DESIGN, DEVELOPMENT AND DEPLOYMENT OF LIGHTING EFFECT COUPLED GADGET FOR PEST MANAGEMENT

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Abstract

The design and development of lighting effect coupled gadget is mandatory for pest management. The deployment and efficacy evaluation of the gadget is also mandatory for effective, eco friendly and economically feasible pest management. In the present research, the lighting effect coupled gadget was designed and developed for the management of insect pests through non-direct control strategies those would not allow toxic residues on commodities. It was deployed for the management of the insect pests through eco-friendly strategies those would not allow hazardous effects on environment. The experiments were conducted in the deployed gadget that had feed containers in which 50 zero day old eggs of insect pest namely R.dominica were kept in different L/D conditions. The research outcomes showed that the number of eggs hatched varied from 5 to 14, 3 to 13, 2 to 7, 1 to 6, and 1 to 6 with variations in hours of exposures of lighting effect such as 24, 48, 72, 96 and 120 hours respectively in diverse L/D conditions. They also showed that the number of eggs hatched varied from 1 to 5, 1 to 5, 1 to 8, 3 to 11, 3 to 8, 3 to 8, 3 to 8, 2 to 9 and 5 to 14 with variations in diverse combination of tenures of light and dark conditions. They as well showed that the hatching failure index had the minimum of 0.05 and the maximum of 0.74 in diverse L/D conditions. As the design, development and performance of lighting effect coupled gadget was satisfactory, it could be concluded that the present gadget would be scaled up with the same user friendly designs, eco friendly measures and cost effective materials so as to have pest management in stored grains. As the impacts of lighting (L/D cycle) on various life stages of pest were found to be substantial, it could also be concluded that the lighting effect would be used in the management of R.dominca in stored grains.

Keywords: *Lighting effect, Fabrication of gadget, Pest management, Hatching failure index*

Introduction

The stored products comprise the post harvest agricultural foodstuffs that do not demand refrigeration and that can be preserved for specific periods under appropriate conditions as cereal grain and other raw material or processed food (Hori and Suzuki, 2017). The presence of insect pests like the internal feeders of stored grains namely R.dominica causes the qualitative and quantitative damages to these stored products (Hori et al., 2014). At this juncture, it is necessary to have pest management without contaminating the stored products. It is also necessary to have pest management without deteriorating environment (Gururaj, 2005). On these perspectives, the present research was devoted for the management of insect pests by using non-direct control strategies those would not allow toxic residues on commodities. It was also devoted for the management of the insect pests by using eco-friendly strategies those would not allow hazardous effects on environment (Zhang et al., 2011). In this connection, the objectives such as (i) Design and development of lighting effect coupled gadget, (ii) Deployment of lighting effect coupled gadget and (iii) Evaluation of efficacy of lighting effect coupled gadget towards pest management. The standard methodology was adopted and the research outcomes were obtained. The adopted methodology, obtained research results, scientific discussions of research results and drawn conclusions have been presented in this research paper.

Materials and Methods

In the present research, the physical factor namely lighting effect due to its easiness, effectiveness and eco-friendliness for applications was selected (Paliwal et al., 2004). It was applied in an experimental set up that was designed in specific dimensions for carrying out the experiments. The experimental set up was developed with suitable materials and it was deployed for the management of the insect pest namely *R.dominica*.

In the case of design of gadget, the integrated cylindrical chambers with necessary accessories for pest management were designed. It was designed in such a way that the LED light could be accommodated inside the

cylindrical chamber so as to provide sufficient lighting on the contents of the container. It was also designed in such a way that small plastic vials could be appropriately fixed at the bottom of the inner side of the cylindrical chamber so as to keep the broken wheat kernels as feed materials during the experimentation on *R.dominica* (Abbas and Nouraddin, 2011). As far as the development of gadget was concerned, the commercially available zinc sheets were used for the fabrication of cylindrical chamber. These sheets were made into nine numbers of cylindrical chambers with internal arrangements for holding light, keeping plastic culture containers with samples and having special provisions for handling containers with different LD cycles (Meenakshi and Srivatsava, 2010). While the LED light was fixed at the top side of the chamber, the plastic culture containers with feed materials were fixed at the bottom side of the chamber. It is noteworthy to mention here that the upper parts of the culture container were closed with muslin clothes so as to have infiltration of lighting through the cloth. The infiltrated lighting could fall uniformly on the wheat kernels with desirable period of exposure.

As it is known, the insect pest *R.dominica* survives in a totally dark environment. So, it is essential to test the survival of *R.dominica* in complete dark environment. In contrary, it is also essential to assess its survival in complete light environment. In this connection, the L/D (L denotes Light and D denotes D) conditions such as 24/0, 21/3, 18 /6, 15/9, 12/12, 9/15, 6/18, 3/21 and 0/24 L/D were maintained manually in all the experimental chambers with variations in the exposures of presence and absence of light and the impacts of L/D conditions with reference to number of hating of eggs, percentage of hatchability of eggs and index of hatching failure were experimentally assessed. In the case of 24 / 0, 21/3, 18 /6 LD cycles, the LED light in the chamber was switched on at 12:00 mid night, 3:00 a.m and 6:00 a.m. respectively and it was switched off in all the LED set ups at 12:00 mid night. As far as 15/9, 12/12, 9/15 LD cycles were concerned, the LED light in the chamber was switched on at 9:00am, 12:00 pm and 3:00 pm respectively and it was switched off in all the LD set ups at 12:00 mid night. With reference to 6/18, 3/21 and 0/24 cycles, the LED light in the chamber was switched on at 6:00 pm, 9:00 pm and 12:00 am respectively and it was switched off in all the LD set ups at 12:00 mid night. The containers of 50 ml capacity with wheat kernels were kept inside the gadget and they were exposed to different L/D conditions. The observed biological parameters were recorded and they have been tabulated.

Results and Discussion

The present research was devoted not only to design, develop and deploy the lighting effect coupled gadget but also to evaluate the efficacy of lighting effect coupled gadget towards pest management. The research outcomes pertaining to technical specifications of the lighting effect coupled gadget have been presented in Table 1. At the same time, the impact of lighting on initial life stage of pest with variations in exposure of light and impact of lighting on the hatchability of eggs have been presented in Table 2 and Table 3 respectively.

Table 1 Technical specifications of lighting effect coupled gadget

	Dimensions (in mm) / materials
Length of the gadget	40 mm
Diameter of the bottom of gadget	10 mm
Thickness of sheet used in gadget	1 mm
Material of sheet used in gadget	Zinc
Watts of bulb	9 W
Luminous intensity	825 Candela
Bottom side insulation	Poly Urethane Foam
Upper side gasket	Ethylene Propylene Diene Monomer rubber

Table 2 Effect of lighting with variations in duration of exposure of light

L/D tenure	Number of hatching of eggs in different durations of exposure of light (in No.)				
	In 24 hours of exposure of light	In 48 hours of exposure of light	In 72 hours of exposure of light	In 96 hours of exposure of light	In 120 hours of exposure of light
24/0	5	3	2	1	1
21/3	5	3	2	2	1
18/6	8	3	3	2	1

15/9	10	4	3	4	2
12/12	8	5	5	4	3
9/15	8	8	4	2	4
6/18	8	4	3	3	6
3/21	9	4	3	2	6
0/24	14	13	7	6	5

Table 3: Effect of lighting on the hatchability of eggs

L/D tenure	Hatchability of eggs		Hatching failure index
	Number of eggs (No.)	Percentage of eggs (%)	
24/0	13	26.6	0.74
21/3	19	33.6	0.62
18/6	25	49.2	0.49
15/9	24	48.1	0.49
12/12	26	52.0	0.46
9/15	34	68.3	0.29
6/18	39	78.6	0.18
3/21	45	90.6	0.05
0/24	48	95.4	0.05

In the present research, a total number of 50 zero day old eggs were kept in the feed containers of gadget and they were exposed to different L/D conditions. The observations on database showed that the number of eggs hatched varied from 5 to 14, 3 to 13, 2 to 7, 1 to 6, and 1 to 6 with variations in hours of exposures of lighting effect such as 24, 48, 72, 96 and 120 hours respectively in diverse L/D conditions. They also showed that the number of eggs hatched varied from 1 to 5, 1 to 5, 1 to 8, 3 to 11, 3 to 8, 3 to 8, 3 to 8, 2 to 9 and 5 to 14 with variations in diverse combination of tenures of light and dark conditions. They as well showed that the hatching failure index had the minimum of 0.05 and the maximum of 0.74 in diverse L/D conditions. The ANOVA results showed significant variations in the hatchability of eggs with diverse L/D conditions. As an affirmation of this statistical result, the Tukey analysis also indicated that there were significant differences in the hatchability of eggs with diverse L/D conditions.

The research outcomes of the present research revealed that there was reduction in the number of hatching of eggs in the experimental set up with increase in exposure duration of lighting effect (Siderhurst et al., 2006). They also revealed that there was reduction in the percentage of hatching of eggs in the experimental set up with increase in the tenure of light in L/D conditions (Ghanem and Shamma, 2007). The number of egg hatching in varied L/D conditions could be correlated to the wavelength of light, intensity of light and appropriate direction of light (Hori et al., 2014. It could also be correlated to tenures of darkness, tenures of lighting effect and power of illumination (Parveen et al., 2004; Blackmer et al., 2002). At the same time, it could be attributed with the design of experimental set up, development of experimental set up and artificial environment to the pest. It could also be attributed with thinness of chorion, delicateness of egg, rhythmic pattern of hatching of egg, embryonic injury to the peripheral parts of egg, defective developmental process in egg and lethal effect of light (Claudio R.Lazzari and Teresita C.Insausti, 2008).

Conclusions

As the design, development and performance of lighting effect coupled gadget was satisfactory, it could be concluded that the present gadget would be scaled up with the same user friendly designs, eco friendly measures and cost effective materials so as to have pest management in stored grains. As the impacts of lighting (L/D cycle) on various life stages of R.dominca were found to be substantial, it could also be concluded that the lighting effect would be used in the management of R.dominica in stored grains.

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