versa. The adult emergence percentage was significantly high (70.97 ± 21.42 in the 3rd generation) comparatively. No abnormal adult emergence was recorded in any generation. Egg production per female was the highest (326.65 ± 163.51 eggs in the 3rd generation) while the lowest (145.00 ± 7.07 in the 6th generation) even when the temperature range difference between the two generations was not that much significant. It was also noted that adults having more longevity or duration of experiment (17.27 ± 3.38 days third generation) laid the highest number of eggs as compare to adults having shorter longevity, while in the case of the 6th generation the night temperature most of the time remained quite low thereby inhibiting oviposition.

Major conclusion

The diet administered proved to be successful for mass-rearing of *Heliothis armigera* (Hubn.) and supported the growth of this insect upto the 6th generation. Moreover the techniques applied in rearing system satisfied the need of a healthy insect culture as per experimental requirements and hence the dioet is recommended for maintaining a healthy insect culture in the laboratory for long periods.

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