

## THE BIOTECHNOLOGY FOR SOLVING OF PLANT PROTECTION PROBLEMS IN ORGANIC FARMING

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### ABSTRACT

Application traditional technologies demonstrate indispensable contradiction between the plant protection requirements condition and the need to preserve environment. The systemic approach of relations between crop and pests opens new possibilities in researching biocenotic relationships within ecosystems and halting spending growth trends directed to plant protection. For solving of plant protection problems were developed biotechnological processes of production and application of an impressive range of biological means, which is used for conventional and organic agriculture. The main legislative documents (Low No 115 from 2005 concerning the ecological agriculture, Government decision No 149 from 2006 concerning its implementation, a series of regulations) have been adopted. Given the experience in the production of biological agents and the need to combat harmful organisms that cannot be countered by other biological means, our scientists were developed a lot of biological active substances, entomophages and biological preparations with a special role in pests control. With their competition have been implemented and approved a lot of biological means, which is a powerful tool to combat harmful organisms and improving environmental conditions.

**Key words:** Biotechnology, conventional agriculture, organic farming, ecology, biological preparations

### Introduction

The pesticide, as a chemical compound, used to control weeds, plant diseases or insects. Since pesticides may be harmful to humans, animals, or the environment, it is important to understand the fate of pesticides after application. In connection with the adverse impacts of pesticides people throughout the world are interested in organic or "naturally produced" foods. However, although similar in principle, growing crops or producing animal food or without use of pesticides is different from "organic" farm production. Legally, there are steps that growers must follow before the word "organic" can appear on the label.

Overestimation of productivity of crops during the period of "green revolution" has led to the underestimation of soil fertility. Higher level of yields could be maintained with higher rates of inputs and higher yield potential of the new varieties and hybrids of crops, but in the same time with decreasing level of soil fertility. The humanity became in the face of dilemma - how to increase the production in order to cover the increased demand of people in food products and in the same time how to avoid the increased degradation and pollution of the environment. This led to the Rio world summit in 1992, where for the first time at the international level it was declared that new ways of intensification, including in agriculture have to be found in order to provide sustainable development

(Altieri M., 2000; Briney A., 2010; FAO, 2010; Maria R. Finckh, Ariena H. C., van Bruggen, and Lucius Tamm, 2015). Typically, the health of the soil is of secondary importance compared to gaining strong short-term crop yields. Conventional farmers can also use manure without restrictions and are not required to keep records of their production practices (CIBA, 2008; Volosciuc L.T., 2009a; Harry Brook and Mark Cutts., 2016).

Organic farming (ecological agriculture) is a completely different system from conventional farming. Over the years, organic farming has become defined very simply as a practice that does not use synthetic pesticides or conventional chemical fertilizers, but organic farming involves much more than this (Cory Jenny S., Myers Judith H., 2000; Badgley C., et al., 2007).

Now, organic farming is more popularly known for what it is not. Conventional agriculture is far more widespread, so let's first take a look at the conventional process in order to better understand the differences that distinguish organic farming from other agricultural systems (Allan S. Felsot, Kenneth D. Racke., 2007; Connor, D.J., 2008; Голдштайн В., Боинчан Б., 2000).

Ecological agriculture is a system which avoids or largely excludes the use of synthetic inputs (pesticides, fertilizers, hormones, feed additives etc.) and to the maximum extent feasible relies upon biological protection, crop rotations, animal manures, mineral grade rock additives and biological system of nutrient mobilization. Organic farming is a method of crop and livestock production that

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involves much more than choosing not to use pesticides, fertilizers, genetically modified organisms, antibiotics and growth hormones (Sundararaman S. R., 2009; Treadwell D., et al., 2010; Organic farming, 2014; Maria R. Finckh et al., 2015).

Taking into account the negative phenomena of conventional agriculture and to ensure permanent progress and lengthy agriculture, which must remain in harmony with nature, the world has consolidated the International Federation of Organic Agriculture Movement (IFOAM). Over the past few years have been crystallized and the main requirements for organic products, which are currently classified in EU Regulation no. 2092/91 of 24.06.1991 (Volosciuc L., 2009b; Голдштайн В., Боинчан Б., 2000). To improve process improvement activities in organic agriculture since 1 January 2009 new regulations were approved (no. 834/2007 and no. 889/2008), which references to Directive 2092/91 were automatically taken over by no. 834/2007 (Volosciuc L., 2009b; Volosciuc L., Josu V., 2014).

Although serious premises are known to promote green technologies, however, the results have been modest, which requires further research to ensure scientific and technological strategy for implementing this kind of activity (Volosciuc L. et al., 2015). In this context, the paper presents an analysis of the situation and problems of plant protection in ecological agriculture.

### **Materials and methods**

Isolation, identification and determination of biological strains of baculovirus, bacteria, fungi, and actinomycetes were performed by applying optical and electronic microscopy, production and application of biological means of plant protection. The efficiency of biologic preparations was determined by Abbot formula, which provides natural insect mortality (Voloşciuc L., 2009a; Altman A., Hasegawa P.M., 2012.).

The establishment of biological protection systems applying bacterial preparations, baculoviral and fungal entomopathogens, biologically active substances, including sex pheromones has been carried out on the systems of pest forecasting development (Чернышов В., 2001; Bellon Stephane, Penvern Servane, 2014).

Testing in laboratory and experimental group means, methods and conventional and organic farming systems was conducted in four randomized repetitions in accordance with the general requirements of experiences of this kind (Volosciuc

L., 2009b; Доспехов Б. 1989; Волошук Л.Ф., Войняк В.И., 2012).

## **Results and discussions**

### **The plant protection and worsening environment**

The losses of crop production caused by various species of pests, pathogens and weeds is 25-30%, and with the development epiphytotic disease and pest and weed invasion vertiginous, crop losses exceed 50-60% or compromise the overall majority crops (CIBA, 2008; Volosciuc L., 2009b; Хлопяников А.М., и др., 2012).

Conventional agriculture based on intensive application of various chemical means, especially pesticides, solved one of the global problems of humanity, that of ensuring food. But against the backdrop of the impressive achievements of traditional agriculture are obvious and negative phenomena of the medals (Allan S. Felsot, 2007; El-Hage Scialabba N., 2007; Voloşciuc L., 2009b). It attests increasing negative impact of plant protection measures and environmental protection requirements (Rundluf M., J. Bengtsson, H. Smith, 2008; Rex Dufour, 2011).

While reducing the ravages caused by harmful organisms, pesticides causes serious disturbances in the ecological balance, greatly reducing the number and role of flora and fauna useful and their application prolonged cause various genetic changes, including the emergence of resistance to pesticides that conditions need to increase the dosage and the number of treatments in controlling pests. The requirements for the organization of plant protection measures are in permanent conflict with the requirements of environmental protection and human health (Volosciuc L., 2009a; 2009b; Future IPM, 2013; Волошук Л., Войняк В., 2012).

### **Alternative directions in plant protection**

The research of ecosystems have shown that the deepening impact of plant protection and the environment can be stopped only at the development of agriculture as a body as a living ecosystem, which has its model in nature, which is an alternative to intensification, specialization and dependence full to chemicals and pesticides. It is directed harmonious not cause any damage agricultural ecosystems environment in which they evolve in accordance with the national laws of development of the biosphere (Ferron Pierre, Beguine Jean-Philippe., 2005; El-Hage Scialabba N., 2007; Голдштайн В., Боинчан Б., 2000).

Integrated plant protection measures is a technological block in technological maps and crop

farm, which lies in the dedication of plant protection based on the biocenotic principles. Operation integrated protection is not just mechanical joining methods and chemical protection is not just alternating different sources of protection is not a simple change of chemical means other, but deep restructuring includes the concept of plant protection (Neil Helyer, Nigel Cattlin, Kevin Brown., 2014).

Wide systemic research approach involves the integration of knowledge from different sciences such as phytopathology, entomology, microbiology, ecology, virology, biotechnology, etc., which are largely related to plant protection. Apart from direct relationships, indirect links integrated plant protection is particularly huge and include knowledge related to biology, cultivation, economy, healthcare. Namely systemic approach has enabled to realize that plant protection include a number of specific systems that interact and function as a whole, thus emphasizing the direction of solving practical problems by using process modelling methods, which take place in agrocenoses.

Organic farming as a flexible complex of measures called to ensure optimum protection of plants over a long period of time, meeting the requirements of sustainable development of society. On the basis of agro knowledge they stand as a functional unit of the biosphere and is not geared to combating a certain species of harmful organisms, but to control the entire complex of harmful organisms that once culture (Letourneau D., Van Bruggen A., 2006; Vinson S.B. et al., 2016).

The application range of knowledge about immunity and resistance of plants to pests and diseases, biotic and abiotic factors that act on harmful organisms, introduction and acclimatization beneficial organisms allow greatly reduce the population density of pests such an extent that damage to them does not exceed the economic damage. We support the use of different measures, called the constitutional, which provides adjustment of population density and establishing useful agents in agro ecosystems. In conditions when applying these measures do not provide the desired effect, propose corrective measures that reduce population density of pests to economically tolerable level. When applying corrective measures are taken into account not only the results close, but subsequent follow-up, more distant.

Organic farming involves more administrative costs than conventional farming. Being certified organic involves quite a bit of regular record keeping, detailing the strict records of their growing practices (Zadoks J.E., Waibeu H., 2000.).

The majority of studies claim no difference in the nutritional content of organic food from conventional food. Keep in mind that the methodology for all of these studies looks at the nutrients contained in the food - vitamins, minerals, proteins, etc. If you factor in the use of chemical fertilizers, pesticides, hormones and antibiotics as part of the equation, organically grown food will come out as more nutritious and more healthful every time (Shamim Md., et al 2013).

Organic farming promotes the use of crop rotations and cover crops, and encourages balanced host/predator relationships. Organic residues and nutrients produced on the farm are recycled back to the soil. Cover crops and composted manure are used to maintain soil organic matter and fertility. Preventative insect and disease control methods are practiced, including crop rotation, improved genetics and resistant varieties (IFOAM, 2015).

### **The Biological Protection - foundation and part of organic farming**

Many different definitions of biological control have been proposed. According to Cook and Baker (1983) "Biological control is the reduction of the amount of inoculum or disease producing activity of a pathogen accomplished by or through one or more organisms other than man". Based on this broad definition of biological control, organisms and procedures involved include: avirulent or hypovirulent individuals or populations within the pathogenic species, antagonistic microorganisms, and manipulation of the host plant to resist the pathogen more effectively.

Biological plant protection utilizes nature's own methods in the prevention and combatting of plant diseases and pests. It is based on ecological balance, where each and every living thing has a place of its very own in nature, its own biological niche. In biological plant protection pathogens are controlled by their natural enemies – microbes isolated from nature. From new methods of pest control are the most effective biological that the current concept would be more correct to name as their density routing methods through biological agents and comprise a broad spectrum of processes.

These include the introduction and acclimatization of new areas of biological entities, mass production and launch seasonal agrocenosis protected (Volosciuc L., 2009a, 2009b). This is a system for regulating population density of pests, taking into account the specific environment and their dynamics, using natural mechanisms and entities useful adapted to maintain the populations of

pests and pathogens below the economic damage, ensuring economic efficiency and environmental .

Enhancing the efficiency of biological protection can be achieved in the phytosanitary situation of the protected-culture knowledge, biology capabilities pest and biological agent. Addressing Plant Protection and Development of the production of organic products can be achieved when applying main groups of biological agents: entomophages, biological products (viruses, fungi and bacteria) and biologically active substances, first sex pheromones (Voloşciuc L., 2009b; Organic farming, 2014).

Given the fact that the mechanisms regulating natural ecosystem is determined by complex relationships between components lower levels of organization of living matter (the consortial systems and food chains), which can be searched in accordance with existing methods, it is obvious that investigations natural ecosystem in order to determine mechanisms of adjustment can be made only in the food web. It is necessary to research the relationships that are falling species enlightening plant and phytophagous specialized as species polyphagous and oligophagous pests do not determine the status circuits of substances, but only serve as elements of doubling the mechanisms of transformation of matter and energy. Therefore, in order to develop models and plant protection systems necessary to detect natural ecosystem regulation naturally mechanisms or less modified under the influence of anthropogenic factors.

As an indication main selection means of plant protection do not have to use the degree of destruction of the pest, but the elimination phytophagous during the whole ontogenetic and taking into account the phenomenon of post action over several years. The persistence of biological agents within agro ecosystems demonstrates that these is extracted from natural conditions, and then apply in order to protect plants become artificial analogues of natural compounds regulating density populations of harmful organisms (Voloşciuc J.I.T., 2019).

The aim of natural control is to restore a natural balance between pest and predator and to keep pests and diseases down to an acceptable level. The aim is not to eradicate them altogether. Here are three important reasons why natural control is preferable to pesticide use (FIBL, 2010).

Pesticides can quickly find their way into food chains and water courses. This can create health hazards for humans. Human health can also be harmed by people eating foods (especially fruit and vegetables) which still contain residues of

pesticides that were sprayed on the crop. There are a number of harmful effects that chemical pesticides can have on the environment. Pesticides can kill useful insects which eat pests. Just one spray can upset the balance between pests and the useful predators which eat them. Artificial chemicals can stay in the environment and in the bodies of animals causing problems for many years. Insect pests can very quickly, over a few breeding cycles, become resistant to artificial products and are no longer controlled.

### **Development of Ecologic Agriculture in the World and Republic of Moldova**

In response to environmental actions, in 1972, in Versailles was established IFOAM who managed to promote organic farming and currently meets approximately 1,000 members in 170 countries. The main results of the latest survey on certified organic agriculture world-wide show that 43,1 million hectares of agricultural land are managed organically by 2 million producers. The regions with the largest areas of organically managed agricultural land are Oceania (17,3 million hectares or 40 % of the global organic farmland), Europe (11,5 million hectares or 27 % of the global organic farmland) and Latin America (6.6 million hectares or 18 %).

On a global level, the organic agricultural land area increased by 6 percent or almost 6 million hectares compared with 2012; mainly due to a major increase of organic land in Australia. The countries with the most organic agricultural land are Australia (17,1 million hectares), Argentina (3,2 million hectares) and the United States (2,2 million hectares). The highest shares of organic agricultural land are in the Falkland Islands (36,3 percent), Liechtenstein (31,0 percent), and Austria (19,5 percent). The countries with the highest numbers of producers are India, Uganda and Mexico (Willer Helga, Lernoud Julia., 2015; Scialabba N., 2015).

As of the end of 2013, 11,5 million hectares in Europe were managed organically by more than 330000 farms. 2,4 % of the European agricultural area is organic. Twenty-seven percent of the world's organic land is in Europe. There are eight, countries in Europe with more than ten percent organic agricultural land: Liechtenstein, Austria, Sweden, Switzerland, Estonia, the Czech Republic, Latvia, and Italy. Compared to 2012, organic land increased by 0,4 million hectares and the European market size was 24,3 billion euros.

As organic moves beyond a niche, the organic movement needs to take stocks of what organic has become and what the future holds for us

all. The movement needs to be prepared to cope with future political developments, environmental challenges and market trends (IFOAM, 2015; Paull, John & Hennig, Benjamin, 2016).

In Republic of Moldova to achieve these goals were taken some measures sparse, which did not allow this movement to grow. It should be mentioned that it is known for some favorable conditions. Besides the achievements already made towards the development and application of biological methods of plant protection, the primary basis for obtaining organic products were taken a series of measures aimed at obtaining, processing and marketing of organic products (Raumjit Nokkoul, 2016).

It is worth mentioning that in terms of production achieved, organic agriculture and responding to the objects particularly important for Moldova, as for example:

- Meet the growing domestic and foreign natural products, which clearly demonstrated the contribution to maintaining and improving the health of humans and animals;
- Considerably diversified range of product categories in the market is in a state of overproduction and increasing the volume of crop production values appreciated at the moment we value;
- Facilitates the production activity of native farm out the lack of competition on the foreign market for some vegetables and fruits that have optimal conditions for the application of technologies for organic products;
- Material interests prices farmers through organic products exceeding 1.5-3 times the conventional prices, although there has been a 15-20 percent decrease in production volume;
- Enhances the quality of biological, biochemical and nutritional organic products. Given the fact that organic products are not a result of industrial processes, the consumer chooses the criteria morphometric but after their biological value;
- Strengthen opportunities for agricultural producers to enter the western market for agricultural products, which is highly conventional and competing products show particularly high requirements for organic products.

Namely in this way can we hope to stop the processes of ecological crisis and maintain the natural dynamic balance. Application technologies for organic farming are resulting in products with high biological value, healthy, pesticide-free and high-quality content.

The new paradigm of sustainable development in agriculture is based on respecting the following principles:

- minimization purchased artificial inputs from outside of the farm and avoiding them completely in organic agriculture,
- intensive use of renewable sources of energy mainly of local provenience, and a more complete energy and nutrient recycling,
- minimization of the negative impact on the environment, and utilization of local, more adapted varieties and hybrids of crops, a higher biodiversity of crops,
- restoration of soil fertility, which is determining the vitality and the health of soil, crops, animals and people,
- equity in relationships between producers, processors, distributors, sellers and buyers.

Republic of Moldova has the legislation in this aspect, harmonized with the European and international requirements which includes:

- the national concept on ecological agriculture and the action plan for the implementation of this concept, adopted by the Governmental Decision no 863 from 21.02.2000,
- the Law no 115-XVI from 09.06.2005 regarding the ecological production,
- the Governmental Decision no 149 from 10.02.2006 regarding the implementation of the low on ecological production.
- the Government Decision no. 1078 of 13.10.2008 "Technical regulations for the implementation of Regulation EC 834/2007 on organic food production, labelling and control."

In order to respect these principles, we should return to holistic (system) researches instead of reductionist ones. Improvement of technologies isn't enough for achieving a more sustainable development and especially for organic farming systems. We need to develop self-sufficient and self-regulating production systems, which are less dependent from artificial, industrial inputs, can use more efficiently local resources and are friendly to the environment (Jigau Gh., 2011).

Researches have to be undertaken for the whole food chain – from crop breeding, primary production by farmers, processing, marketing up to consumers. By saying this we mean to take in consideration not only the production sector, but also the environment and social sectors. In other words, the whole link should be in the attention of researches – from the fork up to the table of consumers.

Vigorous actions taken in Moldova have allowed the institutionalization of this field of

activity, increase activities within the agricultural producers interested in promoting organic agriculture, approval of the National Label "Organic-Moldova" and the recording of significant indicators.

The number of companies concerned with obtaining organic products has increased since 2003 from 11 to 387 operators.

During this period, the area occupied by organic crops increased considerably: from 168 to 51 thousand ha.

It also impresses the dynamics of the volume of the exported organic production: from 1373 tons in 2003 to 81 thousand tons in 2018.

### Use of Pesticides in Ecologic Agriculture

Plant protection is one of the major issues in organic farming. Biologic crop protection strategies often rely on a limited number of methods that provide only partial control of pests and that induce lower yields and economic performances. As a result, farmers hesitate to adopt these strategies and doubts are cast on the ability of organic agriculture to feed the world. This chapter questions how agro ecological concepts may contribute to bio control, while taking the different alternative schemes already developed to manage, integrate and design crop protection strategies into account.

As demonstrated by a bibliographic analysis, integrated pest management (IPM) remains the leading paradigm in crop protection. It also provides its foundational basis, giving priority to ecological processes and alternative techniques to reduce pesticide use. Beyond IPM, agro ecology is characterized by a holistic approach and the importance given to the design of a "healthy" agro ecosystem. In practice, all these concepts are subject to various interpretations, and organic farming includes a variety of practices, ranging from intensive input-substitution to a comprehensive integrated approach (Biotech-Crops, 2012; Фокин А.В., 2010; Кирюшин В.И., 2012).

Organic farmers should be aware of the law relating to substances used to protect their crops from harmful organisms. In addition to checking that they are allowed to use the product with their organic certification bodies, they must also check that substances or products are permitted for use in this country before using them on their crops.

Even natural substances such as plant oils or ingredients used in the food industry such as pepper need to have an approval before they can be marketed or used as a plant protection product. Any retailers and growers will be the subject of

enforcement action should it be discovered that they are marketing or using an unapproved pesticide.

IPM is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

### The biotechnology of production of biologic preparations for organic farming

Plant biotechnology scientists working to maintain healthy plants, optimize crop yields, and minimize pesticide usage. Applying modern technologies of genetic and gene engineering, become more consistent achievements aimed at controlling pests and enhancing plant protection in the next directions: enhancing a plant's resistance with genes from the plant kingdom, genetic engineering, as a powerful tool to combat plant virus diseases, using antimicrobial proteins to enhance plant resistance (Volosciuc L., 2015).

Given the experience in the production of biological species and the need to combat harmful organisms that cannot be countered by other means biological, bio developed a special role of local scientists. With their competition they have been implemented and approved a lot of biological means, which is a powerful tool to combat harmful organisms and improving environmental conditions (Voloşciuc L., 2009a, 2012; Волощук Л., Войняк В., 2012). Among these are the following:

Trichodermin BL is constituted under the fungus *Trichoderma lignorum* and used to combat white rot, grey and root vegetable crops, ornamental, vegetable and tobacco seedlings and vegetable crops, reducing crop attack by pathogens 2-3 times stimulating growth, plant growth by 25-30%.

Trichodermin F7 - based preparation is the fungus *Trichoderma harzianum* granular and liquid. It is used to combat agricultural crops root rots, root rots reducing 1.5-2 times.

Nematofagin-BL is constituted under *Arthrobotrys oligospora* fungus and used for combat nematodes in protect technical and vegetable crops.

Verticilin - the base of preparation is the fungus *Verticillium lecanii* in the form of a wettable powder. It is recommended for the control greenhouse whitefly to the efficacy of 95%.

Rizoplan is constituted under the bacterium *Pseudomonas fluorescens* AP-33 and is used to combat the root rots of crops.

A lot of viral preparations were developed for pest that cannot be combatted by other biological means.

Virin-ABB-3 - to combat *Hyphantria cunea* in orchards, forests and parks. The preparation is based on nuclear polyhedrosis viruses and cumulative and synergistic action granulosis, showing of the epidemic and post-action effects.

Virin-MB - to combat Cabbage worm and is based on *Mamestra brassicae* nuclear polyhedrosis virus.

Virin-OS - to combat insects of genus *Agrotis* and is based on granulosis viruses and nuclear polyhedrosis synergistic action.

Virin-HS-2 - to combat rootworm by cotton and insects of genus *Heliothis* and is based on nuclear polyhedrosis virus.

Virin-CP is intended to combat codling moth and is based on *Carpocapsa pomonella* granulosis virus.

As more and more plant biotechnology products become available, studies to evaluate the ecologic and economic effectiveness, as well as risks associated with biotechnology must be researched. A successful program biological control requires comprehensive cultivation management and good cultivation hygiene, which contributed for effectively prevents of pests and plant diseases. The right plant management guarantee optimum conditions for effective activation of beneficial organisms.

### Conclusions

Application traditional technologies demonstrate indispensable contradiction between the plant protection requirements condition and the need to preserve environment. The systemic approach of relations between crop and pests opens new possibilities in researching biocenotic relationships within ecosystems and halting spending growth trends directed to plant protection.

Integrated plant protection systems, as an element applied conventional and organic farming, is not only a mechanical alternation of chemical methods of pest combating, but a complex of actions aimed at using natural mechanisms regulating the density of populations of organisms harmful and only in critical conditions, implementation of minimum quantities of pesticides.

Ensure effective non-chemical plant protection systems is becoming reality in the deployment of integrated plant protection with predominant application of biological methods of protection.

Biological plant protection - as an efficient method of avoiding the conflict between environmental protection and quality of the plant is based on continuous use of information related to monitoring populations of harmful and useful organisms, and the use of compensation measures and combat application entomophages, bio preparations and biological active substances.

Republic of Moldova has prerequisites and conditions for the extension and deepening of activities sufficient to obtain organic products. Promoting organic agriculture requires improving the legal framework, developing national strategy on organic food production, monitoring compliance of normative acts, strengthening national body for evaluation, inspection and accreditation of operators, supporting farmers to shift conversion period.

Strengthening technology strategy and research functionality to meet needs for technological processes aimed at providing means for obtaining and processing of organic products is the key position in the intensification and extension of educational activities in the taking and processing of organic products.

Organic farming can be a viable alternative production method for farmers, but there are many challenges. One key to success is being open to alternative organic approaches to solving production problems. Determine the cause of the problem, and assess strategies to avoid or reduce the long term problem rather than a short term fix for it. As a result, the wish for better synergy between biotechnology, ecology and plant protection for the benefit of sustainable exploitation of the biosphere could thus be granted.

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