Effects of UV irradiation on the survival of the red cotton bug, *Dysdercus koenigii* (Heteroptera: Pyrrhocoridae)

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Abstract

The effects of UV irradiation on the survival of *D. koenigii* were investigated. Nymphs were irradiated with UV rays (254nm) for 10, 15 and 20 min durations. UV-irradiated nymphs exhibited a significant decrease in survival with increasing exposure time. They showed delayed moulting into adults, which also showed significantly decreased survival. A significant increase in morphological deformities was also recorded in the nymphs as well as their resultant adults. These results show that UV irradiation appears to be a promising agent for controlling the population of cotton stainers.

Keywords: UV irradiation; survival; cotton stainer; *Dysdercus koenigii*.

Introduction

Several species of cotton stainer have been found to exist in various countries (Central America, India and West Indies). Cotton stainers are one of the most destructive cotton pests. Most of the nymphal stages as well as the adults feed on the seeds within the developing cotton bolls (Sprenkel, 2000), leaving a stain on lint. Thus, feeding by puncturing flower buds or young cotton bolls usually causes reduction in size; or the fruiting body may abort and drop to the ground. Cotton stainers are also severe pests of oranges. By puncturing an orange, a cotton stainer often inserts its proboscis full length with no visible wound. Thus, single puncture may cause the orange to drop in a few hours from the tree leading decay in one or two days (Hubbard, 1885). Cotton stainers are also sap sucking insect pests of okra. It does not significantly reduce the yield, but it lowers the quality of the fruits by inflicting a rusty appearance on the surface (Tomas and Gajete, 2008). Further, cotton stainers are also severe pest of some other economically important plants such as legumes, red gram (Singh and Singh, 1971; Singh and Singh, 1978) and portia tree (Peter and Sivasho, 1999). Thus these pests are highly harmful for economically important crops. Hence to have good yields of these plants, pest’s population needs to be controlled.

It is well known that insecticides have created a wide ranging negative impact on the beneficial insects (Michaud et al., 2003; Chauvat et al., 2006), economically important plants (El-Daly and Khalil, 2008), humans’ health (Taylor, 2003; Hdybom et al., 2004; Hampton, 2005) and the several important components of the ecosystem. These existing problems and their concomitant impact on environment have necessitated exploration of alternative non-toxic pest control methods.

Radiation studies on insects have suggested the use of UV rays as one of the potential agents for controlling insect pests in stored grains and their products (Calderon et al., 1985; Sharma and Dwivedi, 1997; Parween et al., 2004; Faruki et al., 2005, 2007). UV rays of 254nm wavelength have been reported to have a germicidal effect on the microorganisms in food, air and water (Pszczola, 1977; Brickner et al., 2003; Michael and Antignus, 2004; Pan et al., 2004). UV rays have also been reported for the control of some other insects such as *Periplaneta americana* (Gingrich et al., 1977; Hwang and Chen, 2004), *Aedes albopictus* (Jayachandran and Fallon, 2002) and *Bactrocera tryoni* (Collins et al., 2008). However, effects of UV irradiation on cotton stainers have not been studied. Keeping above in view, effects of UV rays on the survival of *D. koenigii* were investigated in order to establish UV irradiation as a possible insect pest control measure vice insecticides.

Materials and methods

*Dysdercus koenigii* were collected from the field having okra (Lady’s finger) plants in the Banaras Hindu University campus and agricultural fields abounding Varanasi city. In laboratory, insects were maintained in a biochemical oxygen demand (BOD) incubator (Narang Scientific, NSW 152) on wet cotton seeds (pre-soaked in water for 24 h) under long day (16L:8D) photoperiod at 25 ± 2°C and relative humidity of 70%-80% (Venugopal et al., 1994). Freshly moulted fifth-instar nymphs were used for UV irradiation experiments. A 15-W germicidal lamp (Philips, GE15 T8), measuring 45 × 4 cm was used as the source of 254nm UV radiation. The lamp was fixed inside a desk-type wooden container. Experiments with 2, 4, 6 and 8 min dose: 1.098 ± 0.01097 SE mW/cm² irradiation were performed, but no significant results were obtained. Therefore, higher exposure time of 10,
Results and discussion

The results of the effect of UV rays on the survival of fifth instar nymphs of D. koenigii are shown in Fig. 1. UV irradiation significantly decreased the survival of fifth instar nymphs in comparison to the control group. It was found that as the exposure period increased the survival of nymphs decreased. There was significant difference in the survival of nymphs at each exposure time (p < 0.05 Tukey test). UV irradiation studies on the survival and development of other insects have been extensively carried out (Gingrich et al., 1977; Calderon et al., 1985; Sharma and Dwivedi, 1997; Jayachandran and Fallon, 2002; Hwang and Chen, 2004; Parween et al., 2004; Faruki et al., 2005, 2007; Collins et al., 2008). UV irradiation for 2, 4, 8, and 16 min on the larvae of Alphitobius diaperinus has been reported to affect their survival. However, in the present study UV irradiation for 10, 15 and 20 min on nymphs induced highest mortality. This reveals that the UV irradiation sensitivity varies according to species, strain, and individual and even at different developmental stages of the individual (Tazima, 1978). All the UV-irradiated nymphs moulted into adults showed morphological deformities and significantly decreased survival (Fig. 2). Moulting of nymphs into adults became delayed as the exposure period increased. It was found that as the exposure period increased the survival of resultant adults decreased in comparison to the control group (Fig. 2).

There was further significant difference in the survival of resultant adults at each exposure time (p < 0.05 Tukey test). UV irradiation for 8, 16 and 24 min on A. diaperinus (Faruki et al., 2005; Parween et al., 2004) and Tribolium castaneum, T. confusum and Cadra cautella (Faruki et al., 2007) have also been found to arrest the survival and moulting of larvae and resultant adults. Adverse effects of other radiations such as gamma irradiation on the survival and morphological deformities of T. castaneum, Plodia interpunctella and Oryzaephilus surinamensis (Tilton, et al., 1974), arthropods (Tilton and Brower, 1983), Sitophilus oryzae (Tunel, 1995), S. granarius, T. confusum and Ephestia kuehniella (Warchalewski et al., 2000), and T. castaneum (Banu et al., 2006), X-ray irradiation on T. confusum (Ducoff and Bosma, 1966) and silk worms (Mathavan, 1982), and UV-laser irradiation on Bombyx and Drosophila (Myohara, 1995) and Bombyx mori (Manjunatha et al., 2006) have also been reported.

The number of deformed insects with several morphological deformities was significantly high in the UV-irradiated nymphs as well as in the resultant adults (Fig. 3). Number of deformed insects increased as the exposure period increased in comparison to the control group. These findings are in agreement with the report of Ducoff et al., (1966) who has reported that UV irradiation induces morphological abnormalities in the pupae of T. confusum. These results are also in consonance with the results obtained by Gingrich et al., (1977) and Hwang and Chen (2004), who observed increased deformities with reduced viability in the irradiated nymphs of Periplaneta Americana.
In conclusion, the results of the present investigations clearly demonstrate the adverse effects of UV irradiation on the survival of D. koenigii. The significantly reduced nymphal survival, delayed moulting into adults and severe morphological deformities caused by UV irradiation in this pest is promising from pest management point of view. Therefore, we suggest that by releasing the irradiated-nymphs from the laboratory into the affected field can control the population of cotton stainers. We presume that UV rays might serve as effective, acceptable and cheap approach for controlling cotton stainers and related insects.

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