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Effect of Temperature and Humidity on the Development, Longevity and Predatory Potential of *Pharoscymnus flexibilis* Muls. on San Jose Scale

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ABSTRACT

The influence of temperature (22 , 24 , 28 , 32 , and 37°C) and relative humidity (45,65,85%) on the development, survival, fecundity and predatory potential of *Pharoscymnus flexibilis* Muls. was observed. The optimum temperature and humidity for the development of different stages of *P. flexibilis* and predatory potential were observed to be 28°C and 65% relative humidity respectively. The beetles hibernate at 22°C and could survive for more than 175 days, while at 37°C, they died within 5- 10 days. *P.flexibilis* was observed to consume on an average 1362, 2537 and 2110 San Jose Scale crawlers at 24 , 28 and 32°C, respectively throughout its larval and adult life span.

Key Words : Development, longevity, predatory potential, *Pharoscymnus flexibilis, Quadraspidiotus perniciosus*

Pharoscymnus spp. are well known predators of pests of economic importance. *P.flexibilis* is an effective predator of *Aonidiella aurantii* Mask., *A. orientalis* Newst., *A. citrina* coq, *Lepiosaphes* sp., *Parletoria blanchardii* Targ, *P. cryspta* Mckenzie and *Quadraspidiotus perniciosus* Comstock (Ghani and Ahmad, 1966). Perusal of literature revealed only inadequate informations on the biology, ecology and fecundity of *P. flexibilis* except the report of Ghani and Ahmad (1966) who made some preliminary attempts to study the biology and general ecology of this beetle. Therefore, the present investigation on the influence of constant temperature and humidity on the biology of *P. flexibilis* was carried out.

MATERIALS AND METHODS

Healthy adults of *P. flexibilis* were selected from the culture maintained in the laboratory on San Jose Scale reared on pumpkin at 26±2°C and 60±5% relative humidity. Eggs were obtained from beetles caged in plastic jars (size 3" x 1.5"). The eggs were removed every four hours with a moist camel hair brush and kept at 22±0.5°C, 24±0.5°C, 28±0.5°C and 32±0.5°C under 45±5, 65±5 and 85±5 per cent relative humidity. The temperature and humidity were controlled in the BOD cabinet as per Soloman (1951). The plastic jars were placed in a cabinet at constant temperature (±0.5°C RH (±5%) and food (laboratory reared San Jose Scale crawlers on pumpkin strip (1" x 1")) was provided. Observation on the various biological characteristics were made at 12h interval on 25 individuals in each treatment. The feeding efficacy was recorded by counting the San Jose Scale crawlers consumed per 24h during the entire larval as well as adult life span. The number of eggs laid by a female was observed by confining it with one male under muslin cloth covered jars. Observations were also made on the mortality percentage of

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Table 1. Duration of egg, larval and pupal stage of *Pharoscymnus flexibilis* at different levels of temperature and humidity (mean based on 25 observations)

Temp °C	Duration of egg development in days					Duration of larva development in days					Duration of pupa in days				
	RH(%)					RH(%)					RH(%)				
	45	65	85	Mean	SE	45	65	85	Mean	SE	45	65	85	Mean	SE
24.0	12.9	10.0	7.4	10.1**		32.0	29.9	24.3	28.7		10.9	10.0	10.6	10.5**	
28.0	5.8	4.8	4.3	5.0	±0.62	16.9	17.7	19.7	18.1	±1.87	4.5	6.3	5.2	5.3	±0.48
32.0	3.2	4.4	3.6	3.7		12.3	14.0	11.8	12.7		7.0	5.7	5.3	6.0	
Mean	7.3	6.4	5.1	6.3		20.4	20.5	18.6	26.1		7.5	7.3	7.0	7.3	
SE	±0.62					±1.87					±0.48				

** Significant at 1 per cent level

different life stages of beetle at variable temperature and humidity conditions.

RESULTS AND DISCUSSION

The duration of egg at 24 , 28 and 32°C was 10.1,5.0 and 3.7 days, respectively (Table 1). Development at 28°C was significantly faster than at 24°C and was slightly more at 32°C than at 28°C; the differences were statistically non significant at 32°C and 28°C in the egg development.The viability of eggs at 32°C was significantly lesser than at 28°C. Only 41.6% of the eggs hatched on an average at 32°C as compared to 89.8 and 85.4% at 24°C and 28°C, respectively (Table 2).

The duration of larval and pupal stages at 24 , 28 , 32°C were 28.7, 18.1, 12.7 and 10.5, 5.3, 6.0 days respectively (Table 1) and survival was 80.8, 91.5, 67.5 and 83.0, 94.1, 69.8%, respectively (Table 2). The larval and pupal development were significantly faster as

Table 2. Survival of egg, larva and pupa of *Pharoscymnus flexibilis* at different levels of temperature and relative humidity regimes

Temp °C	SURVIVAL OF EGG					LARVA					PUPA				
	RH(%)					RH(%)					RH(%)				
	45	65	85	Mean	SE	45	65	85	Mean	SE	45	65	85	Mean	SE
24.0	82.0	91.5	96.0	89.8		69.0	75.8	72.5	72.4		80.8	84.3	84.0	83.3	
28.0	80.5	97.0	78.6**	85.4	±4.52	94.9	98.9	96.0**	96.6	±2.05	91.5	97.2	93.6	94.1	±2.02
32.0	45.8	40.4	38.5	41.6		85.2	80.8	89.7**	85.2		67.5	70.2	71.6	69.8	
Mean	69.4	76.3	71.0	72.3		83.0	85.2	86.1	84.7		79.9	83.9	83.1	82.3	
SE	±4.52					±2.05					±2.02				

** Significant at 1 per cent level

Table 3. Longevity and fecundity of *Pharoscymnus flexibilis* at different temperature and humidity regimes (Mean based on 25 observations)

Temp °C	Longevity in days					Duration of larva development in days				
	RH(%)					RH(%)				
	45	65	85	Mean	SE	45	65	85	Mean	SE
24.0	80.5	75.0	72.0	75.8		145.2	142.8	151.5**	146.5	
28.0	67.0	79.8	73.5	73.5	±2.55	195.0	215.4	180.7	197.0	±4.50
32.0	55.0	52.0	45.0**	50.7		170.5	162.0	1603.3	164.0	
Mean	67.5	68.9	63.5	66.6		170.2	173.4	164.2	169.3	
SE		±2.55					±4.50			

** Significant at 1 per cent level

the temperature increased from 24 to 28°C. At 32°C, the larval development was faster than at 28°C. Significant reduction in survival of larvae and pupae was observed at 32°C as compared to 28° C. These findings were in support of Hodek (1958) and Sethi and Atwal (1964), who also observed that the development of immature stages of *Coccinella septumpuntata* L. followed a logistic curve when kept at constant temperature ranging from 15° to 30°C. It is thus confirmed that the rate of development and survival of this insect is retarded above 32°C and below 24°C.

The longevity of *P. flexibilis* at 24°C was 75.8 days and it was reduced from 78.4 to 50.7 days, with the increase in temperature from 28° to 32°C. A female when kept at 24 , 28 and 32° C produced on an average 146.5, 197.0 and 164.3 eggs respectively (Table 3). Significant increase in egg laying was observed as the temperature increased from 24 to 28°C and it got retarded significantly at 32°C. The average number of eggs laid per day at 24 , 28 and 32°C was 1.9, 2.7 and 3.2, respectively. The comparative low fecundity at 32°C appeared to be primarily due to short life span. At 22°C, the

Table 4. Feeding efficacy of *Pharoscymnus flexibilis* at different temperature and humidity (Mean based on 25 observations)

Temp °C	Number of crawlers consumed									
	Larva					Adult				
	RH(%)					RH(%)				
	45	65	85	Mean	SE	45	65	85	Mean	SE
24.0	704	897	880**	827		410	620	576**	535	
28.0	1029	1327	1448	1268	±46.25	1116	1475	1217**	1269	±70.81
32.0	980	944	762	895		1075	1415	1156	1215	
Mean	904	1056	1030	897		867	1170	983	1006	
SE		±46.25					±70.81			

** Significant at 1 per cent level

development stopped and the beetle hibernated. There was no egg laying in the laboratory at a constant temperature of 22° and 37°C. A beetle could survive more than 175 days at 22°C but only for 5-10 days at 37°C.

The grubs consumed an average of 827, 1268 and 895 crawlers and adult beetle 535, 1269 and 1215 crawlers throughout its life span at 24°, 28° and 32°C, respectively (Table 4).

In the apple orchards of India, *P. flexibilis* would thus survive and multiply mostly during summer and rainy seasons when the temperature is around 28°C. From the 15th of November to 15th February, when the maximum temperature remain below 24°C, the beetle might hibernate or diapause which however has to be proven experimentally.

The influence of humidity on the survival of *P. flexibilis* was not so pronounced. The mean duration of egg stage at 45, 65 and 85% RH was 7.3, 6.4 and 5.1 days, respectively (Table 1). It appeared that the egg development at 85% RH was slightly faster than at 45 and 65% RH. The completion of larval and pupal period was slightly faster at 85% RH (Table 1).

The survival per cent does not differ significantly at 65 and 85% RH (Table 2). However, the % survival of larvae, pupae and adults was lower at 45% RH. Hence, low RH (45%) was slightly harmful. Significant influence of RH was observed between 45 and 65% on the consumption of crawlers by grubs and adult beetles. However, the consumption rate by the grubs did not differ significantly between 65 and 85% RH (Table 4) but it was significantly retarded at 85% than at 65% in case of beetles. Higher egg hatching rate was observed at 65% RH (Table 2) as compared to 45 and 85% RH. The observations indicate that 65% RH was more beneficial because the predatory stages of beetle have more longevity and consume more number of crawlers.

The results of this study indicate that the optimum conditions for the development, survival and predatory potential of immature stages as well as adult beetles and fecundity of female were 28±0.5°C and 65±5% RH.

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