Radiosensitivity of 60co gamma irradiation

Science

Gamma radiation was applied within the range of 0. 1-0. 5 kGy at five doses against eggs, larvae, pupae and adults of Oryzaephilus surinamensis. All the experiments were carried out in controlled conditions of Temperature 27± 1ºC and 75±5% Relative Humidity. The results showed that the hatching of eggs, pupae formation, adult emergence and survivality of adults was dependent upon the dose level applied. There were completely no eggs hatched, no larvae developed into pupae, no pupae hatched, and no adult survive when exposed to 0. 5 kGy. The significance of the experiment was evaluated by ANOVA and the CD values at 5% in case of hatching of eggs is 1. 19876, pupae formation is 0. 80016, adult emergence is 0. 9162175 % and adult survivality is 0. 96167 respectively.

Dry cereal grains can be infested by a number of minute stored grain insect pest and they increases exponentially which causes severe damage to the stored grains. Insect activity also cause an increase in the moisture content of the grains, resulting in additional microbial growth which can produce further damage to the grains and made them unfit for consumption. Oryzaephilus surinamensis (Linnaeus, 1758) is commonly called as saw toothed grain beetle which is a worldwide pest of grain and grain products as well as fruits, tobacco, dried fruits, chocolates and drugs.

At present major focus falls on chemical control with insecticides (Thirualaraju et al., 1997; Sundararaju et al., 1999) on cashew. Mixing of synthetic organic pesticides to check grain damage in stored seed was plasticized in the past decades, but the widespread use has led to the development of pest resistance (Zettler and Cuperus 1990). It also eliminates both predators and parasites which are actually more susceptible

than target pest. Commonly used grain protectant such as malathion is often completely ineffective because of very high levels of resistance to this compound (Champ, 1978; Zettler, 1982). Various alternatives to pesticides used under Integrated Pest Management (IPM) to protect theses grains (Halverson and Nablo, 2000). Use of radiation is one of the measures used to disinfect grains from insect pest. Phytosanitary applications of irradiation are now days considered as a new technique used for the treatment of the grains (Hallman 2011, 2012).

Radiation technology

Radiation Technology can complement and supplement the existing technologies to ensure food security and safety and can be applied on pre packed commodities. Gamma rays are short wavelength, high energy photons and have deep penetrating power. Gamma rays come from spontaneous disinfestations of radioactive nuclides (Cobalt-60 or Cesium-137) as their energy source. The research work is concerned exclusively with gamma irradiation used to treat stored cashew nuts against Oryzaephilus surinamensis. The study was conducted to determine the effect of gamma irradiation on insect pest of stored cashew nuts at different doses. The reaction of emission of gamma rays is as following:

Review of literature

Gamma irradiation is not a new approach and it existed in the world for more than 70 years but did not receive any consideration due to some scientific and technical reasons (Koidsumi, 1930; Hallman, 2001). However the practical application and its recognition initiated a few decades ago when

irradiation was accepted as an alternative measure to chemical fumigation of methyl bromine (Burditt, 1994; Ignatowicz, 2004).

Doses of 0. 05 kGy for Tenebrio molitor L. to 0. 45 kGy for Sitotroga cereallela (Olivier) was applied to prevent reproduction of stored product pest by Hallman, 2013. High mortality of adults of Rhyzopertha dominica and Tribolium castaneum were seen in 16 days after 0. 5 kGy. The number of researchers mentioned in the respective work that irradiation does not affect the quality of food material and cereals over a longer period of time (Hasan and Khan, 1998; Pszczola, 1997). According to Bruce 1975 and Guerra et al., 1968 ultraviolet irradiation is used as germicide and attractant and used as surface disinfectant for insect eggs.

Like the gamma radiation, ultraviolet radiation showed a significant decrease in adult emergence of T. castaneum, A. diaperinus upon exposure to the radiation (Faruki, 2005; Parween et al. 2004)

Materials and Method

Oryzaephilus surinamensis were originally collected from the go downs and cultured on a rearing medium containing crushed cashew nuts in the laboratory Department of Zoology, Jai Narain Vyas University, Jodhpur. For the collection of eggs, the adults were placed in a large number on the wheat flour and after few days the medium was sieved to separate out the eggs and kept in petriplates for the exposure. The effect of gamma irradiation was studied on the development of Oryzaephilus surinamensis. Fifty freshly laid eggs and twenty five newly emerged adults of Oryzaephilus surinamensis were collected from a laboratory stock culture. Twenty five 4th

instar larvae and pupae were collected and they all were kept in the voyls for the exposure of gamma radiation using Gamma irradiator- Radioactive source Co60 Model-GC-4000 stationed at Defense Laboratory, Jodhpur. Grains, insects, larval stages, pupal stages are brought into the chamber to be exposed to the gamma rays for a defined period of time required to destroy the targeted pests (Mc Mullen and Sloan, 1985).

Different doses used to study the hatching of the eggs, pupation from the larvae, adult emergence and survivality of the adults were 0. 1, 0. 2, 0. 3, 0. 4 and 0. 5 kilo Gray (kGy). Each treatment was set up in triplicates. For the comparison non treated and treated eggs, larvae, pupae and adults were transferred in the culture tubes and placed in the B. O. D incubator at constant temperature and humidity for the observation of their further development. The observations were made every day in respect to the time required for hatching of eggs, pupation, adult emergence and survivality of the adults. The insects that did not moved or responded when touched gently with a brush were considered as dead and were discarded from the experiment.

Hatching of eggs

The results for the effect of gamma irradiation on O. surinamensis infestation are shown in Table 1. The percentage of hatching of eggs of Oryzaephilus surinamensis was 38. 00, 25. 32, 18. 00 and 4. 66 % at the doses of 0. 1, 0. 2, 0. 3 and 0. 4 KGy respectively (Table: 5. 1). No hatching was found at the dose of 0. 5 kGy. The percentage of development of hatched larvae from irradiated eggs of Oryzaephilus surinamensis was observed after 30 days and then the results were drawn. The significance of the data was analyzed

by ANOVA (Analysis of Variance) from Central Arid Zone Research Institute (CAZRI), Jodhpur and comparison of test was done between the treated and non treated samples. CD value at 5 % was found to be 1. 19876.

Effect on Pupation

The percentage of adult emergence from larvae of Oryzaephilus surinamensis was 64. 00, 36. 00, 13. 32 and 4. 00 % at the doses of 0. 1, 0. 2, 0. 3, and 0. 4 kGy respectively (Table: 5. 1). No adult emergence was found at the dose of 0. 5 kGy in the test insect. At the dose of 0. 5 kGy most of the treated larvae died without pupating, while the others died in the pupal stage. After the dose of 0. 3 kGy emergence of adults showed a delayed effect. The average delayed development period of Oryzaephilus surinamensis 29 day (0. 2 kGy) 32day (0. 3 kGy) and 35days (0. 4 kGy.). The CD value at 5 % for pupae formation is 0. 80016.

Effect on Adult emergence

The percentage of adult emergence from pupae of Oryzaephilus surinamensis was 46. 64, 33. 32, 12. 00 and 5. 32% at the doses of 0. 1, 0. 2, 0. 3 and 0. 4 KGy. (Table: 5. 2). No adult emergence was found at the dose of 0. 5 kGy in Oryzaephilus surinamensis. At the dose of 0. 4 kGy most of the treated pupae died without adult emergence. After the dose 0. 1 kGy emergence of adults was delayed. The average delayed development period of Oryzaephilus surinamensis was 32days (0. 1 kGy) 34days (0. 2 kGy), 37days (0. 3 kGy) and 38days (0. 4 kGy). Statistical analysis showed that exposure of gamma irradiation plays a significant role in reducing the adult emergence. The CD value at 5 % for adult emergence is 0. 916217.

Effect on Survivality of Adults

The percentage of survivality of adults of Oryzaephilus surinamensis was 58. 64, 44. 00, 28. 00 and 13. 32% at the doses of 0. 1, 0. 2, 0. 3 and 0. 4 kGy respectively. No adult survivality was found at 0. 5 kGy as compared to control which was 98. 64% (Table: 5. 2). The CD value at 5 % is 0. 96167. Application of irradiation for insect disinfestations of cereal grain product was studied by Li et al., 2007. Wang, et al., 2012 studied the survival and reproduction of Liposcelis paeta when irradiated by electron beams which showed positive results.

Discussion

Tilton and Brower, 1987 stated the role of ionizing radiaton to control insects infesting grains and grain products. Based on the data obtained from the present study different doses of gamma irradiation from 0. 1 to 0. 5 kGy caused deaths of the adult insect as well as prolonged or paused or killed their developmental stages which showed a positive correlation between the doses and the rate of mortality at any stage. Enu and Enu, 2014 mentioned in their work that the Sitophilus zeamais and Callosobruchus maculatus are radiosensitive to gamma irradiation at the doses 40 Gy, 80Gy, 150Gy, 200Gy, 300 Gy and 500 Gy but the dose of 40 Gy had no effect on the mortality of both the species. All exposure periods of gamma irradiation are found to be significant in the present work as it had reduced the rate of egg hatching, pupation, adult emergence and survivality of the test insect in comparison to the controls.

The effect of gamma irradiation gradually increased with an increase in exposure dose. However, Tilton et al., 1973 reported that Sitophilus zeamais

need a dose of 200Gy to kill 98% population of adults within three days while Bhuiya et al., 1991 recommended the dose of 500Gy to kill 100% mortality of Callosobruchus within 7-14 days. Irradiation kill the insects and their developmental stages is well known; Lan et al, 1987 reported that gamma irradiation have no adverse effect on the viability of maize and cowpea seeds at lower doses of about 1 kGy. The research work also gives information that the eggs are more resistant as compared to the larvae, pupae as compared to larvae and adults are found to be most resistant stage during the development period of the test insect if compared with any of the stage. Considerable research has been done on measuring the effect of the ultraviolet (254nm) and gamma irradiation on egg hatching and adult emergence of the flour beetle, Troibolium castaneum, T. confusum; the almond moth, Cadra cautella; Mediterranean flour moth, Ephestia kuehniella and azuki bean weevil, Callosobruchus chinensis (Faruki et al., 2007; Supawan et al., 2005; Ayyaz et al., 2006). Kachhwaha et al., 2007 experimented on the reproductive potential of Oryzaephilus surinamensis and concluded that the fecundity and fertility was minimum in the combination of treated male x treated female, followed by treated female x untreated male and then treated male x untreated female. With this it was also reported that females are more radiosensitive than males.

Due to the lack of awareness, sometimes there is an apprehension among consumers on the use of irradiated food items. It is a rapid process and completely effective as long as proper doses are selected and applied. It results in no adverse effects on the wholesomeness of the treated products and consumer accepts the irradiated food without any controversy as stated

by Eustice and Bruhn, 2006. It is equally effective during cold weather when insects are diapausing or in egg stage.

The effects of irradiation on insects are many and varied depending primarily on the species, stage, age and physical factors. The younger metamorphic stages of insects are more radiosensitive than older stages. The experiment demonstrated that 60 Co gamma irradiation can effectively eliminate the Oryzaephilus surinamensis from stored cashew nuts. Irradiation is becoming a popular phytosanitary treatment worldwide because of its significant attributes as compared to chemicals and fumigant application Hallman 2011, 2012.

Recommendation

Further research should be done on the effect of different kinds of rays like gamma, ultraviolet, X rays, infrared and their effect on the germination of irradiated seeds, their viability, reproduction capacity etc. In addition to this more research should be practiced towards any health hazards of irradiated technique to the workers handling them and the consumers. Some plant extracts showed the radioprotection towards irradiation in mice as observed by Meena and Kachhwaha 2012 which should be further extended to find out the resistance of irradiation in insects.