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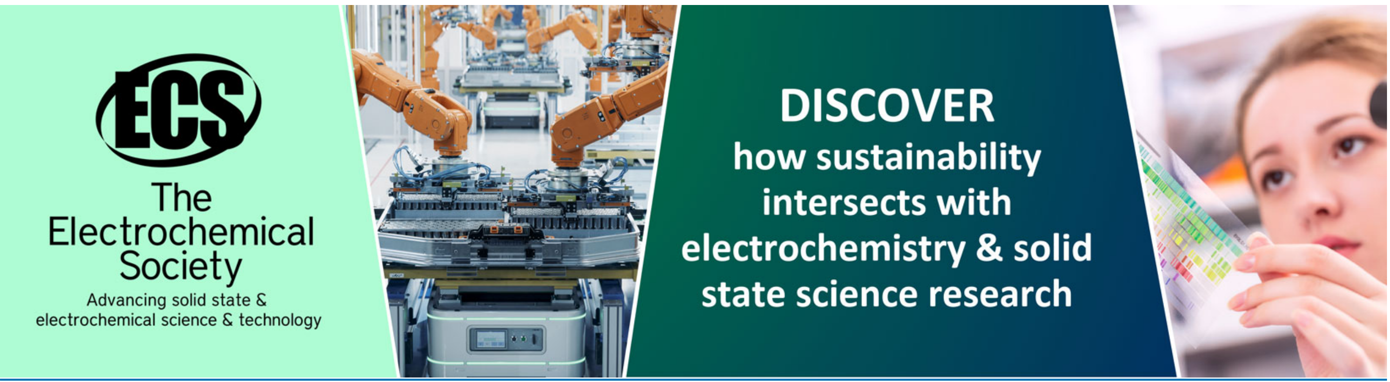

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Effects on Growth of Ectropis grisescens Warren under Illumination

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Abstract: The 2nd and 5th instar of Ectropis grisescens Warren larvae were exposed to 400~405 nm illumination for 0，60，90，120，150 or 180 min to determine the effects of the irradiation on the development time as well as the rates of pupation, pupa emergence, aberration rate, eclosion rate, adult longevity and oviposition rate. The results showed that, as compared with control, as the processing time increases, the developmental duration was significantly shortened with 5 instar of E.grisescens Warren larvae. The eclosion rate and aberration rate were significantly increased. At the same time, the pupa weight was significantly higher than that of the 2nd instar larvae. The mortality increased significantly in 2nd of E.grisescens Warren larvae. There was no difference in adult eclosion rate between the two groups, and there was also no difference in the average oviposition. There was no significant difference between the two groups under 400~405 nm illumination, Male adults live longer than female adults.

1. Introduction

Grey tea looper occurs severely in the provinces south of the Yangtze River basin. When it is damaged, it can eat up all the old leaves, new leaves, tender stems and young fruits of tea trees, leaving only the branches and stems, and even the plant death, which seriously affects the quality and quality of tea[1-3]. In this study, using the phototaxis characteristics of insects, different wavelengths of LED spectra were used to treat the 2nd and 5th instar larvae of the gray tea looper for different periods of time, and then kept them under conventional conditions to observe the changes in their growth period. It provides new ideas for prevention and control methods such as using insects' light-tending/shading properties to trap larvae, drive away or interfere with their developmental rhythm, and reduce the amount of eggs laid in the field.

2. Materials and methods

2.1 Insect source and breeding method

The origin of gray tea geometrids came from the tea garden in Baimiao Village, Shihegang Township. They were successively reared on fresh leaves in an artificial climate room for 5 generations. The breeding environment was 22~26°C, relative humidity 60~70%, and photoperiod of 12L:12D.

2.2 Test equipment
Rtop-310y artificial weather box, Zhejiang top yunnong Technology Company.; pm6612 digital illuminance meter, Shenzhen Huayi Intelligent Measurement Technology Company.; insect cage (50cm × 50cm × 60cm), light reaction device (self-made).

2.3 Test light source
The wavelength of LED light source is 400 ~ 405nm. The light intensity is 200-220lux.

2.4 Test method
The 2nd and 5th instar larvae of geometrid cinerarius on the same day were put into the culture dish and placed 15 cm away from the light source (400-405 nm). The radiation time was set at 0 (CK), 60, 90, 120, 150 and 180 min in turn. Each treatment was repeated three times, with 20 larvae per replicate. After treatment, they were raised under conventional conditions. The number of dead, pupated, deformed, weight, eclosion, longevity of male and female adults (paired feeding), number of eggs laid and eggs hatched were recorded every day.

2.5 Data processing
The data were processed by SPSS16.0 (SPSS Inc., Chicago, IL). F test was used to analyze the significant difference among different light sources, and LSD test was used for multiple analysis.

3. Results and analysis

3.1 Effects of different radiation time on larvae

3.1.1 Effects on 2nd instar larvae

Table 1: Effects of different radiation time on growth and development of 2nd instar larvae

Radiation time/min	Larval stage/d	Mortality/%	Pupation rate/%	Abnormal pupa *rate*/%	Pupa weight/mg	Eclosion rate/%
0（CK）	11.73±0.72a	2.55±1.13d	93±0a	5.84±0.16b	119.83±1.17a	91.58±2.81a
60	8.78±0.55b	35±1.73c	65.33±1.45b	15.68±0.80a	105.54±4.33b	73.55±3.18b
90	10.79±0.33ab	33.13±2.03c	67.33±1.12b	16.77±0.78a	98.5±3.18b	70.45±4.33b
120	10.14±0.67ab	42.25±1.45b	57.67±2.03c	15.94±0.93a	93.59±2.78b	64.95±4.04b
150	10.41±0.63ab	50.17±2.60a	49.67±2.05d	17.59±1.00a	92.64±4.06b	64.14±3.77b
180	9.95±0.10ab	53.22±0.88a	47±1.73d	19.07±0.90a	79.37±2.60c	63.63±5.49b

Note: different letters in the same column indicate significant difference at the level of 0.05, while the same letter means no significant difference; the values in the table are average ± standard error, the same below.

Compared with the control, the second instar larvae of A. cinerarius were all shortened after spectral treatment, and 60 min treatment was more significant; with the extension of UV irradiation time, the mortality of the 2nd instar larvae increased significantly, but the control was the lowest; the pupation rate showed a downward trend, and the pupation rate of 60-180 min treatment was significantly different from that of the control, especially the pupation rate of the 2nd instar larvae was the lowest under 150 min and 180 min treatments; there was no significant increase in the rate of abnormal pupae, and the difference was significant with the control; the pupa weight of the control was the heaviest, with the increase of treatment time, the pupa weight showed a downward trend, and the pupa treated with 180 min was the lightest; with the increase of irradiation time, the pupa emergence rate of geometrid cinerarius decreased gradually, which was significantly different from that of the control (Table 1).

3.1.2 Effects on 5th instar larvae

Table 2: Effects of different radiation time on growth and development of 5th instar larvae

Radiation time/min	Larval stage/d	mortality/%	Pupation rate/%	Abnormal pupa rate/%	Pupa weight/mg	Eclosion rate/%
0（CK）	4.93±0.35a	3.33±1.67b	96.67±1.67a	8.4±0.50b	126.78±4.92a	89.95±2.31a
60	3.89±0.10a	15.33±1.76a	85±2.89b	28.75±0.70a	115.75±3.83ab	87.76±3.47a
90	4.36±0.36a	12.67±1.45a	88±2.31b	29.28±1.09a	104.28±6.93b	77.91±5.77ab
120	4.05±0.11a	13.33±2.03a	87±1.73b	30.13±0.78a	98.78±5.20b	77.23±4.05ab
150	3.87±0.48a	17.67±1.45a	83±2.72b	30.18±0.86a	96.38±4.91b	73.64±2.96ab
180	4.7±0.41a	16.67±1.67a	84±1.15b	32.18±1.05a	94.19±3.47b	67.93±2.63b

Table 2 shows that there is no difference between the 5th instar gray looper larva stage treatments and the control. The reason may be related to the 5th instar larvae's strong resistance. The difference in mortality under 60~180min treatment was at the same level, and the mortality did not change significantly with the prolonged exposure time, but they were significantly different from the control. The performance trends of pupation rate and abnormal pupation rate are the same as mortality. With the extension of the treatment time, the pupal weight gradually decreased, and the pupal weight of 90~180min treatment was significantly different from that of the control; the emergence rate was the lowest when the treatment was 180min; the 5th instar larvae had stronger resistance to stress.

3.1.3 Impact on adult lifespan

Table 3: The effect of radiating the second instar larvae at different times on the lifespan of adults

treat（min）	Female（d）	Male（d）
0（CK）	8.47±0.79a	9.33±0.88a
60	6.33±0.88b	7.67±0.88ab
90	6.03±0.26b	8.9±0.10ab
120	5.7±0.17b	6.76±0.39b
150	4.8±0.25b	6.38±0.36b
180	4.7±0.57b	6.5±0.36b

Table 3 shows that spectral treatment of the second instar larvae has a certain impact on the life span of adults. The treatment with 150min and 180min differed significantly from the control. There was no significant difference in the lifespan of males in 60~180min treatments, and the lifespans of males in each treatment were higher than that of females.

Table 4: Effects of 5th instar larvae irradiated at different times on the lifespan of adults

treat（min）	Female（d）	Male（d）
0（CK）	8±1.15a	9±1.15a
60	5.98±0.54ab	7.85±0.20ab
90	6.08±0.33ab	6.3±0.35b
120	5.67±0.33ab	5.8±0.42b
150	4.55±0.58b	5.33±0.88b
180	4.02±0.77b	5.67±0.33b

After the 5th instar larvae were irradiated with ultraviolet light, with the extension of the treatment time, the life span of both the male and female adults did not decrease significantly (Table 4).

3.1.4 Impact on female worms laying eggs

Table 5: The effect of radiating 2nd and 5th instar larvae at different times on the egg laying rate of adults

treat（min）	Female（d）	Male（d）
0（CK）	100±16.02a	95±2.89a
60	96.63±4.62a	84.74±5.86ab
90	100±6.66a	80.47±4.81ab
120	91.67±5.69a	74.50±7.69ab
150	61.11±5.86b	76±4.33ab
180	43.33±4.36b	63±6.33b

Table 5 shows that the treatment of 2nd and 5th instar larvae has a certain effect on the egg laying rate of adults. The spawning rate of 2nd instar larvae dropped sharply after treatment, and the oviposition rate decreased most significantly when treated with 180min, which was 56.7% lower than that of the control. Under the 5th instar treatment, only the 180min treatment was significantly different from the control, and there was no difference between other treatments and the control. It can be seen that the longer the treatment time, the lower the egg-laying rate of females, especially the decline rate in the 2nd instar stage is more significant than that in the 5th instar stage.

Table 6: The effect of radiating 2nd and 5th instar larvae at different times on the amount of adult eggs laid

treat（min）	2 years old		5 years old	
	Single female egg production/head	Maximum egg production per female/head	Single female egg production/head	Maximum egg production per female/head
0（CK）	422.37±16.02a	775	427.13±8.69a	564
60	195.26±4.62b	672	163.26±6.69b	526
90	144.35±6.66c	622	161.18±3.48b	506
120	145.27±5.69c	439	131.35±5.81c	359
150	123.56±5.86cd	365	122.62±5.33c	327
180	107.33±4.36d	295	102.37±6.94d	210

Table 6 shows that the number of eggs laid by a single female decreases with the time. Under the 2-year-old treatment, there were significant differences between the two groups in 60-180 min. The oviposition amount of 60 min treatment was significantly higher than that of other treatments, and the single female oviposition amount of 180 min treatment was the lowest. Under the 5-year-old treatment, there were significant differences between the treatments of 60 min and 90 min, but there was no significant difference between the treatments of 60 min and 90 min. the egg production of single female in 180 min treatment was the lowest. The change trend of the highest egg production of single female was the same as that of single female, and showed a decreasing trend.

3.2 Effect of insect age on the growth and development of larvae under the same radiation conditions

It can be seen from Figure 1 that there is no difference in the mortality of 2nd and 5th instar larvae in the absence of UV irradiation. The mortality of 2nd instar larvae is significantly higher than that of 5th instar larvae under 60 ~ 180min treatment. With the extension of treatment time, the mortality of 2nd instar larvae increases gradually. The results showed that the mortality caused by UV irradiation was related to the age of the insect. The lower the age, the weaker the resistance, the higher the mortality.

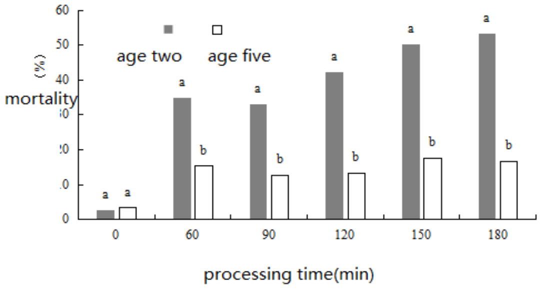

Fig. 1： Effect of different radiation duration on mortality

It can be seen from Fig. 2 that the pupation rate of the two treatments is higher, and there is no difference between them. The pupation rate of 2nd instar larvae was significantly lower than that of 5th instar larvae. The results showed that the pupation rate was greatly affected by the instar of larvae under the same UV irradiation.

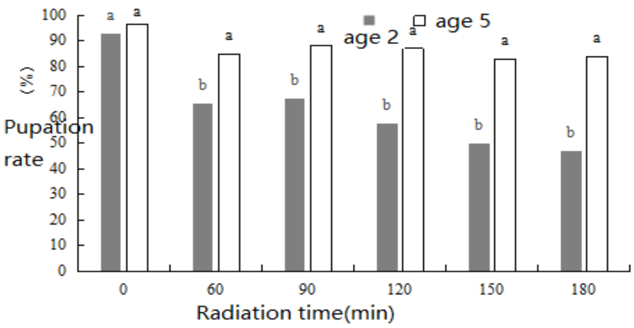

Fig. 2 ： Effect of different radiation duration on pupation rate

Fig. 3 shows that the abnormal pupae rate of the 5th instar larvae is higher than that of the 2nd instar larvae, indicating that with the extension of irradiation time, the pupation quality of the 5th instar larvae is greatly affected, and the pupal deformity rate increases.

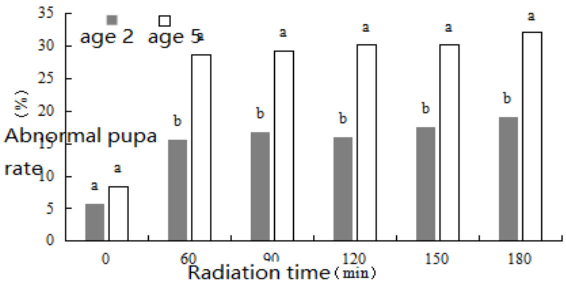

Fig. 3： Effect of different radiation duration on abnormal pupae rate

It can be seen from Figure 4 that the effect of different age treatments on eclosion rate is the most significant in 60 min treatment, and there is no significant difference between the control and other treatments.

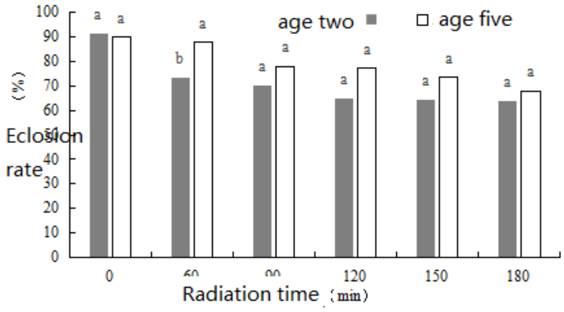

Fig. 4: Effect of different radiation duration on eclosion rate

Fig. 5 shows that there is no significant difference in the life span of female adults between the two instar treatments, and the longevity of female adults of 5th instar larvae is higher than that of 2nd instar larvae at 180min treatment.

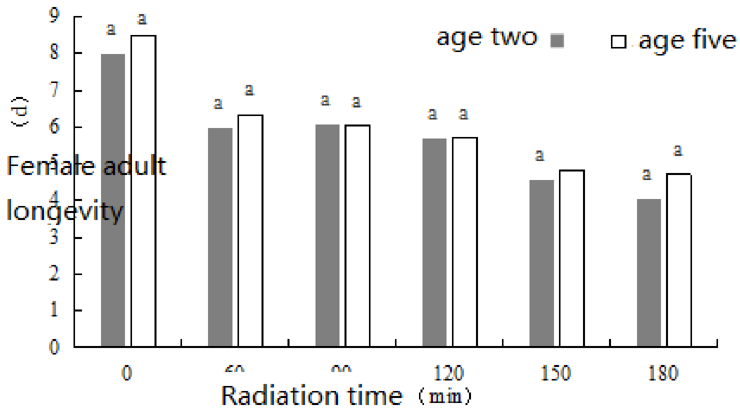

Fig. 5 : Effect of different radiation duration on female adult longevity

Fig. 6 shows that the life span of male adults of 5th instar larvae is higher than that of 2nd instar larvae at 120-180 min, and the difference is most significant under 90 min treatment. The longevity of male adults of 5th instar larvae is significantly longer than that of 2nd instar larvae. It can be seen that the different UV irradiation time can shorten the life span of male adults of tea geometrid, but the effect on the larva with larger instar is relatively small.

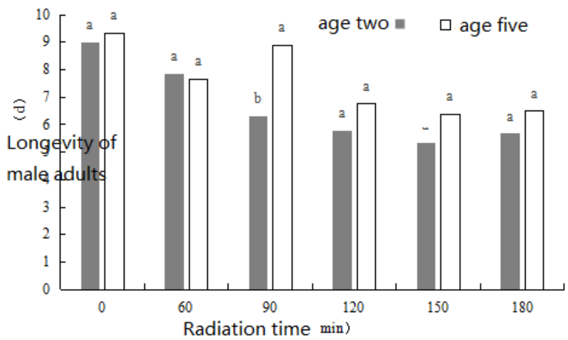

Fig. 6: Effect of different radiation duration on male adult longevity

Fig. 7 shows that the oviposition rate of the 2nd instar larvae is higher than that of the 5th instar larvae under the treatment of 0 ~ 120min, and the oviposition rate of the 5th instar larvae is higher than that of the 2nd instar larvae under 150 ~ 180min irradiation.

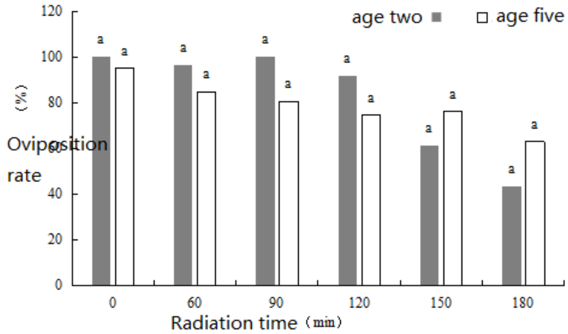

Fig. 7：Effect of different radiation duration on oviposition rate

4. Conclusion

The results showed that the growth period of 2-year-old tea geometrid was shortened after spectral radiation treatment, and the mortality rate increased with the extension of treatment time. The pupation rate, pupal weight, pupal deformity rate and eclosion rate of 2-year-old cinerarius cinerarius showed a downward trend. Under the same conditions, the resistance of 5th instar larvae was stronger than that of 2nd instar larvae. The reason may be that the 2nd instar larvae have thin body wall and weak resistance. In order to reduce the harm of the geometrid, we should try to control it before the 2nd instar.

The life span of the 2nd instar larvae was higher than that of the females, and the pupation rate of the 2nd instar larvae was significantly lower than that of the 5th instar larvae. The abnormal pupae rate of the 5th instar larvae was higher than that of the 2nd instar larvae, which indicated that the 5th instar larvae had a greater impact on the pupation quality and led to the increase of pupal deformity rate. In a word, the control effect of spectral radiation on tea geometrid pests is significant, which is of great significance for the promotion of green and scientific control methods.

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