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BREEDING OF ENTOMOPHAGES IS FROM FAMILY OF PENTATOMIDAE

Technological parameters are offered in relation to optimization of the industrial breeding of predatory stinkbugs from family of Pentatomidae. The offered diet optimizes development, assists the increase of indexes of the productivity of imago, promotes efficiency of the use of predatory stinkbugs as biological agents of limitation of harmfulness of aboriginal phytophages. Cultivation of predatory stinkbugs of the first–second age is recommended on the larvae of Calliphora erythrocephala Mg., third–fourth – larvae of Ephestia kuehniella Zell., fifth – larvae of Tenebrio molitor L. but additionally to bring in a diet the optimal concentrations of nano aqua citrates molybdenum, cobalt, zinc. The changes of quality and quantitative indexes of fodder, that influenced on biology of predators, took place due to the modified technological process, their competition in biocenosis.

Key words: *entomophages, Podisus maculiventris Say., Podisus sagitta Fabricius, Perillus bioculatus F., optimized diet, survivability, fertility, biological defence, nano aqua citrates.*

A problem statement

The market of biological facilities of defence needs the effective industrial populations of entomophages. The searches of innovations that provide the specific necessities of useful organisms are conducted. Providing of vital functions of predatory stinkbugs in the artificially created environment is possible due to optimization of terms of existence. Creation of optimal trophism is one of mechanisms of successful adaptation of organism of predatory stinkbugs to the artificial terms of environment. Modification of quality and quantitative indexes of diet results in the changes of technological process, influences on biology of predators, their competition in biocenosis. Profitability of the use of *Podisus maculiventris* Say., *Podisus sagitta* Fabricius and *Perillus bioculatus* F. in biological defence will depend on regulation of cultivation technology and possibility of management processes in relation to adjusting of quantity of population of predatory stinkbugs.

Review of recent researches and publications

The terms of feed, variety of food adaptation and specialization are related to the search of meal, difficult ethology of predatory stinkbugs and their victims. Researches confirm considerable influence of good quality of feed on survivability, duration of development, fecundity, level of preying on others of *Podisus maculiventris* Say.,

Podisus sagitta Fabricius and *Perillus bioculatus* F. [2, 8]. Worsening of terms of feed appropriately causes to oppressing of vital functions.[6, 10, 11].

Predatory stinkbugs from family of Pentatomidae are polyphages that limits harmfulness of dominant phytophages of agrocoenosis and successfully used for biological defence of agricultural cultures in countries with a warm climate. For the use of predatory stinkbugs biological defence of plants will guarantee the ecological cleanness of products and observance of sanitary-hygenic requirements[4, 5, 7, 9]. For a fight against pests in Ukraine it is economically advantageous to use heat-loving predatory stinkbugs the method of flood at defence of agricultural plants in hothouses and intended for a production ecologically of clean feed. For the best providing of vital necessities of predatory stinkbugs in a period of ontogenesis, their high efficiency as biological agents technologies of breeding are improved on cheap artificial nourishing environments and phytophage-owner [1, 3, 12].

Purpose, objects and methods of research

Research aim – to learn efficiency of the optimized diet for cultivation of predatory stinkbugs from family of Pentatomidae.

For the achievement of the put aim such tasks were solved:

- to create the optimized diet for cultivation of predatory stinkbugs ;
- to learn the features of biology of predatory stinkbugs for the use of the optimized diet;
- to estimate potential possibilities of the predatory stinkbugs grown on the offered diet as biological agents of limitation of harmfulness of aboriginal phytophages.

Researches were conducted during 2012–2015 years on the experimental base of the National University of Life and Environmental Sciences of Ukraine in accordance with the biological features of kind. Efficiency of the offered diet for breeding of predatory stinkbugs from family of Pentatomidae was investigated on the individuals of the laboratory-field culture of *Podisus maculiventris* Say., *Podisus sagitta* Fabricius and *Perillus bioculatus* F. The predatory stinkbugs of the first – second age cultivated on the larvae of *Calliphora erythrocephala* Mg., third – fourth – larvae of *Ephestia kuehniella* Zell., fifth – larvae of *Tenebrio molitor* L.

Additionally in a diet we brought in for 10 larvae the predatory stinkbugs of 2ml of aquatic solution from the first to the end of the second age – nano aqua citrate molybdenum 0,0001%% concentrations, third – to the nano aqua citrate cobalt - 0,0002%% concentrations, fourth and fifth – to nano aqua citrate zinc – 0,00015%% concentrations. Breeding of predatory stinkbugs we conducted at temperatures 24–25°C, relative humidity of air 70–75%% and to the and photoperiod – 16 hours. Experimental *Podisus maculiventris* Say., *Podisus sagitta* Fabricius and *Perillus bioculatus* F. placed in plastic containers the size of 30 x 24 x a 12 cm.

For the additional feed of predatory stinkbugs solution of nano aqua citrate was inflicted on a filtration paper and gave in plastic patellulas a size a 3 cm in a diameter. The predatory stinkbugs of control variants were grown on the larvae of *Ephestia kuehniella* Zell., eggs and larvae of the Colorado potato beetle in analogical with experience individuals terms.

Results of researches

The results of experiments of influence of technological parameters of feed on development of predatory stinkbugs are presented in a table 1. In accordance with results, positive effect from bringing in a diet from the first to the end of the second age – nano aqua citrate molybdenum, third – nano aqua citrate cobalt and fourth and fifth – a nano aqua citrate zinc in optimal concentrations, results in the increase of survivability of larvae of predatory stinkbugs of *Podisus maculiventris* Say. and *Perillus bioculatus* F. The best indexes in relation to survivability of individuals of population of predatory stinkbugs are provided for cultivation of predatory stinkbugs of the first – second age on the larvae of *Calliphora erythrocephala* Mg., third – fourth – larvae of *Ephestia kuehniella* Zell., fifth – larvae of *Tenebrio molitor* L. but bringing in a diet from a calculation for 10 larvae of predatory stinkbugs of 2ml of aquatic solution of nano aqua citrates

Table 1. Influence of technological parameters of feed on development of predatory stinkbugs

Indexes	Predatory stinkbugs			
	Podisus maculiventris Say.		Perillus bioculatus Fabr.	
	Survivability F ₁ , %	Fertility, %	Survivability F ₁ , %	Fertility, %
1	2	3	4	5
Concentration brought in a diet nano aqua citrate molybdenum for the larvae of the first-second age, %%				
0,00005	73	87	73	90
0,0001	76	92	77	93
0,0002	75	89	71	91
Concentration brought in a diet nano aqua citrate cobalt for the larvae of the third age, %%				
0,0001	75	93	72	86
0,0002	77	96	76	93
0,0003	74	94	74	90

Закінчення таблиці 1

1	2	3	4	5
Concentration brought in a diet nano aqua citrate zinc for the larvae of fourth – fifth age, %%				
0,0001	74	92	70	85
0,00015	76	97	75	90
0,0002	74	94	73	84
2ml of aquatic solution of nano aqua citrate on the amount of larvae of predatory stinkbugs, pieces				
5	73	91	68	83
10	75	96	71	88
15	74	93	69	81
Control	70	87	66	79

beginning from: first to the end of the second age – nano aqua citrate molybdenum 0,0001%% concentrations, third – to the nano aqua citrate cobalt – 0,0002%% concentrations, fourth and fifth – to nano aqua citrate zinc – 0,00015%% concentrations. In particular, forage of larvae of parasites beginning from the first to the end of the second age – nano aqua citrate molybdenum 0,0001%% – provided concentrations the shortest indexes of survivability, accordingly, *Podisus maculiventris* Say. – 76%% and 92%% and *Perillus bioculatus* F. – 77%% and 93%%, that in percent correlation anymore on: *Podisus maculiventris* Say. – 6%% and 5%% and *Perillus bioculatus* F. – 11%% and 14%%. Bringing in the diet of larvae of the third age of predatory stinkbugs of nano aqua citrate cobalt – 0,0002%% – provided concentrations indexes of survivability of individuals of population, accordingly, *Podisus maculiventris* Say. – 77%% and 96%%, and *Perillus bioculatus* F. – 76%% and 93%%, that in percent correlation anymore on: *Podisus maculiventris* Say. – 7%% and 9%%, and *Perillus bioculatus* F. – 10%% and 14%%, comparatively with a control variant.

Mixed feed of *Podisus maculiventris* Say., *Podisus sagitta* Fabricius and *Perillus bioculatus* F. by the larvae of *Calliphora erythrocephala* Mg., *Ephestia kuehniella* Zell. and *Tenebrio molitor* L. increased the exit of larvae of the third and fifth centuries of predatory stinkbugs from family of Pentatomidae (fig. 1.), that it is important at the terms of realization of the productive program of receipt of quality product of entomologist for the biological protecting of cultural plants from harmful phytophages. Yes, in experience variants the yield of larvae of the third and fifth centuries presented in middle for *Podisus maculiventris* Say. – 85%% and 76%%, *Podisus sagitta* Fabricius – 81%% and 71%% and *Perillus bioculatus* F. – 89%% and 83%%, that accordingly on 18%% and 14%%, 15%% and 8%% and 16%% and 20%% anymore.

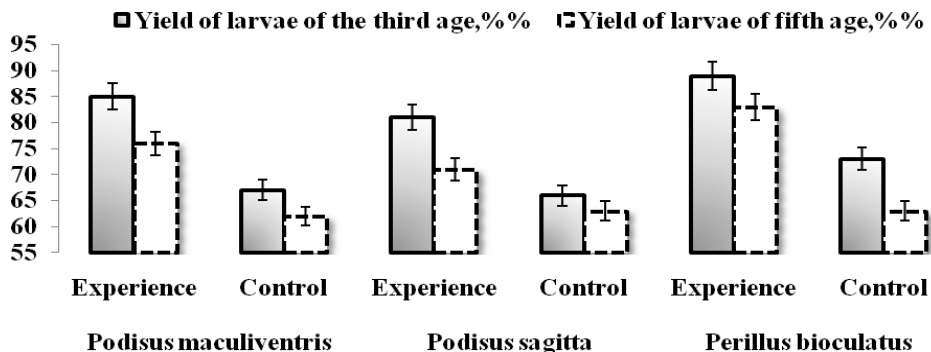


Figure 1. Influence of technological parameters of feed of predatory stinkbugs on the yield of larvae of the third and fifth centuries (average for 2012–2015 years)

On fig. 2 we cited data influence of technological parameters of feed of predatory stinkbugs from family of Pentatomidae on the yield of imago of the first and second generation. From the presented experimental data obviously, that for cultivation of predatory stinkbugs of the first – second age on the larvae of *Calliphora erythrocephala* Mg., third – fourth – larvae of *Ephestia kuehniella* Zell., fifth – larvae of *Tenebrio molitor* L. but bringing in a diet from a calculation for 10 larvae of predatory stinkbugs of 2ml of aquatic solution of nano aqua citrate beginning from: first to the end of the second age – nano aqua citrate molybdenum 0,0001%% concentrations,

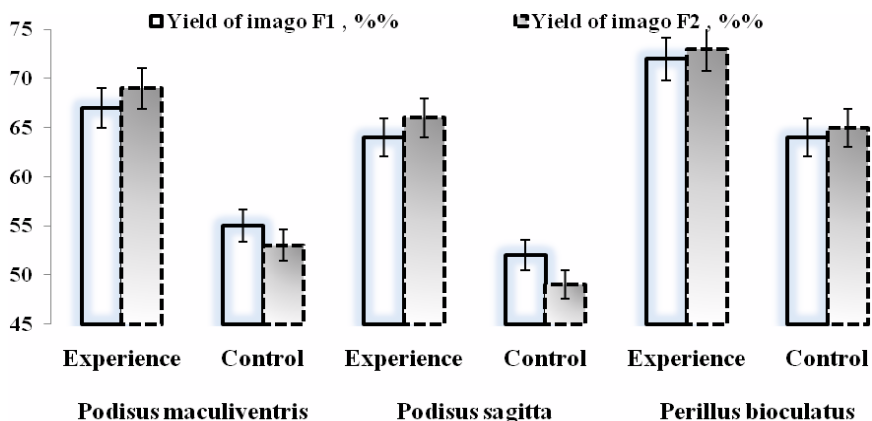


Figure 2. Influence of technological parameters of feed of predatory stinkbugs on the yield of imago of the first and second generation

third – to the nano aqua citrate cobalt – 0,0002%% concentrations, fourth and fifth – to nano aqua citrate zinc – 0,00015%% – the yield of imago of the first and second generation increases a concentration. Example, the percent of imago of the first and second generation of experience variants presented for *Podisus maculiventris* Say. – 67%% and 69%%, *Podisus sagitta* Fabricius – 64%% and 66%% and *Perillus bioculatus* F. – 72%% and 73%%, that accordingly on 12%% and 16%%, 12%% and 17%% and 8%% and 8%% more.

The results of researches of influence of technological parameters of feed of predatory stinkbugs on effective elimination of eggs of the Colorado potato beetle are presented on fig. 3. In accordance with the got results, for the use of nano aqua citrates molybdenum, cobalt, zinc and mixed feed by the larvae of *Calliphora erythrocephala* Mg., *Ephestia kuehniella* Zell. and *Tenebrio molitor* L. the amount of the destroyed eggs of Colorado potato beetle increases for twenty–four hours. In experience variants we looked at the increase of level of voracity of predatory stinkbugs on results the destroyed eggs of the Colorado potato beetle for twenty–four hours, namely, for: *Podisus maculiventris* Say. – 46 pcs., *Podisus sagitta* – 37 pcs and *Perillus bioculatus* – 15 pcs, that accordingly on 21,05%%, 27,59%% and 36,36%% more.

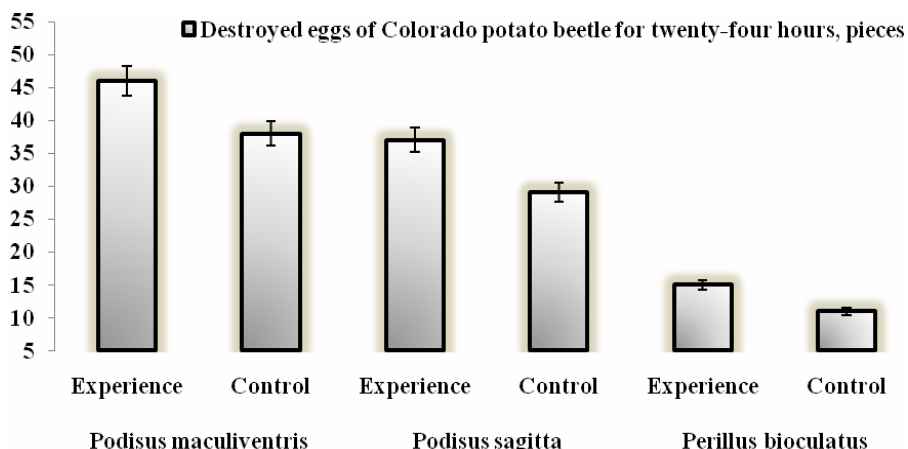


Figure 3. Influence of technological parameters of feed of predatory stinkbugs on effective elimination of eggs of the Colorado potato beetle (average for 2012–2015 years)

The results of experiments of influence of technological parameters of feed on voracity of predatory stinkbugs from family of Pentatomidae in relation to the larvae of the Colorado potato beetle are presented on fig. 4.

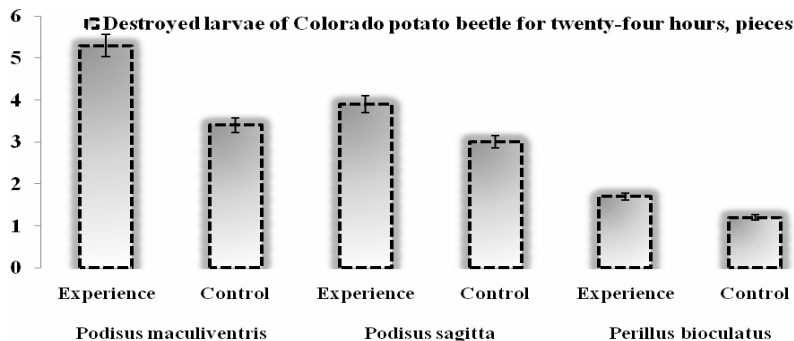


Figure 4. Influence of technological parameters of feed of predatory stinkbugs on effective elimination of larvae of the Colorado potato beetle (average for 2012–2015 years)

In experience variants the average amount of the destroyed larvae of Colorado potato beetle presented for twenty-four hours : *Podisus maculiventris* Say. – 5,3 pcs., *Podisus sagitta* Fabricius – 3,9 pcs. and *Perillus bioculatus* F. are 1,7 pcs., that accordingly on 56%%, 30%% and 42%% more.

On fig.5. we present the data of influence of technological parameters of feed on efficiency of the use of predatory stinkbugs from family of Pentatomidae as biological agents of limitation of harmfulness of aboriginal phytophages of *Pieris brassicae* L. and *Plutella maculipennis* Curt. The results of experiments show that for predatory stinkbugs from family of Pentatomidae peculiar polyphagy, that feeding on eggs and larvae of phytophages limit their potential harmfulness.

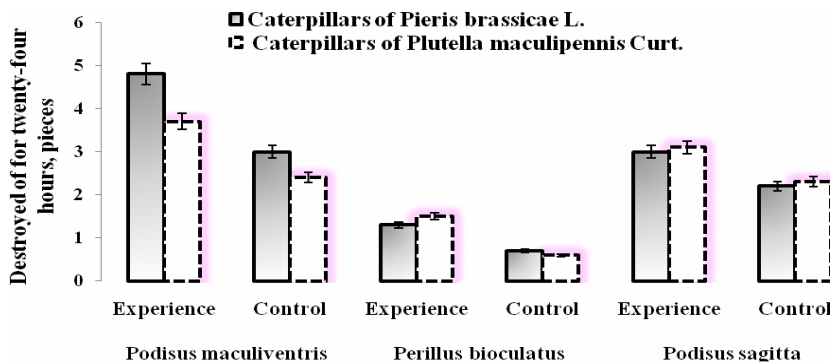


Figure 5. Influence of technological parameters of feed on efficiency of the use of predatory stinkbugs as biological agents of limitation of harmfulness of aboriginal phytophages of *Pieris brassicae* L. and *Plutella maculipennis* Curt. (average for 2012–2015 years)

It is set that for cultivation of predatory stinkbugs of the first – second age on the larvae of *Calliphora erythrocephala* Mg., third – fourth – larvae of *Ephestia kuehniella* Zell., fifth – larvae of *Tenebrio molitor* L. and bringing in a diet from a calculation for 10 larvae of predatory stinkbugs of 2ml of aquatic solution of nano aqua citrate beginning from: first to the end of the second age – nano aqua citrate molybdenum 0,0001%% concentrations, third – to the nano aqua citrate cobalt – 0,0002%% concentrations, fourth and fifth – to nano aqua citrate zinc – 0,00015%% concentrations provided the best indexes in relation to elimination of caterpillars of harmful phytophages for twenty-four hours. In particular, there is the average amount of destroyed caterpillars of *Pieris brassicae* L. in experience variants *Plutella maculipennis* Curt. presented for twenty-four hours : *Podisus maculiventris* Say. – 4,8 and 3,7 pcs., *Perillus bioculatus* F. – 1,3 and 1,5 pcs.. and *Podisus sagitta* Fabricius – 3 and 3,1 pcs., that accordingly on 60 and 54%%, 86 and 150%% and 36 and 35%% more.

Conclusions and prospects of further research

With the use in the diet of optimal concentrations of nano aqua citrate molybdenum, cobalt, zinc results in the increase of survivability of larvae of predatory stinkbugs .

Mixed feed of entomophages by the larvae of *Calliphora erythrocephala* Mg., *Ephestia kuehniella* Zell. but *Tenebrio molitor* L. and the use in the diet of nano aqua citrates assists the increase of exit of larvae and imago of predatory stinkbugs from family of Pentatomidae.

Offered diet, optimizes development, assists the increase of indexes of the productivity of imago, promotes efficiency of the use of predatory stinkbugs from family of Pentatomidae as biological agents of limitation of harmfulness of aboriginal phytophages.

The changes of quality and quantitative indexes of feed, that influenced on biology of predatory stinkbugs from family of Pentatomidae, took place due to the modified technological process, their competition in biocenosis.

A few drugs based on derivatives of nano aqua citrates included copper, cobalt, zinc, magnesium, manganese and water-containing raw materials as well as fullerene of nano-particles of vanadium together with vitamin E are proposed for adding to the feed insects and zoophages.

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