View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Covenant University Repository

IOP Conference Series: Earth and Environmental Science

PAPER • OPEN ACCESS

Potential of Light Spectra as a Control of Cowpea Weevil, *Callosobruchus maculatus*, Activity

To cite this article: F. O. Kehinde *et al* 2018 *IOP Conf. Ser.: Earth Environ. Sci.* **210** 012008

View the article online for updates and enhancements.

This content was downloaded from IP address 165.73.223.242 on 27/11/2019 at 13:55

Potential of Light Spectra as a Control of Cowpea Weevil, *Callosobruchus maculatus*, Activity

*[1]Kehinde, F. O., [1]Dedeke, G. A., [1]Popoola, O. I., and [2]Isibor, P. O.

[1]Department of Pure and Applied Zoology, College of Biosciences, Federal University of Agriculture, Abeokuta
[2]Applied Biology and Biotechnology Unit, Department of Biological Sciences, Covenant University, Ota, Ogun State

Correspondence: festuskehinde7@gmail.com

ABSTRACT

Damage of stored cowpea by the weevil, *Callosobruchus maculatus,* is of great concern in Nigeria. The study investigated the potential of light spectra in the control of the bean weevil; In the first trial, ten individual bean weevils were directly irradiated with green, yellow, red and white and ambient(control) light generated by electric bulbs at 25 Watts. In the second trial, ten individual weevils were housed with 700 bean seeds and exposed to the light spectra. Each light treatment was replicated thrice and weevils were exposed for two hours daily for 10days. Mortality of the bean weevils was monitored daily, and percentage bean damage was determined in 10days. Data obtained were expressed as mean $(\pm SD); mean$ damaged beans were compared by analysis of variance and separated by Duncan multiple range test at $p<0.05$. Under direct exposure, the highest mortality rate was recorded under blue light in the first five days followed by red light. From day six to nine, the highest mortality was recorded under the white light followed by blue and red. The highest mortality was recorded under white light followed by red and blue light under indirect exposure (with beans). Percentage bean seed damage was significantly ($p\leq0.05$) lower under white (1.38%), blue (1.53, 2.38%) and red (2.48%) lights; a significantly ($p<0.05$) higher bean damage was recorded under ambient light (17.81%). White, blue and red lights were lethal to beans weevil by killing them and reducing their activities.

Keywords: Beans, Beans weevils, mortality and light spectra

1. INTRODUCTION

Light is one of the major factors that affect animals in various ways. It has effect on animal physiology such as Photoperiodism, circadian rhythm, hormone metabolism and vision. It also affects animal behaviour such as phototaxis and this has been used extensively in the control of some insect pests. Phototactic behaviors exhibited by insects are attraction and repulsion (Shimoda and Honda, 2013). For instance light such as (UV, blue and green) have been used to attract insect either to kill them or to divert their attention away from infesting plant (Cowan and Gries, 2009 and Aoki and Kuramitsu, 2007).

Bean beetles or southern cowpea weevil, *Callosobruchus maculatus* (Coleoptera: Chrysomelidae: Bruchinae), are agricultural pest insects domesticated in Africa and Asia and found presently are found in the tropical and subtropical part of the world. Bean weevil is a pest of bean and its damage effect on bean is majorly during the storage periods by their larvae. Pests of stored food have been a major concern and several methods have been employed in

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

controlling them. Beans are one of the staple foods in Nigeria and are confronted with beans weevil infection which reduced their quality and the damage of stored cowpea by the weevil is of great concern in Nigeria.

Several methods have been used to control beans weevils and other pest of stored food. Some of the conventional methods which have been used include; microbial control, cultural control chemical control and physical control (Upadhyay and Ahmad, 2011). Other effective options of controlling the infestation of this pest are necessary to prevent their pernicious damages to beans as well as reducing cost of storage. Light has been reported to be lethal to insects through the generation of reactive oxygen species (ROS). The toxic effect of light have received little attention nonetheless its applications. This study aimed at examine the potential of visible light spectra as control measure of controlling beans weevil

Artificial light have been reported to have tremendous effect on the activities of animals. Insects are said to be more prone to the deleterious effects of light. Some of the effects of artificial light on insects are directly as a result of its influence of their vision. This has been used to control them by a way of manipulating their behaviour. The eyes of some insects are sensitive to yellow light and this has been used as a means of attracting them to light trap either to kill them or to determine their upsurge.

Moreover, aside from the artificial light some coloured materials have been improvised in controlling insects. For instance, yellow sticky plates or rolls have made and are effective in attracting some important crop pests such as aphids, leafhoppers, planthoppers, whiteflies, leafminer flies and thrips (Mainali and Lim, 2010; Esker *et al.*, 2004; and Vaishampayan *et al.*, 1975). Also some electric insect killers have been developed which exerts strong attraction on insects. In view of this, this study was designed to investigate the potential of light spectra as a mean to control beans weevils.

2. MATERIALS AND METHODS

2.1 Study area

The study was carried out in the laboratory of Pure and Applied Zoology, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

Experimental Design

The experiment was divided into two sections

i. Exposure of beans weevils to different light colours
ii. Exposure of beans weevils and beans with eggs to different light colours

2.2 Irradiation Chambers

Plate 1 showed the irradiation chamber where the beans weevils and the beans were exposed to light. It is made up of plastic containers rapped with aluminum foil. The lids were perforated and the space was covered with wire mesh. Incandescent bulbs (25 watts) were fixed at the center of the lid.

2.3 Irradiation/ treatments

On daily bases, beans weevils were irradiated for two hours between 8 am and 10 am

Record Taken

After the irradiation, the mortality of the beans weevils was recorded at the end of ten days of exposure and the number of beans perforated was counted and recorded

2.4 Statistical Analysis
Data obtained were represented by graphs and expressed as percentages, mean (±SD) and compared by analysis of variance; significant means were separated by Duncan multiple range test at p<0.05.

Establishing surface sterilization protocol for nodal culture of *Solanecio biafrae*.

Plate1: Experimental Setup showing the exposure chambers with the coloured lights

3. **RESULTS**

Fig. 1.0 showed the daily mortality of beans weevil irradiated with light of different spectral for ten days. Mortality began in beans weevil irradiated with blue, white, red and green lights in day 2 as well as in control but began in day 3 under yellow light. Mortality reached the peak in day 5 on exposure to blue, red, white and green lights in that order.
Fig. 2.0 showed the trend in percentage of daily mortality in beans weevil exposed to light of varying light spectral for 10 days. In day 8 of the irradiation, 100% mortality was recorded weevils with white light, 96.7% with blue and red lights, 70% with yellow light and 50 % under control.
Fig. 3.0 showed the daily mortality of beans weevil housed with beans on exposure to light of varying light spectral for 10 days. Mortality of weevil began in day 2 under red and blue lights. Mortality reached the peak in day 5 under white light and inn day 6 under blue and red light and as at day 9 all the weevil under white, blue and red lights had died. Mortality reach the peak in weevils exposed to green light in day 8 and the peak was reached in day 10 on exposure to yellow light and control.
Fig. 4.0 showed the trend in percentage in daily mortality of beans weevils housed with beans on exposure to light of varying light spectral for 10 days. In day 9 of the irradiation 100.0% mortality was recorded on exposure to white, blue and red light, 96.7% on exposure to green light, 80.0% on exposure to yellow light and 73.3% under control.

Fig. 3.0 showed the daily mortality of beans weevil housed with beans on exposure to light of varying light spectral for 10 days. Beans perforated by beans weevils were significantly difference ($P<0.05$) among the exposures. The highest significant value was recorded under the control (124.67±16.56) followed by yellow light (96.33±6.66) and green light (61.00±17.44). The least significant value was recorded under white (13.67±3.79), blue (16.67±1.53) and red (17.33±4.51) lights.
Fig. 5.0 showed the percentage of beans perforated by beans weevil on exposure to light of varying spectral for 10 days. By day 10 of the exposure 17.81% of the beans have been perforated under the control, 13.76% under yellow light, 8.71% under green light, 2.48% under red light, 2.38 % under blue light and 1.95% percent under white light.

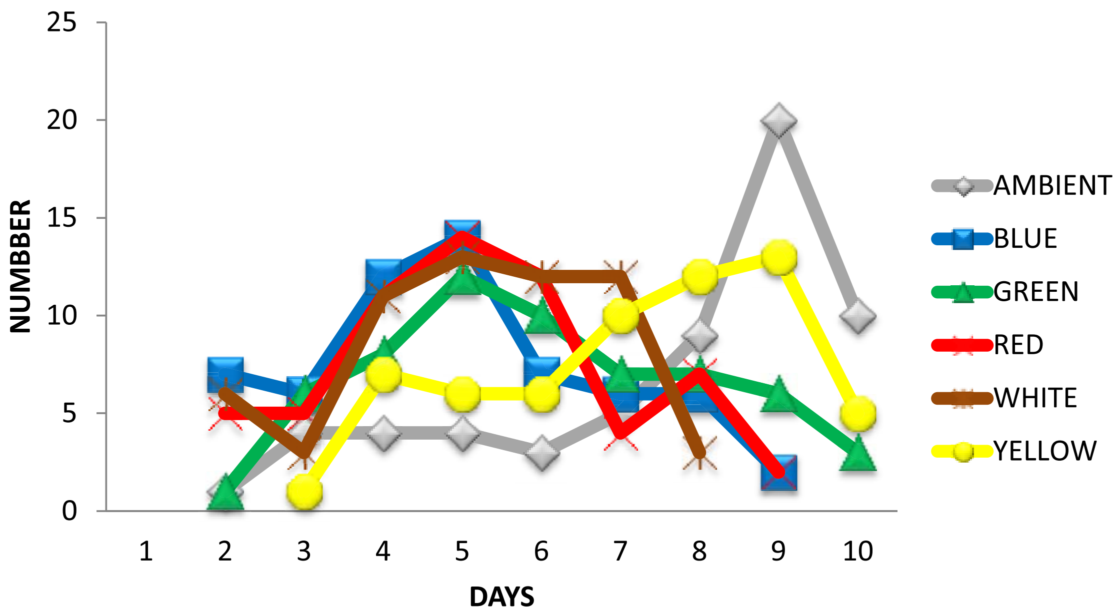

Fig. 1: Daily mortality in beans weevil exposed to light of different light spectral for 10 days

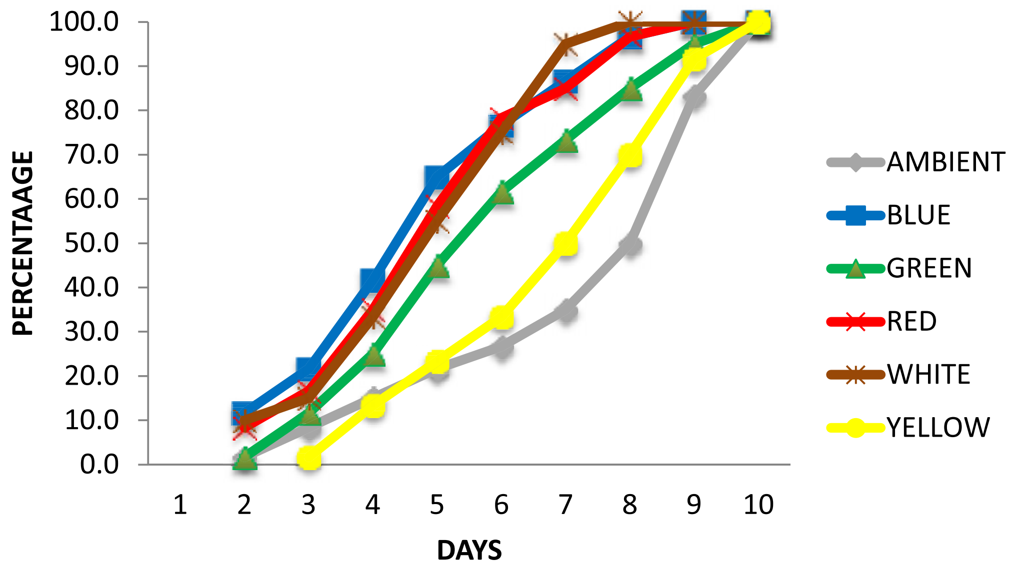

Fig. 2: Trend in percentage of daily mortality in beans weevil exposed to light of varying light spectral for 10 days.

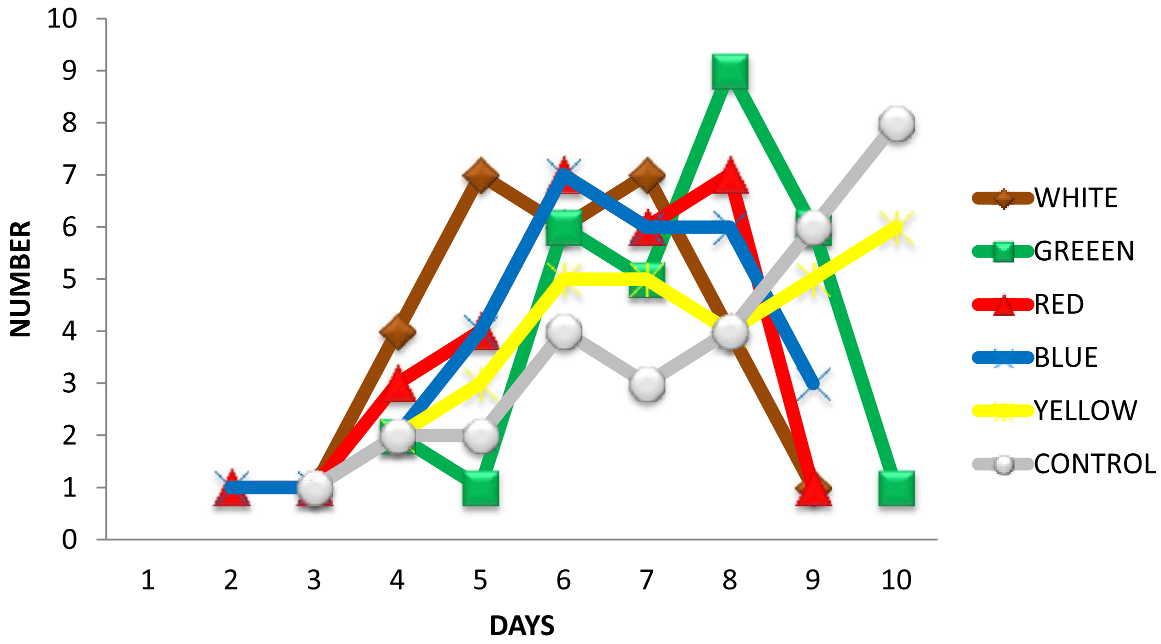

Fig. 3: Daily mortality of beans weevil housed with beans on exposure to light of varying light spectral for ten days

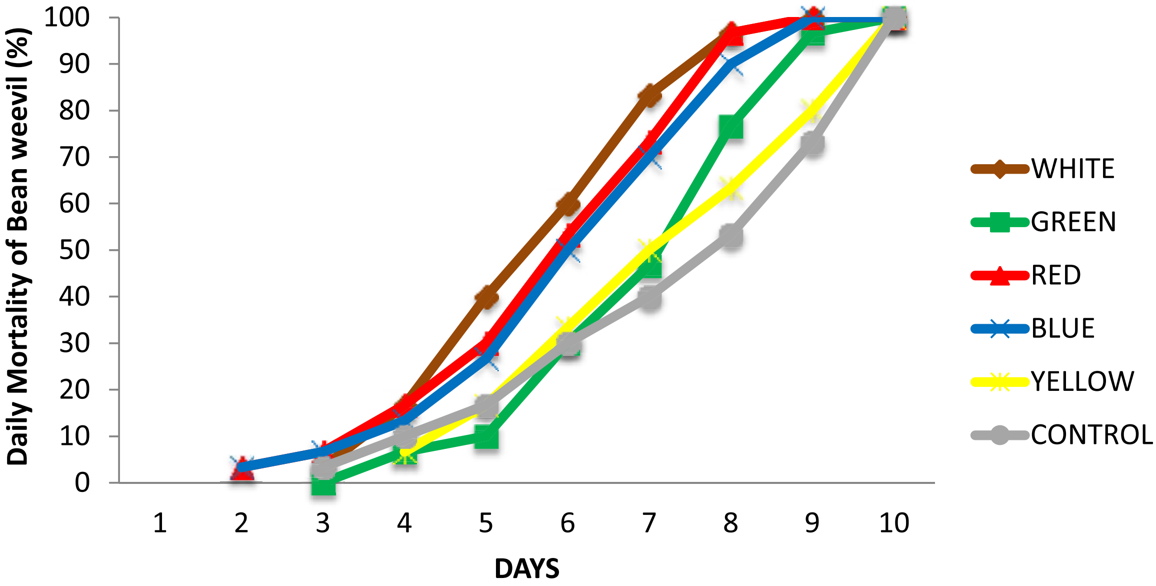

Fig. 4: Trend in percentage in daily mortality of beans weevils housed with beans on exposure to light of varying light spectral for ten days

Table 1: Mean beans perforated by beans weevil on exposure to light of varying spectral for ten days

Light treatments	**N**	**BEANS PERFORATED (Mean±St.dev.)**
Control	3	124.67±16.56[d]
Blue	3	16.67±1.53[a]

Green	3	61.00±17.44[b]
Red	3	17.33±4.51[a]
White	3	13.67±3.79[a]
Yellow	3	96.33±6.66[c]

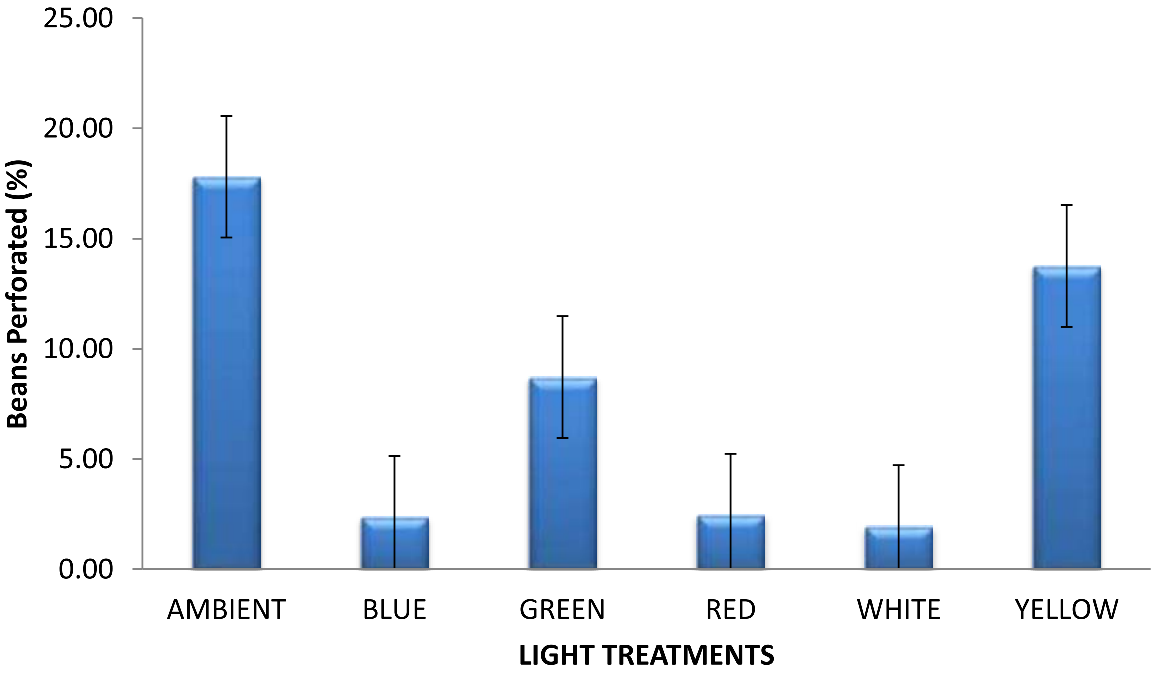

Fig. 5: Percentage of beans perforated by beans weevil on exposure to light of varying spectral for 10 days

4. DISCUSSION

Shimoda and Honda (2013) reviewed insect reactions to light and its applications to pest management and made a remarkable contribution that 'in recent times, attention is shifted from the use of chemicals in the control pest to the used of light which they termed a *clean* form of

pest control'. They also reported that light has been used to control insect pest in various ways such as; attraction, repulsion, Light adaptation, Circadian rhythms disruption, Photoperiodicity manipulation, Light toxicity, invisible and dorsal light reaction. In pest management, light has been used in various ways which affect the behavior and the physiology of the insect pest.
UV and blue lights were used to cause damage to the retina of the insect thereby making them ineffective through blur vision and this was termed light toxicity (Shimoda and Honda, 2013). The toxic effect of light to insect pest was also reported by Masatoshi *et al.* (2014) where in their research, light was effective in killing three species of insect at various stages of their life cycles. The toxicity effect of light was suggested to be as a result of the generation of reactive oxygen species (ROS) on exposure to light.
Various effects of light on insect are spectral specific. For instance, yellow light which was used as attractant to molt was also used as repellant to mosquito. The growth of rice weevil was reported to be inhibited by red light at the early age of development but yellow light and total darkness had no effect on their growth at any stage of developments (Bhagya *et al.,* 2015).
The result obtained from this study showed that by day five of the irradiation, 65 % of the adult weevils have died on exposure to blue and 58 % and 55% have died on exposure to red and white light respectively as against 22 % mortality recorded in the control group. Also as at day 8 of the irradiation, 100% mortality was recorded weevils with white light, 96.7% with blue and red lights, 70% with yellow light and 50 % under control. The drastic reduction in the number of the adult will also lead to the reduction in the number of egg laid and invariably reduced the population of larvae which actually cause damage to the beans.
The same trend was observed in the damaging of the beans by the beans weevils with respect to the light exposed. By the end of day 10 of irradiation, 1.95%, 2.38% and 2.48% damage was reported on exposure to white, blue and red light respectively as against 17.81% recorded in the control group. From this study, white, blue and red light might have inhibited the developments of egg to larva or killed the larvae as they emerged or prevent the larvae from boring into the beans.

5. CONCLUSION

The result from this study confirmed the toxicity of light to animals. White, blue and red lights are lethal to beans weevil by causing their mortality. White, blue and red light could be used as alternative means of controlling beans weevil. Further research is needed to ascertain the effect of these lights mentioned on the egg and the larva of the beans weevil.

REFERENCES

[1] Aoki S. and Kuramitsu O (2007). Development of insect-attracting lighting fixture and evaluation of insect attractiveness by a new index. J Illum Engng Inst Jpn 91:195–198
[2] Bhagya, W. H. G. S., Jayasiri, S. A. I., Kosgolla, K. G. U. M., Madushani, N. H. G. T., Manoj, K. V. S., Perera, S. R. C. and Wijelath, W. A. G. E. (2015). Effect of light on growth and development of stored product insects. Post harvest biology. p 11
[3] Cowan T,and Gries, G. (2009). Ultraviolet and violet light: attractive orientation cues for the Indian meal moth, Plodia interpunctella. Entomol Exp Appl 131:148–158
[4] Esker, P. D., Obrycki, J.and Nutter, F. W. (2004). Trap height and orientation of yellow sticky traps affect capture of Chaetocnemapulicaria (Coleoptera: Chrysomelidae). Journal Economic Entomology 97:145–149

[5] Mainali, B. P. and Lim, U. T. (2010). Circular yellow sticky trap with black background enhances attraction of Frankliniellaoccidentalis (Pergande) (Thysanoptera: Thripidae). Applied Entomology Zoology 45:207–213

[6] Masatoshi, H., Kazuki, S., Mitsunari, S. and Yoshino, S. (2014). Lethal effects of short-wavelength visible light on insects. Scientific Reports 4: 7383 DOI: 10.1038/srep 07383 p 6

[7] Shimoda M. and Honda K. (2013). Insect reactions to light and its applications to pest management. Appl Entomol Zo*ol* p 9.

[8] Upadhyay, R. K. and Ahmad, S. (2011). Management strategies for control of stored grain insect pests in farmer stores and public ware houses. World Journal of Agricultural Sciences 7 (5): 527-549.

[9] Vaishampayan, S. M., Kogan M, Waldbauer G. P. and Wooley, J. T. (1975). Spectral specific responses in the visual beaviour of the greenhouse whitefly, Trialeurodesvaporariorum (Homoptera: Aleurodidae). Entomology Experimental Application *18:344–356.*