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Study on Locust Trapping Behavior Regulation Induced by Photoelectric Light*

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ABSTRACT Objective: The objective of this research was to provide theoretical foundation for manufacturing mechanical locust trapping devices induced by light. **Methods:** We utilized sliding locust capture device regulated by photoelectric induction and investigated locust phototactic trapping behavior to obtain the gain factor on locust sliding capture effect. **Results:** The sudden light characteristic of LED light source make locust trap to be entered easily and the weak illumination regulation stimulation in the upper channel on locust looming vision regulates locust response effectively, which promotes locust to generate the direct sliding behavior, the bounce impact behavior, the retention behavior; channel illumination and slanting capture environment intensify locust behavior response to the changing environment, and generate the sliding bounce impact behavior gaining locust capture effect; the obstacle effect of the upper channel on locust bounce escape behavior and the guiding function of the lower channel on the falling locust after impacting realize locust phototactic sliding capture rapidly. **Conclusion:** The regulation difference of different light on locust, the adjusting discrepancy of locust body balance controlled by the biological friction force with the regulation of locust on the contacting surface, the decline of locust visual function caused by the changing light environment, affect the realization of locust phototoxic trapping effect and locust phototoxic sliding gain behavior, then, according to the optimal experiment results of 65 mm channel height and the combination of the upper channel and the lower channel with (30°, 45°), the regulatory effect of locust phototoxic trap effect could be synergized to utilize the coupling stimulation of the flashing light with 33Hz frequency and the alternating light with 640ms luminous cycle.

Key words: Pest management; Phototactic effect; Photoelectric induction; Sliding capture; Behavior regulation; Locusts

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Introduction

The mechanized equipment technology of photoelectric inducement trapping in swarm locusts control is an innovative measure that avoids environment pollution caused by pesticide, and can be propitious to sustainable development of agriculture produce [1]. In this technology, the stimulation function of light makes the locusts aggregated by photoelectric inducement present violent behaviors, which causes the adverse influence on the aggregated locusts to trap using mechanical trapping devices [2]. Hence, investigating the regulating behavior of locust contacting with mechanical trapping mechanism affected by photoelectric inducing environment has an important significance on locusts trapping installment.

Previous researches [3-5] have demonstrated the function of attachment pads with soft surface and claws with rigidity tip of locust foot on object surface are regarded as the double contacting ways mechanical interlock and adhesive attachment, ensuring to adapt to walk, climb and jump on smooth surface and non-smooth surface. Moreover, the soft attachment pads generate the flexible deformation to increase contact area and generate strong friction force during the course of contacting with substrata, coupling with the secreting glutinous substance generated by the physiological startle reaction of locust sliding on the slope surface, which enhance the adhesive effect with smooth substrata and make locust walk or stay freely on the slope slippery plate, then, it is hard to realize locust sliding capture effectively. And choosing the optimal inclination angle of slippery trapping plate, reducing the surface roughness, increasing the hardness, using the slippery function of bionic material, can only enhance the sliding friction behaviors in a certain degree, not realize the sliding capture completely.

Simultaneously, locust photoreceptors are most sensitive to the photoelectric stimulation which induce locust to jump forward to light by use of the motion parallax to measure distance [6,7], and locust biological physiology effect caused by the gradation stimulation of spectral illumination of locust visual physiology threshold promotes the phototoxic aggregating behavior of swarm locusts induced by light to generate the escaping behaviors, such as jump,

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fly, and etc[8,9], which is difficult to guarantee locust sliding capture effect.

Generally speaking, previous studies have investigated locust sliding friction mechanism, which provides theoretical foundation for the investigations of different trapping behaviors controlled by the sliding friction effect locust foot adhering to the slippery trapping plate. However, the representing form of locust trapping behavior stimulated by sliding environment and light would generate a certain influence on locust sliding capture, moreover, locust visual behavior stimulated by the spectral light closing to light source and sliding capture parameters would affect locust trapping effect, yet it have not been studied.

The present study was to study the visual behavior control effect of locust sliding capture induced by light, analyze the influence of the regulatory behavior stimulated by light and mechanical sliding environment on locust sliding capture effect, to obtain the optimal design parameters of locust trapping mechanical device.

1 Materials and methods

Experimental species sample: Imagoes of locust (Locusta migratoria manilensis), including male and female were collected in the wilderness surroundings of Handan city in August 2013. The average weight is 1.31± 0.17 g, and the body length is 41.82± 1.98 mm. The specimens were kept in cages with food (various grass species collected around the laboratory) and water, and the temperature of cages was maintained between 25℃ and 30℃.

Experiment instruments[7,8]: the designed experimental equipment was shown in figure 1.

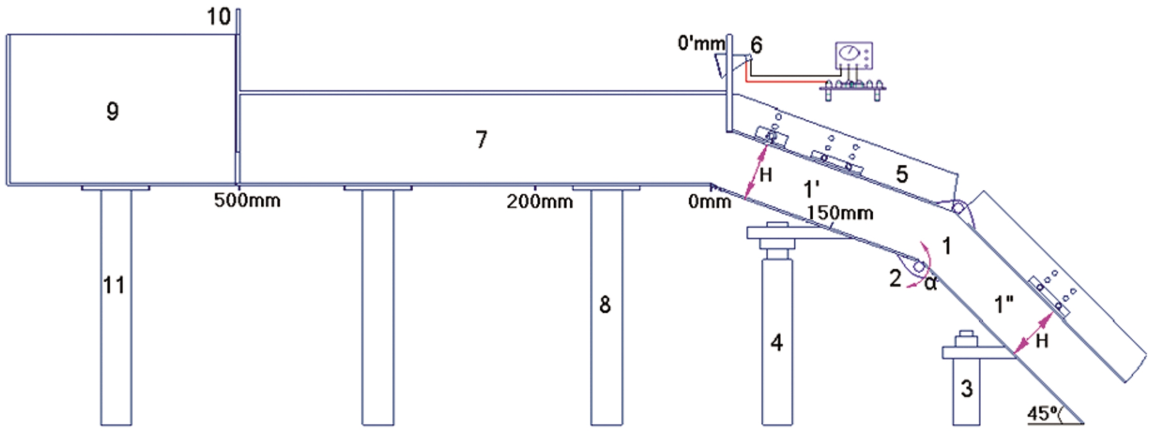

Fig.1 The experimental equipment for testing locust phototoxic sliding capture behaviors

1. Trapping behavior channel(1'. Angle adjustable upper channel; 1". Fixed lower channel); 2. Adjustable hinge; 3. Fixed support; 4. Adjustable support; 5. Fixed side plate; 6. Light source system; 7. Phototoxic channel; 8. Channel support; 9. Locust inhabited room; 10. Channel gate; 11. Inhabited room support.

The sliding capture device was composed of trapping behavior channel including angle adjustable upper channel and fixed lower channel, adjustable hinge, fixed support, adjustable support and fixed side plate. The geometry dimension (length× width) of the upper channel and the lower channel was 220 mm× 400 mm, the top plate and the lower plate of them were manufactured by 1 mm thick stainless steel plate which one side was fixed on the fixed side plate and the other side was assembled by transparent glass plate (to observe conveniently), which formed the trapping behavior channel. The height (H) of the upper channel and the lower channel was used to obtain the tested channel height of 55, 65 and 75 mm by adjusting the top plate according to the adjustment holes on the fixed side plate respectively. Moreover, the lower channel which the lower plate fixed by the fixed support presented 45° with the horizontal plane, and on the base of the same height of the trapping behavior channel, the upper channel was adjusted to obtain the tested inclination angle (α) of 20°, 30° and 45° with the horizontal plane utilizing the adjustable support and the hinge.

Light source systems were consisted of 3 circular LED lamps (spectral light was violet light, the dimension of lamp was φ 8 cm with 40 LEDs) and a micro-control system. 3 lamps were symmetrically installed on the light support plate fixed at the inlet, and the lighting inclination angle was to be adjusted. The light modes were controlled to realize the flashing light with 33Hz frequency, the alternating light with 640ms luminous cycle and the constant light, TIP-122 drives to realize the light supplied by 12 V switch direct-current power.

Locus phototoxic response device was composed of phototoxic channel (the geometry dimension was 500× 400× 200 mm) supported by channel support, locus inhabited room (the geometry dimension was 300× 400× 500 mm)supported by inhabited room support. When the inclination angle of the upper channel was adjusted, the phototoxic channel and locust inhabiting room were adjusted to guarantee the horizontal connection smoothly of the phototoxic channel, the trapping inlet and locust inhabited room.

To analyze the influence of the changing illumination on locust phototoxic sliding capture behavior, the distance in the phototoxic channel and in the trapping behavior channel was shown in Fig.1, and the place of light source and the trapping inlet was set as 0'mm and 0mm respectively to show the different illumination. The measured illuminations at the calibrated distance and different distance scope were shown in Table 1 and Table 6.

Experiment procedures: before experiments, the light was adjusted to cover the phototoxic channel. The illumination of light source was calibrated to 103 lx, and the experiments were carried out at 20:00~22:00.

Experiment 1: The trapping channel height was adjusted to be 55, 65 and 75 mm respectively. For each height (55, 65 and 75 mm), the slanting angle combination of the upper channel and the lower was adjusted to be (20° ,45°), (30° ,45°), (45° ,45°) orderly. To each channel height with one slanting angle combination, we prepared one group composed by 30 locusts, to accomplish the experiment. Before the experiment, we opened the light source system to set illumination characteristic as constant light and the channel gate. Then we put locust in the inhabited room, the locust would be induced to present different phototoxic visual behaviors to enter the upper channel, and would be stimulated to present different trapping behaviors in the upper channel. The experiment was repeated with another locust until 30 locusts were tested completely. Simultaneously, the response distance of locust sliding capture behavior was measured in the upper channel. Through this experiment, the influence of the trapping environment characteristic on locust regulatory behavior, the gaining factors and the optimal trapping parameters on locust trapping effect, were to be determined under locust was stimulated by light.

Experiment 2: based on the above test, the trapping channel height and the slanting angle combining the upper channel with the lower channel were optimized, the phototoxic sliding capture effects of 40 locusts stimulated by constant light, flashing light and alternating light were done to determine the influence of different light patterns on locust phototoxic trapping behaviors. For each light mode, one group was prepared to be consisted of 40 locusts, to accomplish the experiment. When the experiment was started, 40 locusts were put in the inhabited room, as well as the channel gate and light sources were opened immediately, and the experiment was repeated 3 times to average the value (the standard error was ± 2.5 ~ 5%). At the inducement of the stimulation, locusts would take on different phototoxic response to enter the upper channel and would present different trapping states. Furthermore, the trapped locusts were gathered by the capture box in the experiment. The course was observed and locust response state was recorded.

In the experiment, the lighting time was 15 min, and the processing interval of every experiment was 20 min.

Experimental data processing: the creeping bounce rate (R_1,%)was used to reflect the difference of locust bouncing behavior in the upper channel, and analyze the influence of locust behavioral response regulated by the lighting and the sliding environment; the impacting rate (R_2,%)of locust bouncing to crash with the top plate in the upper channel was used to reflect the regulation effect and the crashing obstruction effect of the trapping environment; the sliding rate (R_3,%)in the lower channel was to reflect the bounce crash effect on the gaining degree of the capture.

The corresponding formulas: $R_1=(m_1/n)\times 100\%$, $R_2=(m_2/n)\times 100\%$, $R_3=(m_3/m_4)\times 100\%$.

In the formulas: m_1 was the bouncing locusts in the upper channel; m_2 was the impacting locusts bouncing to crash with the top plate; m_3 was the direct sliding locusts after crashing to fall in the lower channel; m_4 was the locusts after bouncing to fall in the lower channel; n was 30 locusts.

According to experiment 2: the sliding capture rate (R_4, %) was used to reflect the direct sliding capture effect regulated by constant, flashing, alternating light; the impacting slippery capture rate (R_5, %)was used to reflect the impacting capture slippery effect after locusts bounced to crash in the upper channel; the total capture rate (R_6, %)was used to reflect the total effect of locust phototoxic sliding capture; the retention rate (R_7, %)was used to reflect the behavioral differences of locust static attachment, turning around crawling and direct slippage in the upper channel.

The corresponding formulas: $R_4=(m_5/n_1)\times 100\%$, $R_5=(m_6/n_1)\times 100\%$, $R_6=(m_7/n_1)\times 100\%$, $R_7=(m_8/n)\times 100\%$ or $(m_9/n_1)\times 100\%$。

In the formulas: m_5 was the average number of the direct sliding locusts; m6 was the average number of the impacting slippery locusts after bouncing to crash; m_7 was the average number of the total trapping locusts; m_8 (m_9)was the average number of locust static attachment, locust turning around crawling and locust direct slippage in the upper channel in experiment 1(in experiment 2); n1 was 40 locusts.

2 Results

2.1 Investigation of locust phototoxic trapping behavior in the upper channel affected by light and the sliding effect

In experiment 1, the changing illumination in phototactic channel was shown in Table 1, locust behavior in the upper channel under the 30° and 20° angle was shown in Table 2 and Table 3, the response degree in the upper channel and locust falling in the 45° lower channel from the upper was shown in Table 4.

It could be known from Table 1 that the illumination in the phototactic channel presented no-rule change and attained to the maximum at 200 mm. According to measurement, 80% locusts were stimulated to bounce and fly off to light source after locust crept to the place of 200 mm, the others were stimulated to lift up the head to generate the phototoxic crawling behavior. Then, locust phototactic vision was stimulated by illumination spurt to in duce the specific behavior, while under the increasing and decreasing illumination at 0～200 mm, locuststill competed for light source, indicating that locust phototoxic visual behavior oriented to light target under the glare effect of locust was stimulated by the illumination at 0～200 mm. That was, the glare effect induced locust to enter the upper channel.

Table 1 Changing rule of illumination in locust phototactic channel under light source is 10^3 lx

The determination of the parameters	The illumination at a certain distance				
The distance in the phototactic channel /mm	0'	0～200	200	200～500	500
Illumination /lx	1000	260～400	1600	600～1200	650

Table 2 Test results of locust behavior in the upper channel under the 30° slanting angle

Table 2-A

Reactive state		Sliding creep distance under channel height /mm	Creeping bounce rate under sliding creep distance /%
Channel	75	85	85
height	65	70	95
/mm	55	60	90

Table 2-B

Reactive state		Bounce impact distance under channel height /mm	Impacting rate under bounce impact distance /%
Channel	75	85	85
height	65	125	90
/mm	55	105	87.5

Table 3 Test results of locust behavior in the upper channel under the 20° slanting angle

Table 3-A

Reactive state		Sliding creep distance under channel height /mm	Creeping bounce rate under sliding creep distance /%
Channel	75	180	80
height	65	165	85
/mm	55	155	90

Table 3-B

Reactive state		Bounce impact distance under channel height /mm	Impacting rate under bounce impact distance /%
Channel	75	225	75
height	65	215	80
/mm	55	195	87.5

Through analyzing Table 2 and Table 3, it could be known that 85% locusts showed the bouncing behavior after sliding to creep some distance in the upper channel. The bouncing locusts all crashed with the top plate, and the differences of the sliding creep distance, the bounce impact distance, the creeping bounce rate, the impacting rate presented extremely significant （F, 0.05）between different channel height. The other showed the static attaching behavior, the turning crawling behavior, the direct sliding behavior after sliding to creep some distance. While in the 45° slanting upper channel, 90% locusts showed the instability of the bounce impact behavior when sliding to creep, and the differences of the impacting rate presented significant （F, 0.05）between the channel height of 75mm and 65, 55mm.

Combined with Table 4, it could be known that the sliding creep distance, the bounce impact distance in the 20° upper channel were the longest and in the 45° upper channel were the shortest under the same channel height. While when the channel height was different and the slanting angle was the same, the channel height was the lower and the sliding creep distance as well the bounce impact distance was the shorter. Furthermore, the percentage of the static attaching locusts, the turning crawling locusts and the direct sliding locusts versus the no bouncing locusts in the 45° upper channel was 15%, 10% and 75% respectively, and 10% ～20% locusts sliding to the lower channel from the upper with different slanting angles could not slide completely.

Table 4 Reactive state of locust in the 45° slanting upper channel and in the lower channel

Reactive state		The creeping bounce rate at 50mm in the 45° slanting upper channel /%	The sliding rate in the lower channel which locust slided to lower channel directly from different upper channel /%
The channel height /mm	75	90	80
	65	95	90
	55	95	85

It was measured that the illumination changed from 10 lx to 0.1 lx at 0～150 mm in the upper channel. Thereby, light characteristic which illumination decreased rapidly in the upper channel would affect locust visual detection function under the glare effect stimulated by light source, weaken the behavioral regulation ability under the visual effect. The slanting upper channel lowered the control role of the biological friction of locust, the different slanting degree generated the different control effect which caused the different sliding creep degree. Moreover, the different channel height and the weak light environment generated the inhibitory difference of the top plate on locust movement vision during the behavior movement regulation to generate the space time stimulus response [10,11], intensifying the physiological response to light change and the sliding effect on locust regulatory behavior.

So, the coupling regulating effect of the changing light environment and the slanting channel capture environment, caused more than 85% locusts to generate the bounce impact behavior after sliding to creep. It was found that the bounce impact effect of locust was the optimum when the channel height was 65 mm.

2.2 Influence of the bounce impact behavior on locust sliding capture

The test result of locust behavior falling to the lower channel from the upper channel after bouncing to impact under the different channel height and the different slanting upper channel was shown in Table 5.

It could be known from Table 5 that the direct sliding rate in the lower channel, to which locust was fallen from the upper after bouncing to impact, was 100%. Combined with Table 2 and Table 3, it could be known that the impacting rate was the highest and the trapping effect caused by the impacting effect was the best under the 45° upper channel and the channel height of 65 mm. While the bounce impact distance was the shortest under the combination of the 30° upper channel and the height of 55 mm. Thus, the channel height restricted to realize locust impacting capture effect regulated by the slanting upper channel. While the impacting effect regulated by the 30° upper channel was superior to the 20° upper channel, and the impacting effect caused 100% direct slippage in the 45° lower channel.

Therefore, the 45° lower channel which undertook the falling locust from the upper played the role of sliding guide, and the folded channel could avoid the influence of light on the trapped locust, thereby, the slanting upper channel regulated locust to generate the bounce impact behavior gaining the phototactic sliding capture effect.

Table 5 Test result of the sliding rate in the lower channel after impacting in the upper channel /%

Reactive state	Channel height /mm		
	75	65	55
The sliding rate /%	100	100	100

Through measuring and comparing, when the channel height and the slanting combination angle of the upper channel and the lower was 65 mm and (30°, 45°), locust phototactic sliding capture effect was the better, and the synergistic effect of the bounce impact behavior on locust capture could make the length of the upper and the lower channel shorten to 180 and 200 mm respectively, which facilitated the realization of locust phototactic capture.

2.3 Influence of different light on locust phototactic sliding capture effect

Test result of locust phototactic sliding capture effect caused by different light was shown in Fig.2, The changing state of illumination in the phototactic channel and the upper channel when light source was 10^3 lx was shown in Table 6.

Table 6 The illumination in the phototactic channel and the upper channel under light source is 10^3 lx

Illumination characteristic		Distance in the phototactic channel /mm				Distance in the upper channel /mm	
		0'	0～200	200	500	0	150
The flashing light	Illumination /lx		450～600			10	0.1
The alternating light		$10\sim10^3$	26～400	160～1600	65～650	0.1～10	0.001～0.1

It could be known from Fig.2 that locust phototactic sliding capture effect caused by the flashing light was the best and the constant light was the worst. While the retention rate caused by the alternating light was the highest and the flashing light was the lowest. And the impacting slip capture behavior gaining locust capture effect generated by the flashing light was the optimal, the alternating light was the worse.

According to the experiment observation, locust lifted up its head to respond to the light, and after crawling a certain distance, locust showed the behavior states of bouncing to enter, or flying directly with flapping wing to enter, or crawling to enter the upper channel, or staying in the phototoxic channel. The responding time of the direct flying and straight jumping behavior with flapping wing stimulated by the flashing light was the shortest and the alternating light was the longest. While the regulation effect caused by the alternating light was superior to the constant light which made the trapping effect was slightly better than the constant light. Simultaneously, locust phototoxic response to enter the upper channel stimulated by the flashing light was the better, and the responding time of the bounce impact behavior was the shortest, while the alternating light inhibited the bounce impact behavior and the sliding behavior, and the gathered locusts at the trapping inlet of 80 mm were the more.

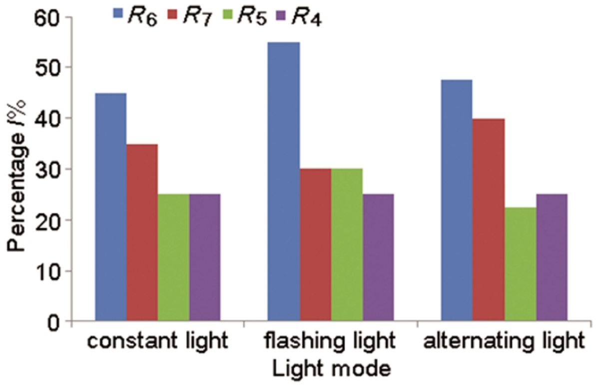

Fig.2 Test results of locust phototoxic slipping and capturing effect under different light

Comparing to analyze Table 1 and Table 6, it could be known that the flashing illumination was more uniform and the alternating illumination presented the periodic change state of light and dark in the phototoxic channel. So, the fusing effect of the flashing pulse light caused the illumination had not changed much, which made the flashing light to form the stronger continuous stimulation effect on locust phototoxic vision, causing locust to generate the stronger sensitive response to light source, while the regulatory change of the alternating light caused locust sensitivity of detecting environment and regulated locust phototoxic visual behavior effectively. Then, locust different phototoxic response and trapping entry behavior indicated the difference of locust phototoxic visual physiology regulation induced by different light. And the stimulation of the slanting slippery capture environment on locust foot, the depressed regulation function of the channel light environment on locust vision [12], the sliding response, aroused locust behavioral response regulation controlled by locust biological friction force. Then the discrepancy of the friction force and the light stimulation of the upper channel, caused the difference of the trapping effect and generated different phototoxic trapping behavior.

3 Discussion

To discuss locust phototoxic sliding capture effect induced by light, the influence and regulatory effect of the channel light environment on locust phototoxic trapping behavior, the analyzing effect figure of the trapping environment on locust was shown in Fig.3.

According to the test results and Fig.3, it could be known that normal force (N), contacting tractive force of mechanical interlock and adhesive attachment (F), contacting friction force (f) and grav-

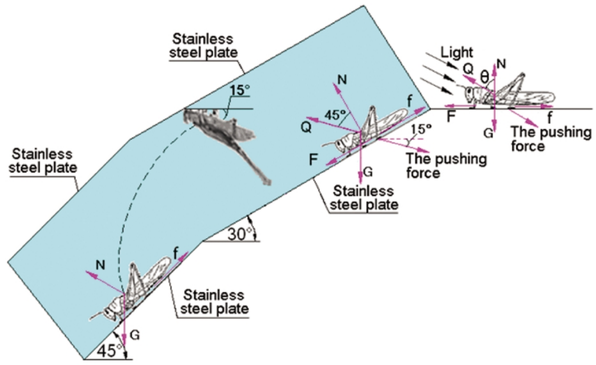

Fig.3 The analyzing effect figure of the trapping environment on locust

ity force (G) on the horizontal surface could ensure locust to adjust the body balance. And light stimulated locust vision system to generate the sensitive excitatory response of the optical nerve, which caused the intense phototoxic behavior. The on-off function of locust vision system inducing the sensitive spectral light intensity signal, and the role of the vision system adjusted by visual pigment to take in spectral energy[13], caused there existed the optimal distance of locust inducing to light stimulation and the most appropriate range of locust vision system accepting the sensitive spectral light energy, which made locust attain to visual acuity to detect external environment optimally [14]. Then, under the visual induction of violet light, locust adjusted its body to make the composite force of the contacting tractive force and the counter force of the pushing force to overcome the contacting friction force [15], and generated the phototoxic behavior. While the sudden increased illumination at 200 mm caused the stimulation effect of spectral light on locust phototoxic vision intensified suddenly which made locust generate different phototoxic behavior, such as the flying behavior with flapping wing, the straight jumping be havior, the phototoxic accelerating behavior, etc., indicating that the sudden increase characteristic of LED light source could make locust generate phototoxic visual disorder to form the dazzling vision and intensify to regulate locust phototoxic visual behavior. Moreover, the increasing and then decreasing of the superimposed LEDs light intensity affected the visual recognition on the induced light environment, and the lag of locust phototoxic dynamic adjustment made light source become visual orienting target when locust moved to light source. Then the physical discomfort of locust phototoxic vision regulated by LED light source made locust seek appropriate place to adjust visual function to detect light source [16], which facilitated locust to enter the trapping upper channel.

And the roughness and stiffness of the 30° slanting stainless steel plate surface could meet locust foot contacting with the plate surface to walk and adjust under the synthetic action of N, F, Q, G and f. While, locust foot contact environment changing from the horizontal surface to the 30° surface made locust adjust to adapt the contact environment controlled by locust contacting friction force. Comparing the bearing force state on the 30° surface with on the horizontal surface, it could be known that G weakened the control effect of locust contacting friction force which made locust walk to slide. And, locust visual light environment in the upper channel changed from 10 lx at 0 mm to 0.1 lx at 150 mm under the constant light which made the sensitive sense of locust vision on the channel light, causing locust to respond to the light of the up per channel inlet. Then, these factors intensified to accelerate locust to regulate behavior.

Through analyzing the bearing force state of locust on the 30° slanting surface, it could be known that the realization of locust regulatory behavior had to increase the biological friction control role to weaken Gsin30° through regulating to lower the contacting tractive force by claws and pads, the pushing force, and improve the normal force, which made the force balance state of locust was F+Gsin30° +Qsin45° +f=0 when locust walked to regulate. While, locust visual guidance function declined by the decreasing illumination affected locust could not control the regulatory behavior effectively, then, locust generated different trapping behavior to avoid the bad stimulation.

On the one hand, locust generated the direct sliding behavior; on the other hand, locust generated the static adhesion behavior through regulating to increase the control effect of the contacting friction force by enlarging the contacting area with body when the control function claws and pads could not stop walking to slide, or turned to respond to light with the self-control of locust. In addition, it was caused to generate the bounce behavior when locust regulated to adapt channel capture environment. Through analyzing Fig.3, it could be known that the bounce behavior was caused by the increasement of the pushing counterforce under the body balance state and presented 45° with the 30° surface. The weak light environment in the upper channel and 65 mm channel height inhibited the required visual detector sensitivity in the bounce, which caused locust could not detect bounce path [17] and crashed with the top plate.

Then, locust bounce impact transient effect blocked the bounce escape, and the transient impact effect affected the control on self-motion and the judgment on spatial orientation, which weakened the adjusting and balancing function of locust body[18], thus, the bounce impact effect made locust fall on the lower channel. According to figure 4 and experiment observation, the direct slippage in the lower channel of locust after bouncing to impact in the upper channel indicated the falling effect affected locust to regulate its behavior completely on the 45° surface, which made the bearing force state was μmg cos 45° <mg sin 45° . Therefore, the bounce impact behavior in the upper channel generated the gain effect on locust sliding capture and the lower channel played the sliding guide role on locust sliding capture.

In addition, The experiment indicated that the coupling property of the flashing light with frequency of 33 Hz and the alternating light with 640 ms luminous cycle could synergy the regulatory effect of the trapping environment and increase the phototoxic trapping effect.

While the more retention phenomenon in the experiment under different light affected to realize the synergistic effect of the sliding bounce impact behavior on locust phototoxic sliding trap. Then, the regulatory stimulus measure realizing locust phototoxic sliding bounce impact behavior effectively must be added.

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蝗虫光电诱导滑移捕集调控行为的研究 *

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摘要 目的：为获得蝗虫捕集装置的优化参数，给蝗虫灾害机械化捕集装置研制提供技术支持。**方法：**针对近光激发蝗虫趋光特性，利用蝗虫光电诱导滑移捕集行为装置，测试了机械捕集物理环境中蝗虫滑移捕集行为特征，分析了捕集光照环境及其物理特征引起的蝗虫生物摩擦行为对滑移捕集的影响，探讨了蝗虫趋光滑移捕集的增益因素及机理。**结果：**LED 光源恒定光照突变特性，对蝗虫趋光视觉行为的调控，易化了趋光捕集实现，而通道光照及倾斜捕集环境特征，强化了其行为响应，产生了增益捕集实现的滑移弹跳碰撞捕集行为，且当通道高度及上、下层通道倾角组合为 65 mm 和(30°、45°)时，捕集作用效果最佳；通道内微弱光照环境，对蝗虫运动视觉的抑制性突变刺激，有效调控了生物摩擦控制下的响应调节，产生了或滑移或滑移弹跳碰撞捕集行为，且上层通道对蝗虫弹跳碰撞阻碍效应及下层通道滑移的导引作用，有助于蝗虫趋光捕集的快速实现；30 ms 发光间隔频闪光照激发蝗虫趋光捕集效果较优，640 ms 发光周期交变光照调控蝗虫行为反应效果较佳。**结论：**试验中，频闪交变及恒定捕集光照环境调控蝗虫生物摩擦控制下滑移行为响应的敏感性，制约了捕集效果，则需利用频闪交变耦合光照的激发特性，结合通道结构组合的最佳捕集参数，增加有效激发捕集通道内蝗虫滑移弹跳行为的调控性措施，来提高蝗虫的趋光捕集效果。

关键词：虫害治理；趋光效应；光电诱导；滑移捕集；行为调控；蝗虫
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