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Effects of the Gamma Radiations and Malathion on Confused Flour Beetle, *Tribolium confusum* J. du Val.

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Abstract: In this study, effects of gamma radiations and malathion on the flour beetle, *Tribolium confusum* were studied. Survival of adults after irradiation was decreased with increasing dos of both irradiation and malathion treatment. In adult irradiation LD_{50} and LD_{99} values were estimated as 94.62 and 198.87 Gy, respectively. In malathion treatment LD_{50} and LD_{99} values were determined as 0.012 mg/cm^2 and 0.131 mg/cm^2 for adults.

Key words: Gamma radiation, *Tribolium confusum*, malathion

Introduction

The confused flour beetle, *Tribolium confusum* (J. du Val.) is an important stored product pest. To control this pest chemical fumigation and other methods are widely used for disinfestation of stored products in Turkey. These chemicals can produce hazards related to public health and environment. Application of ionizing radiation for controlling insects infesting grains and their products has been suggested by many authors. Irradiation has been shown to be an effective pest control method for these commodities and a good alternative to methyl bromide, the most widely used fumigant for insect control, which is being phased out globally because of its ozone depleting properties (Cornwell, 1966; Cogburn *et al.*, 1972; Brown *et al.*, 1972; Tunçbilek and Kansu, 1995). Malathion, besides other chemicals, is widely used to control stored product pests in Turkey. Some strains of *Tribolium castaneum* were reported to be resistant against malathion and some to be susceptible (Adem and Watters, 1984). Not much is known about insecticide resistance levels in *T. confusum.* Previous studies found no evidence of malathion resistance in this insect (Vincent and Lindgren 1967; Strong *et al.*, 1969; Horton, 1984). It was reported that the *T. confusum* strain most resistant to malathion was about as resistant as the least resistant strain of *T. castaneum* was to malathion (Zettler and Arthur, 1997). The present study aimed to determine the resistance of the adult confused flour beetle *T. confusum* to γ radiation and malathion.

Materials and Methods

Confused flour beetles, *Tribolium confusum* J. du Val. (Coleoptera: Tenebrionidae) were obtained from Department of Plant Protection, Faculty of Agriculture, Ankara University, in March 1998 and maintained for over ten generations. Experimental studies have been completed until May 2000. Rearing medium used was composed of 95% white flour and 5% brewer's yeast. Bergerson and Wool (1987), reported that survival of *T. castaneum* on yeast mixtured wheat flour better than on the wheat germ, powdered rice and corn flour.

Cultures and test insects were kept in darkened incubators and maintained at 27± 0.5°C and 70± 5 r. h. Adults were treated in a ^{60}Co gamma cell with a dose rate of 1 Gy/min. Adults (12-14 days old) were exposed to four dose levels ranging from 40-200 Gy, using 120 adults at each dose in petri dishes on small quantities of the foods being investigated and replicated three times. Each irradiated sample was accompanied by a control. After irradiation adults were transferred to 300 ml jars each containing 100 g of medium and control population (0 dose) were started similarly. Adults checked 1-day intervals and dead beetles were removed from the jar. In pesticide treatment, to derive concentration-mortality line, widely used stored products insecticide was chosen as malathion. The insecticide was supplied as technical grade material. The technical insecticide was dissolved in analytical grade acetone (Merck) to make stock solution of 19mg/ml. Before treatment, serial dilution of solution was prepared in acetone and applied to Whatman No. 1 filter paper discs (63.59 cm^2). For the controls, paper discs were treated with acetone. Treated filter paper discs were left to dry for three hours before the bioassay was started. One-day old adult *T. confusum* were placed in petri dishes and bioassayed. Mortality assessment was made at 6 d-days intervals. Insects were considered dead if they failed to move after light probing with a brush. The dose-response curve was determined by placing 30 adults in petri dishes on the filter papers impregnated with different concentrations of each malathion. After the adults were exposed to the malathion for approximately 15 minutes, 500 mg artificial diet was added to each petri dish. Three replicates were treated to provide a sample size of adults per dose. Mortality was recorded at 24, 48, and 72 hours after exposure. The data was subjected to analysis of variance (ANOVA) at 5% level of significance. If significant differences were shown to exist after the ANOVA results, the treatments were further compared using the Duncan's multiple range test. All data are transformed to square root and than analyzed (SPSS, 1999). LD_{50} and LD_{99} values were estimated by Probit analysis (Finney, 1964).

Results and Discussion

After the gamma radiation treatment, the rate of survival of adults is averaged in Table 1. Survival of the adults decreased with increasing gamma radiation doses. *T. confusum* had a greater mortality rate for adults irradiated at 140 and 200 Gy (Fig. 1). There were no significance between adults irradiated with 40 Gy and unirradiated control.

Percentage survival of the adults after malathion treatment is averaged in Table 2. Survival of adults decreased depending on increasing doses and time (Fig. 2). LD_{50} and LD_{99} values were estimated as 0.012mg/cm^2 and 0.131mg/cm^2 for adults respectively.

Irradiation of adults produced similar results by Hu *et al.* (1985). They have suggested that within 3 weeks of irradiation, no pupae and adults receiving doses of 200-600 Gy had survived. The same results were reported by Tunçbilek and Kansu (1996), in their work at 100 Gy was completely suppressed adults of *Tribolium confusum.* Misra and Bhatia (1998), has reported LD_{50} values for the fenvalerate susceptible strain of *T. castaneum* as 97.46 Gy and for resistance strain as 104.38 Gy respectively. In our experiment, life span of irradiated adult was detected in 30th day after treatment and there was no adult living at 140 Gy and above doses. Nakakita *et al.* (1985), reported that doses giving complete

Table 1: Survival percentage of adult flour beetle after exposure to different dose levels of gamma radiation.

Dose (Gy)	Survival after irradiation (Day)	
	0	30
Control	100.00	94.16 a*
40	100.00	94.16 a
100	100.00	57.50 b
140	100.00	4.16 c
200	100.00	0.83 c

(*) Within a column, means followed by the same letter are not significantly different at 5% level of confidence by an analysis of variance and Duncan's Multiple Range test (0.05 level).

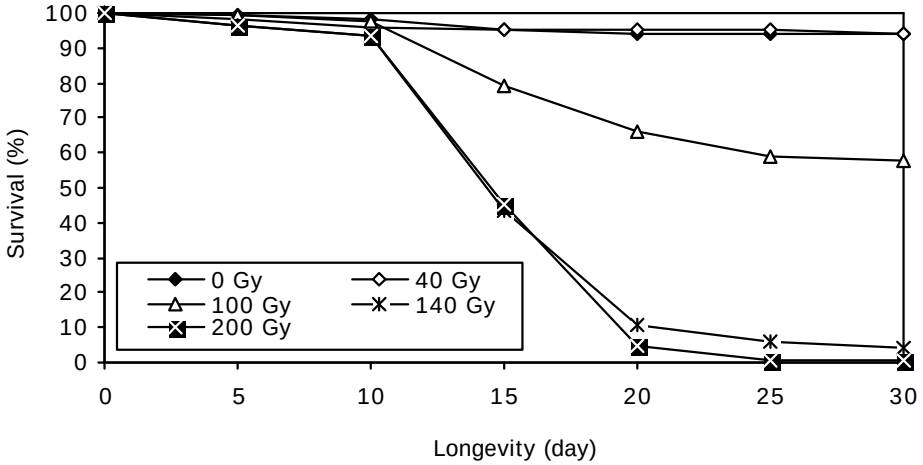

Fig. 1: Percentage survival of the adults during 30 days after irradiation.

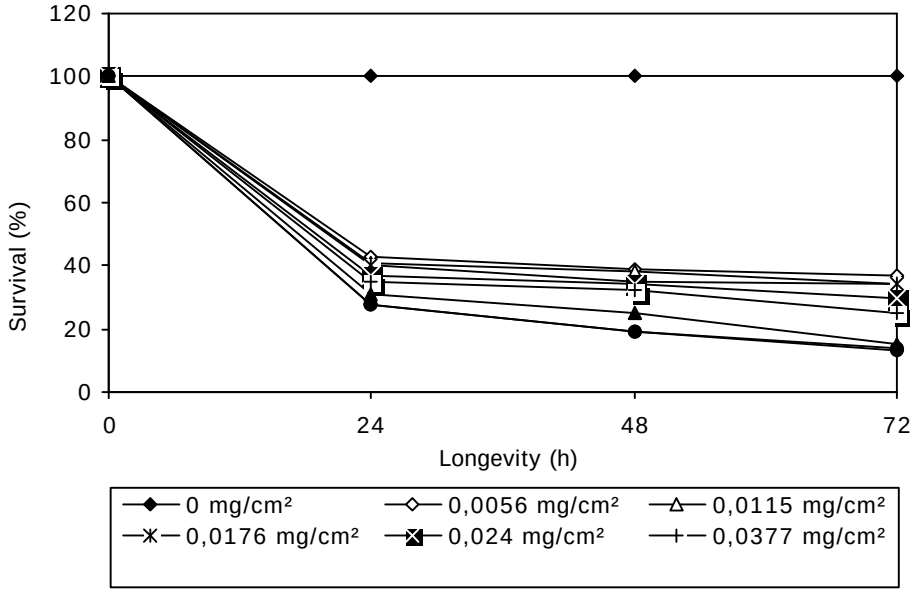

Fig. 2: Percentage survival of the adults during 72 hours after malathion treatment.

Table 2: Percentage survival of flour beetle adults after exposure to different dose levels of malathion

Dose (mg/cm²)	Survival after malathion treatment (h) 0	72
Control	100.00	100.00 a*
0.0056	100.00	41.11 b
0.0115	100.00	37.78 b
0.0176	100.00	37.78 b
0.0240	100.00	33.33 bc
0.0377	100.00	27.78 bcd
0.0527	100.00	16.17 cd
0.0692	100.00	15.56 d
0.0874	100.00	14.44 d

(*) Within a column, means followed by the same letter are not significantly different at 5% levels of confidence by an analysis of variance and Duncan's multiple range test (0.05 level), Chi Square= 88.337, DF= 7

mortality were 150 Gy for adults of the susceptible strain and 200 Gy for those of the resistant strain. Rejesus and Lapis (1973), found that adults of red flour beetle *T. castaneum* Herbst and saw-toothed grain beetle, *Oryzaephilus surinamensis* (Lin.) exposed to 15 Krad, 0-15 days after emergence died 28 days after treatment. It was concluded that 200 Gy is the effective dose for all stages.

In malathion treatment 0.012mg/cm² and 0.131mg/cm² doses were adequate to kill 50% and 99% of the population respectively. Not much is known about insecticide resistance levels in *T. confusum.* Previous studies found no evidence of malathion resistance in this insect (Vincent and Lindgren, 1967; Strong *et al.,* 1969; Horton, 1984). It was reported that the *T. confusum* strain most resistant to malathion was about as resistant as the least resistant strain of *T. castaneum* was to malathion (Zettler and Arthur, 1997).

The data obtained in this study has shown that radiation and

pesticide can be used as effective control methods. It is evident that these two methods can be combined as an additional control approach.

In conclusion, either chemical treatments or irradiation can be used as an effective control method, but chemical treatments may create problems by leaving undesirable residues. Irradiation has been shown to be an effective pest control method for these commodities and a good alternative to insecticide and can also kill or control insecticide-resistant pests

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