

**EFFECT OF DIFFERENT TEMPERATURES ON THE BIOLOGICAL CHARACTERISTICS
OF THE CEREAL LEAF MINER, *Syringopais temperatella* LED.
(SCYTHRIDIDAE: LEPIDOPTERA)**

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ABSTRACT

Wheat and barley are two of the most economic and strategic field crops in the rain-fed areas of Jordan. These crops are attacked by different insects, in which the cereal leaf miner, *Syringopais temperatella* Led. (Scythrididae: Lepidoptera) is the most severe. This study was carried out at the Faculty of Agriculture in the Entomology Research Laboratory with some field observations at Mut'ah University / Al-Karak during 2001/2002 and 2002/2003 growing seasons with average results over two seasons. The effect of three different temperatures (20°, 25° and 30°C) at 70 ± 5% relative humidity and a light period of (8L:16D), on the development and survival of the cereal leaf miner was studied. It was found that 20 °C was the most suitable temperature for development and activities of the insect life stages. At this temperature the results showed that the numbers of emerged eggs of a fertilized female were 26-66 eggs, average eggs incubation period was 12-14 days, the percentage of hatching eggs was 43%, the larval period was 69 days, the percentage of larval mortality was 8%, the pupal period was 15 days, and the adult emergence percentage was 92%. However, at 25 °C the average number of eggs of a fertilized female was 23-56. Average egg incubation period was 10-12 days, the percentage of hatching eggs was 25%, the larval stage period was 59 days, the percentage of larval mortality was 14%, the pupal period was 13 days, and the adult emergence percentage was 86 %. At 30 °C, the results showed that the larval stage period, percentage of larval mortality, pupal period, adult emergence percentage, and average number of eggs of a fertilized female were 51 days, 18%, 11 days, 82%, and 0 eggs, respectively. It was found that the insect has one generation per year, which indicates that 30°C is unsuitable temperature for adult sexual activities, and it died within 3-5 days without mating or laying eggs.

Key words: *biology, cereal leaf miner, life cycle, Syringopais temperatella , temperature.*

1. INTRODUCTION

In Jordan, the cereal leaf miner *Syringopais temperatella* Led. (Scythrididae: Lepidoptera) was introduced as an old pest in wheat and barley; reported more than 50 seasons ago (Anonymous, 1960). It caused a great damage to field economic crops and it reduced their values. This insect pest used to be the most important pest of wheat and barley in the Eastern Mediterranean Basin (Jemsi and Radjabi, 2003). In Jordan the pest is causing great grain losses which needs effective management through integrated pest management techniques, which rely upon accurate monitoring of the pest population. To make environmental factors like climate less favorable to insect, a key factor is the temperature which regulates insect population dynamics,

developmental rates and seasonal occurrences (Campbell *et al.*, 1974, Logan *et al.*, 1976; Schowalter, 2000).

The insect larvae after 8 months of aestivation and hibernation (Abu Yaman and Jarjes, 1971) began to mine the leaves of young barley and wheat during January and February for about 2 months. The larvae had six instars developed in tunnels between leaf sheets of barley and wheat fed by tissue. Later, they entered the soil to pupate inside cocoons. The pupal stage lasted for 12-16 days; adults began to appear from mid March till end of April. Laboratory observations showed that the males lived for 5-10 days and the females for 7-14 days. Eggs were laid on the cereal plants or in cracks in the soil at the rate of 23-66 eggs/female. Next generation larval instar

emerged during May, then descended after 6-8 days of feeding period into the soil, and formed cysts, in which they aestivated during summer, autumn and hibernate part of the winter as first instar larvae (Kaya, 1976). The insect has only an annual generation in Jordan. Also, Abu-yaman. (1971) mentioned one generation per year in Iraq.

No information is available about the effect of temperature on cereal leaf miner population growth. These experiments were conducted to determine the effects of different temperatures on development of cereal leaf miner, and to predict outbreaks of its populations in the field, as well as to find the relationship between insect outbreaks and attacked host cereal sowing time. In addition, to select the suitable time of insect control, in order to prevent and reduce its damage, which increased dramatically in the last seven the seasons in southern part of the country as a result of drought and lack of proper crop rotation. Moreover, to provide information on the biological parameters of the insect, which is endemic in Jordan (ICARDA, 2005).

2. MATERIALS AND METHODS

This study was conducted to investigate the effect of different temperatures (20°, 25° and 30 °C) with the relative humidity of 70 ± 5 and a photoperiod of L8:D16 hours on the cereal leaf miner development from first instar larvae until the next generation larvae during 2001/2002 and 2002/2003 growing seasons. The results were taken over two growing seasons.

First instar larvae (1-1.5mm length) in barley leaves were originally collected from Al-Rabba and Al-Qasir cereal fields in Al-Karak District. The first-instar larvae in barley leaves were randomly collected and placed individually in Petri dishes of 9 cm in diameter. Twenty Petri dishes at each temperature, covered with muslin cloth to prevent larvae escaping were used. Barley leaves secured with cotton and immersed into water to keep it fresh with some sandy soil at depth for pupation. In addition, green leaves were provided for larval feeding. Petri dishes were incubated at 20°, 25° and 30 °C inside electrical incubators. Twenty Petri dishes at each temperature treatment were used, at the same relative humidity and photoperiod. Experiments were repeated twice during 2001-2002 and 2002-2003 growing seasons. The insect developmental durations were recorded daily for the first larval instars, pupae, adult and eggs until the next generation larval dormancy time. In average, 8- 10 couples of adults were randomly selected and

copulated separately at each temperature emerged from. The adults were sexed, placed in small glass vials (5 x 10 cm) covered with muslin cloths to prevent adult flights or larvae escaping, and provided with sugar syrup for adults, and barley leaves for larval feeding. An amount of 1cm sandy soil was added to glass vial to provide a suitable substrate for next generation larval aestivation. The results were averaged over two seasons. Adults life span, egg numbers per fertilized female, eggs incubation period, eggs hatching percentage, next generation larval period and aestivation date were recorded.

In the field observation, adults were released into wooden cages measured 100 x 75 x 50 cm. The cages had wire-mesh on their 5 sides with an open wooden base (100 x 50) covered the barley plant in the field. Twenty meshed cages were randomly placed in different parts of the infested area during the two growing seasons, to obtain an idea about larval period and adult activities under field conditions.

The effects of different temperatures on the biological characteristics of cereal leaf miner were investigated. The data of average mean temperatures and relative humidity had been obtained from the main Metrological Department in Amman (Jordan Climatology Report, 2002-2004). The obtained data were analyzed by using MSTAT program and means separation were conducted by Duncan's Multiple Range Test (DMRT) (Steel and Torrie, 1980).

3. RESULTS AND DISCUSSION

The results showed that the existence of 1-1.5 mm length first instar larvae of cereal leaf miner started from the second half of January in the study area with an average temperature of 16-22 °C. The larvae began mining between barley leaf sheets and entered from different places. Each larva started one tunnel and several larvae (8-12) attacked the same leaf by the end of February (Jemsi and Radjabi, 2003). Tunneling of plant tissue resulted in a reduction of the photosynthetic capacity (Van Rijn, 2002). Table (1) shows the feeding tunnel length for different larval sizes during a limited feeding period. The differences in feeding tunnel length indicated that the larval activity was affected by the daily temperature changes under field conditions.

In the laboratory, head capsule measurement and exuviae were observed to verify that a moult had occurred, as the larvae developed till the sixth larval instar, and became full-fed and 7-8 mm length before pupation. The larval stage lasted 51,

59 and 69 days at 30°, 25° and 20 °C, respectively. Two seasons replicated experiment observations showed that the longest period of the larval stage development and the lowest mortality

Table (1): The food tunneling distance for some selected different larva sizes during limited feeding period under field conditions.

Larva length (mm)	Feeding period (hours)	Feeding distance length (mm)
1.5	168	4.0
2.5	168	5.0
3.0	24	1.9
4.0	24	2.4
4.0	3.0	7.0
4.0	2.0	1.5
4.5	4.0	6.6
5.0	168	7.5

were recorded for the insect reared at 20 °C, while the lowest larval development period and the highest mortality for insect were reported at 30 °C (Tables, 2 and 6). This means that the average temperature of winter months during January and February (16-22 °C), is the most suitable temperature for larval developmental period and damages. The field studies showed that pupal duration was 12-16 days in the soil, but in the laboratory larvae pupated on the plants, in the soil or attached their silken cocoons to the sides of the glass containers, where they were reared. Pupae completed their development to adults during 11, 13 and 15 days when the insect were reared at 30°, 25° and 20°C, respectively (Table, 2), with 6 days

Table (2): Effect of different temperatures on development of immature stages and adult longevity of cereal leaf miner during 2001/2002 and 2002/2003 growing seasons.

Temp. (°C)	Larval period (days)		Pupation period (days)		Male period (days)		Female period (days)		Eggs period (days)	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
20	68.32 a	69.60 a	15.18 a	15.07 a	8.30 a	8.70 a	12.00 a	11.80 a	12.75 a	13.25 a
25	59.28 b	58.85 b	13.13 b	12.88 b	7.13 b	5.88 b	9.63 b	9.39 b	11.25 b	10.75 b
30	50.80 c	50.75 c	10.90 c	11.13 c	3.13 c	3.30 c	3.88 c	3.63 c	0.00 c	0.00 c

Values within the same column having different letters are significantly different at p= 5% (DMRT)

interval from the last pupation date in mid April at 20 °C. Cereal leaf miner adults occurrence in the fields start from mid March until early May when the average daily temperature was typically and ranged from 17-23°C during late March and early April. Some of these temperatures were included to the finding by Silveira *et al.*, (1976), who reported that temperature within the range of 22-28 °C were optimal for insect development in

tropical conditions. It would be recommended that the treatment of infestation of winged adults with insecticides must be done during this period in the field. High temperature of 30 °C was harmful to the development of adults, where they died quicker as well as no eggs were laid. Tables (2 and 4) show that, adult life spans either for male or female were significantly affected by temperature. At 20 °C, the adult survival ranged from 7-10 days for males and from 10-14 days for females, while at 25 °C, the adult survival ranged from 5-7 days for males and from 7-10 days for females. On the other hand, at 30 °C the male and female adults died within 3-4 days, (Table, 2). It was clear that no fixed trend of the ratio of females or males produced at each experimental temperature, (Table, 3). These results indicate that temperature might not play an important role in the sex selection of the cereal leaf miner (Abu Yaman and Jarjes, 1971).

The highest rate of egg oviposition of cereal leaf miner was at 20 °C, but it was little at 25 °C and no eggs were laid at 30 °C. Thus the higher temperature had lowered the production of insect eggs (Table, 4).The average egg incubation period for the two seasons study was 13 and 11 days at 20 and 25°C, respectively (Table, 2), while no eggs at 30°C. The average numbers of eggs laid per female and their incubation periods increased as long as temperature decreased (Tables 2 and 4).

Next generation larvae before diapausing their average feeding periods were 8 and 6 days at 20° and 25 °C, respectively (Table, 5). They entered

aestivation as first instar larvae for the next generation in the soil in the glass vial. There was no next generation larvae at 30 °C. This indicates that high temperature was not suitable for the development of the cereal leaf miner or its flight activity.

The mortality of larvae, pupae, adults and eggs was affected by temperature. Table (6) presents the percentages of mortality of different

Table (3): Effect of different temperatures on adult sex ratio taken from twenty samples during 2001/2002 and 2002/2003 growing seasons.

Temperature (°C)	Number of emerged males		Number of emerged females		Averaged adults
	2002	2003	2002	2003	2001/2002 2002/2003
20	9	9	9	9	9.00
25	9	9	8	9	8.75
30	9	8	9	9	8.75

Table (4): Effect of different temperatures on the percentages of mean fecundity and egg hatchability of cereal leaf miner during 2001/2002 and 2002/2003 growing seasons.

Temperature (°C)	Mean fecundity		Eggs hatchability (%)	
	2003	2002	2003	2002
20	55.7 a	56.3 a	43.0 a	43.0 a
25	46.7 b	45.3 b	25.3 b	25.3 b
30	0.0 c	0.0 c	0.0 c	0.0 c

Values within the same column having different letters are significantly different at p=5% (DMRT)

Table (5): Effect of different temperatures on next generation larval period of the cereal leaf miner during 2001/2002 and 2002/2003 growing seasons.

Temperature (°C)	Next generation larval period (days)	
	2003	2002
20	7.9a	8.1a
25	6.0b	6.0b
30	0.0c	0.0c

Values within the same column having different letters are significantly different at p=5% (DMRT)

Table (6): Percentages of larval, pupal, adult and eggs mortalities during 2001/2002 and 2002/2003 growing seasons.

Temperature (°C)	Larval mortality	Pupal mortality	Adult mortality	Eggs mortality
20	8	3	8	57
25	13	14	16	75
30	18	18	100	-

life cycle stages of cereal leaf miner. The mortality percentages increased with increasing temperatures and *vice versa*.

4. Conclusions

The developmental durations of cereal leaf miner varied according to temperature differences. Data are needed to clarify the effect of temperature on the population growth potential, especially on the reproductive patterns and life

time fecundity of females at different temperatures. Eventually, this information will be used to predict when the cereal leaf miner likely to develop to adults. Also, growers should begin scouting fields for damaging levels by the insect, and managing this pest with little detailed information on its basic biology. Moreover, sowing barley affected the complete of cereal leaf miner life cycle, so sowing dates have to be used

to manage this pest for a long time. The characteristic of temperature-dependent development can be useful to conduct and evaluate biological control potential. In general, it can be concluded that the most suitable temperature for cereal leaf miner development is 20 °C, especially during the dangerous period.

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5. REFERENCES

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تأثير درجات الحرارة المختلفة على الصفات البيولوجية لصانعه انفاق اوراق النجيليات *Syringopais temperatella* Led. (Scythrididae:Lepidoptera)

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ملخص

تعد محاصيل القمح والشعير من المحاصيل المطرية الهامة اقتصاديا واستراتيجيا في حياة الإنسان والحيوان. تصاب هذه المحاصيل بأفات حشرية مختلفة منها دودة الزرع (*Syringopais temperatella* Led. (Scythrididae: Lepidoptera). والتي تعتبر من الآفات الحشرية المهمة نظرا لما تسببه من خفض القيمة الاقتصادية لمحاصيل الحبوب. لقد تم إجراء الدراسة في مختبر بحوث الحشرات في كلية الزراعة بجامعة مؤتة / الكرك خلال موسمي الزراعة ٢٠٠١/٢٠٠٢ و ٢٠٠٢ / ٢٠٠٣ وبمعدل نتائج مكرره لموسمين، لدراسة تأثير درجات الحرارة المختلفة (٢٠°، ٢٥°، ٣٠° م) على فترات الأطوار الحياتية للحشرة ورطوبة نسبية ٧٠ ± ٥ %، كانت الفترة الضوئية ثماني ساعات يوميا متبوعة بست عشرة ساعة ليليه. كان ارتباط تعداد الدودة مع الحرارة معنويا، حيث وجد أن درجة حرارة ٢٠° م ملائمة لنمو ونشاط أطوار الحشرة، ودلت النتائج أن عدد البيض للأنتى الملقحة الواحدة ٢٦-٦٦ بيضه، وفترة حضانه البيض تراوحت ما بين ١٢- ١٤ يوما، ونسبة فقس البيض كانت ٤٣ %، وفترة الطور اليرقي ٦٩ يوما، ونسبة موت اليرقات ٨%، وفترة العذراء ١٥ يوما، ونسبة خروج البالغات (الطور الكامل) ٩٢%، بينما على درجة حرارة ٢٥° م بلغ عدد البيض للأنتى الملقحة الواحدة ٢٣- ٥٦ بيضه، وفترة حضانه البيض ١٠- ١٢ يوما، ونسبة فقس البيض ٢٥% وفترة الطور اليرقي ٥٩

يوماً، ونسبة موت اليرقات ١٤%، وفترة العذراء ١٣ يوماً، ونسبة خروج البالغات ٨٦%. بينما ظهر على درجة حرارة ٣٠°م بان متوسط فترة الطور اليرقي، نسبة موت اليرقات، فترة العذراء، نسبة خروج البالغات ومتوسط عدد البيض للأنثى الملقحة الواحدة ٥١ يوماً، ١٨%، ١١ يوماً، ٨٢%، صفر بيضه، على الترتيب، كما أن للحشرة جيل واحد سنوياً. كذلك تبين أن درجة الحرارة ٣٠°م غير ملائمة لتكاثر الحشرة وذلك لموت البالغات خلال ٣-٤ أيام بدون تزواج أو وضع بيض.

المجلة العلمية لكلية الزراعة - جامعة القاهرة - المجلد (٥٩) العدد الثاني (أبريل ٢٠٠٨): ١٤٢-١٤٧.