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REGULATION OF BIOLOGICAL BALANCE BETWEEN PESTS AND THEIR ENTOMOPHAGES IN BIOLOGICAL PROTECTION OF COTTON

Aminova Dildor Xolmurodovna*
*Senior Researchers, Doctor philosophy on Agricultural Science, Scientific Research Institute of Southern Agriculture, Karshi city, Kashkadarya Region, Uzbekistan

Bakhromova Nilufar Nazarovna*
*Senior Researchers, Doctor philosophy on Agricultural Science, Scientific Research Institute of Southern Agriculture, Karshi city, Kashkadarya Region, Uzbekistan

Aminova Gulzor Xolmurodovna*
*Researcher, Karshi State University
Karshi city, Kashkadarya Region, Uzbekistan

Isomiddinova Yulduz Aminjanovna*
PhD Student, *Scientific Research Institute of Southern Agriculture

ABSTRACT

The issues of regulation of biological balance between the main pests of cotton and their entomophages in biological protection are considered. The ways and methods of developing optimal work plans of biological factories for the production of useful entomofauna (trichogram, brackon, golden-eyed) against cotton pests (cotton and winter scoops) for various zones of the republic using mathematical modeling and programming methods are determined.

Keywords: Biological Equilibrium, Regulation, Management, Cotton Pests, Useful Entomophages, Mathematical Modeling, Algorithm and Program.

INTRODUCTION

Of significant importance in the production of raw cotton, especially organic cotton, is the issue of regulating the biological balance between pests and their beneficial entomophages in obtaining environmentally friendly products without the use of pesticides. At the same time, the regulation and restoration of biological equilibrium is one of the acceptable ways by which large losses of the cotton crop from pests can be avoided.

The creation of a system for regulating biological equilibrium in agrobiocenoses is not an easy task and it requires the development of a specific system for the cultivation of cotton and other agricultural crops.

Biological suppression of harmful pests has occupied today a constant predominating position in the concept of integrated suppression of pests. In certain cases for successful regulation of number of insects - pests any form of biological suppression of their populations is enough; in a number of other cases, suppression is often supplemented

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with any other method, and at last, in the third, it plays only an auxiliary role. Nevertheless, an effective utilization of biological agents became now a method to be considered and widely applied in all chances. In this connection it is necessary to study the inter-specific ecological communications which play an important role in vital systems of populations.

Research Results

There are following biological methods of control against agricultural pests: cultivation and reproduction of a carnivore (parasite) of the devouring certain pest for the purpose of suppression of agricultural pests reproduction; cultivation of pathogenic microorganisms causing certain diseases of pests, leading to reduction of their number, etc. But among the above listed methods of control the most comprehensible is a method of cultivation and reproduction of carnivores (parasites). So, for sucking pests' control the main position is occupied with application of natural entomophages (trichogramma, bracon, lacewing, etc.). The big role plays an increase in number (density) of these useful insects by artificial cultivation and their seasonal colonization against pests. Thereto biological factories on cultivation and reproduction of parasites have been built and successfully functioning.

It is necessary to develop optimum plans of control against agricultural pests to define the plan of release of parasites (entomophages) depending on available forecast of number (density) of the owner (pest) for the most effective work of these biological factories. And development of optimum plans of control, in turn, being a difficult problem enough, demands preliminary mathematical modeling of population dynamics of agricultural pests.

As it has been noted in [3], among biological control the most effective is a method of mass release of "entomophages" grown up in laboratory conditions (now the automated biological factories on manufacture of "parasites" and " carnivores" exist and successfully function. From that follows the problem of development of optimum work plans of these biological factories (terms and norms of "entomophages" release depending on seasonal conditions of a year. For example, against cotton worms the parasite of Trichogramma sort, parasitizing the eggs of this pest is successfully used. But the authors of work [1] consider that "parasite" of this sort has a very low search ability which prevents to become it the agent of biological control.

But according to Yu.N.Fadeev (note to work [1]) these obstacles can be eliminated by applying "a flooding" method, at which a number of parasites is supported at high level by periodic mass releases of "parasite" in agrocoenosis. In this case the acceptability of this method is defined by purely economic reasons.

By their nature the trichogramms infect eggs of the pest. Hence, a correct forecasting of terms of pests' mass ovipositions raises an efficiency of application of this kind of a parasite at pest control.

At realization of this problem in work [5,6] the following assumptions have been made:
1) Owing to small period of trichogramms life, to be equal to 3-5 days, summands

$f_1 (R_1, V_1, t_1) - g_1 (R_1 * , V_1 * , t_1 *)$ and
$f_2 (R_2, V_2, t_2) - g_2 (R_2 * , V_2 * , t_2 *)$
as gain factors, have equated to zero;

2) Instead of frequency factor of occurrence of "parasite" and "owner" the factor of intensity of "owners" defeat by "parasites" is used. This indicator has been defined experimentally, from a parity of a share of "owners" to the infected individuals.

Then, an expression (3.32) from [4,6] becomes:

}(3.1)

$N_1^k (t + 1) = N_1^k (t) - mN_1^k (t)N_2^k (t)$
$N_2^k (t + 1) = N_2^k (t) - mN_1^k (t) N_2^k (t)$

Thus, the problem was reduced to finding of such optimum values of $N_2^k (t)$ from (3.1) to satisfy restrictions system of (3.33) and providing a minimum of functional (3.34) of [6].

It is established that the intensity factor (m) of owners' defeats by the parasites, defined in laboratory conditions, gives the big errors in field conditions. As m really, directly depends on a number of pests.

If S - number of infected eggs of victims then the intensity of owners defeat by parasites is equal to $m = S:N_1$. On the basis of this and according to expression (3.33) from [3] it is possible to write down for m:

$m = (e^{aN_2}-1): e^{aN_2}$ }   (3.2)

Where: a - the search area (an average area which a parasite searches in a current of its life). The search area depends on search ability of a parasite and is defined under the field data or in laboratory conditions. Then expression (3.1) taking into account (3.2) will become:

On the basis of (3.3) and with application of casual search method the optimum norms of release of a parasite (trichogramma) at the set prognostic values of the owner at a = 0,01 are defined.

}(3.3)

$N_1^k (t + 1) = N_1^k (t) – [e^{aN_2 (t)}-1]: e^{aN_2 (t)} N_1^k (t) N_2^k (t)$
$N_2^k (t + 1) = N_2^k (t) - [e^{aN_2 (t)}-1]: e^{aN_2 (t)} N_1^k (t) N_2^k (t)$

TABLE 1. NORMS OF TRICHOGRAMMA RELEASE AT GIVEN VALUES OF COTTON LACE WING

№	Number of the "owner" on 100 plants, in pieces	Optimum values of a parasite produced by bio-factory	
		piece	gramm
1	7,0	158221,0	1,58
2	7,5	158010,0	1,58
3	8,0	152930,0	1,53
4	8,5	152448,0	1,52
5	9,0	150025,0	1,50
6	9,5	147842,0	1,48
7	10,0	146200,0	1,46
8	10,5	145830,0	1,46
9	11,0	143990,0	1,44
10	11,5	142650,0	1,42
11	12,0	141100,0	1,41

The results of calculation are resulted in Table1. It is visible from Tab. 1 that at owner's presence in the field, the certain quantity of trichogramma is necessary. The more the owners number, the lower the quantity of parasites norm released by biological factory on 100 cotton plants. It allows concluding that on the basis of such calculations scheduling it is possible to plan biological factories' work on operating time of a biomaterial depending on owners' number in concrete economic year for concrete region of cotton growing.

Thus, for definition of optimum terms of basic cotton pests' occurrence (cotton worms and winter cotton warms), depending on mean annual and real data for different zones of cotton growing in the Republic, the mathematical models and their algorithms are developed. On the basis of these algorithms the program of definition of terms of cotton worms and winter cotton warms' occurrence is made and introduced in practical activities of Plant protection Centers of Kashkadarya, Khorezm and Namangan regions.

The research results are shown in Table 2. According to Table 2, it is visible that except the terms of cotton worms' development, the optimum terms of release of useful entomophages such as trichogramma, lace wing and bracon are revealed.

The specificity of the ecological interaction "parasite-host" is such that the host (pest) appears much earlier than its entomophagus. If the timing of the appearance of the entomophage is delayed or the number turns out to be insignificant, then human intervention is necessary. In other words, a person must maintain the necessary number of parasites by multiplying them in the laboratory and releasing them, taking into account their number in natural conditions.

Taking into account the above positions, to solve this problem, expression (3.3) is transformed as

}(3.4)

$N_1^k(t+1) = N_1^k(t) - [e^{aN_2(t)}-1]: e^{aN_2(t)} N_1^k(t)$

$N_2^k(t)$ $N_2^k(t+1) = N_2^k(t) + [e^{aN_2(t)}-1]: e^{aN_2(t)} N_1^k(t) N_2^k(t)$

$N_3^k(t+1) = N_3^k(t) + [e^{aN_3(t)}-1]: e^{aN_2(t)} N_1^k(t) N_3^k(t)$

where N3 is the number of entomophages in natural conditions.

The solution of a system of finite-difference equations of the form (3.4) makes it possible to regulate the biological diversity of the agrobiocenosis (in our case, the cotton field).

CONCLUSIONS

In addition to all this, one of the main problems associated with the protection of plants from pests is the solution of the issue of maintaining the biological balance between harmful organisms and their entomophages. This is essential in the production of environmentally friendly products without the use of pesticides, for example, an organic crop of raw cotton.

Moreover, this procedure may be used for integrated protection of cotton, cereals, forestry crops and medicinal plants from harmful organisms.

When regulating biological diversity against pests of forestry crops, entomophagus cryptolemus is used, the use of which is given in the works [2].

TABLE 2 DEVELOPMENT OF COTTON LACE WING AND OPTIMUM TERMS OF CARRYING OUT OF BIOLOGICAL PROTECTION (THE FIRST COTTON GENERATION, 2019)

Regions, areas	Development terms (day, month)				**Release terms of entomophages (day, month**		
	Egg laying	Caterpillars of 2 nd age	Caterpillars of 4 th age	Caterpillars of 6 th age	**Tricho gramma**	**Lace wing**	**Bracon**
	Namangan region						
Pap Uchkurgan	On June,6 th	On June, 11th	On June, 17th	On June, 22th	On June, 5-7th	On Jun, 6,12th	On June 18,23 th
	On June, 8 th	On June, 14th	On June, 19th	On June, 24th	On June, 9-12th	On Jun, 9,15th	On June, 18,23th
	Kashkadarya region						
Kasan Nishan	On June, 3 rd	On June, 9th	On June, 14th	On June, 19th	On June, 2-4nd	3, on June, 8th	On June, 15,20th
	On June, 2nd	On June, 8th	On June, 14th	On June, 19th	On June, 1-3st	2, on June, 8th	On June, 13,18th
	Khorezm region						
Urgench Shavat	On June, 3 rd	On June, 9th	On June, 14th	On June, 19th	On June, 2-4nd	3, on June, 9th	On June, 14,19th
	On June, 2 nd	On June, 8th	On June, 12th	On June, 17th	On June, 1-3st	2, on June, 8th	On June, 11,17th

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