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POPULATION PARAMETERS OF *SITOPHILUS GRANARIUS* (L.) (*COLEOPTERA: CURCULIONIDAE*) ON RICE

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Abstract. Population parameters of *Sitophilus granarius* (L.) were measured under various conditions of temperature and relative humidity. The range of five examined temperatures (15 to 35°C) had a remarkably stronger effect on all examined parameters than applied range of two relative humidities (75%; 85 or 95%). The highest intrinsic rate of natural increase (r_m) and the highest finite rate of increase (lambda) were recorded when temperatures of 25 and 30°C were used. The generation time (T) ranged from approximately 10 weeks at 30°C and 75 or 85% RH to approximately 22 weeks when 15°C was used. At 35°C there were no survivors of any immature stages of *S. granarius* regardless of relative humidity, so population parameters could not be counted.
A brief narrative is presented on the potential of these environmental variables for control applications.

Key words: *Sitophilus granarius*, granary weevil, rice, population parameters

I. INTRODUCTION

Granary weevil *S. granarius* is one of the most common pests occurring in Polish grain storages. This species was found by Champ & Dyte (1976) in the majority of common cereals. Infrequently it can be also found in pasta, processed animal foods, split peas (Longstaff 1981) and chick pea (Zakladnoi & Ratanova 1986).

The optimal conditions for the development of the granary weevil as reported are a grain moisture content of 15-16%, temperature from 20 to 28°C and wheat, rye or barley as a food and habitat (Zakladnoi & Ratanova 1986).

The objective of the research reported here was to assess the population development of *S. granarius* under various temperatures and when insects were reared under unfavourable conditions.

The conditions of this study used rice as the food source (10 kernels for 5 pairs/per week), and a range of two high relative humidities.

Stressed conditions were established to simulate the probable situation when numerous insects have no possibilities to select the number and type of cereals which serve them as a food and habitat. Such situation may occur in nature e.g. in empty storages or in unloaded grain delivery ships or trucks.

II. MATERIALS AND METHODS

The stock culture of *S. granarius* was maintained in glass jars on wheat and held in the dark at 25°C and 55% RH.

Newly emerged (one-day old) weevils were sexed and placed (5 pairs) in separate vials (7.0 cm high, 2.0 cm ID) with 10 rice kernels. Observations were performed on insects on rice at five temperatures (15, 20, 25, 30 and 35°C) and two relative humidities (75, 85 or 95% RH). The experiment was replicated 10 times for each combination of temperature and relative humidity. Twice a week rice kernels were replaced by new ones and old ones were checked for the egg deposition cavities using the Frankenfeld-Harris staining method (Gołębiowska & Nawrot 1970; 1976). Twice a week the fecundity and mortality were recorded.

To record the developmental time of *S. granarius* ten unstained rice kernels with deposited eggs were observed under proper magnification and the number of glandular secretion plugs covering depressions in the grain with deposited eggs was recorded. Kernels with deposited eggs were kept in separated vials (7.0 cm high, 2.0 cm ID) in continous darkness under controlled relative humidity and temperature. Kernels were observed weekly until the first adult appeared. Then all emerging adults were counted and removed. The experiment was replicated 10 times for each combination of temperature (15, 20, 25, 30 and 35°C) and humidity (75, 85 or 95% RH).

The following population parameters were computed according to the methods described by Birch (1948) and Andrewartha & Birch (1954): r_m – intrinsic rate of natural increase, lambda – finite rate of increase, Ro – net reproductive rate, T – generation time.

III. RESULTS

Table 1 presents the data illustrating the population parameters of *S. granarius* reared under various conditions of temperature and relative humidity. Observations of population development at temperatures of 15, 20, 25, 30°C and at two relative humidities (75, 85 or 95%) applied in various combinations were completed. At a temperature of 35°C, there was 100% mortality for all immature stages of *S. granarius*, at all relative humidity conditions tested, so the life tables and population parameters could not be counted.

Table 1

Population parameters of *Sitophilus granarius* at various temperatures and humidity

°C	%RH	r_m	Lambda	Ro	T
15	75	0.09	1.09	7.13	22.43
	95	0.10	1.10	8.11	21.47
20	75	0.17	1.18	14.50	15.85
	85	0.18	1.20	19.38	16.64
25	75	0.21	1.24	20.00	13.98
	95	0.22	1.25	21.21	13.81
30	75	0.20	1.22	7.66	10.12
	85	0.21	1.23	8.32	10.17

Results obtained from performed studies showed significant influence of temperature on *S. granarius* development. At 25°C, the survival rate (number of eggs developed into adults) reached the highest value but was not statistically different from those for 20 or 30°C (Tab. 2).

Developmental time depended on temperature and was statistically different for every temperature tested. Increasing temperatures significantly decreased the insect developmental time. At temperature of 30°C developmental time was almost 3 times shorter than at 15°C (Tab. 2). Using relative humidities between 75 to 95% with the same temperature had no effect on developmental times (Tab. 2).

The highest intrinsic rate of natural increase (r_m) was observed when temperatures of 25 and 30 °C were used (Tab. 1). The finite rate of increase (lambda) showed similar ten-dency.

Table 2

Developmental time and survival rate of the immature stages of *Sitophilus granarius* at various temperatures and humidity

°C	%RH	Survival rate (from egg to adult) mean	SD	Developmental time from egg to adult (in weeks) mean	SD
15	75	0.27[b]	0.09	13.97[a]	0.75
	95	0.27[b]	0.06	13.63[a]	0.80
20	75	0.35[ab]	0.10	10.12[b]	0.49
	85	0.40[ab]	0.13	10.33[b]	0.45
25	75	0.54[a]	0.18	7.97[c]	0.45
	95	0.52[a]	0.15	8.12[c]	0.32
30	75	0.35[ab]	0.10	5.99[d]	0.40
	85	0.34[ab]	0.08	5.97[d]	0.51

Means in the same column marked with different letters are significantly different ($p<0.05$), Scheffe F-test

The generation time (T) depended upon temperature and ranged from approximately 10 weeks at 30°C and 75 or 85% RH to approximately 22 weeks when 15°C was used with 75 or 95% RH (Tab. 1).

IV. DISCUSSION

Development of *S. granarius* reared on various types of grain has been examined by several authors (El-Fattah & Abd-El-Fattah 1975; Gołębiowska & Nawrot 1970; Gołębiowska & Nawrot 1976; Zakladnoi & Ratanova 1986; Schwartz & Burkholder 1991). Schwartz & Burkholder (1991) reported that development of granary weevil was the slowest on maize and the fastest on rice, when experiments were conducted at 27.5°C and 75% RH. Progeny production was the lowest on oat and increased significantly when rice, corn, wheat and barley were offered as a food. Zakladnoi & Ratanova (1986) indicated a different favourable food preference list for granary weevil and reported that this species prefers wheat, rye and barley followed by (in descending order) maize, rice and oats. This agrees with the data presented by Gołębiowska et al. (1976).

Zakladnoi & Ratanova (1986) reported that temperatures above 35°C or below 13-15°C caused the weevils to stop ovipositing. Similar results were obtained in this research where no adults developed from eggs laid at temperature 35°C, independly of the RH the tests were performed.

Other ecological studies performed on two species, granary and rice weevil, showed that the fecundity was the highest at 28°C and 85% RH and the lowest at 28°C and 50% RH (El-Fattah & Abd-El-Fattah, 1975), which again demonstrated the importance of the role of relative humidity in controlling pests in storages. Evans (1979) pointed out that 27°C was an optimum temperature for development of *S. granarius* and *S. oryzae*.

Applied in our tests temperature had significant influence on the most calculated population parameters (Tab. 1), survival rate and developmental time (Tab. 2). Such effect was not observed when any of selected relative humidities (75, 85 or 95%) were applied. Conclusion from the conducted study seems to be obvious showing remarkably stronger effect of selected range of temperatures (from 15 to 35°C) on *S. granarius* development than selected for the set of experiments range of relative humidities (75, 85 or 95%).

Controlled relative humidity and temperature can be used for decreasing the numerous populations of stored product pests occurring in stored grain. Influence of variable conditions of relative humidity and temperature on development of stored-pests, including *S. granarius* was investigated by Evans (1987), Lin (1989), Shwartz & Burkholder (1991).

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PARAMETRY POPULACYJNE WOŁKA ZBOŻOWEGO *SITOPHILUS GRANARIUS* (L.) (*COLEOPTERA: CURCULIONIDAE*) HODOWANEGO NA RYŻU

STRESZCZENIE

Określono parametry populacyjne wołka zbożowego *Sitophilus granarius* hodowanego w kontrolowanych warunkach temperatury i wilgotności względnej powietrza. Zakres pięciu testowanych temperatur (od 15 do 35°C) miał silniejszy wpływ na testowane parametry niż zakres dwóch użytych w testach wartości wilgotności względnej powietrza (75%; 85 lub 95%). Najwyższe wartości wrodzonego tempa wzrostu populacji (r_m) i tempa zwiększenia liczebności populacji (lambda) rejestrowano w testach, gdzie zastosowano temperaturę 25 i 30°C. Czas rozwoju pokolenia (T) wynosił: 10 tygodni przy temperaturze 30°C i 22 tygodnie w temperaturze 15°C. W temperaturze 35°C owady w ogóle nie rozwijały się.