FAT BODY ROLE IN THE DYNAMICS OF CEREAL BUG POPULATIONS (*EURYGASTER INTEGRICEPS* PUT.)

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ABSTRACT

The accumulation of reserve matter and the fat body level among the *E. integriceps* species present a great ununiformity, both individually and from one zone to another or from one generation to another, being the consequence of a complex of factors from which the climatic and agrotechnical ones are the most important. The fat body presents a significant role into the life-cycle of this species, constituting one of the most important factors of perpetuation and numerical blasting with invasion role. The mean value of the fat body is different between sexes too, the females presenting a higher level. The fat body level influences the mortality during diapause, the sterility and fertility, strongly influencing the bug population multiplication. The insects with low level of fat matter accumulations have a high mortality percentage during diapause as well as a very low fertility. The fat body is consumed in a proportion of 25% for maturation during diapause and 50% for oviposition. The main factor of the formation of a well developed fat body is the complete rearing of adults under the best conditions. This factor is the premise of an optimum development of bug population in a specific area determining an adequate multiplication. The multiplication index ranges between 0 and 56.47 depending on the fat body level.

Key words: bug population, diapause, fat body level, life-cycle.

INTRODUCTION

Because of the damages produced on large areas from Asia and Europe, *Eurygaster integriceps* Put. species is considered one of the most harmful insect from the wheat crops, fact which imposes the chemical control on about ten million ha (Arnoldi, 1955; Scepetilnikova, 1963; Vinogradova, 1969; Paulian and Barbulescu, 1970; Popov and Rosca, 1991; Nesterova, 1998). For this cause, the bug populations have been studied during both active period (April – July) and diapause (August – March).The researches performed till now have emphasized that the long diapause is a complex problem of surviving, depending on lots of ecological factors (Barbulescu et al., 1977; Popov, 1977), but often the observations have been oriented on a single factor, climatic (Popov, 1980; Radjani, 1994) or biological (Popov, 1979, 1984, 1985; Scepetilnikova, 1963; Polivanova, 1994; Radjabi, 1995) without to try the explanation of the complexity of all factors which influence the diapause. The paper presents a complex analysis of the physiological preparation role, expressed by the fat body, on bug populations during both diapause and active life in postdiapause.

MATERIALS AND METHODS

The biological material consisted of *Eurygaster integriceps* adults from different generations, during 1970–2000, collected from the wheat fields and forests placed in the central-southern part of Romanian Plain, Calarasi county respectively.

The prolificacy of populations was studied under field and controlled conditions, by individualized couples, collected at the end of diapause, in spring.

For the experiments regarding the fat body, the gatherings were performed from diapause places, beginning from August till March, and in field during all active period of adults, from April till the beginning of June. The fat extraction was made by Soxhlet method, in petroleum ether. The fat analyses were performed on groups of 25 or 100 insects, separately on sexes and weight groups, depending on the desired objective. The obtention of some variants with different fat body degrees, was achieved by the selection of insects on the basis of different weight and by the formation of some groups as part of population from the same generation.

On the basis of the physiological preparation evaluation, established by the fat body percentage, the main study directions were:

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– influence of the fat body on mortality, during diapause;

– dynamics of fat body exhaustion, during diapause;

– influence of the fat body on prolificacy.

In order to establish the influence of fat body on prolificacy, a multiplication index (M.I.) was calculated, using the original formula;

$$M.I. = \frac{a \times c \times d}{b} \times 100$$

in which:

a = population participation percentage, into group;

b = mortality during diapause;

c = fertile female percentage, from each group;

d = mean prolificacy.

All calculations were performed in relative values (after the model 8% = 0.08), with a view to abstracting and ensuring the mathematical calculus availability.

RESULTS AND DISCUSSION

The long-term analysis of *E. integriceps* populations prolificacy from the Central-Southern part of Romanian Plain, at Fundulea, reveals a very great annual variation during 1970-2000. In comparison with a multiannual average of 40.2 egg/female under field conditions (57.9 egg/female respectively, under controlled conditions), the annual values ranged between an annual maximum, in 1986 generation, of 56.3 egg/female under field conditions (71.3 egg/female respectively,under controlled conditions) and an annual minimum, in 1989 generation, of only 18.8 egg/female under field conditions (27.1 egg/female respectively, under controlled conditions). The maximum individual prolificacy registered during 1970– 2000, also, presented a large variability, from 87 egg/female in 1989 generation to 311 egg/female in 1970 generation (Table 1).

The accumulations of the reserve matter and the fat body level at *E. integriceps* are the consequence of a complex of factors, the climatic and agrotechnical ones being the most important. In this paper, the fat body as an independent factor, with decisive role in diapause and postdiapause is analysed.

In accordance with table 2, the *E. integriceps* populations prolificacy differs very much from one generation to another when the prolificacy for the fertile females is analysed too. From the data accumulated during a long research period, mean values of the prolificacy per generation from 32.1 egg/female to 104.7 egg/female were registered. This aspect is dependent on both external factors and internal ones (the climatic conditions having a special role). Among the internal factors, the most important is the nourishment reserve accumulated by each insect in the process of intense nourishing, in the period after the appearance of imago stage and till the entering in diapause and which is stored as fat body. The mean level of the fat body can be, with variations from one generation to another, of 36–38% at females and 33–35% at males, from the body dry weight.

Table 1. Reproduction ability of the *E. integriceps* recent generations, as compared with multiannual average (1970–2000) and with the specific years: favourable (1986) and unfavourable (1989)

Natural generation of *E. integriceps*	Prolificacy (egg/female)		
	Under field conditions	Under controlled conditions	
		average	maximum/ female
1970–2000	40.2	57.9	311
1986	56.3	71.3	298
1989	18.8	27.1	87
1996	47.1	69.9	302
1997	46.6	68.6	197
1998	37.5	53.8	209
1999	38.8	54.5	219
2000	39.3	55.7	208

Table 2. Prolificacy level of some *E. integriceps* populations (fertile females), from generations with different fat body levels, collected from the field, at the beginning of migration and studied under controlled conditions

Fat body	Generation	Prolificacy (egg/female)	
		average	maximum
23.4	1989–1990	32.1	97
22.5	1972–1973	33.4	127
26.5	1971–1972	46.4	148
27.9	1977–1978	67.5	186

28.0	1984–1985	83.6	210
29.7	1985–1986	95.3	234
29.8	1994–1995	104.7	246

Concerning the utilization of the fat body during all adult stage, the analyses started at the beginning of diapause, from August and till the disappearance of adult stage, in June next year, have showed that during diapause the fat body diminishes on an average with 27%, but the most part of it (52%) is consumed during ovogenesis process of the active period after diapause. The rest of about 20% represents the natural weight of fats from the insects body, level which is kept till the death of insects (Table 3).

Table 3. Level and stages of fat body diminution at *E. integriceps* (multigeneration average)

Stages	Fat body level		Diminution	
	limits	average	limits	average
Diapause beginning	33.03–37.58	35.69	0	0
End of diapause	21.97–27.64	25.43	24.57–36.33	27.39
End of oviposition	8.12–10.39	8.78	66.50–78.69	74.43

The utilization of fat body during diapause is strongly correlated with temperature, increased consumption levels being registered at the beginning of diapause, in warm months of summer-autumn as well as in spring (Figure 1). At the same time with cold weather, at the beginning of winter, the fats consumption decreases at both females and males, having low values of 4–7% as compared with 25–35% from August or March, from the total consumption during diapause.

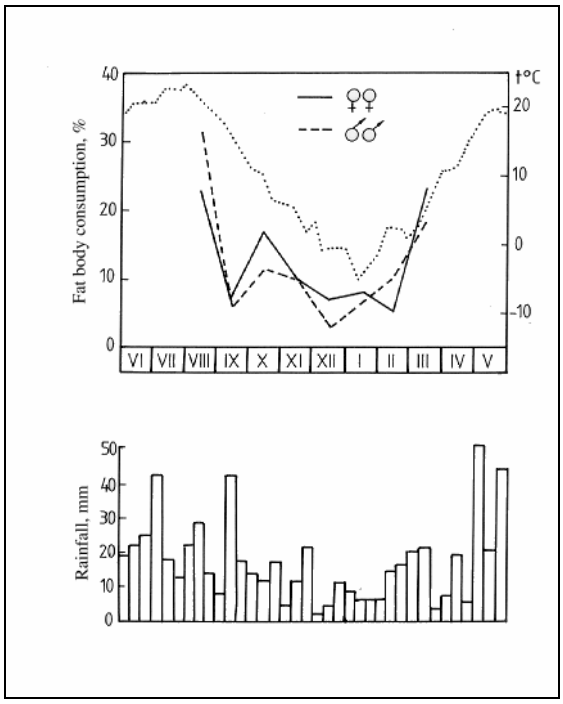

Figure 1. Dynamics of fat body level at *Eurygaster integriceps* populations, during diapause (multigeneration mean)

One can ascertain that the fats reserve diminution during diapause is in direct connection with the climatic factor (especially the low temperatures during November – February) but, at the same time, the consumption depends very much on the physiological preparation level of populations from the respective generation. In the cases when the accumulation level is high, the consumption is relatively low, even when unfavourable climatic conditions for diapause are registered. Under unfavourable conditions, at an insufficient preparation, the consumption is accentuated. The direct consequence of the accumulation level as well as of the consumption rhythm during diapause is the mortality over winter (Table 4).

Table 4. Mortality registered at the *Eurygaster integriceps* populations, during diapause in different generations, from Romanian area

E. integriceps natural generation	Mortality (%)	
	limits in counties	total area (mean)
2000–2001	4.6–35.7	8.7
1995–1996	3.7–36.4	10.2
2001–2002	5.1–32.3	12.7
1985–1988	3.8–41.2	14.8
1999–2000	4.8–97.6	24.5
1973–1974	11.6–85.0	39.5
1988–1989	17.5–68.4	48.2

At the same time, one emphasizes that the insect populations from each generation are unhomogeneous as regards the physiological preparation, both in populations of female insects (Table 5) and male (Table 6).

Table 5. Fat body value at *Eurygaster integriceps* populations, established on female groups, distributed in weight classes, at the beginning of diapause (multigeneration average)

Weight (mg)	% from the total of population		Fat body (%)	
	limits	average	limits	average
below 0.110	3.7–7.7	5.6	26.2–26.6	26.4
0.111–0.118	7.6–23.1	13.3	26.5–28.8	28.7
0.119–0.126	15.9–24.7	19.7	32.8–33.5	33.6
0.127–0.134	32.5–34.8	33.7	34.9–36.4	35.4
over 0.145	22.4–30.8	28.6	35.7–39.8	38.7

Table 6. Fat body value at *Eurygaster integriceps* populations, established on male groups, distributed in weight classes, at the beginning of diapause (multigeneration average)

Weight (mg)	% from the total of population		Fat body (%)	
	limits	average	limits	average
below 0.105	7.0–19.7	12.3	25.3–26.7	26.2
0.106–0.113	16.8–19.9	17.3	27.2–28.5	27.7
0.114–0.121	20.3–29.5	23.7	29.4–33.8	31.5
0.122–0.129	19.2–32.7	28.5	31.2–35.5	32.6
over 0.130	15.5–23.9	19.4	31.4–36.6	33.8

This unhomogeneity is strongly reflected on surviving during diapause as well as on prolificacy. Tables 7 and 8 present the mortality, differentiated on sexes and physiological preparation groups. One can remark the high mortality level in variants with insufficient physiological preparation, fact which explains the data presented under natural conditions from table 4.

Table 7. Mortality registered at *Eurygaster integriceps* female populations, depending on the fat body (multigeneration average)

Fat body (%)	Mortality (%)			
	August – October		November – March	
	limits	average	limits	average
26.4	17–22	20.4	59–64	61.3
28.7	13–15	12.9	43–54	47.6
33.6	9–17	12.5	41–52	46.2
35.4	4–11	6.6	29–34	33.6
38.7	4–7	5.8	26–35	30.9

Table 8. Mortality (%) registered at *Eurygaster integriceps* male populations, depending on the fat body (multigeneration average)

Fat body (%)	Mortality (%)			
	August – October		November – March	
	limits	average	limits	average
26.2	22–31	22.6	62–71	67.1
27.7	11–24	20.4	53–62	57.4
31.5	12–19	14.3	39–47	44.0
32.6	9–18	12.7	30–44	37.6
33.8	5–14	9.1	24–45	32.3

The fat body level strongly reflects on reproduction parameters, the sterility and prolificacy being in strong connection with physiological preparation degree (Table 9). The insects with a low fat body level are almost sterile or present a very low prolificacy. According to the increase of fat body value, the prolificacy level is higher and higher reaching maximum values.

By the calculation of a multiplication index, one could significantly emphasize the fat body role in the establishment of bug populations level. In table 10 one can notice that at a low physiological preparation, expressed by a low fat body level, the multiplication index is extremely reduced; according as the fat body registers higher values, the multiplication index is better emphasized. Thus, the population insufficiently nourished, which failed to ensure an optimum level of reserve matter, dies during winter, having a multiplication index zero and according as the accumulated reserves increase, the multiplication index presents increasing values, from 1.54 to 56.47 times.

Table 9. Sterility and prolificacy registered at the *Eurygaster integriceps* populations, depending on the fat body (multigeneration average)

Fat body (%)	Female sterility (%)		Mean prolificacy (egg/female)		
	limits	average	limits	average	maximum
26.4	100	100	0	0	0
28.7	60–72	63.5	4.1–6.6	5.4	42
33.6	54–63	57.3	16.2–22.8	19.5	78
35.4	35–44	39.1	26.4–33.1	30.3	135
38.7	25–32	29.8	38.9–51.7	45.8	194

Table 10. Multiplication index at the *Eurygaster integriceps* populations, depending on the fat body (multigeneration average)

Fat body (%)	Multiplication index (egg/female)	
	limits	average
26.4	0	0
28.7	0.37–2.47	1.54
33.6	4.54–9.62	6.95
35.4	28.57–40.18	35.22
38.7	49.38–64.83	56.47

CONCLUSIONS

The fat body presents a very important role in the life-cycle of *Eurygaster integriceps* species, being the main factor of surviving during diapause.

The fat body mean value differs on sexes, from one area to another and from one generation to another.

As part of each generation there is a great ununiformity of fat body value, both individually and between sexes.

The fat body determines the mortality level during diapause, the insects sterility and prolificacy, thus strongly influencing the populations with fluctuations of the multiplication index, from 0 to 56.47 times.

The fat body is consumed in proportion of 25% for surviving during diapause and of 50% for oviposition.

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