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Effect of temperature, relative humidity and food material on the biology of *Sitophilus oryzae* LINNAEUS and *Rhizopertha dominica* FABRICIUS

(Coleoptera: Curculionidae and Bostrichidae)

With 1 text figure

A good deal of information has been accumulated about the taxonomy, morphology, bionomics and control of *Sitophilus oryzae* and *Rhizopertha dominica*. Nevertheless there are many gaps in the knowledge of their biology in India. KHARE and AGRAWAL (1963) reported that *Sitophilus oryzae* and *Rhizopertha dominica* both prefer maize for egg laying over wheat and temperature and relative humidity (r. h.) effect the egg out put.

The embodied work deals with the effect of temperature and r. h. and food material on the length of larval, pupal and adult stages and their mortality. OXLEY and HOWE (1944), RICHARDS (1947), HOWE (1952) have studied the length of different stages of *Sitophilus oryzae* at various temperatures on wheat only. HOWE (1949) and BIRCH (1945) studied the complete developmental period of *Rhizopertha dominica* in successive stages in flour and in whole grain. HOWE (1952) reported that there is a critical point at about 60% r.h. below which egg laying decreases rapidly and mortality is high. BIRCH (1945) reported that mortality at 14% moisture content (m.c.) generally occurred in eggs and I instar larvae of *Sitophilus oryzae*.

Methods and Materials

Test insects of *Sitophilus oryzae*, *Rhizopertha dominica*, (28.30 days) were obtained by the method described by KHARE and AGRAWAL (1963) and reared at temperatures 18 °C, 25 °C, 30 °C and 50%, 60%, 75% and 80% r.h. in wheat and maize.

Sitophilus oryzae LINNAEUS

The results in *Sitophilus oryzae* were obtained on successive daily estimates of the proportion of population in each instar by dissecting the infested grain from fifth day of oviposition until the emergence of the adult. Each larval instar was recognised by the size of the head. Grains were soaked in 5% alcohol to kill the larva and soften the grain.

Rhizopertha dominica FABRICIUS

Larvae of *Rhizopertha dominica* were recognised for moults by the presence of cast skin of the previous instar which was always removed. First stage was recognised by the terminal median spine and subsequent instars by the size of the head capsule.

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Results

The results obtained are tabulated as average of number of days in each instar, pupa and adults.

Table I

Number of days of each instar, pupa and adult of *Sitophilus oryzae* on wheat (W) and maize (M) at different temperatures and r.h. levels. Each figure is mean of 10 insects

Temp. °C	r.h. %	I		II		III		IV		Pupa		Adult	
		W	M	W	M	W	M	W	M	W	M	W	M
18	50	8	8	15	18	20	21	29	26	40	38	58	58
	60	10	10	28	30	38	36	45	42	72	70	93	89
	75	12	12	30	32	39	39	47	46	76	78	92	90
	80	16	18	35	38	42	40	52	50	74	72	93	90
25	50	6	8	13	14	19	20	35	33	48	46	57	56
	60	5	7	8	9	14	13	17	16	23	22	26	25
	75	5	6	10	11	15	15	22	20	32	32	38	38
	80	5	5	12	14	13	14	21	20	34	33	38	36
30	50	5	5	9	10	12	11	14	12	21	21	26	24
	60	5	5	6	6	10	9	14	14	20	21	24	24
	75	5	6	8	9	13	11	16	14	23	21	27	26
	80	6	7	12	13	16	14	13	21	31	31	37	36

It is seen from table I that on an average the maximum time taken by the adult to emerge in wheat and maize at 18 °C, 80% r.h. is 93 and 90 days respectively and minimum at temperature 30 °C, 60% r.h. is 24 days in wheat and maize. First stage larvae emerged earliest on 5th day from the date of oviposition at 25 °C 60%, 75%, 80% r.h. and 30 °C 50%, 60%, 75% r.h. and took maximum time to hatch, 16 to 18 days at 18 °C 80% r.h.

Fourth stage larvae took less time to change into pupa in maize than in wheat.

Table II

Number of days of each instar, pupa and adult of *Rhizopertha dominica* in wheat (W) and maize (M) at different temperature and r.h. levels. Each figure is the mean of ten insects

Temp. °C	r.h. %	I		II		III		IV		Pupa		Adult	
		W	M	W	M	W	M	W	M	W	M	W	M
18	50	9	9	16	15	18	19	28	29	35	33	50	50
	60	11	11	16	16	22	24	30	30	36	34	53	52
	75	12	13	18	18	22	23	31	30	35	34	56	54
	80	16	16	18	19	24	26	30	29	36	34	55	54
25	50	8	8	14	14	19	21	28	27	34	33	48	46
	60	7	7	15	16	14	16	22	20	31	30	49	45
	75	7	7	16	16	15	18	22	21	32	32	50	50
	80	9	8.5	16	17	15	18	22	21	32	32	50	50
30	50	6	6	9	9	11	12	15	14	20	18	33	33
	60	6	6	6	6	10	12	14	14	19	18	32	31
	75	5	6	8	9	12	13	16	14	21	20	32	32
	80	6	7	9	9	14	16	20	19	25	23	32	32

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Table II indicates that number of days taken by *Rhizopertha dominica* to become adults is maximum at 18 °C 75% r.h. 80% r.h. and minimum at 30 °C 60%, 80% r.h. First instar took minimum time to change to second stage at 30 °C 75% r.h. and maximum at 18 °C 80% r.h.

Mortality of successive stages of *Sitophilus oryzae* and *Rhizopertha dominica* at different temperature, r.h. and food material

Sitophilus oryzae LINNAEUS

Test insects of *Sitophilus oryzae* were released to lay eggs in wheat and maize at 18 °C, 25 °C, 30 °C and 50%, 60%, 75%, 80% r.h. After a week 500 Kernals of wheat and maize were selected at random to count the number of eggs present in them. Grains were stained in 1% acid fuchsin to take the count of eggs. The grains having eggs inside were kept seperately. When weevils started emerging they were counted. Emerged weevils were not allowed to feed on grains. When all the weevils emerged; grains were dissected for the mortality of larval stages. It was difficult to separate natural mortality from cannibalism but efforts were made to obtain some information under above mentioned conditions. The data obtained is tabulated in Table No. III.

Table III

Mortality of successive larval, pupal and adult stages of *Sitophilus oryzae* in wheat and maize

Temp. °C	r.h. %	No. of eggs	I	II	III	IV	Pupa	Adult	No. of adult	Mortality	
										Total	%
Wheat											
18	50	80	15	8	6	8	3	10	30	50	62.5
	60	60	12	9	5	4	6	12	32	48	80.00
	75	80	8	3	6	6	4	6	47	33	41.25
	80	60	6	4	6	8	2	4	30	30	50.00
25	50	80	10	8	6	3	4	4	45	35	43.75
	60	60	8	6	4	2	4	3	34	26	43.33
	75	80	4	3	2	1	2	4	65	15	18.75
	80	60	5	4	3	4	3	2	39	21	35.00
30	50	80	12	8	3	3	5	6	43	37	46.25
	60	60	8	6	2	1	3	5	35	25	41.66
	75	80	4	3	2	2	3	2	64	16	20.00
	80	60	5	2	2	2	2	3	44	16	26.66
Maize											
18	50	80	22	8	8	10	3	8	21	59	73.75
	60	60	16	6	7	5	4	7	17	45	75.00
	75	80	10	2	4	6	3	6	49	31	38.75
	80	60	8	3	3	5	2	3	36	24	40.00
25	50	80	10	9	7	2	4	5	43	37	46.25
	60	60	9	8	5	1	2	5	30	30	50.00
	75	80	6	4	3	..	1	4	61	18	22.70
	80	60	5	3	2	1	2	4	43	17	28.33
30	50	80	10	8	4	3	6	6	43	37	46.25
	60	60	6	6	2	2	4	5	35	25	41.66
	75	80	4	3	2	3	3	4	61	19	23.75
	80	60	4	2	1	1	4	3	45	15	25.00

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Table III indicates that larval mortality varies from 13.5 to 46.25% in wheat and 16.25 to 60% in maize. The mortality from egg to adult stage varies from 20 to 80% in wheat and 22.5% to 75.00% in maize. The maximum mortality is 80.00% at 18 °C 50% in wheat and 75.00% in maize and minimum is 18.75% in wheat and 22.5% in maize at 25 °C 75%.

It becomes obvious from above data that weevils survive better at temperature 25 °C 75% r.h. though oviposition record is best at 30 °C 75% r.h. (KHARE and AGRAWAL 1963). Mortality due to cannibalism of larvae could not be considered as it was difficult to follow the insect from first stage to adult stage.

Mortality of successive stages of *Rhizopertha dominica* at different temperatures, r.h. and food material

Test insects of *Rhizopertha dominica* were released to lay eggs in wheat and maize at 18 °C, 25 °C, 30 °C and 50%, 60%, 75% and 80% r.h. After a week 500 Kernals were taken out and the number of eggs were counted. Insects were followed from first larval stage to the adult stage. The mortality of larval stages was counted and the records were tabulated in table IV.

Table IV

Comperative mortality of successive stages of *Rhizopertha dominica* at different temperatures and r.h. in wheat and maize

Temp. °C	r.h. %	No. of eggs	I	II	III	IV	Pupa	Adults emerged	Mortality	
									Total	%
Wheat										
18	50	80	5	4	5	4	2	60	20	25.00
	60	60	5	4	2	2	1	46	14	26.66
	75	80	6	3	3	2	–	66	14	17.50
	80	60	5	3	3	1	1	47	13	21.66
25	50	80	5	4	3	3	2	63	17	21.25
	60	60	3	2	1	1	–	53	7	11.66
	75	80	5	4	3	3	2	63	17	21.25
	80	60	5	4	2	2	1	46	14	26.66
30	50	80	6	4	5	3	2	60	20	25.00
	60	60	4	3	3	2	2	46	14	26.66
	75	80	4	3	2	2	1	68	12	15.00
	80	60	4	3	2	2	1	48	12	20.00
Maize										
18	50	80	6	5	5	4	2	58	22	27.60
	60	60	8	3	3	2	1	43	17	28.33
	75	80	8	5	4	3	2	58	22	27.75
	80	60	8	4	2	1	1	44	16	26.66
25	50	80	7	4	2	2	2	63	17	21.25
	60	60	3	2	2	2	1	80	10	16.66
	75	80	6	3	3	2	1	65	15	18.75
	80	60	8	2	2	2	1	45	15	25.00
30	50	80	8	5	6	2	1	58	22	27.50
	60	60	5	3	3	4	2	43	17	28.33
	75	80	4	4	4	3	1	64	16	20.00
	80	60	5	3	2	2	1	47	13	21.66

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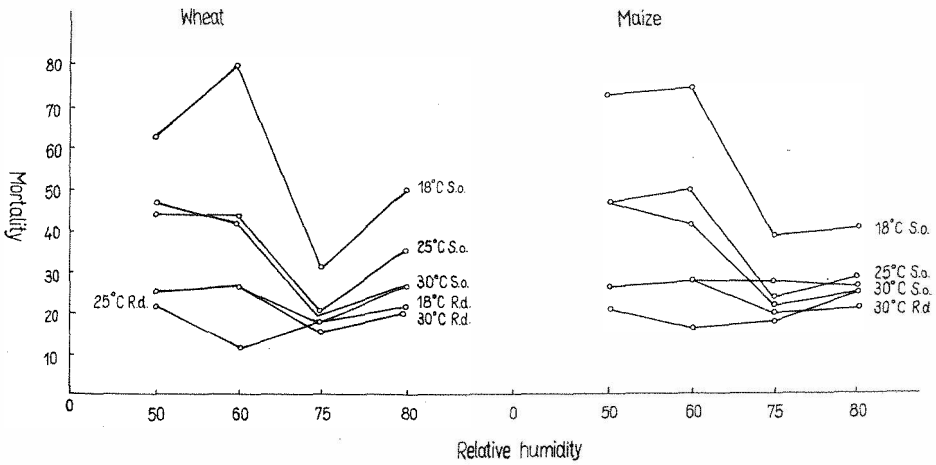
Table IV indicates that mortality of first instar larvae is maximum varying from 5 to 8. The mortality from egg to adult stage varied from 11.66% to 26.66% in wheat and 16.66 to 28.33% in maize. *Sitophilus oryzae* and *Rhizopertha dominica* both prefer 30 °C 75% r.h. for egg laying. This is indicative of fact that the whole development of insects can not go uninhibited at one temperature. *Rhizopertha dominica* can develop better at temperature 25 °C r.h. 60% as total mortality is only 11.66% in wheat and 16.66% in maize.

Discussion

Eggs of *Rhizopertha dominica* and *Sitophilus oryzae* hatched earlier in high temperature and low humidity 30 °C 50% r.h. but for development of both the insects temperature 30 °C and 60% r.h., *Rhizopertha dominica* can develop even in lower limits of temperature and humidity. *Sitophilus oryzae* on the other hand can neither resist dry nor damp conditions. Insects developed after a longer time in maize than in wheat. The reason might be that wheat being softer is easier to be eaten up by the grubs, and presumably they have greater difficulty in feeding on maize grains.



Total mortality of *Sitophilus oryzae* and *Rhizopertha dominica* at different temperatures and relative humidity levels

Sitophilus oryzae when allowed to breed suffered mortality due to Cannibalism by newly emerged larvae. Effect of food could not be marked as much as of temperature and r.h. levels. *Rhizopertha dominica* did not have cannibalism and hence could easily be followed from first instar to the full grown grub stage.

In *Sitophilus oryzae* and *Rhizopertha dominica*, the mortality is minimum at 25 °C 75% r.h. and 25 °C 60% respectively but in maize it is comperatively more.

This indicates that in maize insects thrive less in comparison to wheat. Thus not only the temperature and m.c. and food material are responsible for the development but physical condition of grain also checks infestation and thereby increases mortality. Potter (1935) in *Rhizopertha dominica* found variation in number of moults and reported four, six and seven but such extra moults or

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instars have not been observed in the present studies. KHARE and AGRAWAL (1963) reported that the *Sitophilus oryzae* could lay highest number of eggs at 30 °C 75% r.h. it is interesting to note that the development of larvae of both the insects is better at 25 °C 75% r.h., though the threshhold of *Rhizopertha dominica* is better at 25 °C, 60% r.h.

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Summary

A study of the developmental period and mortality of *Sitophilus oryzae* and *Rhizopertha dominica* was carried out at temperatures of 18 °C, 25 °C, 30 °C and 50%, 60%, 75% and 80% r.h. levels. Observations from the above study revealed that time taken by *Sitophilus oryzae* to become adult at 18 °C 80% r.h. and by *Rhizopertha dominica* at 18 °C 75% r.h. was maximum. Mortality was minimum in *Sitophilus oryzae* at 25 °C 75% r.h. and in *Rhizopertha dominica* at 25 °C 60% r.h. in both wheat and maize. It was further observed that mortality was higher in case of maize than in wheat.

Zusammenfassung

Die Entwicklungszeit und die Sterblichkeit von *Sitophilus oryzae* und *Rhizopertha dominica* wurden bei Temperaturen von 18 °C, 25 °C und 30 °C und relativen Luftfeuchtigkeiten von 50%, 60%, 75% und 80% untersucht. Die Beobachtungen ergaben, daß die maximale Entwicklungszeit bis zur Reife bei *Sitophilus oryzae* bei 18 °C und 80% relativer Luftfeuchtigkeit und bei *Rhizopertha dominica* bei 18 °C und 75% relativer Luftfeuchtigkeit vorlag. Die Sterblichkeit von *Sitophilus oryzae* war am geringsten bei 25 °C und 75% relativer Luftfeuchtigkeit und von *Rhizopertha dominica* bei 25 °C und 60% relativer Luftfeuchtigkeit, sowohl auf Weizen als auch auf Mais. Es wurde ferner festgestellt, daß die Sterblichkeit bei Mais höher war als bei Weizen.

Резюме

Длительность развития и смертность *Sitophilus oryzae* и *Rhizopertha dominica* изучались при температурах 18 °C, 25 °C, и 30 °C и при относительной влажности воздуха 50%, 60%, 75% и 80%. Наблюдения показали, что у *Sitophilus oryzae* при 18 °C и 80% и у *Rhizopertha dominica* при 18 °C и 75% имеется максимальный срок развития до зрелости. Смертность у *Sitophilus oryzae* была при 25 °C и 75% и у *Rhizopertha dominica* при 25 °C и 60% самая маленькая, и на пшенице и на кукурузе. Отмечалась высшая смертность на кукурузе чем на пшенице.

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