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Orientation of *Caryedon serratus* (Oliver) towards Various Colour Lights and Scents

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Orientation of *Caryedon serratus* (Oliver) towards various colour lights and scents was evaluated at Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh in which it was found that the chronological order of orientation of *C. serratus* adults to various colour lights was dark > blue > indigo> white > green > yellow > red and that for various scents/perfumes was jasmine >borsali>nargis> rose > sandal wood> marigold >kevdo.

Keywords: Bruchid; Caryedon serratus; groundnut; light; scent.

1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.), is an annual prostrate herbaceous legume native to South America [1], belongs to plant family Fabaceae and subfamily Papilionaceae. The area under groundnut cultivation in India during 2014-15 was 4.68 million hectares with production of 6.56 million tonnes and productivity of 1400 kg ha^{-1} [2].

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Groundnut is cultivated in all the districts of Gujarat State; however, about 82 per cent area is covered by Junagadh, Rajkot, Amreli and Surendranagar districts of Saurashtra region. The area under groundnut cultivation in Junagadh district during 2014-15 was 2.26 lakh hectares with production of 6.52 lakh tonnes and productivity of 2889 kg ha^{-1} [3].

During storage, groundnut pods per seeds are susceptible to the attack of many insect pests including groundnut seed beetle (Bruchid), *Caryedon serratus* (Olivier). The grubs of *C. serratus* mostly cause damage to the kernels [4]. Pest control strategy is mainly based on chemical pesticides ultimately environmental hazards are arising fast. Highly toxic chemical pesticides are being added in to agro-ecosystem, which are damaging for all living beings. This situation invites the attention of scientists to devise some non-chemical pest control technologies.

Orientation of insects toward light in the darkness of night (Phototropism) can be exploited to kill them mechanically. Many of the insect species, mostly nocturnal, are known to be positively phototrophic and attracted towards artificial lights in large numbers [5]. Entomologists have used this phenomenon since long to capture night flying insects in a device called light trap. Light traps can be used to monitor and suppress certain pest species. In western countries, light traps have been successfully used against house hold pest but, this technology has been hardly tried under storage. This study has been conducted to identify the most effective light spectrum, which could attract higher number and diversity of insects on a screen at night [6]. Therefore the study was taken up to test orientation of *C. serratus* towards various light intensities and scents.

2. METHODOLOGY

Laboratory experiment was conducted for the evaluation of orientation of *C. serratus* to various colour lights and scents at Department of Entomology, College of Agriculture, JAU, Junagadh during 2013-14 in Completely Randomised design (CRD) fashion comprising of 4 replications having following seven treatments was taken up.

2.1 Colour Light Test

Six types of colour lights (red, yellow, green, white, indigo and blue) were tested. The bulb (60 wt.) wrapped with each thin respective colour papers or plastic was arranged in crescent position at in fixed distance (1 m) at the equal distance of the insect release poll. Hundred adults confined in plastic jar were kept in centre and allowed to liberate. Number of adults attracted to each colour light was recorded. This test was repeated four times. Following this procedure, different colour radium strips (red, yellow, green, white, indigo and blue) of which each strip wrapped on light bulb was also be tested to determine the attraction of *C. serratus* adults. Data thus obtained were analysed statistically under SPSS programme.

2.2 Scents Test

For studying the orientation of *C. serratus* different chemical scents or perfume available in market was tested. The cotton treated with the known amount of 0.3 ml *i.e.* 2-3 small drops of the respective scents/ perfume were placed in a small petridish. These dishes were attached with the large Petridish in the centre. 25 pairs of *C. serratus* adults were released in large petridish. Number of the adults attracted to the respective scent treatments will be recorded. Each treatment was repeated four times after 3-4 h interval and dissented room air the data thus obtained were analysed statistically under SPSS programme.

Table 1. The details of various colour lights used for experiment

S. N.	Colour lights	Wavelengths (nm)	Frequency (thz)
1	Red	750-610	480-405
2	Yellow	590-570	530-510
3	Green	570-500	580-530
4	White	400-700	750-429
5	Indigo	450-425	670-700
6	Blue	500-450	670-600
7	Dark (Control)	370-350	0

Table 2. The details of various scents/perfume used for experiment

S. N.	Various scents/perfume	Scientific name
1	Garden marigold	*Tagetes erecta* (L.)
2	Maulsari	*Mimusops elengi* (L.)
3	Jasmines	*Jasminum officinalis* (L.)
4	Kewada	*Pandanus fasicularis* (L.)
5	Rose	*Rosa spp.* (L.)
6	Sandal wood	*Santalum album* (L.)
7.	Nargis	*Narcissus poeticus* (L.)

3. RESULTS

3.1 Orientation of *Caryedon serratus* (Oliver) to Various Colour Lights over a Period of Time

The data obtained while conducting laboratory experiment was conducted for the evaluation of orientation of *C. serratus* to various colour lights and scents at various intervals is present in tables hereunder.

3.2 Orientation after 12 h

Data presented in Table 3 revealed that all the colour lights were found effective in orientation of *C. serratus* adults after 12 hours as compared to control. The dark colour light (81.25%) gave better orientation of *C. serratus* result over other all the treatments and red colour light (0.00) found no orientation of *C. serratus* adults. Next to the control (dark colour light), maximum orientation (6.25%) was found in blue colour light, which was closely followed by indigo colour light (5.75%), white colour light (5.50%) and green colour light (2.25).

3.3 Orientation after 24 h

Data presented in Table 3 revealed that all the colour lights were found less effective in orientation of *C. serratus* adults after 24 h as compared to control. The dark colour light (76.25%) gave better orientation of *C. serratus* over all the other treatments and red colour light (0.00) found none orientation of *C. serratus* adults. Next to the control (dark colour light), the maximum orientation (8.00%) was found in blue colour light, which was statistically at par with indigo colour light (6.75%) and white colour light (4.00%).

The chronological order of orientation of *C. serratus* adults to various colour lights based on overall performance was dark > blue > indigo > white > green > yellow > red.

Table 3. Orientation of *Caryedon serratus* (Oliver) to various colour lights after 12 h

T. N.	Colour light	Orientation after 12 h				Orientation after 24 h			
		Average	Min	Max	Attraction (%)	Average	Min	Max	Attraction (%)
T_1	Red	0.00* (0.00)	0	0	0.00	0.00* (0.00)	0	0	0.00
T_2	Yellow	1.21 (1.50)	1	3	2.25	1.47 (2.25)	1	2	1.50
T_3	Green	1.47 (2.25)	2	4	2.75	1.64 (2.75)	1	3	2.25
T_4	White	1.79 (3.25)	3	5	4.00	1.99 (4.00)	2	4	3.25
T_5	Indigo	2.34 (5.50)	6	8	6.75	2.59 (6.75)	5	6	5.50
T_6	Blue	2.50 (6.25)	7	9	8.00	2.83 (8.00)	6	7	6.25
T_7	Dark (Control)	9.01 (81.25)	73	79	76.25	8.73 (76.25)	80	82	81.25
	S.Em.±		0.36				0.35		
	C.D. at 5%		1.06				1.01		
	C.V. %		5.07				4.83		

**Square root transformation; Figures in parenthesis are retransformed values*

3.4 Orientation of *Caryedon serratus* (Oliver) to Various Scents over a Period of Time

In the present investigation, it was found that all the scents showed significant attraction of *C. serratus* adults at concentration of various scents/perfume treatments, which indicated the higher protecting potential of these scents/perfumes against groundnut bruchid damage. The attraction of *C. serratus* over control due to different plant scents/perfume varied significantly.

3.5 Orientation after 30 Minutes

Data presented in Table 4 revealed that all the scents were found significantly lesseffective in orientation of *C. serratus* adults as compared to control. The control treatment (70.75%) gave better orientation result over all the other treatments. Regarding different scents/perfume, the average orientation of *C. serratus* adults' property ranged from 1.50 to 9.00 per cent. Next to the control, maximum orientation (9.00%) was found in jasmine scent, which was at par with borsali scent (6.50%) and nargis scent (6.00%) with same concentration. The lowest orientation of *C. serratus* 1.50 per cent was found by kevdo scent and marigold scent.

3.6 Orientation after 1 h

The data on orientation of *C. serratus* adults recorded after 1 hare furnished in Table 4. All the scents were found effective in orientation of *C. serratus* as compared to control. Treatment of jasmine scent found maximum orientation of 9.75 per cent and it was at par with the treatment of borsali scent (7.00%), nargis scent (6.75%) and rose scent (5.00%).

Application of sandal wood scent (2.25%), kevdo scent (1.75) and marigold scent (1.75%) were in the next least effective group of treatments on the orientation of *C. serratus* adults.

3.7 Orientation after 2 h

The data presented in Table 5 and depicted in Fig. 3 about the orientation of *Caryedon serratus* (Oliver) adults recorded after 2 h revealed that the control treatment found maximum orientation of *C. serratus s* of 55.25 per cent.

Among the different scents, jasmine scent recorded the maximum orientation of *C. serratus* adults of 13.25 per cent and it was at par with the orientation of *C. serratus* 10.75 and 8.25% recorded by borsali scent and nargis scent, respectively.

Table 4. Orientation of *C. serratus* to various colour lights after 24 h

T. N.	Colour light	Wavelength (nm) Frequency (thz)	Orientation after 24 h			
			Average	Min	Max	Attraction (%)
T_1	Red	750-610 (480-405)	0.00* (0.00)	0	0	0.00
T_2	Yellow	590-570 (530-510)	1.47 (2.25)	1	3	2.25
T_3	Green	570-500 (580-530)	1.64 (2.75)	2	4	2.75
T_4	White	400-700 (750-429)	1.99 (4.00)	3	5	4.00
T_5	Indigo	450-425 (670 – 700)	2.59 (6.75)	6	8	6.75
T_6	Blue	500-450 (670-600)	2.83 (8.00)	7	9	8.00
T_7	Dark (Control)	370-350 (0)	8.73 (76.25)	73	79	76.25
	S.Em.±		0.35			
	C.D. at 5%		1.01			
	C.V. %		4.83			

**Square root transformation*

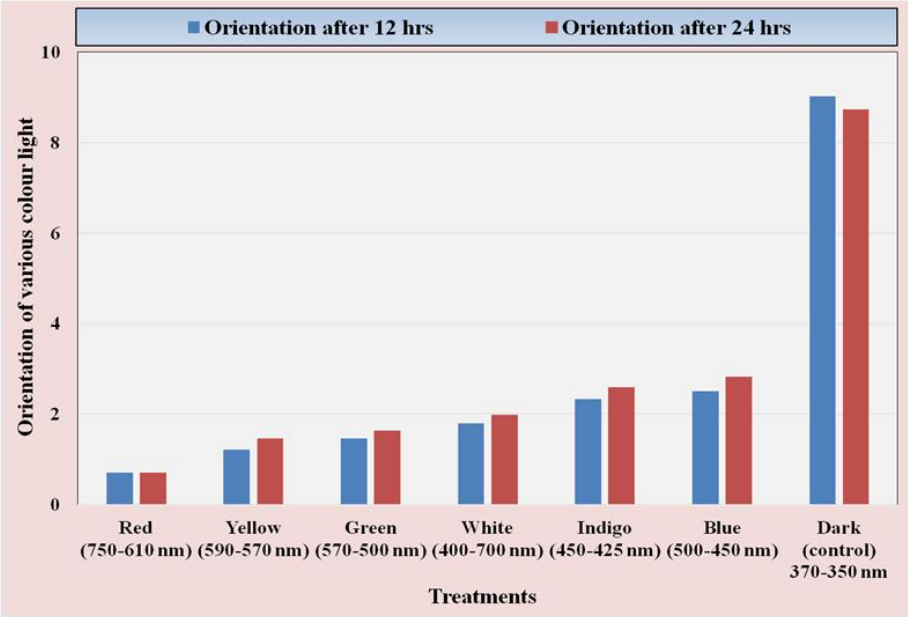

Fig. 1. Orientation of *C. serratus* to various coloured lights at 12 & 24 hrs

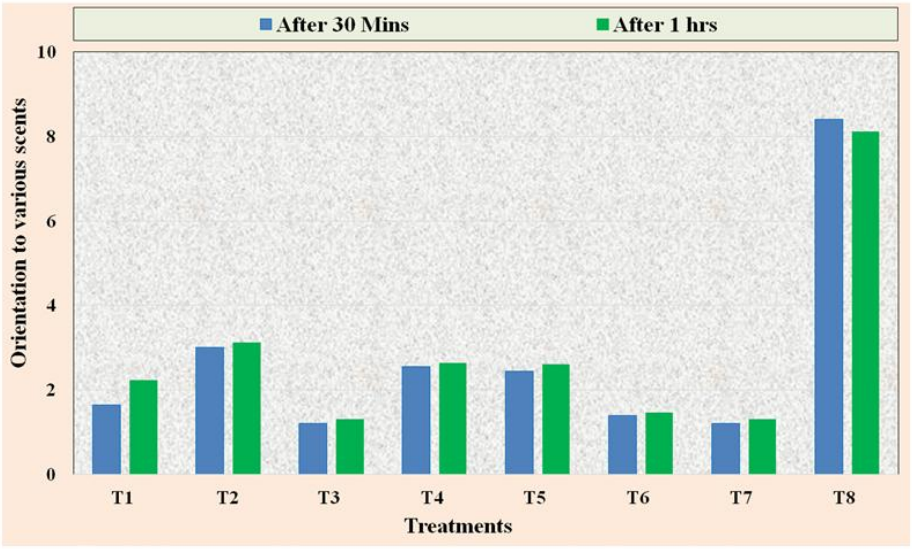

Fig. 2. Orientation of *C. serratus* to various scents after 30 min. & 1 hrs

The minimum orientation of *C. serratus* adults of 1.75 per cent was found by kevdo scent followed by sandal wood scent and marigold scent in which, 2.25 per cent orientation of *C. serratus* adults was recorded.

3.8 Orientation after 24 h

The orientation of *C. serratus* adults Table 5 and depicted in Fig. 3 recorded after 24 h revealed that all the scents were found significantly effective in orientation of *C. serratus* adults as compared to control treatment (43.50%).

Next to the control, jasmine scent found significantly maximum orientation of *C. serratus* adults of 16.50% and it was at par with the treatment of borsali scent (13.50%).

Application of nargis scent, rose scent, kevdo scent, sandal wood scent and marigold scent were in the next lowest effective group of

treatments recorded by 8.75, 8.00, 3.25, 3.25 and 3.00% orientation of *C. serratus* adults, respectively after 24 h.

Thus, the results of the different period of time application of various scents/perfumes against the *C. serratus* found that jasmine scent, borsali scent, nargis scent and rose scent were found more effective treatments on orientation of *C. serratus* adults as compared to other treatments. The chronological order of orientation of *C. serratus* adults to various scents/perfumes based on overall performance was jasmine > borsali > nargis > rose > sandal wood > marigold > kevdo.

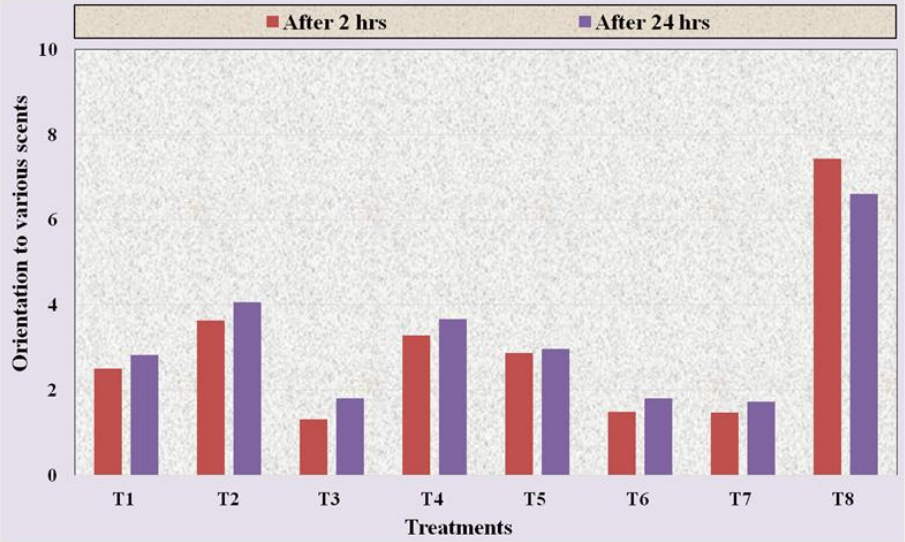

Fig. 3. Orientation of *C. serratus* to various scents after 2 & 24 hrs
Figures in parenthesis are retransformed values

Table 5. Orientation of *C. serratus* to various scents over a period of time

T. N.	Scents	Orientation (%) after period of time			
		30 min	1 h	2 h	24 h
T_1	Rose (*Rosa* spp.)	1.65* (2.75)	2.23* (5.00)	2.50* (6.25)	2.83* (8.00)
T_2	Jasmine (*Jasminum officinale*)	3.00 (9.00)	3.12 (9.75)	3.64 (13.25)	4.06 (16.50)
T_3	Kevdo (*Pandanus fascicularis*)	1.21 (1.50)	1.31 (1.75)	1.31 (1.75)	1.80 (3.25)
T_4	Borsali (*Mimusops elengi*)	2.55 (6.50)	2.64 (10.75)	3.28 (10.75)	3.67 (13.50)
T_5	Nargis (*Narcissus poeticus*)	2.44 (6.00)	2.60 (6.75)	2.87 (8.25)	2.96 (8.75)
T_6	Sandal wood (*Santalum album*)	1.39 (2.00)	1.47 (2.25)	1.49 (2.25)	1.80 (3.25)
T_7	Marigold (*Calendula officinalis*)	1.21 (1.50)	1.31 (1.75)	1.47 (2.25)	1.72 (3.00)
T_8	Control	8.41 (70.75)	8.11 (65.75)	7.43 (55.25)	6.61 (43.75)
S.Em.±		0.36	0.33	0.32	0.37
C.D. at 5%		1.05	0.97	0.94	1.07
C.V. %		5.77	5.29	5.16	5.89

**Square root transformation*
Figures in parenthesis are retransformed values

4. DISCUSSION

The present results get corroborate with the findings of [7] evaluation to the response of insects to varying wavelengths of light. During experiment, lights of six different colours (blue, green, yellow, red, black and white) were tested. All lights were kept on simultaneously for half an hour and the insects attracted on both sides of the screens were collected in tubs containing soapy water. The highest number of insects was observed in container placed under black light (ultraviolet light), while the lowest in that of red light. Similarly, the common insect orders frequented among all colour lights were Diptera, Coleoptera and Lepidoptera, respectively. The experimental results indicated that insects are attracted in more number on lights with short wavelength and high frequency and vice a versa.

It was found that among six species of bruchids, *Bruchus pisorum* (L.) was highly active during the day, the adults flying about freely, consuming the pollen of pea flowers, mating and ovipositing [8]. There was also some activity in darkness. Adults of *Caryedon serratus* (Ol.) avoided light, mating took place at dusk and oviposition usually in darkness. A report suggests that the collections of a light trap provide significant clue to the diversity of insects active at night, their respective affinity to different wavelengths of light and to understand and predict how populations function [9]. The results conducted on groundnut bruchids showed that most of the orders were attracted to blue and black lights [10]. This attraction is merely due to shorter wavelengths and higher frequency while the red light otherwise makes it harder for the insects to detect. Insects have three special eyes, called ocelli, with the specific job of identifying light and not movement [11]. The shorter the wavelengths are easier for the ocelli to detect [10,12].

It was also found that various perfumes were found to be the most effective in *C. serratus* found 50 per cent attraction of adults [13]. Similar results were also observed and reported that orientation property in pulse crop against *Caryedon* spp. and concluded that the scent of forest tree found maximum attraction of *Caryedon* spp [14]. Present findings are also most similar with above workers consequence, slight variation in results may be due to different storage conditions.

5. CONCLUSION

The chronological order of orientation of *C. serratus* adults to various colour lights based on overall performance (after 12 h and 24 h) was dark > blue > indigo> white > green > yellow > red. The chronological order of orientation of *C. serratus* adults to various scents/perfumes based on overall performance (after 30 min, 1 h, 2 h and 24 h) was jasmine >borsali>nargis> rose > sandal wood> marigold >kevdo.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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