*J. Plant Prot. and Path., Mansoura Univ., Vol. 3 (11): 1165 - 1171, 2012*

# EFFECTS OF PHOTOPERIOD ON THE BIOLOGY OF THE GRANARY WEEVIL, *SITOPHILUS GRANARIUS* L. IN THE LABORATORY

**Darwish, Y. A.[*]; Y. M. Omar [*]; R. E. Hassan[**] and M. A. Mahmoud[**]**
*** Plant Protection Dept., Fac. of Agric., Assiut Univ., Assiut, Egypt**
**** Plant Protection Dept., Fac. of Agric., Al-Azhar Univ., Assiut, Egypt**

## ABSTRACT

The present study investigated the effects of photoperiod on the development of immature stages, oviposition periods and adult longevity of the granary weevil, *Sitophilus granarius* L. at constant temperature of 27±2C° and 70±5°% R.H. in the laboratory. Statistical analysis proved considerable effect of 16 and 24 hr. photophase on the incubation period of eggs. At complete darkness the shortest larval duration (19.6 days) was observed while the longest one (25.3 days) was shown at 24 hr. photophase. Pupal exposed to continuous light showed the lowest mean pupal period (4.7 days) as compared with 5.4 days for the pupal exposed to 16 hr. light. In addition, the period from egg to adult was markedly influenced by the tested photoperiods. The longest developmental period (40.9 days) was observed under continuous light while the shortest one was recorded at complete darkness. The oviposition periods of adult females decreased by increasing the photophase periods. Adult females kept in complete darkness recorded the longest oviposition period (89.4 days). Meanwhile, the shortest period (84.6 days) was reported for females lived under continuous light. Also, adults exposed to complete darkness lived longer than those lived under continuous illumination, however both sexes lived nearly equal periods at any tested photoperiodic regimes.

## INTRODUCTION

Wheat is one of the foremost cereals cultivated in the world nowadays and it is a major source of dietary carbohydrates for most peoples. The granary weevil, *Sitophilus granarius* L. is a serious pest of wheat, and capable of developing on all other cereal grains and cereal products (Anderson, 1934, Tipping *et al*., 1987 and Omar *et al*., 2012). Initial infestation occurs in the store just after harvest and the population builds up rapidly. Both larvae and adults cause damage by destroying kernels. Post-harvest losses as a result of the incidence of these insects is approximately 10-15% worldwide annually (Neethirajan *et al*., 2007) in addition to a reduction in quality and monetary value (Fornal *et al*., 2007). For such reasons a lot of scientist efforts should be done to find ways and means to reduce losses of store pests.

On the other side, it is well established fact that the seasonal activity of many insects is governed by environmental factors; light is the basic factor that determines timing of organism activity in most cases. Besides temperature, the daily cycle of light and darkness is one of the main environmental factor affecting population phenology and density of insects during growing season and timing of life history events (Luker *et al*., 2002). Furthermore, photoperiod can be also considered the main factor regulating diapause (Ali and Ewiess, 1977).

Therefore, the present investigation aims to study the biology of the granary weevil, *S. granarius* reared under different light systems. This is necessary to have thorough understanding of the favourable situation for the pest and to know the vulnerable stages in the life history which would be taken advantage for effective management of the pest, thus losses in the stored products could be minimized.

## MATERIALS AND METHODS

**Test insect:**

The weevil individuals used in the present study were obtained from a laboratory colony maintained at the Stored Product Insects Research Section, Ministry of Agriculture and Reclaimed Lands, Dokki, Giza, Egypt. Rearing the pest was always carried out in a maintaining room at 27±2C° and 70±5% R.H. according to Saleh (1990). From this culture, the newly emerged weevils were removed every day, and reared until the desirable age to use these insects during the following experiments.

**Effect of photoperiod:**

To study the effect of photoperiod on the developmental stages of *S. granarius,* three incubators were adjusted at 27±2C° and 70±5% R.H. The required light systems were L/D 0/24 hr., L/D 16/8 hr. and L/D 24/0 hr. Photoperiod effects on the life cycle of the pest was studied on the following developmental stages.

**Immature stages:**

**Egg stage:**

From the special insectary culture, 10 pairs of adult weevil were daily removed and kept on wheat grains in Petri dishes. Adult females were allowed to lay eggs on wheat grains, then removed after 48 hours. Twenty five of infested grains were daily dissected to determine the incubation period of eggs.

**Larval stage:**

Daily dissection of 25 infested grains (5 grains/replicate) was made after egg hatching to determine the duration of larval stage at each tested light system. The dissection of grains was continued up to the pupal stage.

**Pupal stage:**

Continuous daily dissection of 25 infested grains for each light system was made after pupation of larvae until emergence of adults to determine the duration of pupal stage, consequently the whole developmental period of the pest.

**Adults stage:**

Newly emerged adults were obtained from stock culture reared on wheat grains. Pairs of adult (male and females) were placed in glass tubes 7.5x2.5 cm containing 3 gms of wheat grains (about 60 grains). These tubes were covered with muslin fixed firmly with rubber bands, then kept at tested light systems. One batch of 5 tubes was used representing one replicate. Three replicates were made for each photoperiod. The grains were changed daily and the weevils were daily transmitted during the oviposition period to

new tubes with 3 gms of grains. This procedure was continued until death of adults. The dates of death in each tube were recorded. Then, the longevity of adults and oviposition periods were also calculated.

## RESULTS AND DISCUSSION

**1- Effect of photoperiod on immature stages:**

**1-1- Egg stage :**

Data given in Table (1) show the incubation period of eggs laid by the granary weevil females reared at different light systems. The highest mean incubation period (3.9 days) was recorded at 24 hr. photophase, while the lowest (3.1 days) was observed at 16 hr. photophase. Statistical analysis of the data indicated considerable effect of 16 and 24 hr. photoperiods on the egg incubation period. These results agreed with those reported by Mai El-Degwi (1983) who found that continuous light increased incubation period of eggs laid by *S. granarius* and disagree with Moustafa (1977) who observed a reduction in the incubation period of eggs of *S. cerealella* reared under continuous light. The variation between the results of Moustafa (1977) and our results may be attributed to the fact that insect species differ in their responding to light, some are photonegative and the other are photopositive (Hawk *et al*., 1974 and Baert, 1978).

**Table (1): Duration (days) of immature stages of *S. granarius* reared at different light systems.**

| Light systems L/D (hr.) | Duration (days) Mean ± SE | | | | |
|---|---|---|---|---|---|
| | Egg | Larva | Pupa | Adult remaining period inside the grains | Egg to adult |
| 0 hr. L. / 24 hr. D. | 3.5 ± 0.15 ab | 19.6 ± 0.11 c | 6.2 ± 0.18 a | 4.4 ± 0.17 b | 33.7 ± 0.33 c |
| 16 hr. L. / 8 hr. D. | 3.1 ± 0.17 b | 23.2 ± 0.27 b | 5.4 ± 0.15 b | 5.2 ± 0.27 a | 36.9 ± 0.18 b |
| 24 h.r L. / 0 hr. D. | 3.9 ± 0.22 a | 25.3 ± 0.24 a | 4.7 ± 0.20 c | 5.0 ± 0.47 a | 40.9 ± 0.20 a |

**Means in a column followed by the same letter are not significantly different at 0.05 level of probability.**

**1-2- Larval stage :**

The duration of larva was gradually increased with the increase of photophase hours. The shortest larval duration (19.6 days) was observed at complete darkness, whereas the longest one (25.3 days) was shown at 24 hr. photophase (Table 1). These results show that continuous light increases larval development period indicating that granary weevil larvae are photonegative. The adverse effect of continuous light on the development of larvae may be explained on the base that under continuous light, the metabolic processes become less than normal; consequently metamorphosis processes delayed thus increasing larval period.

**1-3- Pupal stage :**

Pupal exposed to continuous light (24 hr. : 0 hr. D.) showed lowest mean pupal period (4.7 days) as compared with 5.4 days for pupal exposed to 16 hr. L: 8 hr D. and 6.2 days for those reared at 0 hr. L : 24 hr. D. (Table 1). These findings show that continuous light decreases pupal period indicating that the pupae and the larvae of *S. granarius* are in contrast concerning their responding to light.

**1-4- From egg to adult :**

As shown in Table 1, the period from egg to adult is markedly influenced by the tested photoperiods. The longest developmental period (40.9 days) was recorded at 24 hr. photophase and the shortest one (33.7 days) was observed at 0 hr photophase (complete darkness). Statistical analysis of the experimental data revealed a significant effect of photoperiods on the duration from egg to adult stage.

**2- Effect of photoperiod on adult stage :**

**2-1- Adult remaining period inside wheat grains :**

Adults that remained inside wheat grains after their emergence from pupal stage were influenced by the three experimented light systems (Table 1). It is clear that adults of both sexes reared under complete darkness (0 hr. L : 24 hr. D.) remained shorter period (4.4 days) inside the grains than those reared under continuous light (24 hr. L : 0 hr. D.). Statistical analysis of the data showed significant differences between the remaining period of adults reared under complete darkness and those exposed either to 16 hr. photophase or to continuous light.

**2-2- Ovi-position periods :**

**- Pre-oviposition period :**

The longest pre-oviposition period (6 adys) was observed for females kept at continuous light whereas the shortest one (4.50 days) was recorded for females kept under complete darkness (Table 2). Statistical analysis of the data proved significant effect of photoperiod on pre-oviposition periods.

**- Oviposition period:**

A complete darkness resulted a longest oviposition period (89.40 days). Meanwhile, the shortest period (84.6 days) was observed for females lived under continuous illumination. Moderate oviposition period (87.3 days) was recorded for females kept at 16 hr. photophase (Table 2). Significant differences between means of oviposition period at different experimental light systems were observed.

**- Post-oviposition period :**

The post-oviposition period of granary weevil adult females decreased by increasing the photophase period. Adult females reared under continuous illumination had the shortest post-oviposition period (11.7 days) while those exposed to complete darkness had the longest one (17.3 days).

**2-3- Adult longevity:**

As shown from the data given in Figure 1, adults exposed to complete darkness lived longer (109.2 days) than those reared under continuous illumination (102.9 days). The decrease of photophase from 24 hr. to 16 hr. resulted an increase in the average longevity of adults from 102.9 to 105.5 days (Figure 1). Generally, both sexes of the pest lived nearly equal periods at any tested photoperiodic regimes. Statistical analysis of the data proved significant effects of photoperiod on adult longevity. These results are in close agreement with those of Mai El-Degwi (1983), who indicated that continuous light decreased life of *S. granarius* female and attributed this decrease in life to indirect effect of light on nervous system causing hyper-activity to adults.

**Table (2): Oviposition periods (days) of adult female of *S. granarius* reared at different light systems.**

| Light systems L/D (hr.) | Oviposition periods (days) Mean ± SE | | |
|---|---|---|---|
| | Pre- Oviposition | Oviposition | Post- Oviposition |
| 0 hr. L. / 24 hr .D. | 4.5 ± 0.15 c | 89.4 ± 0.60 a | 17.3 ± 0.14 a |
| 16 hr. L. / 8 hr. D. | 5.2 ± 0.18 b | 87.3 ± 0.24 b | 13.2 ± 0.23 b |
| 24 hr. L. / 0 hr. D. | 6.0 ± 0.20 a | 84.6 ± 0.20 c | 11.7 ± 0.28 c |

**Means in a column followed by the same letter are not significantly different at 0.05 level of probability.**

**Fig. (1) : Adult longevity (days) of *S. granarius* at different light systems.**

From the data on the effect of light on oviposition period and adult longevity of the granary weevil, *S. granarius*, it is obvious that the oviposition periods consequently adult longevity of the pest were markedly reduced by continuous light. These findings are in agreement with those El-Shaarawy *et al*. (1978) and Salem (1981) who found that shortest oviposition periods and life span of silkworm moths occurred at continuous light. It seems that *S. granarius* needs darkness even for a short period to stimulate various activities throught its life cycle such as feeding, mating, maturation of eggs and sperms … etc. On the other hand, continuous illumination disturbs the

pest resulting in shorter adult duration consequently fewer eggs or production of unmature sperms due to the adverse effects of light on maturation of gonads, the readiness with which eggs are laid, and the age at which adults mated. Hawk *et al*. (1974) stated that photonegative insects are adversely affected with light.

In conclusion, the available literatures as well as the present findings clearly indicate that photoperiod plays prominent role in determining developmental periods of immature stages, length of oviposition periods, adult longevity and reproductive potential of diverse insect forms.

## REFERENCES

Ali, M. and Ewiess, M. A. (1977): Photoperiodic and temperature effects on rate of development and diapause in the green stink bug, *Nezara viridula* L. (Heteroptera: Pentatomidae). Z. Ang. Entomol., 84: 256-264.

Anderson, K. T. (1934): Biologie der kornkafers *Calandra granaria* L. Nachr. Schadlings bekampfung, 9: 105-131.

Baert, L. (1978): Influence of photoperiodicity on ovarian maturation in *Gongylidium pufipes* (Saund) (Aran., Linphiidae). Rev. Arachnol., 2(1): 23-27.

El-Shaarawy, M. F.; A. A. Gomaa and A. H. Megalla (1978): Reaction of photoperiodism on the silkworm, *Bombyx mori* L. to biology. Z. Ang. Zool., 65, 415: 423.

Fornal, J.; T. Jelinski; J. Sadowska; S. Grunda; J. Nawrot; A. Niewiada; J. R. Waechalenski and W. Blaszczak (2007): Detection of granary weevil, *Sitophilus granarius* L. eggs and internal stage analysis. J. Stored Prod. Res., 43: 142-148.

Hawk, J. A.; J. J. Colaianne and A. E. Bell (1974): Genetic, photic and temperature effects on the fecundity of *Tribolium castaneum* (Herbst). Ecol., 55: 910-912.

Luker, L. A.; J. D. Hatle and S. A. Juliano (2002): Reproductive responses to photoperiod by a South Florida population of the grasshopper *Romalea microptera* (Orthoptera: Romaleidae). Environ. Entomol. 31: 702-707.

Mai El-Degwi, M. S. (1983): Ecological and biological studies on the granary weevil, *Sitophilus granarius* L. (Coleoptera: Curculionidae) M.Sc. Thesis, Fac. of Agric., Cairo Univ.

Moustafa, T. S. (1977): Biological and ecological studies on the Angoumois grain moth, *Sitotroga cerealella* (Oliv.) (Lepidoptera: Gelechiidae). Ph. D. Thesis, Fac. of Agric., Cairo Univ.

Neethirajan, S.; C. Karunakaran; D. S. Jayas and N. D. G. White (2007): Detection techniques for stored-product insects in grain. Food Cont., 18: 157-162.

Omar, Y. M.; Y. A. Darwish; R. E. Hassan and M. A. Mahmoud (2012): Insecticidal activity of certain plant essential oil, plant extracts and inorganic salts against the granary weevil, *Sitophilus granarius* (Linnaeus) infesting wheat crop in Egypt. J. Plant Protec. and Pathol., Mansoura Univ., 3(9): 897-903.

Saleh, R. Y. A. (1990): Comparative study on the biology and morphology of two different grain weevil strains: *Sitophilus granarius granarius L.* and *Sitophilus granarius africanus* Zach. (Curculionidae, Coleoptera). Ph. D. Thesis, Fac. of Agric., Cairo Univ., Giza, Egypt, 193 pp.

Salem, A. A. (1981): Effect of light spectrum on the mulberry silkworm moths, *Bombyx mori* (L.). Res. Bull. Ain Shams Univ. Fac. of Agric., Egypt, 1581: 1-17.

Tipping P. W.; M. Rudringuez; C. G. Ponelei and D. E. Legg (1987): Effects of whole corn kernels and extracts on the behaviour of maize weevil (Coleoptera: Curculionidae). Entomol. Soc. Am. 85: 1010-1013.

## تـأثيرات فتـرة الإضـاءة علـى بيولوجيـة سوسـة الحبـوب *Sitophilus granarius* (L.) فى المعمل

**يوسـف عـوض درويـش* ، يوسـف محمـد عمـر* ، رسـمى السـيد حسـن** و محمود عبدالحميد محمود****

*** قسم وقاية النبات – كلية الزراعة – جامعة أسيوط – مصر**

**** قسم وقاية النبات – كلية الزراعة – جامعة الأزهر – فرع أسيوط – مصر**

اجريت الدراسة الحالية لدراسة تأثيرات فترة الإضاءة على نمو الأطوار غير الكاملة وفترات وضع البيض وعمر الحشرة الكاملة لسوسة الحبوب *Sitophilus granarius* L فى المعمل على درجة حرارة 27±2°م ورطوبة نسبية 70±5% .

أكد التحليل الاحصائى وجود تأثير كبير لفترتى الإضاءة 16، 24 ساعة على فترة حضانة البيض. وبالنسبة للأطوار غير الكاملة فإن أقصر فترة لنمو الطور اليرقى (19.6 يوماً) تحت ظروف الإظلام التام وأطول فترة (25.3 يوماً) تحت ظروف الإضاءة المستمرة. وكان أقل متوسط لفترة طور العذراء 4.7 يوماً للعذارى التى عرضت للضوء المستمر مقابل 5.4 يوماً لتلك التى عرضت لفترة إضاءة مدتها 16 ساعة . إضافة إلى ذلك فإن الفترة من طور البيضة حتى طور الحشرة الكاملة قد تأثرت بوضوح بفترات الإضاءة المختبرة حيث بلغت أطول فترة للنمو من طور البيضة حتى طور الحشرة الكاملة 40.9 يوماً تحت ظروف الإضاءة المستمرة بينما سجلت أقصر فترة (33.7 يوماً) تحت ظروف الإظلام التام. كما لوحظ قِصر فترات وضع البيض للإناث الكاملة مع زيادة فترات الإضاءة، فالإناث الكاملة التى عاشت تحت ظروف الإظلام التام سجلت أطول فترة لوضع البيض (89.4 يوماً) أما أقصر فترة (84.6 يوماً) فقد تقررت للإناث التى عاشت تحت ظروف الإضاءة المستمرة.

فيما يتعلق بعمر الحشرة الكاملة، وجد أن الإناث التى عرضت للإظلام التام عاشت فترة أطول من تلك التى عاشت تحت ظروف الإضاءة المستمرة ومع ذلك فإن كلا الجنسين (الذكر والأنثى) عاشا فترات متساوية تقريباً تحت أى من نظم الإضاءة المختبرة .

**قام بتحكيم البحث**

| | |
|---|---|
| **أ.د / سمير صالح عوض الله** | **كلية الزراعة – جامعة المنصورة** |
| **أ.د / جابر حسن ابو الحجاج** | **كلية الزراعة – جامعة اسيوط** |