

THE USE OF HIGH TEMPERATURES FOR DISINFESTING WHEAT FROM *SITOPHILUS GRANARIUS* L., AND COWPEA *CALLOSBRUCHUS* *MACULATUS* (F.)

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Abstract

High temperatures were tested as a means of controlling all stages of *Sitophilus granarius* L. in wheat and *Callosobruchus maculatus* F. in cowpea. Complete control of all immature stages of *S. granarius* was achieved by exposing infested wheat to 70°C for 20 minutes. Complete kill for the adult stage occurred at 50°C for 15 minutes. In case of *C. maculatus*, eggs, larvae, pupae and adults were killed at 65°C for 20 minutes, 70°C for 20 minutes, 70°C for 15 minutes and 55°C for 20 minutes, respectively.

INTRODUCTION

Mansour and Hassan (1976) stated that *Bruchus alferii* Pic. immature stages were controlled by exposing the infested berseem seed to 60°C for 10 minutes. Vardell and Tilton (1981 b) found that complete control of immature stages of *Rhizopertha dominica* F. and *Sitophilus Oryza* L. was achieved by exposure to 67 and 58°C for 1.75 and 3.75 minutes, respectively.

The present work in an attempt to control *Sitophilus granarius* in wheat and *Callosobruchus maculatus* in cowpea by exposing grains to different temperatures.

MATERIALS AND METHODS

The insects used were obtained from laboratory cultures kept at the Stored Product Research Laboratory, Plant Protection Research Institute, Dokki, Cairo, Egypt. Rearing conditions were $28 \pm 1^\circ\text{C}$ and 65% R. H. The rearing media for *S. granarius* were the wheat variety Sakha 69 and the cowpea variety Kareem-9 for *C. maculatus*. Wheat and cowpea contained 12% water and were freed from infestation by fumigation for 3 days with Phostoxin tablets at the rate of 1.5 tablet/ m^3

S. granarius

Batches of twenty adult insects, 1-3 days-old, were released on 20g of wheat in plastic tubes. After 3-4 days, all adults were removed. The infested wheat in the tubes was incubated at $28 \pm 1^\circ\text{C}$ and 65% R. H. to be used later for the tests shortly after removing the adults. The eggs were counted, and the larva and pupae were recorded after 20 and 30 days, respectively. Batches of 25 one week-old adults in plastic tubes containing wheat seeds were used for assessing the effect of temperatures on adult's life.

C. maculatus

The tests of eggs were carried out on batches of 50 cowpea seeds in plastic tubes each seed having one egg. In the tests of larvae and pupae, batches of 50 seed, each infested with one egg, were incubated at $28 \pm 1^\circ\text{C}$ and 65% R. H. for 12 days to be used for larvae and 20 days for pupae. In case of adults, batches of 25 newly emerged ones in plastic tubes containing cowpea seeds, were used.

Experimental design and analysis of data

The temperatures tested for *S. granarius* were 40, 45, 55, 65, 70, 75 and 80°C at 10, 15 and 20 minutes exposure. The temperatures for *C. maculatus* were 50, 55, 60, 70, 75 and 80°C at the same times of exposure. Each test was replicated three times using three batches for each replicate. Parallel control experiments for both insects were carried out by keeping similar batches throughout the experimental period at 28°C and 65% R. H. In all cases of immature stages, the criterion of effect used was the failure to reach to adult stage, and all the comparisons were based on the percentages of reduction in adult emergence in treatment compared with the control. In case of adults, percentages of mortality were determined and

related to the percentages of mortality in the controls. All results were subjected to analysis of variance.

RESULTS AND DISCUSSION

Sitophilus granarius L.

As shown in Table 1, the overall means of percentages of reduction for adult emergence from all the immature stages in the treatments of 45 and 55°C at 10 minutes exposure did not differ significantly since they varied slightly within a range from 17.9 to 19.3%. Increasing the exposure time to 15 and 20 minutes increased significantly the percentages of reduction of adult emergence to 44.7 and 64.1%, respectively.

At 65°C and 70°C for the different periods of exposure, the percentage reduction of adult emergence increased considerably in treatments of all immature stages. The overall means percentages reduction of adult emergence at 65°C were 40.2, 67.4 and 81.0% and increased to 57.2, 84.4 and 100% at the exposure times 10, 15 and 20 minutes, respectively.

The effect of heating on infested wheat was discussed by Vardell and Tilton (1981b). They found that complete control of immature stages of *R. dominica* and *S. oryzae* was achieved by exposure to 67 and 58°C for 1.75 and 3.75 min., respectively.

It was clear that the larva was the most tolerant stage to the effect of temperature in comparison with eggs and pupae. The overall percentages of reduction of emerging adults for the three periods of exposure and at all temperatures were 66.1, 52.8 and 69.8% for eggs, larvae and pupae, respectively. In this respect, Vardell and Tilton (1981 a) reported that the most sensitive portion of the insect life cycle of *R. dominica* was the egg stage and the most tolerant portion was the pupal stage.

Treatments at 75°C for 15 minutes caused 83.1 and 73.4% reduction in adult emergence when the eggs and larvae were exposed to such high temperature. Exposing the pupae to the same treatment achieved complete control.

Complete control was also achieved when infested wheat with all immature

Table 1. Effect of exposing wheat to different temperatures for different periods against the different stages of *S. granarius*.

Temp. °C	Treatment of immature stages												Adult
	Reduction % of adult emergence at indicated periods of exposure in minutes												
	Eggs			Larvae			Pupae			Mortality % at indicated periods of exposure in minutes			
	10	15	20	10	15	20	10	15	20				
40	-	-	-	-	-	-	-	-	-	38.7	53.3	72.0	
45	27.9	28.7	35.8	0.0	0.0	5.4	25.6	33.3	77.8	50.7	73.3	82.7	
50	-	-	-	-	-	-	-	-	-	78.7	100.0	100.0	
55	29.7	40.7	58.4	0.0	15.4	41.4	28.1	77.8	92.3	-	-	-	
65	44.0	68.0	90.9	6.6	48.6	85.4	70.0	85.6	96.7	-	-	-	
70	52.0	80.6	100.0	49.4	82.6	100.0	70.0	92.3	100.0	-	-	-	
75	69.6	83.1	100.0	56.0	73.4	100.0	85.6	100.0	100.0	-	-	-	
80	92.2	96.9	100.0	86.0	98.6	100.0	100.0	100.0	100.0	-	-	-	

L.S.D. at 5% for

Egg

Larvae

Pupae

Adult

Temp.

Time

Temp. X time

17.57

25.31

12.43

19.24

27.60

13.56

2.92

4.20

2.06

stages was exposed to 70°C for 20 minutes.

All adults exposed to 50°C for 15 and 20 minutes were killed. Mortality percentages ranging between 70 to 80% occurred when the adults were exposed to 45°C for the same periods of exposure.

Callosobruchus maculatus

As indicated in Table 2, at 40°C only a slight effect occurred on adult mortality at the three times of exposure. At 45°C, only 50% kill occurred when the adults were exposed for 20 minutes while 80% kill was achieved at 50°C. Complete adult's kill occurred at 55°C at all periods of exposure.

Increasing temperature to 55°C did not significantly reduce adult emergence at the exposure times 10 and 15 minutes. Hence, these treatments seemed not to affect immatures. Increasing the exposure period to 20 minutes at the same temperatures revealed a significant reduction of adult emergence when the eggs were treated, reaching to 11.3 and 32.3%, respectively.

In general, exposure to 60°C for 20 minutes increased significantly the percentage reduction of emerging adults in treatments of all immature stages. Mansour (1969) found that the beetles of *C. maculatus* were killed at 55°C for 15 minutes and 60°C for 5 minutes. Mansour and Hassan (1976) stated that all immature stages of *B. alferi* were controlled by exposing the infested berseem seeds to 60°C for minutes.

Data in table 2 also indicated that the larval stage was the most tolerant to heat. Reductions in adult emergence were 68.1, 21.9 and 39.7% for eggs, larvae and pupae, respectively at 60°C for 20 minutes. Exposure to 65°C for 20 minutes was fatal for both eggs and pupae, while 50% control occurred in case of exposing the larval stage. Complete control of all immatures occurred by exposure to 70°C for 20 minutes.

Table 2. Effect of exposing cowpea to different temperatures for different periods against the different stages of *S. granarius*.

Temp. °C	Treatment of immature stages												Adult			
	Reduction % of adult emergence at indicated periods of exposure in minutes												Mortality % at indicated periods of exposure in minutes			
	Eggs						Lrvae							Pupae		
	10	15	20	10	15	20	10	15	20	10	15	20		10	15	20
40	-	-	-	-	-	-	-	-	-	-	-	-	-	2.7	13.3	
45	-	-	-	-	-	-	-	-	-	-	-	-	-	34.7	50.7	
50	0.0	11.3	11.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	84.3	81.3	
55	0.0	90.7	32.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	100.0	100.0	100.0	
60	0.0	100.0	68.1	0.0	10.5	21.9	7.7	27.1	39.7	100.0	100.0	100.0	100.0	100.0	-	
65	43.1	100.0	100.0	28.0	36.3	45.7	17.7	27.1	98.8	-	-	-	-	-	-	
70	65.3	100.0	100.0	44.1	58.1	100.0	20.7	100.0	100.0	-	-	-	-	-	-	
75	74.7	100.0	100.0	65.9	74.3	100.0	72.3	100	100.0	-	-	-	-	-	-	
80	100.0	100.0	100.0	90.3	100.0	100.0	87.5	100	100.0	-	-	-	-	-	-	

L.S.D. at 5% for:

Temp.

Time

Temp. X time

Egg

34.7

45.3

N.S.

Larvae

10.41

13.42

N.S.

Pupae

16.8

N.S.

N.S.

REFERENCES

- 1 . Mansour, M. M. and M. R. Hassan, 1976. Lethal effect of high temperature on various stages of the colver seed beetles, *Bruchus affierii* Pic. Bull. ent. Soc. Egypt, Econ. Ser., 10:129 - 135.
- 2 . Mansour, M. M., 1969. Ecological and biological studies on certain grain pests of family Bruchidae (Coleoptera). Ph.D. Thesis, Fac. of Agric., Ain Shams Univ. Cairo, Egypt.
3. Vardell, H. H. and E. W. Tilton, 1981 a. Heat sensitivity of the lesser grain borer, *Rhyzopertha dominica* (F.). J. Georgia Entomol. Soc., 16 (1) : 116 - 121.
4. Vardell, H. H. and E.W. Tilton, 1981b. Control of the lesser grainborer, *Rhyzopertha dominica* F. and the rice weevil *Sitophilus oryzae* L. in wheat with a heated fluidizedbed. Journal of the Kansas Entomological society. 54 (3), PP. 481-485.

إستخدام الحرارة كوسيلة لمكافحة أطوار حشرتى سوسة الحبوب وخنفساء اللوبيا

مواهب زيوار

معهد بحوث وقاية النباتات - وزارة الزراعة - الدقي

إختبرت الحرارة كوسيلة لمقاومة جميع أطوار حشرتى سوسة الحبوب *S. granarius*، خنفساء اللوبيا *C. maculatus* فى القمح واللوبيا وذلك بتعريضها لدرجات حرارة من ٤٥ الى ٧٥° م لمدة ١٠، ١٥، ٢٠ دقيقة.

وقد أدى تعريض القمح لدرجة ٧٠° م لمدة ٢٠ دقيقة الى وقاية تامة لكل الأطوار الداخلية لحشرة *S. granarius* كما أدى تعريض الحشرة الكاملة لدرجة ٥٠° م لمدة ١٥ دقيقة إلى إبادة تامة للحشرة.

وتم إبادة بيض حشرة خنفساء اللوبيا *C. maculatus* عند تعريض بذور اللوبيا المصابة لدرجة ٦٠° م لمدة ٢٠ دقيقة أما طور اليرقة والعذراء فقد تمت مقاومتها عند درجة ٧٠° م لمدة ٢٠، ١٥ دقيقة على التوالى. ولقد تم إبادة الحشرة الكاملة على درجة ٥٥° م لمدة ١٠ دقائق.