International Journal of Pharmacy and Biological Sciences-IJPBS™ (2019) 9 (1): 1373-1376
Online ISSN: 2230-7605, Print ISSN: 2321-3272
Research Article | Biological Sciences | Open Access | MCI Approved
UGC Approved Journal

Effect of Ultraviolet Irradiation on Cowpea Beetle, *Callosobruchus maculatus* F

V.T. Noble Singh* and S. Sam Manohar Das
Department of Zoology, Scott Christain College (Autonomous), Nagercoil, Tamilnadu, India.

Received: 10 Oct 2018 / Accepted: 8 Nov 2018 / Published online: 1 Jan 2019
***Corresponding Author Email:** dr.noblesingh@gmail.com

Abstract
C. maculatus is a pest of household stored cereals which can be controlled by radiation treatment to any of the life-stages (egg to adult). There is potential for using ultraviolet C (UVC) radiation as an alternative source for the control of stored grain pests. Using 254 nm exposure for (2,4,6 and 8 min) on *C. maculatus* one-day old eggs, adult emergence seems to be significantly reduced. The development of C. *maculatus* is slower following UVC treatment compared to untreated control. Exposure to UVC irradiation did not affect grain quality and this is in favour of the use of UV-C in field application.

Keywords
C. maculatus, UV-C, adult emergence, development record.

*****

INTRODUCTION
Radiation is a process in which energetic particles or energetic waves travel through a medium or space. In an electromagnetic wave, the changes induced by the electric field shifts the wave in the magnetic field in one direction while the action of the magnetic field shifts the electric field in the same direction. Together these fields form a propagating electromagnetic wave [1]. Electromagnetic radiation (EMR) with wavelength between approximately 400nm and 700nm is directly detected by the human eye as visible light [2].
EMR is classified in order of increasing frequency into radio waves, microwaves, terahertz, infrared radiation, visible light, UV-radiation, X-rays and gamma rays. Of these, radio waves have the longest wavelength and gamma rays have the shortest [3]. Both ionizing and non-ionizing radiation could be harmful to organisms. Ionizing radiation is more harmful to living organisms than nonionizing radiation [4]. Non-ionizing radiation refers to any type of electromagnetic radiation that does not carry enough energy per quantom to ionize atoms or molecules. Instead of producing charged ions when passing through matter, this electromagnetic radiation has sufficient energy only for exitation, resulting in the movement of an electron to a higher energy state [5]. There is scope for utilizing non-ionizing radiation in the control of insect pests infesting stored products.
Irradiated foods might be more acceptable to those sensitive to chemical treatments [6] and irradiation is developing into an established technique for controlling stored grain insects because of residue free advantages over chemical fumigation [7]. In order for UV radiation to be effective in most organisms, it must effectively penetrate into the tissues and be absorbed. Structural and biochemical changes induced by enhanced levels of UV-B radiation ultimately modify the penetration of UV

radiation into plants and other organisms [8]. Frylink *et al* [9] showed that massive doses of ionizing radiation induced physiochemical changes in plants such as initiation of enzyme activities. Hasan and Khan [10] mentioned that irradiation does not significantly change the quality of many commodities, it is comparatively safe to the environment and consumers and does not need to kill the insects to provide quarantine security [11]. Preventing adult emergence may be difficult, so adult sterility is the goal [11]. Adult sterility has been the focus of irradiation treatment in the control of many insect pests [12] ; [13].

UV irradiation sensitivity varies according to species, strain, and individual [14]. Islam [15] stated that UV-rays are generally less harmful to living organisms than the ionizing radiations as they penetrate only the surface layer of cells. UV-C rays of 254nm wavelength have been reported to have a germicidal effect on the microorganisms in food, air and water [16]; [17], widely used as an attractant for insects [18], and for surface disinfection of insect eggs from pathogens [19]. A number of investigators have considered the possibility of using UV-rays to control, or at least to suppress development of various species of stored product insects [20]; [21]. Typically, embryonic stage of an animal is highly radio sensitive and insects are no exception [22]. The present investigation was therefore aimed at determining the effect of UV-C rays on the eggs of *C. maculatus* deposited on the surface grains.

MATERIALS AND METHODS

Collection of Eggs: Egg layed *V. ungulata* grains were collected from the nearby grain godown. Stock cultures of *C. mculatus* were maintained on cowpea *V.ungulata* at a constant room temperature of 30°C and 75% RH with a natural LD 12:12h cycle. To obtain virgin females of known age, seeds containing ready to emerge eggs were removed from the stock boxes and placed in individual tubes. Each hour, for a maximum of 4h, females which had emerged in cells not containing males were removed.

Mating and Oviposition: The virgin females were introduced into petriplates containing sex-starved males in the ratio of 1:1. The mated females were segregated after 24h and each female was introduced into a transparent plastic container with *V. ungulata* grains. When females were presented with multiple seeds of the same size, they distributed their eggs relatively uniformly among seeds.

UV irradiation: Exactly 6h after the introduction of the gravid female, the grains with eggs were removed to a petri plate, so that one - day old eggs could be irradiated with UV-C from a laboratory source. The irradiation was for 2,4,6 and 8min from a source 5 or 10cm away. The grains were kept turned in such a way that the eggs faced the radiation source. Extra eggs were carefully removed if the grains were carrying more than one egg before irradiation. The irradiated eggs were subsequently incubated in labelled Petri plates for a maximum period of 40 days. Eclosion was carefully recorded and the eclosed beetles were released after counting. Eclosion was counted for timings of 21-25, 26-30, 31-35 and 36-40 days. The percentage of reproduction control (PRC) was calculated using a modified formula of Rizvi [23].

$PRC = (X_1 - X_2)100/TE$

X_1 - control mortality X_2 - treatment mortality

TE – Total Expected Eclosion

All data were subjected to student t test at 5% level of significance.

RESULTS AND DISCUSSION

Results show that increasing duration of exposure to UV-C irradiation affected the development of *C. maculatus.* From 100 one day old control eggs the number of adults emerged in 21-25, 26-30, 31-35 and 36-40 days were 78.4±1.35, 4.2±0.52, 2.2±0.28 and 1.2±0.28 respectively. After 2, 4, 6 and 8 minutes of treatment with UV-C, the percentage of reproduction control (PRC) is 20, 29, 37 and 42 percent. The hatching rate of the irradiated eggs of *C. maculatus* decreased with increasing dose of radiation. A significant reduction in egg hatching was presumed in UV irradiated eggs. Irradiation weakens the development, percentage of adult reproduction, oviposition and hatching of eggs in *Exorista sorbillans* Wiedemann [11]. Ionizing radiation may be considered as an alternative to methyl bromide for treating agricultural products to overcome quarantine barriers in trade [24]. Morphological deformities were significantly high in the UV irradiated nymphs as well as the resultant adults of *Dysdercus koenigii* [25]. Kumar *et al.,* [26] reported a significant reduction in adult emergence from gamma irradiated pupae of *Exorista sorbillans.* Larval-pupal and Pupal –intermediate forms were common at each exposure period showing various morphological deformed characters. The larval-pupal intermediate forms had pupal head with larval body and pupa with larval skin. The pupal- adult intermediate forms had adult head with pupal abdomen and small pupae that are unable to emerge as adults. Some of the adults that emerged from treated larvae had incomplete elytra, widely spread or crumpled wings, small wings and short abdomen.

Development record of *C. maculatus* one day old eggs

Sl.No	Days	Control	Duration of irradiation (min)	No of adults emerged from 100 eggs in treatment				No dead after 40 days	PRC
				Days					
				21-25	26-30	31-35	36-40	13.8±1.6	
				78.4±1.35	4.2±0.52	2.2±0.36	1.2±0.28		
1	21-25	78.4±1.25	2	41.2±1.46 (-90.29)	10.6±1.14 (60.37)	8.0±0.70 (72.5)	6.2±0.83 (80.64)	34.0±2.75 (58.82)	20
2	26-30	4.2±0.83	4	37.6±1.01 (-85.07)	9.0±1.41 (53.33)	6.2±0.83 (64.51)	4.6±1.14 (73.9)	42.6±1.95 (67.13)	29
3	31-35	2.2±1.30	6	34.8±1.72 (-125.28)	7.6±1.14 (44.73)	4.4±1.14 (50.0)	2.8±0.83 (57.14)	50.4±2.24 (72.22)	37
4	36-40	1.2±0.44	8	33.2±1.32 (-136.14)	6.0±1.58 (30.0)	3.2±0.30 (31.25)	1.6±1.14 (25.0)	56.2±2.48 (75.08)	42

PRC - Percentage of Reproduction Control
Note: Values in parentheses are percent change over control values; all deviations significant at $P \leq 0.05$ (Student's 't' test)

REFERENCES

1. Kinsler, P. How to be causal: time, spacetime, and spectra. *European Journal of Physics,* 32: 1687, (2011).
2. Kinsler, P. Optical pulse propagation with minimal approximations. *Physiological Reviews, A,* 81, (2010).
3. Kwan-Hoong, N.G. Nonionizing radiations- source, biological effects, emissions and exposures. *Proceedings of the International Conference on non-ionizing radiations at UNITEN ICNIR.* (2003).
4. ICNIRP (International Commission on Non-ionizing Radiation Protection)., Guidelines for limiting exposure in time-varying electric, magnetic and electromagnetic fields (upto 300GHz). Health Physics, 74: 494-522, (1998).
5. Raymond, S.A. and John, J.W. Physics for Scientists and Engineers (6th ed) Brook Cole. ISBN, 0-534-40842-7, (2004).
6. Pszczola, D.E. 20 ways to market the concept of food irradiation. *Food Technology,* 51: 46-48, (1997).
7. Faruki, S. I. Effects of UV-radiation on the growth and development of malathion-susceptible and multiresistant strains of *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). *Bangladesh Journal of Entomology,* 25: 55-63, (2005).
8. Longstrth, J., de Gruijl, F.R., Kripke, M.L., Abseck, S., Arnold, F., *et al.,* Health risks. *Journal of Health Physics,* 74: 494-522, (1998).
9. Frylink, L., Dubery, I. A., and Schabort, Biochemical changes involved in stress response and ripening behaviour of gamma irradiated mango fruit, *Phytochemistry,* 26: 681-686, (1987).
10. Hasan, M. and Khan, A. R. Control of stored-product pests by irradiation. *Integrated Pest Management Review,* 3: 15-29, (1998).
11. Ravuiwasa, K.T., Lu, K. H., Shen, T.C. and Hwang, S. Y. Effects of irradiation on *Planococcus minor* (Hemiptera: Pseudococcidae). *Journal of Economic Entomology,* 102: 1774-1780, (2009).
12. Lester, P. B., Rogers, D.J., Petry, R. J. Conolly, P.G. and Roberts, P. B. The lethal effects of gamma irradiation on larvae of the huhu beetle, *Prionoplus reticularis:* a potential quarantine treatment for New Zealand export pine trees. *Entomologia Experimentalis et Applica,* 94: 237-242, (2000).
13. Follett, P.A. Irradiation as a quarantine treatment for mango seed weevil (Coleoptera: Curculionidae). *Proceedings of the Hawaiian Entomological Society,* 35: 95-100, (2001).
14. Tazima, Y. Radiation mutagenesis of the silkworm. In: The Silkworm, An Important Laboratory Tool, Tazima, Y. (ed). Kodensha Limited, Tokiyo Japan. (1978).
15. Islam, M.S. and Kabir, M.A. Integration of cytoplasmic incompatibility with UV radiation and its consequence on the suppression of *Tribolium castaneum* population. *University Journal of Zoology, Rajshahi University,* 19: 43-49, (2000).
16. Brickner, P.W., Richard, L., First, M., Nardell, E., Murray, M. and Kaufman, W. The application of ultraviolet germicidal irradiation to control transmission of airborne disease: bioterrorism countermeasure. *Public Health Reports,* 118: 99-114, (2003).
17. Michael, R. and Antignus, Y. UV radiation effects on pathogens and insect pests of greenhouse growth crops. *Photochemistry and Photobiology,* 79: 219-226, (2004).
18. Bruce, W. A. Effect of UV radiation on egg hatch of *Plodia interpunctella* (Lepidoptera: Pyralidae). *Journal of Stored Products Research,* 11: 243-244, (1975).
19. Guerra, A.A., Ouye, M.T. and Bullock, H.R. Effect of ultraviolet irradiation on egg hatch, subsequent larval development, and adult longevity of the

tobacco budworm and the bollworm. *Journal of Economic Entomology,* 61: 541-542, (1968).

20. Calderon, M., Bruce, W.A. and Leecsh, L.G. Effect of UV radiation on eggs of *Tribolium castaneum*. *Phytoparasitica,* 13: 179-244, (1985).
21. Sharma, M.K. and Dwivedi, S.C. Investigation on the effects of ultraviolet and infrared light on the life of *Callosobruchus chinensis* Lin. *Journal of Advanced Zoology,* 18: 27-31, (1997).
22. Tilton, E.W. and Brower, J.H. Radiation effects on arthropods. In: Josephson, E.S. Peterson, M.S. (editors). CRC. Press Inc. *Preservation of food by ionizing radiation,* 2: 269-316, (1983).
23. Rizvi, S.J.H., Pandey, S.K., Mukerjii, D. and Mathur, S.N. 1,3,7-Trymethylxanthne, a new chemosterilant for stored grain pest, *Callosobruchus chinensis* (L). *Zeitschrift fuer Angewandte Entomologie,* 90: 378-381, (1980).
24. FAO (Food and Agricultural Organization), Guidelines for use of irradiation as a phytosanitary measure. International Plant Protection Convention, ISPM no. 18. Food and Agricultural Organization, Rome, Italy. (2003).
25. Mohan, S. and Kumar, D. Effects of UV irradiation on the survival of the red cotton bug, *Dysdercus koenigii* (Heteroptera: Pyrrhocoridae). *Australian Journal of Agricultural Engineering,* 1: 132-135, (2010).
26. Kumar, P., Jayaprakas, C. A., Kishore, R. and Sengupta, K. Effect of gamma radiation on the reproductive potential of Uzy-fly. *Indian Journal of Sericulture,* 29: 295-296, (s1990).