EFFECT OF DIFFERENT HOST-PLANTS ON DEVELOPMENT AND FECUNDITY OF THE COTTON LEAFWORM, *SPODOPTERA LITTORALIS* (BOISD.) (LEPIDOPTERA: NOCTUIDAE)

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Abstract

Studies on the effect of different host-plants on the development and fecundity of the cotton leafworm *S. littoralis* were carried out under constant laboratory conditions.

Results indicated that, among the summer host-plants (SHPs), larvae fed castor leaves spent 15.66 day to reach the pupal stage, while larvae fed cotton or corn leaves spent 16.92 and 19.76 days, respectively. Among the winter host-plants (WHPs), larvae fed castor leaves spent 15.36 days to reach the pupal stage compared with 16.26 and 18.09 days for larvae on clover and cabbage leaves, respectively. Male and female pupae obtained from larvae fed castor leaves (SHPs) were significantly heavier than those fed cotton or corn. Among WHPs, male pupae obtained from larvae fed castor leaves were significantly heavier than those of clover and cabbage strains, while the female pupae obtained from larvae fed clover leaves were significantly heavier than those obtained from larvae fed castor or cabbage leaves. Among the SHPs, male and females pupae of cotton strain developed into adult ~1 day sooner than corn strain one. For the WHPs, male and female pupae of castor strain developed
into adults more than one day sooner than clover strain one. Among the SHPs, the percentage of pupal survivorship in the corn strain was significantly lower than those of cotton or castor ones. In WHPs, survival in the cabbage strain was lower than those of castor or clover ones.

Among SHPs, female fecundity was significantly lower on corn compared to castor and cotton. No significant differences in the adult fecundity were found among the WHPs. Significant differences in the percentages of egg hatchability as well as longevities of male and female adults were observed between all tested host-plants. Except for clover strain, females lived 0.5-1.5 day longer than males. Among SHPs, the incubation period of eggs was significantly shorter in case of castor leaves than those fed cotton or corn leaves. Among WHPs, no significant differences in egg incubation period were observed.

Introduction

Although the level of field infestations of the Egyptian cotton leafworm, *S. littoralis*, was decreased in recent years, it is still considered as one of the most destructive insect pests in cotton-growing areas not only in Egypt but also in Africa, Asia and Europe (Horowitz *et al.*, 1994 and Smagghe and Degheele, 1997). However, this insect is a voracious pest not only of cotton but also of other field crops and vegetables in Egypt.

According to Moussa *et al.* (1960), this pest attacks approximately 112 species belonging to 44 different families of plant crops. Knowledge on the factors affecting the size of population of *S. littoralis*, whether biological or ecological, will help in understanding the general trend of population of this pest in the field (Moussa and Nasr, 1960). The effect of larval diet on the biology of this pest has been studied by many authors (Nasr and Ibrahim, 1965; Patel *et al.*, 1968; Nasr *et al.*, 1973; Baker and Miller, 1974; and Badr *et al.*, 1983).

In herbivorous insects, host use is mediated by physiological factors associated with larval development or adult behaviors such as ovipositional preferences or both (Futuyma and Philippi, 1987;
Futuyma and Moreno, 1988; and Jaenike, 1990). Testing for physiological differences in herbivores is relatively easy and is often the first step in studies of differential host use (Pashley et al., 1995). Variation in development is common even when a population is kept under constant condition that the range of variation depends on temperature and food (El-Saadany and Hamed, 1991).

The effects of host-plants on esterases activity and isozymes in the *S. littoralis* head were declared (El-Aw, 1997). EL-Aw and Hashem (2001) also studied the effect of host-plants and day times on the susceptibility of *S. littoralis* larvae to an OP-insecticide and on the kinetics of head esterases. Recently EL-Aw (2003) indicated the presence of qualitative changes in protein patterns of larval and adult heads of *S. littoralis* when fed on different host-plants and reared on different light regimens. When differences in development are detected and related to fitness traits, performance on multiple hosts can be evaluated in an adoptive context (Pashley et al, 1995).

The present study was conducted to investigate the influence of rearing of *S. littoralis* larvae on different host-plants on the development and fecundity.

**Materials and Methods**

**Experimental insects:**

The stock culture of the Egyptian cotton leafworm *S. littoralis* was maintained for several years in the laboratory at room condition of 25 ± 2.0 C, 75.0 ± 5.0% R.H., and LD 16:8 (lightness from 8 a.m., to 12 p.m. and darkness from 12 p.m to 8 a.m., daily). Larvae were fed on castor leaves and adults were fed on 10% sucrose solution. Egg masses deposited by females of the stock culture were collected daily and the hatched larvae were transferred to the host-plant.

**Host-plants:**

The selected summer host-plants (SHPs) were leaves of castor oil (*Ricinus communis* K., Fam. Euphorbiaceae), cotton (*Gossypium barbadence* L., Fam. Malvaceae) and corn (*Zea mays* L., Fam. Gramineae). The mean temperature and RH in the rearing room were 25.0±-2.0 and 75.0+-.5.0%, respectively, either in summer or in winter.
season. The winter host-plants (WHPs) were leaves of castor oil, cabbage (*Brassica oleracea capitata* L., Fam. Cruciferae) and clover (*Trifolium alexandrium* L., Fam. Leguminoseae).
Biological studies:
To study the effect of host-plants on the biology of *S. littoralis*, the insect was reared on the above-mentioned host-plants for two successive generations. One hundred newly hatched larvae of the third generation were set for each replicate and four replications were set for each host–plant. Survival pupae were counted, sexed, and weighed at 24 hr-old, and kept until adult emerged. Larval duration, pupal weight and duration and pupal survivorship were determined.

Freshly emerged moths of each host-plant were paired. Each pair (male and one female) was placed in a glass jar and fed on 10% fresh sucrose solution. A folded sheet paper was placed in the jar to provide suitable sites for oviposition. The data were recorded until oviposition ceased and adult died. The effects of various tested host-plants on fecundity (total number of eggs / female), fertility (hatchability percentages of eggs), and the longevity of unmated adults of both sexes were determined. Initially, 10 matings were planned for each replicate and four replications were set for each host-plant. The mating cups were check daily and egg masses were removed until female death. The total number of eggs / female for each mating, the incubation period of eggs, and hatched eggs percentages were evaluated. The above-mentioned data were statistically analyzed to obtain the analysis of variance (ANOVA) and least significant differences (L.S.Ds) by the method of Steel and Torrie (1984) according to which the data were transformed, when desired, using square root and angular transformation.

Results and Discussion
Influence of host-plant on development of the immature stages:
Table (1) compares larval and pupal durations as well as pupal weights and survivorship of *S. littoralis* larvae reared, for two generations, on castor, cotton and corn leaves in summer season as well as castor, cabbage and clover leaves in winter season. It is observed that the larval duration, pupal duration and pupal weight were generally differed from one host-plant to another one either for the SHPs or the WHPs.
Larval duration was significantly affected by the host–plant upon which larvae fed. Among the SHPs, larvae fed castor leaves spent 15.66 day to reach the pupal stage, while larvae fed cotton or
corn leaves spent 16.92 and 19.76 days, respectively. It means that larvae fed castor leaves developed into pupae 3.0 days sooner than those fed corn leaves. However, indicated that food consumption and growth of last-instar larvae of *Helicoverpa armigera* were lowest on maize diet (Singh, 1999). For larvae reared on castor, cabbage and clover as WHPs, the larval duration was significantly affected by the host-plant. Larvae fed castor leaves spent 15.36 days to reach the pupal stage compared with 16.26 and 18.09 days for larvae on clover and cabbage leaves, respectively. In other words, larvae reared on cabbage leaves spent 2.73 days longer in the larval stage than those reared on castor leaves. However, the present results indicated that the shortest larval duration period was recorded in the castor culture (Moussa *et al*., 1960; and Nasr *et al*., 1973) followed by clover (berseem) and cotton cultures, while the longest one was recorded in corn followed by cabbage. El-Saadany and Hamed (1991) found that the minimum generation duration occurred in the castor oil treatment (27.42 days), while it was (30.88 days) in berseem and (31.14 days) in cotton treatment.

Results proved that *S. littoralis* larvae performed better on castor leaves than those on cotton and corn leaves (SHPs) and cabbage and clover leaves (WHPs). Table (1) shows also that the male and female pupal weights were affected by the host-plant. It is observed that the male pupae obtained form larvae fed castor leaves (SHPs) were significantly heavier than those fed cotton or corn ones by about 22.32 and 21.60%, respectively. Female pupae of castor culture were about 11.14% and 9.48% heavier than those of cotton or corn cultures, respectively. Among the WHPs, the male pupae obtained from larvae fed castor leaves were significantly heavier than those of cabbage and clover strains by about 19.78% and 8.37%, respectively, while the female pupae obtained from larvae fed clover leaves were significantly heavier than those obtained from larvae fed castor by about 16.88% and 4.87%. Also, in most cases, the female pupae were generally heavier than male pupae. This generally means that weighs gain of larvae fed corn or cabbage was reduced. However, results of Nasr *et al*., (1973) indicated that pupae ensuing from *S. littoralis* larvae fed on castor leaves showed the heaviest mean weights.
Pupal duration was significantly affected by the host-plant. Among SHPs, corn strain male and female pupae spent one day longer than cotton strain. For the WHPs, male and female pupae of castor strain developed into adults more than one day sooner than cabbage strain one. The present results clearly showed that the amount of time spent in the pupal stage increased with decreasing the pupal weights in all tested host strains, except in the case of castor strain of both seasons. It is also observed that faster growing larvae produced heavier or larger pupae (Table 1). Hanna et al. (1979) found that pupae and adults of *Spodoptera exigua* which were obtained from larvae fed on castor bean leaves had significant high weights of fat and a high percentage of fat per fresh or dry weights than those fed on cotton, jaw's mallow and okra leaves.

Percentages of pupal survivorship were significantly affected by the host-plant upon which larvae fed on. Among the SHPs, survival in the corn strain was significantly lower than those of cotton or castor strains. Pupal survivorship percentages of the corn strain were about 81% and 83% for male and female pupae, respectively. In WHPs, survival in the cabbage strain was lower than those of castor or clover strains. Such survival percentage values in the cabbage strain were 82 and 85% for male and female pupae, respectively.

**Influence of host-plant on reproduction of the adult stage:**

Table (2) shows traits of adults obtained from larvae fed different host-plants in summer or winter seasons. Among the SHPs, moths obtained from larvae fed cotton leaves had the longest life span (8.25 and 9.10 days for male and female adults, respectively), while moths obtained from larvae fed corn had the lowest one (7.3 and 7.8 days). For WHPs, moths obtained from larvae fed castor leaves had the longest life span (9.17 and 10.08 days for male and female adults, respectively), while moths obtained from larvae fed clover had the lowest one (6.83 and 6.58 days). In general, females lived 0.5-1.5 day longer than males, except in cabbage strain. Such finding is supported by Nasr et al. (1973) who found that female moths of *S. littoralis* lived slightly longer than males. However, it is observed from the present results that females tended to die at an old age, have a greater number of eggs and had the greatest egg-hatching rate. Among SHPs, the longer pupal duration of the corn strain was associated with both
lower longevity (r = - 0.38, P < 0.001); and lower percentage of egg hatch (r = - 0.56, P < 0.001). However, in most tested strains, individuals with the highest fecundity had the greatest percent egg.
It is observed that the female moths of *S. littoralis* produced from larvae fed on castor leaves (SHPs) laid the highest number of eggs. This finding supports the results of Moussa *et al.* (1960) and Harakly and Bishara (1974). However, female moths produced from larvae fed corn leaves laid the lowest number of eggs. No significant differences in adult fecundity were found between all the three tested WHPs. However, it is recently revealed that not only the kind of host-plant affect the insect development (host plant resistance to the insect pest) but also different cultivars of the same host-plant. That Liu and Trumble (2005) found that different tomato cultivars show variable resistance to the tomato psyllid, *Bactericera cockerelli* (Sulc), since the PI 134417 cultivar was the most resistant line with significantly reduced development rates and survivorship. In contrast, it was found that the developmental, survival and fecundity rates of the silverleaf whitefly, *Bemisia argentifolii*, were not significantly different between cultivars within crops of either cotton or cantaloupe, but varied between crops (Nava-Camberos *et al.*, 2001).

Table (2) shows that the incubation period of eggs was significantly shorter in case of castor culture than those obtained from cotton or corn cultures. The eggs obtained from castor culture hatched 1 day sooner than corn culture. Among WHPs, no significant differences in the incubation period of eggs were observed between all of the three-tested host-plants.

It is concluded that *S. littoralis* larvae were more affected by SHPs and performed better on castor leaves than cotton or corn ones. Survival in the castor strain was higher and rate of development was significantly shorter. Among WHPs, larvae performed better on castor leaves than clover or cabbage ones. In other words, *S. littoralis* larvae exhibited more significant differences in development either on corn (SHP) or cabbage (WHP). Pashley *et al.* (1995) concluded that less protein in corn could explain why of the fall armyworm, *Spodoptera frugiperda* developed slower on corn. In fact, allelochemicals from plants often seen to have little or no intrinsic toxicity but affect growth negatively by acting as feeding deterrents (Bernays and Cornelius, 1992). In addition, Houseman *et al.* (1992) concluded that the
allelochemical, DIMBOA (2,4-dihydroxy-7-methoxy-1,4-benoxazin-3-one), which has been isolated from corn, exerts its antibiotic effects before absorption into the midgut by reducing the digestibility of ingested food on the European corn borer, *Ostrinia nubilalis*. However, the present results suggest that the slow development of corn-fed larvae may have been resulted from growing for two generation on the corn seedlings which contain the corn allelochemicals. However, allelochemical contents should be taken into account in integrated pest management for their effects on both herbivores insects (Li et al., 2004). Recently it was found that the cotton bollworm, *Helicoverpa armegira*, can complete their life cycle on cotton corn, tomato, hot pepper, tobacco, and common bean, although tomato and hot pepper were relatively unsuitable (Liu et al., 2004).

The present results showed that the kind of host-plant used for rearing *S. littoralis* to achieve the laboratory experiments must be defined. It is concluded also that castor leaves are the most preferable host-plant for rearing *S. littoralis* under laboratory conditions. On the other hand, results suggest that trap crop techniques using more suitable host plants than cotton should be considered for the management of this pest in cotton agroecosystems.

**References**


تأثيّر التغذية على عوائل نباتية مختلفة على نمو وخصوبة حشرة 

S. littoralis 

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تمت دراسة تأثيّر التغذية على عوائل نباتية مختلفة على نمو وخصوبة حشرة دودة ورق القطن الكبرى S. littoralis. أظهرت النتائج الحالية أنّ وثقت العوائل النباتية الصيفية في ارقات التغذية على أوراق الخروع قد أمضت 15.66 يوماً؛ بينما امتدّت الارقات التي تغذت على أوراق نبات القطن والذرة من أوراق القطن والذرة 11.06, 16.09 يوماً على الترتيب. وفيما يخص العوائل الشتوية، فقد بلغت مدة الطور اليرقي لليرقات التي تغذت على أوراق القطن وذرة 15.96 و18.59 يوماً، بينما بلغت تلك المدة 16.26 يوماً على اوراق الخروع التربة. في انخفاض معنوي نسبة نمو الذكور من مزرعة الخروع مقارنة ببقية العوائل الأخرى المختبرة. وقلّت نسبة النمو في البيض عند تغذية الفسيائية مقارنة بالعوائل الصيفية الأخرى، بينما لم توجد اختلافات معنوية في النسبة المئوية للبيض. وعلاوة على ذلك، لم توجد اختلافات معنوية في نسبة عزل الرؤوس في جميع العوائل النباتية الثلاث المختبرة.