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EFFECT OF MICROWAVE RADIATION ON THE SOUTHERN COWPEA BEETLE *CALLOSOBRUCHUS MACULATUS* (F)

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ABSTRACT

This study investigated the effect of microwave radiation at different power levels of 100, 300, and 600 w at different exposure durations of 60, 80, and 100 sec, against eggs, first-instar larvae, and adults of the southern cowpea beetle *Callosobruchus maculatus* (F). The results showed significant differences in mortality, and 600 w with exposure time of 100 sec being superior. There was 100% mortality of eggs, first-instar larvae and adult; the incubation period of the eggs increased with exposure. The germination of cowpea grains was not significantly affected.

Key words: *Callosobruchus maculatus*, microwave, radiation treatment, cereals, legumes, larvae, instar, adult, mortality, egg period, germination, exposure time

Humans and animals use legumes as an important food source, either as dry seeds or as a green crop, making them one of the important economic crops globally (Singh, 2017). The southern cowpea beetle *Callosobruchus maculatus* (F) is the most important and dangerous insect pests that infect legumes (Ismail and Sufyan, 2008); its infestation starts in the field, after which it completes its life cycle and multiplies in the warehouse (Hamel et al., 2020). Its damage also affects the germination rates (Bhalla et al., 2008). One larva may consume about 5% of the weight of one grain during the duration of its development inside the grain (Abdelfattah and Zinhoum, 2024). Also, insect residues, droppings, and excretions change the nature of food and cause contamination, which helps the growth of fungi and bacteria that secrete toxic substances affecting the quality and quantity (Yadav et al., 2014). There are many negative effects of insecticides, and there is need to develop new and safe alternatives (Kaur et al., 2014; Yadav et al., 2014; Al-Hamadani et al., 2019). Electromagnetic heat treatment using microwave radiation is one of the new and effective methods in the treatment of many stored agricultural products, as it does not work to leave any toxic residues in the stored products, it also works to maintain the quality of products well, and it is characterized by its lack of impact on the environment, For this reason, micro-irradiation has been used as one of the alternative techniques to chemical insecticides in the control and treatment of insect pests infecting stored materials (Ahmed et al., 2011; Raju et al., 2023). Because of the economic importance of the insect, as it is an important storage pest that infects legumes and causes damage to them in the field and in the store, this study included the physical control of some insect roles using laboratory micro-radiation and at three power levels (100, 300 and 600 watts) at exposure times (60, 80 and 100 sec) on the following life aspects: (the percentage of killing eggs, the incubation period of eggs, the percentage of killing the insect).

MATERIALS AND METHODS

Adults of *C. maculatus* were obtained from the laboratory of the Badia Research Center/ Al-Muthanna University, and mass cultured with cowpea grains in one l bottles with 250 g of grains and 20 pairs of beetles. Testing the effect of microwave radiation was done in a KWS-17D black microwave device at 700 watts (at 100,300 and 600w); egg, first larval instar, and adult were used at exposure of 60, 80 and 100 sec); with a control treatment without radiation. These were done in glass dishes 9 cm dia, with three replications. Then the holes of the dishes were covered with a piece of boring cloth for ventilation to ensure that the hatched larvae did not come out, tied tightly with an elastic band and then placed in the incubator (30± 2°C; 70± 5%RH). The data on % of eggs killed and the incubation period were recorded. Similarly studies were done with first instar larva (@10 larvae/ dish with grains) and % mortality was computed. With adults also similar studies were done (10 adults/ dish) and % mortality was computed. The germination of the treated grains

was also evaluated by standard procedures. The data were subjected to statistical analysis in a completely randomized design with Gen Stat 2012 program. Significant differences were evaluated with test of the least significant difference (LSD, $p \leq 0.05$) (Al Rawii and Khalafullah, 2000).

RESULTS AND DISCUSSION

The results given in Table 1 reveal that 100 w microwave radiation led to 100, 100 and 98.7% germination with exposure durations of 60, 80 and 100 sec, respectively, compared to 300 w giving 97.6, 96.6 and 95.0%, respectively; and at 600 W reached 90.0,

Table 1. Effect of microwave radiation on germination of cowpea, and on life stages of *C. maculatus*

Power level (w)	Exposure (sec)	% Germination	Kill of eggs %	Incubation period of eggs (day)
Eggs				
The Control	00	100	00.0	4.8
100	60	100	00.0	5.0
	80	100	20.0	5.3
	100	98.7	30.0	5.3
Mean		99.6	16.7	5.2
300	60	97.6	23.3	5.1
	80	96.6	53.6	5.5
	100	95.0	80.0	6.3
Mean		96.4	52.3	5.6
600	60	90.0	57.6	5.5
	80	87.6	100	…….
	100	83.7	100	.....
Mean		87.1	85.9	1.8
L.S.D 0.05	Energy level	2.23	5.23	0.31
	Time	2.21	5.12	0.25
	Energy level x time	4. 45	11.8	0.52

First instar larvae, pupa and adults

Power level (w)	Exposure (sec)	% mortality (larvae)	Duration (larvae)	% for pupation	Duration of pupa (day)	% adult emergence	% mortality (adults)
The control	00	00.0	4.30	100	7.20	100	00.0
100	60	00.0	4.22	93.3	7.22	90.0	00.0
	80	13.6	4.50	80.0	7.42	80.0	10.0
	100	20.0	4.91	70.0	7.73	67.3	20.0
Mean		11.2	11.2	81.1	7.45	79.1	10.0
300	60	16.7	5.11	68.6	7.80	60.0	16.7
	80	46.7	5.83	50.0	8.11	47.7	36.7
	100	73.3	6.20	23.5	8.66	20.0	53.3
Mean		45.6	45.6	47.4	8.19	42.6	35.6
600	60	50.0	6.43	47.3	9.15	40.0	46.3
	80	100	……..	00.0	……..	00.0	86.7
	100	100	…….	00.0	……..	00.0	100
Mean		83.3	83.3	15.8	3.05	13.3	77.7
LSD (p=0.05)	Energy	4.46	0.20	4.33	0.42	3.51	4.33
	level	4.21	0.20	4.04	0.36	3.26	4.19
	Time	9.75	0.33	7.63	0.58	6.28	9.16
	Energy level x time						

87.6, and 83.7%, respectively; while in control it was 100%. A study in wheat earlier at 200,400 and 700 w at 30,60 and 90 sec exposure led to 90.66, 80 and 66.33% (at 90 sec), respectively (Saleh, 2015). on eggs, it has a significant effect on hatching as given in Table 1; the incubation period of eggs also varied to 5.3 and 6.3 days, respectively, at the exposure time of 100 sec, and so on, while in control treatment, it was 4.8 days. These results are consistent with those of Al-Hamdani (2016) on *Sitotroga cerealella*, where there was 100% killing at 600 w, and 90 sec. Kirkpatrick (1974) explained the reason for difference in energy levels and duration of exposure giving a significant effect on hatching of eggs when evaluated with *Callosobruchus maculatus;* decreased hatching may be because of the constant division of cells inside the eggs, their high humidity, and their small size (Heller, 1970). Killing of eggs of the lesser grain borer *Rhyzopertha dominica* increases with power level and duration of exposure; maximum killing was100% with 700 w and 60 and 90 sec duration (Saleh, 2015). Ismail and Sufyan (2008) with *C. maculatus* showed that the incubation period of eggs exposed to radiation increased with increasing energy levels and exposure durations.

As regards the first larval instar, a significant impact was observed (00.0%, 4.30 days, 100%, 7.20 days, and 100%; with *S. cerealella* it was observed that maximum killing in the larvae of was 100% at 600 w for 90 sec (Al-Hamdani, 2016). Saleh (2015) also showed that in the first instar of *R. dominica*, there was 100% mortality at 700 w and for 60 and 90 sec. Tayeb et al. (2018) showed that with the red flour beetle *Tribolium castaneum* also it was 100% with 800 w radiation for 20 sec. In the adult stage of *C. maculatus*, 600 w of radiation for 100 sec gave 100%, while 100 w for 60 sec gave no mortality; it was 53.3% at 300 w for 100 sec. Younus and Karso (2023) showed that in *T. castaneum*, and saw toothed grain beetle *Oryzaephilus surinamensis* and khabra beetle *Trogoderma granarium* when exposed to similar effect was observed. Al-Hamdani (2016) also showed this with *S. cerealella*. Srivastava and Mishra (2022) pointed out that with *R. dominica* mortality reached 90% when treated with a 720 w radiation. Thus, the microwave radiation significantly affects the life cycle of *C. maculatus* in terms of egg death rates, egg incubation period, and emerging adult rates.

AUTHOR CONTRIBUTION STATEMENT

MHH, MKI and AHA conceived of the original idea. MHH and MKI developed the theoretical and performed the statistical analysis for experimental data. MKI and MHH verified the analytical methods. MHH, MKI and AHA worked for lab analysis and supervises the project. MHH, MKI and AHA discussed the results and contributed to the wrote the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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