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ASPECTS OF USING TECHNOLOGICAL MULTIFUNCTIONAL SYSTEM FOR BENEFICIAL INSECT MASS REARING

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Abstract

The paper studied the basic and technical research dealing with the obtaining of beneficial insects by development of suitable and economically feasible system for insect and arthropod mass rearing under controlled conditions and the design, achievement and testing/expert appraisement of one multifunctional technological system for beneficial insect rearing and releasing. Practically, the paper is proposing the introduction into plant protection strategy against pest insects of field crops of the specific biological control and biotechnical methods which are not the result of emphasizing of pest resistance and meanwhile are involved in reducing of impact environmental pollution risk. The research activity in the frame of this study is complex and multidisciplinary. The technical methods used consist in designing/drawing up of the components of multifunctional technological system for beneficial insect mass rearing, achievement, testing and optimizing and validation of the system. The main objective and result of this research program was to optimize the production, quality and effectiveness of mass reared natural pest enemies (especially insects) for the integrated or ecological pest management of field crops.

Key words**:** *biological control, biotechnology, mass rearing insect program*

INTRODUCTION

Recent developments in entomological research have augmented the importance of insect mass rearing colonies to basic research and practical control [7]. Research on insects can be facilitated in many ways if the insect species under study can be colonized and produced in the quantity needed for both basic and applied investigations [2]. One of the most exciting new developments in entomology is the role that insects themselves or products derived from insects may play in the future for the control of insects. The full development of these potentials may mean that in the years ahead the mass production of insects will become an important industry in support of insect control.

MATERIALS AND METHODS

This paper presents recent contributions and engineering developments and equipment specifications necessary for constructing a workable, economically feasible rearing multifunctional technological system capable of supplying a production of individuals from beneficial insects populations. This system should also be of value in developing different levels of technology for the mass rearing of other insects, pest insect including. The design of facilities for culturing insects is, or should be, a key topic in the broader subject of insect rearing.

RESULTS AND DISCUSSIONS

The ability to rear insects under controlled conditions has long been regarded as desirable or necessary to facilitate research on many aspects of entomology [5]. It is integrated in the informational system used for assisting the measures of sustainable utilization of the natural fond, as a fundamental layer of viable economical development and social welfare which necessitates a new approach on the biodiversity conservation strategy.

It is axiomatic that the ability to colonize insects under managed conditions is fundamental to virtually every aspect of entomological endeavour. Pest management schemes have actually come to rely upon rearing facilities like one of basic directions of sustainable management of resources and moderate-size populations of beneficial parasitoids and predators for inundative releases are being supplemented by large-scale production for mass releases over extensive geographical areas. Autocidal control measures rely absolutely upon massive releases for imposition of sterility on natural populations. Thus, the ready and constant availability of specimens makes possible the consideration of pest-control options not otherwise available and facilitates associated research or establishment of the priorities. Substantial numbers of insects are required for testing toxicants and behaviour – and growth-modifying chemicals, as well as for basic studies of the mechanisms involved in these and other physiological phenomena. The study of insecticide resistance, genetics, host interaction, insect pathology, epidemiology, transmission of insect-borne diseases, insect-related allergies, and other critical areas also consume large numbers of test insects. Concerns about the impact of agricultural practices on environmental quality, as well as the reduced effectiveness of traditional chemically-based insect and weed control measures, have increased the need for alternative biologically-based integrated pest management strategies which are economical and sustainable in nature. Many established pests such as the Colorado potato beetle and diamondback moth continue to cost growers millions of dollars each year in crop losses. Continuous use of pesticides to manage these and other agricultural insect pests has resulted in populations which are resistant to nearly all major classes of insecticides. The major objectives of parasitoids/predatory insect species it foresee: (i) design and optimizing artificial diets and other rearing techniques; (ii) the achievement of large-scale engineering developments and automatic equipment specifications necessary for construction of a rearing system capable of supplying a minimum of 10 million usable specimens/week; (iii) the establishment of biological stage and the best instars for releasing of parasitoids/predatory insect species; iv) drawing up of the releasing system. The Worldwide Directory of Aerobiological first published in 1990 contains in the fourth edition revised and updated information, with more then 2000 product listings, 276 active ingredients, 500 companies in over 42 countries to locate bio products, suppliers or sales agents. This shows the universal interest in agro biological products and proves also that parasitoids/ predatory insect species current stage are commercially available on the market. Among the greatest facilities worldwide, research-development units performing activities in the mentioned field it could mentioned those of Metapa (Mexic), Waimanlao (Hawaii), Stoneville and Boll weevil research laboratory (Mississippi), Phoenix (Arizona), British Columbia (Canada), Mission (Texas) and Niles (Michigan) [1]. In Europe many private companies are dealing with production of natural enemies on artificial diet like: Bunting Biological Control Inc., Koppert B.V. [12], CABI Bioscience, Chr.Hansen's Bio Systems and so on. Referring only on insects the agro biological industry would greatly improve the potential of selection, taxonomically speaking considering all taxonomic groups, over 1,400 beneficial insects are reared in facilities and laboratories, and among 50 are used on large-scale releases in biological control of some important pests [3]. Other research centres could be also listed:

→ Centre for Research and Development (CID), Spanish Council for Scientific Research, Jordi Girona 18-26 08034 Barcelona, Spain, phone: 343 4006100; Fax: 343 2045904, e-mail: leaam@cid.csic.es, (coordinator centre ENOF → European Network for Scientific Research Coordination in Organic Farming) [9];

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7948; e-mail: info@ibdf.de; spiess@ibdf.de [11];

→ Research Institute of Organic Agriculture (FiBL) – Forschungsinstitut für biologischen Landbau Ackerstrasse/Postfach CH-5070 Frick, Switzerland; phone: +41 62 865 7272/ Fax + 41 62 865 7273 e-mail: admin@fibl.ch [10];

Considering the recommendations of the Biological Diversity Commission [8], this project is focused on defining the populations/species as service rendering units according to the model introduced by Luck [4]. The concept allows the approach of the biodiversity conservation from an innovating perspective, focused on the biodiversity value for the society for a better development of the decisional process. The research activity within this field is constantly developing worldwide, under the influence of numerous local and global factors, as well as the clarification of some basic research aspects. Development of these systems materialized into a series of technical achievements which allowed defining the fields in which alternative means can be integrated in order to control the pest problem in agriculture. Along with the first industrial and experimental successes the resulted products, meaning the useful individuals or insect stages were defined, classified and introduced for sale under the name of "agro-biological products" in the plant protection field, at convenient prices. In the present paper the main components of the system elaborated will be designed and the work technical and physical parameters established:

- containment system**;**
- climatic system**;**
- light control system;
- relative humidity control system

Needham [6] was the first who clearly identified the basic requirements for successful rearing:

- Food;
- Protection from natural enemies;
- A suitable physical environment;
- Fit conditions for reproduction.

Over the years the recent researchable refinements of these elements in considering insect mass production are:

- Inexpensive standardized artificial media;
- Techniques for extracting insect stages from their media;
- Techniques for providing acceptable high-density space use;
- Full understanding of the chemical and physical stimuli mediating mating and oviposition;

The mass-rearing facility of RDIPP Bucharest was designed and builds with the governmental financing for providing main technological equipment (Fig.1).

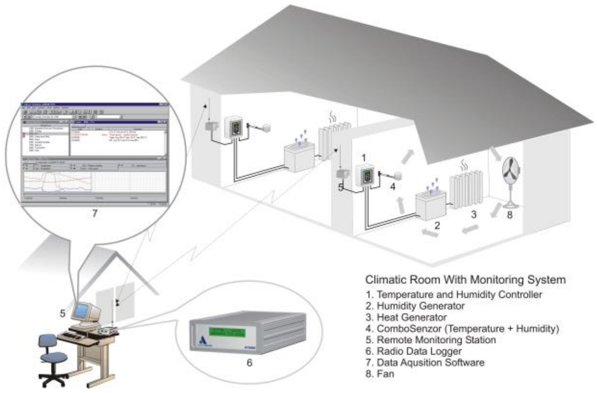

Fig. 1. The draft of facility controlled – environment system

This paper presents recent contributions and engineering developments and equipment specifications necessary for constructing a workable, economically feasible rearing multifunctional technological system capable of supplying a production of individuals from beneficial insects populations. This system should also be of value in developing different levels of technology for the mass rearing of other insects, pest insect including.

Engineering developments are discussed in this paper, and specifications necessary for technical and physical parameters of the system monitoring are presented. The construction of the system are versatile, modular concept to provide automated electronically adjustable environments parameters, i.e., accurate temperature, humidity heating and air filtered against airborne contaminants. The room's climatic parameters are digitally controlled by the system designed in the block diagram of controlled-environment system showing the interfacing with all of the six chambers. The extended-memory unit the SDI-12 M512 interface. The complete system is composed by a central data-control bus links the six chambers in a parallel configuration to the control system. Since the HPxw4400 Workstation employs discrete-component logic and the remainder of the system is built around logic-level converters (wireless sensor interface) which are used to process the incoming and outgoing signals for system compatibility. The basic control scheme consists in four phases of each of the six chambers:

- measuring;
- data transmission;
- data processing;
- remote control unit.

During the first phase, the controller (Metrilog T707 unit) sequentially addresses each chamber, requests temperature data from the chamber, and then compares the received information with the desired programmed environment. The controller then transmits the appropriate command signal (temperature on or temperature off, or changing the desired level). Once the first phase has been completed, the second phase is initiated. The second phase is an RH scan and performs essentially the same tasks, turning the humidification circuit on or off. Consecutively the system has initiated the feedback turning on or off digitally all the sensors (relative humidity, MC light RF modem, radio data logger and so on).

CONCLUSIONS

Mass production of natural enemies has grown tremendously in the last period of time: it increased the number of species, the number of individuals produced, increased the quality of the material obtained, have evolved methods of growth, storage, packaging and transport, release of natural enemies.

Improvement of the methods of growth, production and marketing of a large number of specimens has led to depressed prices. Innovations in long-term storage of certain stages (e.g. by inducing diapauses), in transport and in release methods have led to increasing quality of natural enemies and biological control of cost reduction, which became more economical and easier to apply.

Natural enemies raised safely routed sun used successfully both in biological inundative battle (with the introduction of a large number of natural enemies for the destruction of a immediate without damaging the track establishment and reproduction in nature of this natural enemy) as well as in biological inoculate battle (with the introduction of a small number of natural enemies, in order to establish, their colonization and multiplication in certain areas).

Particularly important in ensuring the success of environmental manipulation has, what means maximizing the beneficial effects of species of natural enemies, by altering the habitats adjacent to launch sites, in order to ensure pollinators and nectariferous plants, places of wintering or unfavourable weather shelter.

The importance of systemic approach of the harmful insect-insect entomofagous for achievement in good condition of mass increase as a result of their parallel evolution and related pest populations, and the entomofagous were constituted as subsystems of dynamic systems, within which, through natural selection, have developed mutual adjustment mechanisms of herds, keeping them within the framework of an area of stability and permanence of the subsystems.

Through feedback mechanisms, each of which has the ability to adjust their birth rates and mortality compared with the corresponding parameters of the other, thereby inducing, appropriate adjustments, related, in the other subsystem. In the absence of intervention by pesticides, natural enemies have the ability to regulate livestock depending on the pest population density values, however, and participating in setting the latter, which means their food resources.

In natural ecosystems, selection, and retention time of these adjustment mechanisms protect both components of the system, avoiding the use by over multiplication trophy resources available, it would jeopardize the long-term existence. In this case, a huge number of effective natural enemies, small flocks of host can disrupt these adjustment mechanisms, with the subsequent negative consequences on natural enemies.

Reducing the density of natural enemies, through various human activities, but primarily through pesticides, as well as the release of a small number of natural enemies in the event of large herds of pests, or inconsistency of the biological cycles of the two partners, creates favourable conditions for these pests, allowing them to increase their herds.

It is necessary to maintain a flock of pests in the field, the tolerable from economic point of view, because the reduction of pest density too is affecting as a last resort and entomofagous, by the absence of hosts available, leading to decreased density and therefore their efficiency. Permanent variations, with increases and decreases are related and mutually conditioned natural enemies and herd the pest, within certain limits, given the relative stability of the system, the ability to achieve a state of dynamic equilibrium in livestock populations, it tends to fail permanently and to return to this status, to avoid disruptions that would be outside of a certain area of stability.

If attempts to intervene as a factor of adjustment of the flocks of harmful insects, through growth and releases natural enemies.

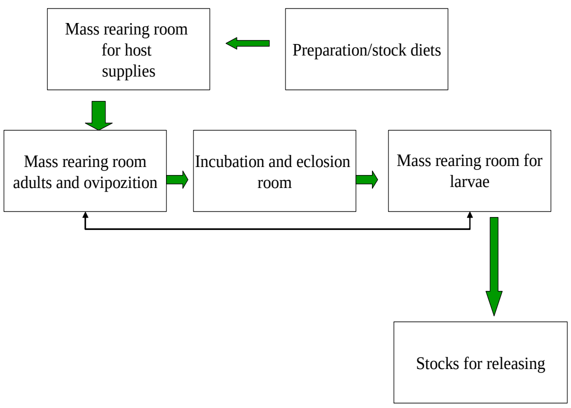

Fig. 2. Block diagram of major areas of RDIPP, Bucharest, mass – rearing facility

Special attention should be paid to avoiding damage mechanisms of self-regulation of the system of natural enemy-pest, by estimating populations, their correlation with livestock pests, continuous evaluation of the results. To mitigate the effect of interference, direct and indirect human intervention, due to the use of parasitoids and prey species of insects against insects or other animals considered to be harmful, it should therefore be substantiated both economically and ecologically.Digitally system for physical parameters monitoring are originally designed and build at RIDPP Bucharest and now are in the patented proceeding (Fig.3).

- PARAMETER 1 – Humidity (RH %)

Adiabatic Humidifiers DEFENSOR ABS – EICHLER

- PARAMETER 2 - Airflow circulation

Vane axial blower fan for airflow circulation

- PARAMETER 3 – Temperature

Electrical heating element (2,000 W) in each room

- PARAMETER 4 – Light

Block fluorescent located at the ceiling center of each chambers. All parameters are digitally controlled at the standard configuration which can be easily modified by remote control from every earth location. Digitally sensors provided by METRILOG GmbH Austria and radio remote units for data transmission by A730MD and Data Logger (A730SD).

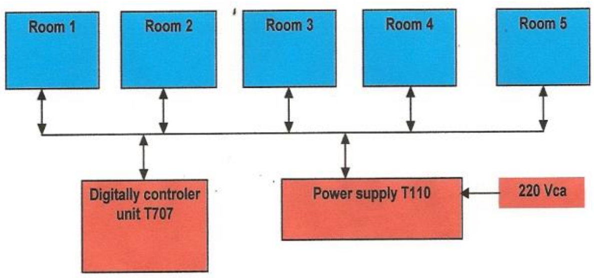

Fig. 3. The draft of digitally monitoring system of climatic conditions inside of facility chambers

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