

EFFECTS OF NATURAL AND SEMI-SYNTHETIC DIETS ON THE
GROWTH AND DEVELOPMENT OF THE CORN EARWORM
HELICORVERPA ARMIGERA (HUBNER)¹

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The biology of *Helicoverpa armigera* on four natural hosts and two formulated diets were studied.

Growth and development were fastest in corn and on the semi-synthetic diets. Very few individuals were successfully reared on tobacco and tomato. This suggests that the food derived from these host plants was enough to sustain life but not adequate qualitatively and quantitatively for normal growth and development.

H. armigera attacks all the test host plants. Thus, the differential response of the insects to these plants in terms of development and growth in the laboratory may be due to the variation in the nutrient contents of the diets.

Helicoverpa armigera (Hubner) is an oligophagous species and is known by a number of common names — corn earworm, cotton bollworm, tomato fruitworm, tobacco budworm and sorghum headworm. On young corn plants, they bore through the unfolded leaves. Corn ears are heavily attacked and the distal portion of the cobs are irregularly injured. The species is also a serious threat to the vegetable industry, damaging a variety of crops like cabbage, tomato, legumes by feeding on the leaves and fruits. Even cotton and tobacco are not spared from these insects.

The corn earworm is a much studied insect. Its biology has been investigated in various parts of the world. The works of Hardwick (1965) listed a bibliography of more than 500 titles. In 1968, Bailey and Chada studied the effects of sorghum and artificial diet (wheat germ) on the development of the insects and found no significant differences as far as pupal weights were concerned. In another development, gram proved to be a much better host than lucerne (Patel et al 1968). In mass producing corn earworm for research work, the workers found that corn produced the most number of pupae, followed by cotton sesame, and tobacco (Sparks et al 1971). These findings revealed that the insects show differences in growth and development in relation to the type of host plant on which they were reared. Even resistance of insects to insecticides and color variation among larvae of *H. armigera* are attributed to nutrition (Hardwick 1965, Ramos & Morallo-Rejesus 1976).

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In the Philippines, only a few studies have been conducted. Catan (1958) investigated its biology on corn. Uichanco (1959) and Gabriel (1969) published short biological notes on the insect while Deang (1971) studied its morphology and life history on formulated diet (mungbean).

MATERIALS AND METHODS

The stock culture of *H. armigera* came from field-collected larvae feeding on corn, cotton, tomato, and tobacco (Ramos & Morallo-Rejesus 1976) and maintained on the same hosts until pupation. The pupae were allowed to emerge and the adults to mate and oviposit. Larvae that hatched from these eggs were used as test insects.

Four natural hosts, tobacco (*Nicotiana tabacum* L.), corn (*Zea mays* L.), tomato (*Lycopersicon esculentum* Nill.) and cotton (*Gossypium barbadense*) and a semi-synthetic diet using green and yellow mungbean seeds were used. Batches of each host plant were grown from time to time to provide a continuous supply of plants during the experiments.

Larvae of corn-reared insects were placed individually on all the diets following the procedure of Ramos & Morallo-Rejesus (1976). At the same time, larvae from cotton, tomato, and tobacco were reared on their respective host plants. The duration of each life stage, larval weight, adult weight, fecundity and longevity on the various hosts were noted. Larval weights were recorded for each instar by taking the weight just after each molt and noting the duration of each stadium. Pupae were weighed and sexed (Deang 1971). After emergence, adults were weighed and allowed to mate. The total number of eggs laid by the females was also determined.

For each host, 60 insects were reared, maintaining 30 cultures at one time. The experiments were conducted in the laboratory at 24-26°C and a relative humidity of 75 percent.

RESULTS AND DISCUSSION

Table 1 summarizes the data from the life history study on the six diets. Rate of larval development was fastest on corn although not statistically significant compared to most of the diets. Those that fed on foliage and fruits of tomato distinctly require more time to develop than those on any other host plants. Prolonged development could be traced to inadequate nutrition. There is an inverse relationship between nutrition and duration of growth of a given species so that Quaintance and Brues (1905) contends that molts in excess of the normal are caused by insufficient or disagreeable food. Tomato may thus be deficient in some of the essential nutrients needed by the earworms. This deficiency is in turn reflected on the growth of the larvae feeding on them.

Weight comparisons of the newly-molted sixth-instar larvae indicate that tomato- and tobacco-fed larvae are relatively smaller (Table 1). Death usually occurred in the early instars. Such low larval survival may be caused

Table 1. Biology of *Helicoverpa armigera* (Hubner) on several hosts.^a

PARAMETERS	Percentage of insects w/ complete life cycle	Duration of egg stage (days)	Duration of larval period (days)	Weight of 6th instar larva (mg.)	Number of larval instars	Pupal weight (mg)	Pupal period (days)	Adult fecundity (mean) of eggs/female	No. of reproductive days	Adult wt. (mg)	Adult long. (days)
HOSTS											
Original Host											
Corn	88.33 a	2 a	28.32 cd	214.78 abc	6 a	412.29 a	11.84 c	680.50 a	5.83 a	213.31 a	8.20 a
Artificial Diets											
Yellow Mongo	71.67 abc	2 a	32.29 cd	209.84 abcd	6 a	349.24 b	11.69 c	491.12 a	6.03 a	172.08 cb	9.16 a
Green Mongo	80.00 ab	2 a	31.60 cd	215.09 ab	6 a	347.67 b	11.65 c	465.09 a	8.17 a	169.76 bc	10.71 a
Natural Hosts											
Cotton	30.00 cd	2 a	31.79 cd	225.84 a	6 a	309.16 c	11.69 c	138.25 a	3.25 a	141.19	5.84 a
Cotton Control	21.67 cd	2 a	29.42 cd	148.8 bcd	6 a	290.54 cd	15.25 b	523.22 a	6.64 a	181.68 ab	7.79 a
Tomato	26.67 cd	2 a	40.43 a	93.17 ef	8 a	272.35 d	11.83 a	551.50 a	5.23 a	152.86 cb	8.54 a
Tomato Control	48.33 cd	2 a	38.17 ab	112.83 e	7 a	261.59 d	20.79 a	538.30 a	8.0 a	137.92 c	12.12 a
Tobacco	16.67 d	2 a	33.42 bc	96.72 ef	7 a	275.21 cd	13.4 bc	396.0 a	8.0 a	167.54 bc	11.0 a

^aSignificant differences were taken at the 5% level. Values having at least one letter that are the same are not significant.

by certain plant chemicals that may have deleterious effects on the early instars. Nicotine, tomatidine, gossypol and other secondary plant substances have some bearing on this. Consequently, larval growth and development were slow on these host plants that caused the greatest mortality.

The food value of the different hosts is also shown by their effects on the size of the pupae and adults developing from them. Corn produced the heaviest pupae and adults, followed by artificial diets. On the other hand, tomato still produced the smallest pupae but the adults were comparable in size to most of the diets. So far, corn is still the best food and tomato the poorest. Isely (1935) reported an apparent relationship between pupal size and weight and fecundity of moths issuing from them. On the other hand, the experiments of Lukefahr and Martin (1964) found no correlation between pupal size, longevity, and fecundity. However, among adults from the different media, no significant differences were found as far as egg production and reproductive period were concerned.

Adult longevity on the different hosts was not significantly different. The mean longevity of adults on cotton, however, is relatively short indicating premature death as a possible cause for its low fecundity because many of its eggs would then be left unlaidd. Potentially prolific females may thus fail to reach their full reproductive stage (Hardwick 1965). Isely (1935), however, contends that the larval host had the greatest influence on fecundity than any other factor including food during the adult stage.

Comparisons of the growth and development of corn-, cotton-, and tomato-collected larvae reared on cotton and tomato revealed no significant differences in all the above parameters except in the duration of the pupal period and larval weight (Table 1). Adults from corn-collected larvae emerged earlier than the others.

The results of these experiments show that phytophagous insects grow faster, live longer, and reproduce better on some plants than on others. Thus corn is the most suitable food, followed by cotton. The formulated diets can even take the place of corn in mass rearing the insects. Beck (1965) even stated that the insects perform best on mixed diets. However, differences in suitability do not furnish us with enough information on the relative nutritional value because non-nutritional factors, like chemosterilants, physical factors, and micro-environment contribute to the total effect.

REFERENCES

- BAILEY, D.L. and H.D. CHADA. 1968. Effects of natural (sorghum) and artificial (wheat-germ) diets on the development of the corn earworm and southwestern corn borer and fall armyworm. *J. Econ. Entomol.* 61: 257-60.
- BECK, S.D. 1965. Resistance of plants to insects. *Ann. Rev. Entomol.* 10: 207-32.
- CATAN, G.O. 1958. The biology of the corn earworm, *Heliothis armigera* (Hubner) (Agrotidae, Lepidoptera) with a consideration of its natural enemies in the Phil-

ippines. (unpublished B.S. thesis, University of the Philippines, College of Agriculture).

DEANG, R.T. 1971. Life history and morphology of *Helicoverpa armigera* (Hubner) reared on synthetic diet and topical toxicity of five organic insecticides to the insects. (unpublished M.S. thesis, University of the Philippines, College of Agriculture).

insects. (unpublished M.S. thesis, University of the Philippines, College of Agriculture).

DEANG, R.T. 1971. Life history and morphology of *Helicoverpa armigera* (Hubner) reared on synthetic diet and topical toxicity of five organic insecticides to the insects. (unpublished M.S. thesis, University of the Philippines, College of Agriculture).

GABRIEL, B.P. 1969. The insects with many aliases. Philip. BIOTA. 4: 14-16

HARDWICK, D.F. 1965. The corn earworm complex. Mem. ent. Soc. Can. 40. 247 pp.

ISELY, D. 1965. Relation of hosts to abundance of the cotton bollworm. Arkansas Agr. Expt. Sta. Bull. 320.

LUKEFAHR, M.J. and D.F. MARTIN. 1964. The effects of various larval and adult diets on the fecundity and longevity of the bollworm, tobacco budworm, and cotton leafworm. J. econ. Entomol. 57: 233-5.

PATEL, R.C., J.K. PATEL, P.B. PATEL and R. SINGH. 1968. Mass breeding of *Heliothis armigera* (Hbn.) Indian J. Ent. 30: 272-280.

QUAINTANCE, A.L. and C.T. Brues. 1965. The cotton bollworm. USDA. Bur. Ent. Bull. 50.

RAMOS, V.E. and B. MORALLO-REJESUS. 1976. Effects of nutrition on larval coloration of *Helicoverpa armigera* (Hubner). Philipp. Entomol. 3: 201-224.

SPARKS, A.N., B.R. Wiseman, and W.W. McMillan. 1971. Production of corn earworms on several hosts in field cages. J. Econ. Entomol. 64: 540-41.

UICHANCO, L.B. 1959. Philippine Agriculture. Field Crops. Vol. I. 922 p. College, Laguna. University of the Philippines, College of Agriculture.