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BEHAVIOURAL RESPONSE OF STORED PRODUCT INSECTS TO LIGHT AND BAIT SOURCES IN PADDY STORAGE GODOWN

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ABSTRACT

This study was carried out at the Central Farm, Agricultural College and Research Institute, Madurai, from July to August 2021. Behavioural response of lesser grain borer *Rhyzopertha dominica,* red flour beetle *Tribolium* spp. and Angoumois grain moth *Sitotroga cerealella* to different light and bait sources revealed that the incandescent light 25W was effective with *R. dominica* (17.08%), *Tribolium* spp. (9.28%) and *S. cerealella* (2.98%) followed by compact fluorescent light (CFL) 18W attracting *R. dominica*, *Tribolium* spp. and *S. cerealella*. The least trapping efficiency was observed with CFL 15W and light emitting diodes (LED) 20W lights. The behavioural response to bait when analysed revealed that maximum attraction was observed in wheat flour 41.41% followed by cracked sorghum (32.14%), sorghum flour (24.09%) and pearl millet flour (24.08%).

Key words: Paddy godown, bait and light trap, *Rhyzopertha dominica*, *Tribolium* spp., *Sitotroga cerealella*, incandescent, CFL and LED lights, wheat flour, attraction, monitoring

Phototactic response is an important tool in IPM programme (Nirmal, 2015). Insect pest control in stored grains is critical for the management of food products, post-harvest grains and processed foods (Kim et al., 2010). These insects have the potential to severely degrade the quality, commercial value, weight and seed viability of stored grains (Dal Bello et al., 2000). The most destructive insects of cereals in storage are the lesser grain borer *Rhyzopertha dominica*, rice weevil *Sitophilus oryzae*, red flour beetle *Tribolium* spp. and Angoumois grain moth *Sitotroga cerealella* (Kim et al., 2010; Ahamed and Raza, 2010; Duehl et al., 2011; Ahmad et al., 2013). Light traps are used to control insects in other stored product insects such as the cigarette beetle *Lasioderma serricorne*, and the Indian meal moth *Plodia interpunctella* (Samburaj and Phillips, 2008). Incandescent and black lights have wide wavelength and low electric efficiency, while more efficient light sources such as light-emitting diodes (LED) could be used for making insect light traps (Cohnstaedt et al., 2008). Detection of insect incidence using bait traps with pheromones or food attractants or a combination of pheromone and food attractants may influence IPM (Barak, 1989). Therefore, in the present study, the behavioural response of *R. dominica*, *Tribolium* spp. and *S. cerealella* to LED, CFL and incandescent lights and food baits was evaluated under storage condition.

MATERIALS AND METHODS

The study was conducted at the Central Farm storage godown (14.5x 6.5x 3.5 m), Agricultural College and Research Institute, Madurai during July to August 2021. The light trap setup consisted of a plastic plate (35 cm dia) on top and a plastic funnel on the bottom, which was linked to the top plate via PVC pipes fastened to it. The light source was positioned in the centre of the top plate. To secure the insects, a polythene cover was tied to the funnel. The entire setup was hung upside down in the godown. The experiment was done using LED, CFL and incandescent light traps of different electrical power of 15, 18, 20 and 25W with an untreated control of trap without light. The light traps were operated for 12 hr from 6 pm to 6 am in all the week days and observed for the number of insects trapped. The trap catches were recorded for 35 days (5 standard weeks). All the light traps were installed at 2 m above the ground level. Insects attracted in each trap were observed and sorted out based on major species. The insects collected in the collection bag were killed by exposure to ethyl acetate. The number of *S. cerealella*, *R. dominica* and *Tribolium* spp. were counted and the trapping efficiency of light sources was calculated using the formula (Dangi, 2004)-

$$\text{Trapping efficiency (\%)} = \frac{\text{Number of a particular species}}{\text{Total number of all species}} \times 100$$

Food materials were cracked and crushed grains and flours of sorghum, wheat, groundnut, rice, maize pearl millet and rice bran were taken and filled in the polythene receptacles of probe trap-like structure which was made of rustproof metal, hollow cylinders of 23 and 5 cm long and dia, respectively; and with 280 evenly spaced 4 mm hole which can hold 50 g food bait, with one end closed by a removable cap. The bait traps filled with 50 g of materials were inserted into the interspace between the staked bags for the insects to drop into the bottom part of the polyethene receptacle attached with traps. The trap catches were recorded for 25 days and the attraction index was calculated using the formula (Smith et al., 1993): Attraction Index (%) = ((T-C)/N) x100, where T- no. of insects attracted in treatment; C- No. of insects trapped in the control; and N- Total no. of individuals. The attraction index and the difference in the behavioural response/ orientation of the insects were analysed using completely randomized design (CRD) by one-way ANOVA subjecting the data to arcsine transformation and were separated by using Duncan's Multiple Range Test (DMRT) with SPSS 22.0 software and the differences were regarded as significant at $p < 0.05$ (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Trapping of insect pests of stored paddy observed using different light and bait sources and the relative insect trapping efficiency of various light sources was analysed. The weekly insect trapping efficiency of incandescent light 25W was found to be the maximum for *R. dominica* (17.08%), *Tribolium* spp., (9.28%) and *S. cerealella* (2.98%) followed by CFL 18W 14.98%, 8.60% and 2.32% of *R. dominica*, *Tribolium* spp. and *S. cerealella*, respectively; the lower attraction was due to CFL 15W viz., 3.91, 2.41 and 1.87% of *R. dominica*, *Tribolium* spp. and *S. cerealella,* respectively; while due to LED 20W the attraction was 3.44, 2.54 and 1.33% of *R. dominica*, *Tribolium* spp. and *S. cerealella,* respectively (Table 1). The results indicate varied attraction indices of insects in bait sources. The attraction of *S. cerealella* towards wheat flour was 23.44% followed by pearl millet flour (9.81%) and rice bran + rice flour (9.55%). A least attraction of *S. cerealella* was observed in sorghum flour (4.80%); *R. dominica* was attracted more in cracked sorghum bait (11.72%) followed by pearl millet flour (9.95%) and rice flour (4.23%). For *Tribolium* spp. higher attraction

Table 1. Trappings of storage pests in light sources

Light sources	Insects collected	No. of insects trapped/trap/week* 28 SW	29 SW	30 SW	31 SW	32 SW	Total	Trapping efficiency (%)
LED 15W	*Rhyzopertha dominica*	22.67	24.33	97.00	75.33	66.00	285.33	7.05
	Tribolium spp.	13.67	21.67	28.00	31.67	25.67	120.68	2.98
	Sitotroga cerealella	4.67	6.33	15.00	13.00	13.67	52.67	1.30
CFL 15W	*Rhyzopertha dominica*	13.67	15.67	34.33	51.67	42.67	158.01	3.91
	Tribolium spp.	9.00	10.33	23.67	29.00	25.67	97.67	2.41
	Sitotroga cerealella	19.00	14.67	10.00	16.00	16.00	75.67	1.87
Incandescent 15W	*Rhyzopertha dominica*	96.33	88.00	71.00	74.33	64.00	393.66	9.73
	Tribolium spp.	13.00	29.67	40.67	40.00	34.33	157.67	3.90
	Sitotroga cerealella	10.00	4.67	14.00	17.67	16.67	63.01	1.56
LED 20W	*Rhyzopertha dominica*	9.00	14.00	26.67	45.00	44.33	139	3.44
	Tribolium spp.	8.33	15.67	24.67	30.00	24.00	102.67	2.54
	Sitotroga cerealella	3.00	7.33	12.00	14.33	17.33	53.99	1.33
CFL 18W	*Rhyzopertha dominica*	128.33	120.67	121.00	117.00	119.00	606	14.98
	Tribolium spp.	79.67	73.00	73.33	61.00	61.00	348	8.60
	Sitotroga cerealella	14.33	9.33	16.33	23.67	30.00	93.66	2.32
Incandescent 25W	*Rhyzopertha dominica*	90.33	139.67	172.67	150.67	137.67	691.01	17.08
	Tribolium spp.	62.67	68.33	89.67	82.33	72.33	375.33	9.28
	Sitotroga cerealella	13.67	13.33	22.67	32.00	39.00	120.67	2.98
Control (No light)	*Rhyzopertha dominica*	5.33	8.00	14.67	13.00	13.33	54.33	1.34
	Tribolium spp.	3.00	5.33	7.00	9.33	9.00	33.66	0.83
	Sitotroga cerealella	1.67	3.00	5.00	5.67	6.67	22.01	0.54
Grand total							4044.7	100.00

*Mean of three replications; SW-Standard week index to cracked sorghum was 13.72% followed by sorghum flour (11.72%) and the least attraction of *Tribolium* spp. was observed in rice flour (3.66%) (Table 2).

Jeon et al. (2011) observed the behavioural response of the rice weevil *Sitophilus oryzae* to LED at different intensities and wavelength and observed greater number of weevils getting attracted to blue wavelength (84.3%) followed by green, red, UV and IR. In the present study, LED attracted the least number of insects compared with incandescent and CFL lights. Ultraviolet light 4W installed 1.5 m above ground level in the corners and alleyways of a rice warehouse, combined with the use of a bait trap, accurately detected the presence of lesser grain borer, resulting in timely insecticidal treatment (Mohan et al., 1994). The attraction of *R. dominica*, *S. cerealella*, *T. castaneum* and *S. zeamais* to light traps (6W blacklight-blue) was evaluated by Nualvatna et al. (2003). The blacklight was preferred by *R. dominica* over the blacklight-blue and green incandescent lamps. The incandescent 25W was attractive to *R. dominica*, *Tribolium* spp. and *S. cerealella* (29.69, 30.37 and 25.05% respectively), followed by CFL 18W (with attraction of 26.04, 28.16 and 19.45%, respectively) (Table 2).

Phototactic response of *T. castaneum*, *S. zeamais* *Lasioderma serricorne* and *Tyrophagus putrescentiae* to red LED, and *S. cerealella* and *S. oryzae* to blue LED was reported by Park et al. (2017). Present study is in conformity with the findings of Song et al. (2016) who studied the attraction of *T. castaneum* and *S. zeamais* to LED in the granary and the attraction with black light bulb (BLB) trap and red LED attracted more *T. castaneum* and *S. zeamais* than BLB. Phototactic behavioural responses of the Indian meal moth *Plodia interpunctella* to seven wavelengths of light-emitting diodes (LEDs); the green LED to *P. interpunctella* adults was approximately 1.81x more attractive than black light bulb (BLB) as reported by Park and Lee (2016). The attractiveness of wheat flour to *S. cerealella* observed now is comparable with earlier studies indicating that larger grain borer *Protephanus truncatus* and *R. dominica* were attracted towards cereal host odour (Bashir et al., 2001; Edde and Phillips, 2006). Cracked wheat alone had attracted *S. zeamais* six times more than *S. oryzae* (Likhayo and Hodges, 2000). Maximum attraction of *R. dominica* (11.72%) and *Tribolium* spp. (13.72%) was observed due to some attractive compounds present in the cracked sorghum and *S. cerealella* to wheat flour (23.44%) and pearl

Table 2. Response of stored product insects to bait and light sources

Attractants	*Relative attraction index (%)			Total attraction index (%)	Light sources	*R. dominica*	*Tribolium* spp.	*S. cerealella*	Insect response (%)
	S. cerealella	*R. dominica*	*Tribolium* spp.						
Crushed groundnut	5.00 (12.92) ^{f}	8.46 (16.91) ^{d}	9.11 (17.57) ^{d}	22.57	LED 15W	12.26 (20.50) ^{d}	9.77 (18.21) ^{d}	10.93 (19.31) ^{e}	32.96
Wheat flour	23.44 (28.96) ^{a}	7.53 (15.93) ^{ef}	10.44 (18.85) ^{c}	41.41	CFL 15W	6.79 (15.10) ^{e}	7.90 (16.33) ^{e}	15.71 (23.35) ^{c}	30.40
Cracked corn	7.82 (16.24) ^{c}	9.62 (18.07) ^{c}	4.32 (11.99) ^{g}	21.4	Incandescent 15W	16.92 (24.29) ^{c}	12.76 (20.93) ^{c}	13.08 (21.20) ^{d}	42.75
Sorghum flour	4.80 (12.65) ^{f}	7.57 (15.97) ^{e}	11.72 (20.02) ^{b}	24.09	LED 20W	5.97 (14.15) ^{e}	8.31 (16.75) ^{e}	11.21 (19.56) ^{e}	25.49
Rice flour	5.75 (13.87) ^{e}	4.23 (11.87) ^{h}	3.66 (11.02) ^{h}	13.64	CFL 18W	26.04 (30.68) ^{b}	28.16 (32.05) ^{b}	19.45 (26.17) ^{b}	73.65
Pearl millet flour	9.81 (18.25) ^{b}	9.95 (18.39) ^{b}	4.32 (11.99) ^{g}	24.08	Incandescent 25W	29.69 (33.02) ^{a}	30.37 (33.44) ^{a}	25.05 (30.03) ^{a}	85.12
Rice bran	7.72 (16.13) ^{c}	5.52 (13.58) ^{g}	6.98 (15.32) ^{e}	20.22	Control	2.33 (8.79) ^{f}	2.72 (9.50) ^{f}	4.57 (12.34) ^{f}	9.63
Rice bran + Rice flour	9.55 (18.00) ^{b}	7.21 (15.58) ^{f}	5.36 (13.39) ^{f}	22.12	-	-	-	-	-
Cracked sorghum	6.70 (15.01) ^{d}	11.72 (20.02) ^{a}	13.72 (21.74) ^{a}	32.14	-	-	-	-	-
Control	0.00** (0.52) ^{g}	0.00 (0.52) ^{i}	0.00 (0.52) ^{i}	0.00	-	-	-	-	-
SEd	0.297	0.153	0.159	-	-	0.558	0.347	0.283	-

*Mean of three replications; **Figures in parentheses arc sine transformed values with formula: 1/4n for 0%; Mean followed by same letter (s) in a column not significantly different by DMRT (p=0.05) millet flour (11.65%). These results are in line with earlier findings in which *R. dominica* was getting attracted to wheat flour (Ahmad et al., 2013). The trapping efficiency of different light sources observed now demonstrate that these sources can be used as a tool in IPM, and sorghum and pearl millet flour can be exploited for monitoring and mass trapping of insect pests in rice godowns.

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