Evaluation of three Semi-artificial Diets for Cotton Leafworm Mass Rearing and Their Effects on some Biological Parameters

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ABSTRACT

Three semi-artificial diets were evaluated compared to castor oil leaves in cotton leafworm (CLW), ***S****podoptera littoralis* (Boisd.), rearing for maximizing the production of insect population under laboratory conditions. Effects of the developed diets were studied on some biological aspects of *S. littoralis*. Results indicated that, reared larvae on broad bean produced the highest weights followed by castor oil leaves and kidney bean diet. The larval duration was comparable for the castor oil leaves, broad bean and kidney bean diets. On the other hand, the wheat bean diet recorded the longest larval duration (43.5 days). Pupae reared on the broad bean gained the highest pupal mean weight (391.6 mg / pupa). Pupation percentage was the highest in insects reared on broad bean and castor oil leaves diets (96.5 and 95.0%, respectively). Adult emergence of the insects reared on broad bean and castor oil leaves diets was the highest, where it was 97.2 and 96.5%, respectively. Insects reared on broad bean diet recorded the highest fecundity and fertility, followed by insects reared on castor oil leaves. The obtained data indicated that, the broad bean diet is better than the other two diets of wheat and kidney bean for *S. littoralis* mass rearing.

Key words: Cotton leafworm, Semi-artificial diets, Biological parameters.

INTRODUCTION

Cotton leafworm (CLW), *Spodoptera littoralis* (Boisd.) is a polyphagous insect attacking many vegetable, field, ornamental crops and several other economic host plants. In Egypt, CLW is from the major cotton insects and require many insecticide applications (Sorour *et al.*, 2011; Shaurub *et al.*, 2014). A multifaceted approach is required for the control of this pest because it has developed resistance against a wide range of insecticides and because of limitations in other control strategies when applied as a single tactic (Ramakrishnan *et al.*, 1984).

In common, control of this pest has largely been depending on the use of insecticides (Ahmad *et al.*, 2009). Thus, the intensive use of the insecticides has given rise to CLW population resistant to the used insecticides (Abou-Taleb, 2010). Therefore, selective insecticides with modes of action different from the used insecticides must be evaluated against CLW. So, it is important to be able to economically rear the insect to evaluate the susceptibility of the new insect control insecticides against CLW and studying the resistance mechanisms. The development of artificial diets has been pioneered by Vandersant *et al.*, (1934).

Different artificial diets have been developed and used for the maintenance and continuous rearing of economically important insects (Ahmed *et al*., 1998; Cohan, 2001; Chen, 2003; Mckinley, 2004; Castane and Zapata, 2005; and Robert *et al.*, 2009). Concerning *S. littoralis* larvae many rearing artificial diets have been developed (El-Minshawy and Zeid, 1972; Hegazi *et al.*, 1977; El-Guindy *et al*., 1979; Mckinley *et al.*, 1984; Mabrouk *et al*., 2001; El-Awady *et al*., 2009). Rearing insects on artificial diets is an expensive process. So, considerable effort has been invested to develop a cheaper ingredients and testing potential agar substitutes (Hunter *et al*., 1998; Morimoto *et al.*, 2004; Szewezyk *et al*., 2006; Sujatha and Joseph, 2011). In addition, rearing insects under laboratory conditions are useful for insects' uniform size and age and may be produced in relatively great numbers (Matar *et al.*, 2011). Therefore, the present study was carried out to develop a low-coast simplified semi-artificial diet for maximizing the production of *S. littoralis* population under laboratory conditions. Effects of the developed diets on the biological aspects of *S. littoralis* were also studied.

MATERIALS AND METHOD

Cotton leafworm was reared using different semi-artificial diets compared to the natural food (castor leaves) to produce high quality population. Colonies were reared in the laboratory at a temperature of 26.0 ± 2 °C, 65 ± 5% RH and 12 L: 12 D photoperiod. In the present study, Shorey and Hale (1965) diet was used with a minor modification where the broad bean or kidney bean or wheat bean was used instead of kidney bean. Effects of the artificial diets compared to castor bean leaves as a natural diet on the larval and pupal mean weight, larval and pupal durations, %pupation and %adult emergence, fecundity and fertility were evaluated. The all components and

quantities of the tested semi-artificial diets were presented in Table (1).

Rearing technique:

Egg masses of CLW were obtained from infested cotton plants at Alexandria Agricultural Experimental Station. After hatching the first instar larvae were reared on castor-oil leaves until the first moult, after that the larvae were put in clear-plastic cups 10 cm in diameter and 5 cm height for feeding on the different diets. The lids of these cups were covered with small pieces of muslin to allow respiration. Ten of CLW larvae were put in each container and a small amount of diet was forwarded daily. After pupation, each of the pupae was sexed and transferred to a small tube covered with a muslin lid. The emerged moths were fed on 10% sugar solution. A male and a female of the emerged moths were put in small cages for egg deposition. Leaves of *Nerium oleander* were put inside these cages for depositing egg-masses. Five replicates for each diet was carried out.

Statistical analysis:

The SAS 8.0 software was used for analysis of the data obtained from each treatment and the means were tested for significant differences by Duncan`s multiple range tests at P = 0.05.

RESULTS AND DISCUSSION

The operation of mass rearing is a basic pre-requisite for conducting evaluations of insecticides on the CLW. So, maximizing the production of healthy CLW population is becoming very important. In the present work, three semi-artificial diets are compared with castor oil leaves as a natural diet for CLW rearing. Effects of these diets on biological parameters of CLW are evaluated (Tables 2, 3 and 4). Data showed that, larvae reared on broad bean produced the highest weights followed by castor oil leaves and kidney bean diet, descendingly. The average of larval weight was 46.5, 217.2, 510.4, 801.5 and 940.3 mg / larva after 4, 8, 12, 16 and 20 days of hatching, respectively for the larvae reared on the broad bean diet. On the other hand, the wheat bean diet achieved the lowest larval weight (Table 2).

The larval duration was comparable for the castor oil leaves, broad bean kidney bean and wheat bean diets. The wheat bean diet recorded the longest larval duration value (43.5 days). Such value significantly differed from the other tested diets. The pupal duration was 10.3 and 10.7 days for the insects reared on the castor oil leaves and broad bean diets, respectively. Pupal duration was the longest in the case of insects which reared on the wheat bean diet. Pupa which reared on the broad bean gained the highest pupal mean weight (391.6 mg / pupa), while pupa reared on the wheat bean diet gained the lowest pupal mean weight (215.5 mg / pupa). Pupation percentage was the highest in the case of insects reared on the broad bean diet and castor oil leaves (96.5 and 95.0%, respectively), where %pupation was the lowest in insects reared on the wheat bean (82.5%) (Table 3).

As shown in Table (4), the adult emergence of the insects reared on the broad bean and castor oil leaves diets was the highest, where it was 97.2 and 96.5%, respectively. On the other hand, adult emergence was the lowest in the case of insects reared on the wheat bean diet. Insects reared on the broad bean diet recorded the highest values of fecundity and fertility, followed by insects reared on the castor oil leaves.

Table 1: The components of the three artificial diets.

Contents(gm)	Shorey and Hale diet	Broad bean diet	Kidney bean diet	Wheat bean diet
Agar	128g	12g	12g	12g
Yeast	320g	30g	30g	30g
Broad bean	-	150g	-	-
Kidney bean	233	-	150g	-
Wheat bean	-	-	-	150g
Ascorbic acid	32g	3g	3g	3g
Methyl-p-hydroxy benzoate	20g	3g	3g	3g
Formaldehyde (40%)	20ml	1ml	1ml	1ml
Water	6400 ml	700 ml	700 ml	700 ml

Table 2: Effect of three semi-artificial diets compared with castor bean leaves on the mean larval weight gain of cotton leafworm.

Diets	Larval mean weight (mg / larva) ± SE after different days				
	4	8	12	16	20
Castor bean leaves	40.2 b ± 2.1	184.5 b ± 10.3	413.3 b ± 25.2	634.2 b ± 37.7	753.2 b ± 46.6
Broad bean	46.5 a ± 2.6	217.2 a ± 12.4	510.4 a ± 20.7	801.5 a ± 41.8	940.3 a ± 59.2
Kidney bean	33.2 c ± 1.4	171.1 c ± 10.3	385.8 c ± 14.6	544.2 c ± 32.0	636.4 c ± 40.1
Wheat bean	30.1 c ± 2.5	146.2 d ± 12.0	351.5 d ± 23.1	413.6 d ± 27.1	492.1 d ± 22.8

*Within the same column numbers followed by the same letter (s) are statistically equal.

Table 3: Effect of three semi-artificial diets compared with castor bean leaves on the larval duration, %pupation, pupal mean weight and pupal duration of cotton leafworm.

Diets	Larval duration (days) ± SE	%Pupation ± SE	Pupal mean weight (mg / pupa) ± SE	Pupal duration ± SE
Castor bean leaves	23.5 b ± 1.8	95.0 a ± 3.5	323.4 b ± 17.3	10.3 c ± 2.3
Broad bean	24.8 b ± 2.5	96.5 a ± 1.5	391.6 a ± 22.5	10.7 c ± 1.8
Kidney bean	26.2 b ± 2.0	88.4 b ± 3.2	278.2 c ± 11.7	13.5 b ± 2.2
Wheat bean	43.5 a ± 3.2	82.5 c ± 4.8	215.5 d ± 14.9	17.6 a ± 3.4

*Within the same column numbers followed by the same letter (s) are statistically equal.

Table 4: Effect of three semi-artificial diets compared with castor bean leaves on the %adult emergence, fecundity and fertility of cotton leafworm.

Diets	**%adult emergence**	**Fecundity (No. eggs / female)**	**Fertility (%Hatching)**
Castor bean leaves	96.5 a ± 2.3	540.0 b ± 34.5	98.4 a ± 1.2
Broad bean	97.2 a ± 1.3	890.0 a ± 54.6	97.8 a ± 2.1
Kidney bean	91.6 b ± 5.2	450.0 c ± 24.7	96.3 a ± 1.8
Wheat bean	78.3 c ± 3.9	260.0 d ± 15.4	91.5 b ± 3.9

*Within the same column numbers followed by the same letter (s) are statistically equal.

Average number of eggs laid / female was 890 eggs in case of insects reared on the broad bean diet. Percent of egg hatching was comparable in the case of insects which reared on the broad bean and castor oil leaves diets**.**

From all the aforementioned data, we can conclude that, the broad bean diet is better than the other tested semi-artificial diets for CLW rearing. Our results are comparable with results of Matar *et al.*, (2011) who reported that, the broad bean semi-artificial diet maximized the production of healthy CLW population. Cabello *et al.*, (1984), reared CLW for one generation on eight diets based on four meals (made from: dried alfalfa leaves, corn kernels, broad beans or soya bean) offered with and without a vitamin-amino acid supplement. The length of development, percentage of pupae and adult longevity changed according to the basic meal used in the diet. The weight of pupae and adult fecundity were affected by both: the kind of meal and the presence or absence of the vitamin-amino acid additive. Diets based on soya bean meal reduced percentage of pupae, adult longevity and fecundity.

From the present results we recommended using broad bean diet for mass rearing of *S. littoralis* under laboratory conditions.

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الملخص العربى

تقييم ثلاثة بيئات نصف مصنعه على التربية الكمية لدودة ورق القطن وتأثيراتها على بعض المؤشرات البيولوجية

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تم تقييم ثلاثة بيئات نصف مصنعة مقارنة بأوراق الخروع على تربية دودة ورق القطن وذلك بهدف تعظيم إنتاج أعداد كبيره منها تحت ظروف المعمل. كما تم دراسة تأثيرات هذه البيئات النصف مصنعة على بعض الجوانب البيولوجية لدودة ورق القطن. بينت النتائج أن اليرقات التى تم تربيتها على بيئة الفول البلدى كان وزنها أكبر تلاها اليرقات التى تم تربيتها على ورق الخروع ثم اليرقات التى تم تربيتها على بيئة الفاصوليا. مدة الطور اليرقى كانت متشابهه فى بيئة الفول البلدى وأوراق الخروع وبيئة الفاصوليا. من ناحية أخرى سجلت بيئة حبوب القمح أطول مده للطور اليرقى(٤٣,٥ يوم). العذارى التى تم تربيتها على بيئة الفول البلدى أظهرت أعلى متوسط وزن(٣٩١,٦ جرام/ عذراء). نسبة التعذير كانت الأعلى فى حالة التربية على بيئة الفول البلدى وأوراق الخروع(٩٦,٥، ٩٥,٠% على الترتيب). نسبة خروج الحشرات الكاملة من العذارى كانت الأعلى فى حالة التربية على بيئة الفول البلدى وفى حالة التربية على أوراق الخروع حيث كانت ٩٧,٢، ٩٦,٥% على الترتيب. كما أظهرت الحشرات التى تم تربيتها على بيئة الفول البلدى أعلى خصوبة وأعلى معدل وضع بيض تلاها الحشرات التى تم تربيتها على أوراق الخروع. من هذه النتائج يمكننا تلخيص أن تربية حشرات دودة ورق القطن على بيئة الفول البلدى أفضل من تربيتها على أى من البيئات النصف مصنعة التى تم إختبارها.