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DEVELOPMENT OF COTTON PEST *Helicoverpa armigera* HUBNER ON SEVERAL ALTERNATE HOSTS

ELNA KARMAWATI[1] and AGUS KARDINAN[2]

[1] Central Research Institute for Industrial Crops

[2] Research Insitute for Spices Medicinal Crops

ABSTRACT

The research was conducted the laboratory of the Bogor Research Institute for Food Crops during 1994 to identify the effect of host plants on the development of *H. armigera*. The research activities were devided into two steps. The first step was to select the best pod/cob stadia (very young, moderately young, rather old and old) in each host plants (maize, soybean, mungbean and crotalaria). The second step was to compare all of pod/cob stadia selected. Completely randomized design was used in this research. The first step used four treatments for each host plant and 30 replications, meanwhile the second step used seven treatments (all of the host plants) and 30 replications. The research revealed that there was no effect of varieties within soybean and mungbean on the development of insects. Soybean and mungbean gave the shortest life cycle. The highest fecundity and fertility were obtained from larvae with soybean as its feed, followed by mungbean and maize. From all the host plants observed, crotalaria was the worst for the insect development compared to other host plants.

Key words : *Helicoverpa armigera* Hubner, *Zea mays, Glycine max, Vigna sinensis.*

RINGKASAN

Perkembangan hama kapas Helicoverpa armigera Hubner pada beberapa tanaman inang pengganti

Penelitian dilakukan di Laboratorium Hama Balai Penelitian Tanaman Pangan Bogor selama tahun 1994 bertujuan untuk mengidentifikasi pengaruh tanaman inang terhadap perkembangan *H. armigera*. Kegiatan penelitian dibagi menjadi dua tahap. Tahap pertama adalah memilih stadia polong atau tongkol terbaik untuk setiap inang pengganti (jagung, kedelai, kacang hijau dan crotalaria). Tahap kedua adalah membandingkan semua stadia tongkol atau polong yang terpilih pada tahap pertama dengan meneliti perkembangan fase serangga. Rancangan acak lengkap digunakan dalam penelitian ini. Pada tahap pertama digunakan empat perlakuan dan 30 ulangan untuk setiap jenis tanaman inang, sementara pada tahap lanjutan digunakan tujuh perlakuan dan 30 ulangan. Hasil penelitian menunjukkan bahwa tidak ada pengaruh varietas dalam kacang kedelai dan kacang hijau terhadap perkembangan serangga. Kacang kedelai dan kacang hijau memberikan siklus hidup terpendek. Keperidian dan fertilitas tertinggi diperoleh dari larva yang diberi makan kacang kedelai, diikuti dengan kacang hijau lalu jagung. Dari semua inang yang diteliti, crotalaria merupakan inang pengganti terbaik untuk serangga ini dibandingkan dengan serangga lainnya.

Kata kunci : *Helicoverpa armigera* Hubner, *Zea mays, Glycine max, Vigna sinensis.*

INTRODUCTION

Helicoverpa armigera is the major cotton pest which has several alternative host plants. The larvae are the damaging stadium. The colour of the larvae vary from greenish yellow, green, yellowish or a little bit blackish brown. This insect has body hair or fine hair (METCALF and LUCKMANN, 1982; JOHNSON, 1992). The insects lay their eggs at the one-third upper part of the plant and 70 % of the eggs are laid on the shoot tip, bud, and upper leaf surface (KARMAWATI, 1988). The pupae can diapause. The imagoes appear in the afternoon and evening, starting at 16.00 and reach climax at 20.00 - 22.00. During the day time they do not appear. At 02.00 - 04.00 the male insects fly above the plants, while the females stay on the plants releasing pheromone. The eggs are laid individually. The larvae have six instars. The range of larva stadium in the laboratory was 18 to 32 days (KARMAWATI, 1989). The newly hatched larvae eat their egg skin before they eat parts of the plants. The parts of the plants which are attacked can be seen from their waste which is piled on it. This attracts their natural enemies, so that the larvae are easily attacked (JAYARAJ, 1982).

On maize cob, the larvae can spend the whole stadium without damaging the whole maize seeds and lastly they fall down to the ground to form the pupae (JAMARNMARN, 1987, WISEMAN, 1987).

Density dependent factor inhibits the population rate of the insects. This factor is the cannibalistic character of the insects. The population of eggs and young larvae (newly hatched larvae) can be repressed by high rainfall. High humidity makes the larvae to be easily attacked by fungi. Dry season (particularly its affect the soil) can inhibit the pupae growth (KALSHOVEN, 1981).

In Indonesia the outbreak of the insects frequently occurs in the area 0 - 2000 m a.s.l. The outbreak is estimated as the result of intensive insecticide application and change in farming system (REED and PAWAR, 1982; METCALF and LUCKMAN,1982).

The critical period of cotton plants against *H. armigera* is at the age between 50 and 80 days (KARMAWATI *et al.*, 1989). The recommended pest control for this pest is integrated pest control which consists of utilization of resistant varieties, cultivation technique (including trap-crops), natural enemies, and proper insecticide application. The utilization of maize as trap-crops was studied widely (SUBIYAKTO and SAHID, 1990). The objective of the research is to identify the development of *H.armigera* on host plants which will be used as the basis in formulating the strategy for the utilization of host plants as the trap-crops, considering that cotton is recommended to be planted in intercropping patterns.

MATERIALS AND METHOD

The research was conducted in 1994 in the entomology laboratory, Bogor Research Institute for Food Crops. The research was devided into two steps. The first step was preliminary testing for the stadia of cob or pod of the host plants suitable for *H. armigera* growth, and the second steps was the study of the development of the insects on the cob or pod of the suitable stadia. The first step consisted of several experiments on host plants, namely maize variety Arjuna; soybean variety Dieng, Wilis, and No. 29; mungbean variety Merak and Walet; and a local variety of crotalaria. The treatment for each host plant was the stadia of the cob or pod, namely very young, moderately young, rather old and old (Table 1.). The research used a completely randomized design with 30 replications. The observation was conducted on the mortality of larvae into pupae and the failure of pupae to survive into imagoes.

In the second step the development of insects in the best stadia of cob or pod of each host plants was studied further. This research used a completely randomized design with seven treatments and 30 repliations. The treatments were seven host plants with the best stadia of cob or pod for the insect growth.

Helicoverpa armigera larvae were placed in small plastic tubes, one larva per tube. The application of one larva per tube was because the larvae are cannibalistic. The larvae in each plastic tubes were fed with various host plants. The larvae derived from insect bred in the laboratory. Previously larvae were collected from the field then they were raised into imagoes and bred. Their newly hatched larvae (first instar) were immediately placed in the plastic tubes and fed with various host plants, while the imagoes were fed with honey diluted in water. Observations were conducted on the following parameters :

1. The number of larvae which survive into pupae.
2. The number of pupae which survive into imagoes, and the number of male and female.
3. The number of eggs from each couples.
4. The percentage of fertility (fecundity).
5. The period of the stadia.
6. The weight of pupae.

RESULT AND DISCUSSION

The effect of cob or pod stadia of several host plants on *H armigera* mortality

The research activities were conducted to identify the best cob or pod stadia of each host plants. The result of the observation is presented in Table 1.

Table 1 shows that the insect grow best on maize variety Arjuna on very young cob stadium, on soybean (all varieties) on moderately young pod stadium, on mungbean (all varieties) on moderately young pod stadium, and on crotalaria on moderately young pod stadium. The colour of the larvae differ in various host plants, for example, on maize, the larvae are yellowish, and on pulses they are greenish. The size of larvae on maize was relatively bigger and longer compared with those on pulses.

The mortality of larvae occured mainly 3-5 days after they were fed. Generally, the larva died because the feed was not suitable, for example, on rather old and old cob or pod stadia most of the larvae died 3-5 days after they were fed. The young larvae could not bite cobs or pods which

Table 1. The mortality of *H. armigera* in different crop species
Tabel 1. Mortalitas H. armigera pada beberapa tanaman inang

Crop varieties *Varietas tanaman*	Cob/pod stadia *Stadia tongkol/polong*	Age (days) *Umur (hari)*	Mortality *Mortalitas* Larva *Larva* (%)	Pupae *Pupa* (%)
Maize *Jagung arjuna*	Young *Muda*	0-10	73.3	37.5
	Before mature *sedang*	10-20	83.3	40.0
	Early mature *agak tua*	20-30	100	100
	Mature *tua*	>30	100	100
Soybean *Kedelai* No.29	Young *Muda*	0-10	100	100
	Before Mature *sedang*	10-20	83.3	20.0
	Early mature *agak tua*	20-30	96.6	100
	Mature *tua*	>30	100	100
Wilis	Young *Muda*	0-10	100	100
	Before Mature *sedang*	10-20	76.6	28.5
	Early mature *agak tua*	20-30	93.3	50.0
	Mature *tua*	>30	100	100
Dieng	Young *Muda*	0-10	100	100
	Before Mature *sedang*	10-20	86.6	0.0
	Early mature *agak tua*	20-30	96.6	100
	Mature *tua*	>30	100	100
Mungbean/Walet	Young *Muda*	0-6	93.3	0.0
	Before Mature *sedang*	6-12	70.0	22.2
	Early mature *agak tua*	12-18	96.0	0.0
	Mature *tua*	>18	100	100
Merak	Young *Muda*	0-6	96.6	0.0
	Before Mature *sedang*	6-12	63.3	27.2
	Early mature *agak tua*	12-18	100	100
	Mature *tua*	>18	100	100
Crotalaria	Young *Muda*	0-15	100	100
	Before Mature *sedang*	15-30	86.6	25
	Early mature *agak tua*	30-45	96.6	100
	Mature *tua*	>45	100	100

were already hard. In relation to the female imago character in the field, the imago has the instinct to lay its eggs on the young cob hair, so that the first instar larvae which were newly hatched could reach the end cob to survive. This also happened on soybean on very young pod stadium, when the seeds were small and not fully developed the larvas mortality was high.

The larvae could generally survive on moderately young pods on beans and on very young and moderately young cobs of maize. The cause of the mortality of the larvae was the feed and the failure to survive into pupae. The data showed that the highest percentage of larvae to survive into imagoes was 27 %, namely on mungbean variety Merak on moderately young pods.

The effect of host plants on *H. armigera* development

Survival of larvae and pupae

Thirty larvae were placed on each crop based on cob or pod stadium. The larvae which successfully pupated reached the average of 46.15 %, the highest percentage occured on mungbean variety Merak (60%) and the lowest occured on Crotalaria (30%). While the pupae which succesfully survived into imagoes reached the average of 42.3 %, the highest percentage occured on soybean variety Dieng (53.3%) and the lowest occured on Crotalaria (30%). From the existing number of males and females, 4-6 couples were found in each cob or pod stadium of each crop.

The data above showed that the insects could survive on all commodities tested, even though the percentage on crotalaria was lower compared to other commodities tested. The mortality of larvae on each crop happened on the first stadium (because of the feed) and failure to pupate.

The failure of pupae to survive into imagoes was small, it ranged between 0 - 23 % with an average of 8 %. These figures were not really different from the results of the research in the laboratory at optimum condition with maize as feed where it reached 20 % (KARMAWATI, 1989). The data on the survival of larvae into pupae and imagoes are presented in Table 2.

Period of each stadia

The period of each stadia (larva, pupa and imago) on various host plants on certain cob or pod stadia is presented in Table 3.

Table 3 shows that the average period of larva stadium was 19.18 days, the longest period occured on maize (21.1 days) and the shortest period occured on mungbean variety Walet (17.5 days).

The average period of pupae stage was about 13 days, the longest period was on maize (14.2 days) and the shortest period on mungbean variety Walet (12.4 days). Relating to Table 2, the

Table 2. Survival of larvae developed to pupae and imagoes, and sex ratio in different host crops
Tabel 2. Kelenggangan larva menjadi pupa, imago dan perbandingan kelamin pada berbagai tanaman inang

Host plant *Inang*	Variety *Varietas*	Percentage into pupae	Percentage into imagoes	Sex ratio *Perbandingan kelamin*
Maize *Jagung*	Arjuna	36.6	36.6	1 : 1.75
Soybean *Kedelai*	No.29	40.0	40.0	1 : 1.40
	Wilis	46.6	43.3	1 : 2.25
	Dieng	53.3	53.3	1 : 1.66
Mungbean *Kac. hijau*	Merak	60.0	50.0	1 : 0.66
	Walet	56.6	43.3	1 : 0.62
Crotalaria	Lokal	30.0	30.0	1 : 0.80

Table 3. The period of larva, pupae and imago of *H. armigera* in different crops (day)
Tabel 3. Lama stadia, larva, pupa dan imago H. armigera pada berbagai tanaman inang (hari)

Host plant *Inang*	Variety Varietas	Larva	Average *Rata-rata*	Pupa	Average *Rata-rata*	Imago
Maize *Jagung*	Arjuna	21.1 a	21.1	14.2 a	14.2	14.1 b
Soybean *Kedelai*	No. 29	19.1 ab		13.0 ab		4.8 b
	Wilis	19.2 ab	18.6	12.5 b	12.9	17.7 a
	Dieng	17.6 b		13.1 ab		16.8 ab
Mungbean *Kc. hijau*	Merak	19.7ab	18.6	12.5 b	12.5	16.2 ab
	Walet	17.5 b		12.4 b		17.7 a
Crotalaria	Local	20.1ab	20.1	13.1 ab	13.1	15.0 b

Note : Numbers followed by the same letter in each column are not significantly different at 5% level
Keterangan : Nilai yang diikuti dengan huruf yang sama pada satu kolom tidak berbeda nyata pada taraf 5%

failure of pupae to survive into imagoes on mungbean variety Walet was the highest (23.3 %).

The period of imago stadia ranged between 14.1 to 17.7 days, with an average of 16.04 days. However, there was a difference in the age of male and female insects. Generally, the female insects lived longer than the male insects. The age of the male ranged between 9.4 and 14 days, while the female age ranged between 18.2 and 21.5 days.

The survival of larvae into pupae, pupae into imagoes, and the period of larvae, pupae, and imago stadia were strongly influenced by the kinds and the quality of the feed given. In relation to the parameters observed (stated above), the varieties of the same feed, both on soybean and mungbean were not different. Therefore, if soybean or mungbean is used as a trap-crop, the choice of the variety depends on the variety existing in the location.

The content of plant nutrition according to CHAPMAN (1971) influenced the development of insects. Out of four kinds of feed tested, mungbean showed the highest percentage of the survival of larvae into imagoes with an average of 58.3 %, followed by soybean (46.8 %). The larval stadium was the stadium where the insect actively damaged the plants and the stadium which determined the nutrition demand for developing further stadia. The protein content of soybean is higher than that of mungbean, however, the mungbean contains fibre and minerals which do not exist in soybean (Table 4). These two elements are needed for the larva digestion and metamorphosis process.

The effect of mungbean and soybean on the life cycle of insects (the period of larva, pupa and imago stadia) was not significantly different. The periods of larvae and pupae were shorter compared with that on maize and crotalaria, so that the insect development was faster. The imago period was longer because the protein contents of mungbean and soybean were higher so that the fecundity of the imagoes were larger.

Pupa weight

The of pupa was weighed at three days after katcling. The equipment used for weighing is an

Table 4. The nutrition contents of soybean, mungbean, and maize
Tabel 4. Kandungan nutrisi kedelai, kacang hijau dan jagung

Nutrition *Nutrisi*	Soybean [a] *Kedelai*	Mungbean [a] *K. hijau*	Maize [b] *Jagung*
Protein	38	24	8.2
Fat *Lemak*	18	1.3	3.9
Carbohydrate	32	56.7	74
Mineral	-	3.5	-
Fibre *Serat*	-	4.1	-

Source : a) Thirumaran and Seralthan, 1988
b) Copeland and Donald, 1985

electronic scale which can weigh up to 4 decimal points. The results of the measurement is presented in Tabel 5.

The heaviest pupae were obtained from maize, i.e. 395.2 mg, while the lightest pupae were obtained from crotalaria, i.e. 307.9 mg. The pupae weight usually decisive the imago period and the percentage of pupae survive into imagoes, however, this parameter was not really decisive, although the pupae were the heaviest but their imago period was the shortest. In this study the weight and the size of pupae were not measured, considering that some of the larvae bored and got into the pods, particularly on mungbean and crotalaria. So that, if they were forced to come out from the pods it would disturb the larva condition and had negative effect on the larvae.

Fecundity and fertility

Fecundity and fertility of the insects are presented in Table 6. The highest number of eggs was obtained from soybean followed by mungbean and maize, while the lowest was obtained from crotalaria. The percentage of hatching capacity of the insect was almost the same, however, maize and crotalaria gave a lower percentage compared with the other host plants tested. Most of the eggs hatched after three days.

Fecundity and fertility were strongly influenced by the protein content of the feed given. The highest protein content was obtained from soybean, followed by mungbean and corn.

Generally, the life cycle of the insects on crotalaria, was less successfull, the numbers of pupae, imagoes, pupa weight, oviparous capacity, and fertility were consistently the lowest.

Therefore, the feed significantly influenced the process of the insect development. The imagoes of the insects always has instinct to choose their feed. The selected feed was the plants that could give the best food for their development (CHAPMAN, 1971).

Table 5. The weight of 3-day old pupae on various host plants

Host plants *Inang*	Pupae weight *Berat pupa* (mg)
Maize *Jagung*	395.2 a
Soybean *Kedelai*	351.8 b
Mungbean *Kacang hijau*	339.6 c
Crotalaria	307.9 d

Note : Numbers followed by the same letter in the column were not significantly different at 5% level

Keterangan :

Angka yg diikuti dengan huruf yang sama pada satu kolom tidak berbeda nyata pada taraf 5%

Table 6. Fecundity and fertility on several host plants
Tabel 6. Keperidian dan fertilitas pada berbagai tanaman inang

Host plants *Inang*	Number of eggs/female *Jumlah telur/betina*	hatched (%) *Menetas*
Maize *Jagung*	223 c	23 ab
Soybean *Kedelai*	1137 a	30 a
Mungbean *K. hijau*	795 b	27.5 a
Crotalaria	150 d	17 b

Note : Numbers followed by the same letter in one column were not significantly different at 5% level

Keterangan :

Nilai yang sama diikuti oleh huruf yang sama pada suhu kolom menunjukkan tidak berbeda nyata pada taraf 5%

CONCLUSION

The best cob or pod stadia for *H. armigera* growth were corn of very young stadium, soybean (all varieties) of moderately young stadium, mungbean (all varieties) of moderately young stadium and crotalaria of moderately young stadium.

The feed from various host plants significantly influenced the process of *H. armigera* growth, the highest survival of larvae into pupae was obtained from mungbean, while the shortest life cycle was obtained from soybean and mungbean. The highest oviparous capacity and fertility were obtained from soybean followed by mungbean and maize.

Crotalaria was the host plant with the lowest level in suporting the insect growth among the host plants tested.

Mungbean and soybean are potential to be used as trap-crops for *H. armigera* intercropped with cotton, and also maize.

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