TEMPERATURE THRESHOLD AND THERMAL REQUIREMENTS FOR THE DEVELOPOMENT OF RICE STEM BORER, *CHILO AGAMEMNON* Bles. (LEPIDOPTERA: CRAMBIDAE)

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Abstract

Developmental thresholds and the accumulative thermal requirements of the different stages of the rice stem borer (RSB) *chilo. agamemnon* were estimated at constant temperatures of 20, 25, 28, 30 and 35°C. The thermal requirements for completion the development of the egg stage was 65.53 degree-days (dds) above a threshold of 11.2°C ,larval and puapal stages required 193.24 (dds) and 152.16 (dds) above 12.8°C, and 10.0°C, respectively .

INTRODUCTION

The rice stem borer (RSB) *Chilo agamemnon* Bles.(Lepidoptera: Crambidae) is one of the most destructive insect pests for both quantity and quality of rice yield. Dead heart is the uniform symptom caused early of the plant while white head is the damage caused during of flowering stage which resulting in drying of the entries panicle and consequent drop in yield (Ali, 1978 and Cheng *et al*, 1999). The insect is a polyvaltine species and develops into four generations per year (ELNahal. *et al,* 1970, EL-Rahman and Saleh. 1987 and Mourad, 2003).

Heat units or day – degrees (dds) are a method of quantifying a biological organisms thermal environments. Researches conducted over the pest cereal decades have proved that proper use of heat units (= thermal requirements) can provide a reliable means of predicting the growth and development of many crop pests (Hashem *et al.* 1997, Ismail *et al.* 2005 and Ali *et al.*, 2007)

Predicting the seasonal occurrence and abundance of any pest is essential for the accurate scheduling for control tactics. Such predictions require an understanding the relationship between insect developmental rate and temperature driven phonology models, the most widely used are based on degree-day summation which assumes linear relation ship between developmental rate and temperature over the normal range (Gregg, 1981). A method of heat summation reported by Sevacherian *et,al.*, (1977) was used to predict the pattern of emergence of the boll worm *Lyguo spp* by monitoring daily maximal and minimal temperature and summation heat units i.e degree-day when zero of development was considered.

The present study aims to estimate temperature thresholds of different stages of the rice stem borer C *agamemnon* Bles.and thermal requirements to be used through forecasting and determination the proper time for applying IPM programs for the pest concerned .

MATERIALS AND METHODS

Assessment of temperature threshold of the different developmental stage of the rice stem borer *C. agamemnon* Bles.(Lepidoptera: Crambidae) was carried out in heat – cooling incubators adjusted at five constant temperatures, 20, 25, 28,30and 35±1°C. Five groups of newly laid eggs at the same age, 50 eggs each, were distributed in the five incubators, one group for each. After hatching, larvae of each group were directly separated singly in glass vials supplied with a piece of maize plant stalk serving as food and also kept at the same previous constant temperature .All vials were inspected daily until pupation and emergence of moths. Durations of egg, larval and pupal stages were recorded under for each tested temperature. On moth emergence. Pairs of moths (female and male) were kept in rearing glass vials provided with a piece of cotton wool sooked in 5% sugar solution served as adult food. The tubes were daily observed until females deposited their eggs

(EL- Khodary *et al.* 1984).The developmental threshold (Zero of development) was estimated according to the method of Pedigo (1991), while thermal units required for complete development of each stage was determined according to the equation of thermal summation by (blank , 1993)

RESULTS AND DISCUSSION

Result in Table (1) show the relationship between the duration of *C.agamemnon* developmental stages and constant temperatures: 20, 25, 28, 30and 35±1°C. This relationship is a linear correlation and the developmental time of egg, larva and pupa significantly decreased as temperature increased. The total developmental time of these stages averaged 37.20 days at a constant temperature 20±1°C, shortened to 20.60 days at 35°C. These results reveal that, temperature is a development – dependent and *C.agamemnon* could develop successfully at a temperature range of 20-35°C.

Laboratory studies revealed that, developmental time as well as rate of development (1/t x100) of the different stages of this insect was obviously affected by constant tested temperatures Table (1).

By application the formulae described by Blank (1993) and Pedigo (1991), the lower temperature of development (temperature threshold or zero of development)

is 11.2, 12.8 and 10°C for the egg, larva and pupa, respectively (Fig 1 a,b,c). Consequently, the accumulated thermal units (U.T) are degree –days (DDS) were needed for completion of development from egg stage until the emergence of adult moth (Table 2).

Accumulated thermal units required for the development of the considerable immature stages of C. *agamemnon* were different at the tested constant temperatures. Generally, it was found that, heat units demanded for the development of a stage considerably increased with the increase of prevailing temperature within a range of 20-35°C.Egg stage required 56.32 DDs at 20°C increased to 73.78 DDs at 35.00°C. Similarly, 131.04 DDs were required for the development of larval stage at 20°C increased to 235.32 DDs at 35°C .The pupal stage demanded 126.00 DDs at 20C° and 172.50 DDs at 35°C.

Temperature thresholds as well as thermal requirements were estimated for several insect species. In this concern, Waiyaki

(1986) reported 51.00-56.00 day – degrees above 10 were sufficient for completing development of the egg stage of the sugar stalk borer. Similary, Salem *et al.*, (1994) mentioned that 59.00-70.20 DDs with an average of 65.65 DDs were needed for the egg development of the stalk borer, *Eldana saccharina*. These results seem to be in harmony with our achieved results on *C. agamemnon*. However, temperature threshold and thermal unit requirements may differ with different insect species. Egg, larva and pupa of *Spodoptera exigua* needed 40.20, 192.90 and 124.60 DDs respectively to complete development above 11.2 and 10.5°C Mourad, (2003). In sugarbeet beetle, *Cassida vittata,* 79.80, 103.00 and 105.00 DDs were required for development the same stages above temperature thresholds 10.50 13.80 and 11.00 °C, respectively Ali *et al.,* (2007).

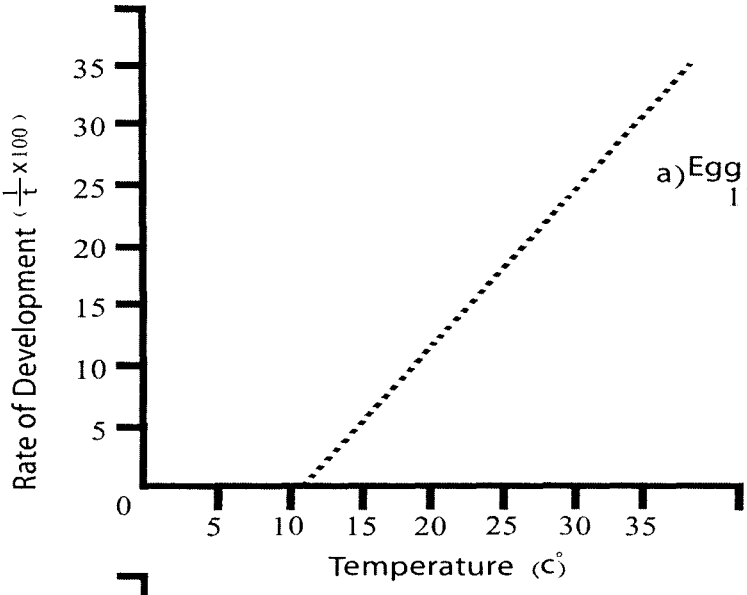
Thus, assessment of temperature thresholds of the various immature *C. agamemnon* stages as well as accumulated heat units required for their development of may play a great role for understanding population size of this species at different environmental temperatures and planning for successful forecasting and control programs.

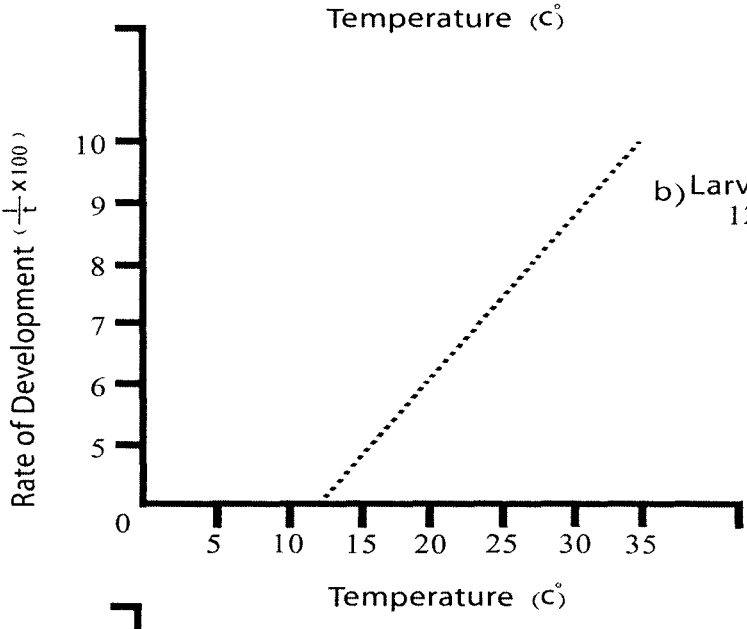
Table 1. Mean duration (days) of egg, Larval and Puapal stages of *Chilo agamemnon* Bles. and rate of development (%) at fife constant temperatures

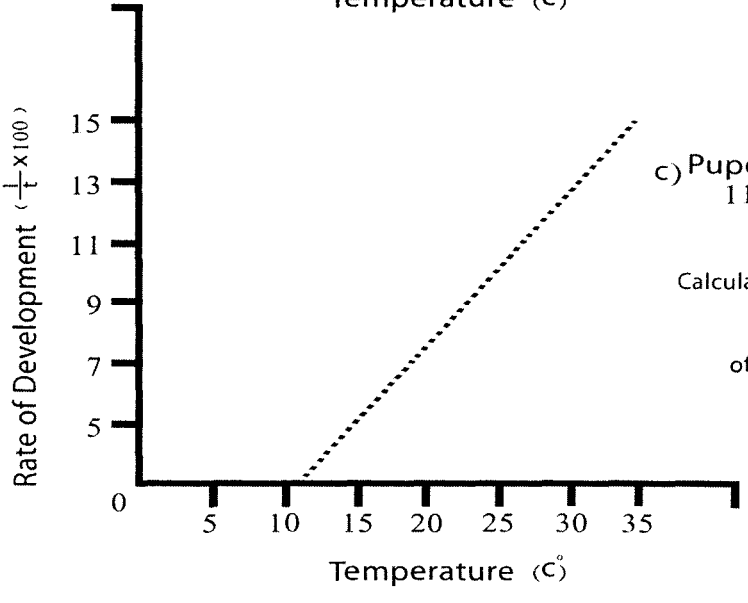
Stages		Temperature (°C)					Zero of
		20 °C	25 °C	28 °C	30 °C	35 °C	Development (°C).
Egg	Duration	6.4	4.8	3..9	3.5	3.1	11.2
	Rate of Development (100/t)	15.6	20.8	25.6	28.6	32.3	
Larvae	Duration	18.2	15.2	13.5	12.2	10.6	12.8
	Rate of Development (100/t)	5.5	6.6	7.4	8.2	9.4	
Pupae	Duration	12.6	10.1	8.6	7.8	6.9	10
	Rate of Development (100/t)	7.9	9.9	11.6	12.8	14.5	
Total duration		37.2	30.1	26.0	23.5	20.6	--

Table 2. Estimated thermal units (day – degrees) for the egg, larval and puapal stages of *Chilo agamemnon* Bles. at five constant temperatures.

Stage	Accumulated thermal units					Average
	20° C	25° C	28° C	30° C	35° C	
Egg	56.32	66.24	65.52	65.8	73.78	65.53
Larva	131.04	185.44	205.20	209.20	235.32	193.24
Puapa	126.00	151.50	154.80	156.00	172.50	152.16
Total	481.60	313.36	403.36	425.52	431.00	481.60







Calculated zero of development for different stage of c. agamemnon Bles

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الإحتياجات الحرارية وحد الحرارة الحرج لتطور ثاقبة ساق الأرز *Chilo agamemnon* Bles

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ربيت حشرة ثاقبة ساق الأرز تحت ظروف معملية ثابتة علي خمس درجات حرارة مختلفة (٢٠ ، ٢٥ ، ٢٨ ، ٣٠، ٣٥° م) وغذيت علي سيقان نبات الذرة وذلك لدراسة الإحتياجات الحرارية وتقدير حد النمو الحرج للاطوار غير الكاملة للحشرة(البيضة – اليرقة – العذراء). أوضحت النتائج أن فترات حضانة البيض ، الطور اليرقى وطور العذراء قد تتناقصت بزيادة درجات الحرارة بينما زادت معدلات نموها داخل المدى الحراري المختبر من ٢٠- ٣٥°م ، وقد أشارت النتائج أيضا إلي زيادة معدلات نمو الأطوار غير الكاملة للحشرة بإرتفاع الحرارة .

تم تقدير وحساب صفر النمو أو الحد الحرج للنمولثلاثة أطوار حيث بلغت ١١,٢، ١٢,٨ ، ١٠° م علي التوالي ثم بإ ستخدام صفر النمو تم تقدير الإحتياجات الحرارية فكانت ٦٥,٥٣ ، ١٩٣,٢٤ ، ١٥٢,١٦ وحدة حرارية لإستكمال نمو كل منها)علي التوالي ، كما أن مجموع الإحتياجات الحرارية التى تتطلبها تلك الأطوار غير الكاملة (بيضة – خروج الحشرة الكاملة) قد بلغ ٤٨١,٦ وحدة حرارية يوميةعلي درجة ٣٥ ° م .

وتفيد مثل هذة النتائج في تصميم برامج التنبؤ بهذة الآفة وتحديد الموعد المناسب لتطبيق برنامج مكافحتها .