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Chapter 2

Pest Control in Organic Systems

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http://dx.doi.org/10.5772/64457

Abstract

Conventional agriculture techniques applied in the latest decades have had undesired consequences on the environmental sustainability, carried out to the soil erosion, the degradation of the ecological system, changing the balance between beneficial and harmful pests, and contamination of soil, water, and agricultural products by heavy metals and pesticides. Thus, in organic agriculture, using synthetic chemicals for pest control is prohibited, assigning to the diversity a major role. The study provides to the reader many important practical data, judiciously documented, which are useful for the researchers and farmers from the world. Pest control in organic agriculture can be obtained through prevention and curative measure, but modern agriculture must be focused on the prevention.

Keywords: organic agriculture, pest control, preventive and curative methods

1. Introduction

Organic agriculture (OA) farming aims to achieve sustainable, diversified, and balanced systems, with the purpose of protecting the environment for present and future generations. In the same way, OA provides on the food market, products of a certain nutritional quality, suitable in terms of lower contaminants.

The organic product is governed by some well defined principles, aimed at ensuring environmental and crop sustainability.

1.1. Circumstances of pest control in organic systems

Being a type of sustainable agriculture the purpose of OA can be expressed by a mini–max function, maximizing production and minimizing the negative agricultural activities on the environment [1].

OA stimulates the activity of useful microorganisms, flora and fauna. Soils under crops are increasingly lifeless and infested with weeds, diseases, as well as pests. This situation is determined by current agricultural practices that excel in monoculture and short crop rotations, of 2–3 years, much delayed and bad quality soil tillage and plant care, burning plant debris, etc.

Biodiversity management. The soil's biological resources are vital to the economic and social development of all humanity. That is why, it is more and more frequently recognized that biological diversity is universal asset, of inestimable value for future generations. Biological (ecologic, organic) agriculture generally uses a greater number of cultivated species, to explore their suitability and ecological plasticity. Non-using synthetic herbicides, and instead using milder solutions for weed destruction, ensures the coexistence of weeds together with the crop.

Protecting the natural landscape. Elevation diversity, as well as flora and fauna variability, is inseparable to the applied vegetable growing systems, the most aggressive ones being of the intensive type, often causing deterioration.

Many cultivation techniques applied in the past decades have had undesired consequences on the environment, contributing to soil erosion, the degradation of the ecological system, contamination of ground water and crops with pesticides and nitrates.

Organic agriculture aims to preserve the environment unaltered, using organic fertilizers and also less soluble mineral fertilizers, organic fertilizers, such as composts and green fertilizers, avoiding to use products that can have harmful effects [2].

The use of synthetic herbicides and pesticides are prohibited, and only products that are harmless for the plant are allowed, products based on simple minerals (Cu, S, Na, silicate, etc.) or plant extracts (pyrethrum), including the application of physical (thermal) methods.

In organic agriculture, the emphasis is laid on the quality of human intervention over nature, which is non-aggressive, compared to conventional agriculture.

1.2. Standards and regulations regarding organic farming

After 2010, OA can be considered a period of consolidation for standards and the regulations, which aimed and still aims to facilitate international trade with organic products in order to reduce legislative gaps which exist among the various certification types, such as the EC Regulations [3, 4], the USA (NOP), Australia (AS 6000-2009), Japan (JAS), and Switzerland (Bio Swiss). Thus, the EC Regulation of organic agriculture [3] has been improved in the least years with new regulations, targeting aquaculture and organic wine production.

http://dx.doi.org/10.5772/64457

The number of the certification bodies, in 2013, was at 569, increasing from 2010 when there were 532. Most certification bodies are found in the European Union, Japan, the United States of America, South Korea, China, Canada, India, and Brazil [5].

Organic farming (biological, ecological) is currently one of the most dynamic forms of agriculture. This affirmation is mainly supported by the expansion of agricultural areas, currently occupying 40.2 of the surface in Oceania, 26.6 in Europe, and 15.3% in Latin America. There are also cases of countries, such as Argentina, Spain, and USA, in which the area increased in 2013 compared to 2011 with over 185,000 ha.

Around the world, at the end of 2013, the organically certified area covered more than 78 million ha. Organically certified agricultural areas covered over 43 million ha (1% from total arable land), including the same land under its conversion period, but excluded wild collection and aquaculture. From these data, it appears that the organically administered surface has had a growth rate of over 14.94% compared with 2012 (approx. 37.4 million ha). Europe and Oceania recorded the fastest land expansion rhythm in 2013, compared to 2011, which shows that the expansion of the areas is supported by an intensive marketing of organic products [5].

Compared to 2012, the organically certified area in the world increased by over 5.6 million ha, which means a growth rate of the arable production from the total agricultural area of 0.1%.

At the end of 2013, the situation of the organic agricultural area distributed on categories of land use highlighted that 63% was permanent grassland, 18% was arable land (cereals, green fodder, oilseed, vegetable, and protein crops), and 7% was permanent crop (coffee, olives, nuts, grapes, and cocoa) and the rest with other crops [5].

Of course, in some countries, the conversion areas or the cultivated ones are decreasing, especially due to legislation and government support, which differ from country to country (UK).

Global sales of organic food and drinks reached more 72 billion dollars at the end of 2013. Compared to 2009, this sector revenue increased almost five times. Europe and North America made a big contribution to cover these specific sectors. Asia, Latin America, and Africa have become really important producers of organic crops for this market. About 43% from this market is covered by the United States followed by Europe at percent 40% [5].

In 2013, the countries with the largest organic markets were the USA (24.3 billion €), Germany (7.6 billion €), and France (4.4 billion €) [5].

2. Pest control measures

Organic farming (OF) is a system-based agricultural production system working with rather than against natural systems [2].

The major differences that have been made in terms of technology between organic and conventional cultivation of plants are as follows: soil fertility, weeds, pathogens, and pest control.

Pest control in organic agriculture can be obtained through prevention and curative measure but must be focused on the preventive infestation of pests [2]. Measures to prevent infestation by pests refers to: phytosanitary quarantine (special for seed and planting materials used for establishing crops); monitoring pest infestation (used in general agro-expert stations or traps); choice of cultivars according to the criterion of resistance and ecological plasticity; seed conditioning; destruction of problematic weeds; solarization; and hygienic conditions.

2.1. Prevention pests in an organic system

The fundamental principle of controlling pests in organic systems (OS) should consider the mechanism of adjusting its biocenosis (total community of organisms from o biotope), through the correlation and interdependence between the cultivated species, pathogens, weeds, pests, technology, and the environment. Protecting plants from pests and diseases probably has the greatest impact on achieving an organic vegetable crop, due to the very large spectrum of pathogens and pests from these crops. The first major attempt to reduce chemical treatments took place even before 1970, when the concept of integrated control was promoted [6, 7]. According to this concept, all technical methods are allowed to maintain the populations of pests and pathogens under a certain degree of impairment, which does not affect the yields from an economic point of view.

This concept is approved by the International Organization for Biological Control (IOBC), but first of all natural factors must be used, together with other methods appropriate for the economic, ecological, and toxicological requirements [8].

In organic farming, the principles of the integrated pest control are perfectly applicable in substantializing the mechanisms for fighting pests, diseases, but most chemical means are forbidden; instead, new unconventional methods have been used, like some biodynamic preparations.

The strong attack of some pests may be favored by some technical mistakes, in general, or mistakes in the environmental context such as the following: improper choice of the place of culture; using seeds or plants that are weakly developed; mistakes in crop association; practicing monocultures without using proper crop rotation; incorrectly executed soil tillage; unilateral or excessive fertilization, without organic fertilizers; insufficient fertilization; extreme weather conditions; and improper choice of the sowing period [1, 9].

2.1.1. Phytosanitary quarantine

The quarantine is a complex of preventive measures taken to stop the penetration of diseases, pests, or weeds from other countries and to limit their spread. Overall, export products between countries shall be binding accompanied by a phytosanitary document certifying that the seeds or agricultural materials for setting up the crop (seeds, cuttings, tubers, bulbs, seedlings, shrubs, or trees) are free from pest quarantine.

There are numerous species (mites, insects), generally in polyphagus that are considered extremely dangerous and huge efforts have been made to limit their expansion, for example:

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Leptinotarsa decemlineata (Colorado beetle), *Tetranychus urticae (*red spider mite*)*, *Myzus persicae (*green peach aphid*)*, *Bemisia tabaci (*silverleaf whitefly*)*, *Trialeurodes vaporariorum* (greenhouse whitefly), *Liriomyza trifolii (*leaf miner flies*)*, *Tuta absoluta* (tomato leaf miner), *Spodoptera litura (*Oriental leaf worm moth*)*, *Frankliniella intonsa red (*red thrips*)*, *Diabrotica virgifera virgifera* (western corn rootworm), or others [10–12].

2.1.2. Maintenance of biodiversity

Synthetic pesticides are not permitted in organic farming which serves to preserve and enhance biodiversity within the system. Natural enemies of pest species are therefore able to thrive, exerting control on pest populations. Conservation and improvement of natural features of the landscape, such as hedgerows and ponds and the construction of beetle banks and sown flower strips, have also enabled communities of predators to flourish.

In agriculture, in general, farmers work with biological organisms, which behave differently under the action of nature's biotic or abiotic factors [13].

The pests are very adaptive to the changes of production systems, especially from the transfer from conventional to organic farms (in conversion).

In OA, pest problems are influenced by three major components of farming systems, such as: crop species and cultivar, agro-ecosystem structure, and technology production (**Figures 1** and **2**).

Figure 1. Management of land for organic agriculture (photograph by Stoleru Vasile).

Researchers developed flowering strips that are tailored to requirements of the specific complex of natural enemies within a cropping system. So, any experiments identified selective plant species that would improve the longevity and parasitization rate of the parasitoid wasps (*Microplitis mediator*, *Diadegma fenestrale,* and *D. semiclausum*) on the *Mamestra brassicae*.

Figure 2. Sea buckthorn hedge on an organic farm (photograph by Stoleru Vasile).

Comparing the effects of floral and extrafloral nectar of different plants, beneficial effects of *Fagopyrum esculentum* (floral nectar), *Centaurea cyanus* (floral and extrafloral nectar), and non-flowering *Vicia sativa* (extrafloral nectar) on parasitoids were found. Extensive plant screening is essential to achieve plant selectivity and to maximize biological control. *F. esculentum*, *C. cyanus* and *V. sativa* are recommended as selective plant species to enhance parasitoids of *M. brassicae* [14].

2.1.3. Selection of cultivars according to the resistance and ecological plasticity criteria

The cultivar is perhaps the most important factor that productivity and quality depend on. Because of its biological and technological potential, it will be expressed in terms of appropriate measures [15].

In order to choose the most suitable cultivar for OA, the farmer should take into account main criteria: consumer preferences regarding appearance, taste [2], etc.; climate and soil conditions, adaptation to extreme environmental conditions; extreme temperatures, the length of the photoperiod, tolerance to high concentrations of salts, and economic use of fertilizers; resistance or tolerance to diseases and pests; cultivation technology (field, greenhouse, tunnels, time of sowing, planting and the harvesting period, irrigated regime or less, mechanization) [16]; and product destination: fresh consumption and industrialization (canning, freezing, dehydration, etc.);

A cultivar cannot meet all these requirements, but, depending on the destination of the products and both the consumers' requirement and farmers' preferences, the most suitable biological material will be chosen under the given conditions [17].

There are very different requirements from the growers regarding variety characteristics, depending on the size of the surfaces and the destination of the products. Thus, for small gardens, created by amateurs for their own consumption, large fruit species can be cultivated, as they are more sensitive to transport and storage. OA can be used as varieties, hybrids, local populations, and clones [3, 4], but not accepted genetically modified organisms.

Choosing varieties and hybrids with resistance to pathogens and pests is necessary both for protected crops and for early field crops, because the investment is often large, so risks and loss must be eliminated [18–20].

For many crops (tomatoes, cucumbers, eggplants, bushes, or trees) grafted method may be used that causes plant vigor and thus resistance to nematode (**Figure 3**).

Figure 3. Fado hybrid grafted on the Rezistar rootstock for an attack on nematodes (photograph by Stoleru Vasile).

In **Table 1** are presented any cultivars with resistance or tolerance to the attack of different pests, especially for nematode control, in temperate climate conditions.

Recent research on the outside cabbage crop in the temperate climate highlighted, Timpurie de Vidra cultivar (cv) of early cabbage is most resistant to the cabbage fly (8.5% degree of attack) in comparison with the Golden acre cv., where the degree of attack was 14.2%, during two study years [21].

The reaction of cultivars resistant to pests and the nematode default may be determined by its presence in the plant silica [22], iron [23] genes that provide resistance [18, 24, 25], or protein presence in bean or cowpea [23, 26, 27].

Species	Cultivar	Pest resistant or tolerance
Tomato	Getina F1 Gloria F1, Splendid F1, Solara F1, Nemarom F1	*Meloidogyne incognita Chitw.*, *Meloidogyne hapla Chitw.*
Dianthus	Sooty	*Meloidogyne arenaria Neal.*,
Pineapple	Turiacu	*Meloidogyne arenaria Neal.*,
Zucchini	Amalthee	*Meloidogyne* spp.
Cucumber	Dasher II	*Meloidogyne* spp.
Soybean	Huasteca 300	*Tamaulipas state*

Table 1. Varieties created with resistance or tolerance to various pests.

2.1.4. Seed conditioning

Numerous pests, especially from the coleopteran order, can be found between the seeds or inside them during sowing, as they feed within their endosperm, endangering seed germination or weakening the newly sprouted plant [8]. The larvae and adults of nematodes (*Ditylenchus dipsaci*, *Tylenchorhynchus cylindricus*) attack both the garlic and onion bulbs but also the roots of the vegetables, making the plant die dry [28, 29].

2.1.5. Crop rotation

Effective crop rotations are fundamental to pest control in OS. Correct rotations provide an obstacle to the pest life cycles by removing host crops for prolonged periods of time. They also help in supporting a more diverse and stable agro-ecosystem to assist with natural pest suppression.

In areas where the climate permits, two or three crops can be grown during on the year on the same area, both in greenhouses or tunnels. From this point of view, it must be considered as species that succeed have no common pests (**Table 2**).

No.	Crop	Sowing period	Planting	End of the crop
1	Lettuce, anticipated	20 VIII–10 IX	20 IX–10 X	15–30 III
2	Sweet pepper	10–15 I	1–15 IV	20–30 IX
3	Green onion	25–30 IV	1–15 X	25 III–5 IV

Table 2. Plot design for successive crops in greenhouse/tunnel.

For the outdoor crops, in **Table 3**, some design rotation successive crops are presented. For these designs bear in mind that the crops that are grown on the same land area must belong to the same botanical family, have no common diseases and pests, and have different growing seasons.

Type of crop	Crop	Sowing period	Planting	End of the crop
Vegetable design (1)	Radish	10–20 III	–	10–15 IV
	Tomato	10–15 II	15–20 IV	25–30 IX
Vegetable design (2)	Peas pods	1–15 III	–	10–20 VI
	Late cabbage	10–15 V	20–30 VI	15–20 X
Mixed crop design (1)	Barley	20–30 IX	–	10–15 VI
	Cauliflower	10–15 V	25–30 VI	1–10 X
Mixed crop design (2)	Wheat	10–20 X	–	10–20 VI
	Cucumber	1–10 VII	–	1–5 X

Table 3. Plot design for successive crops in the field.

2.1.6. Crop monitoring

Monitoring insects is fundamental in organic farming systems (OFS). Correct identification of insects and insect biology knowledge when they colonize crops is one of the main activities of management decisions that lead to optimal moment. This can be done by simply checking the crop (aphids, spider mites) or by using pheromone traps (thrips, cydia, white fly, rose fly, carrot fly and cabbage moth).

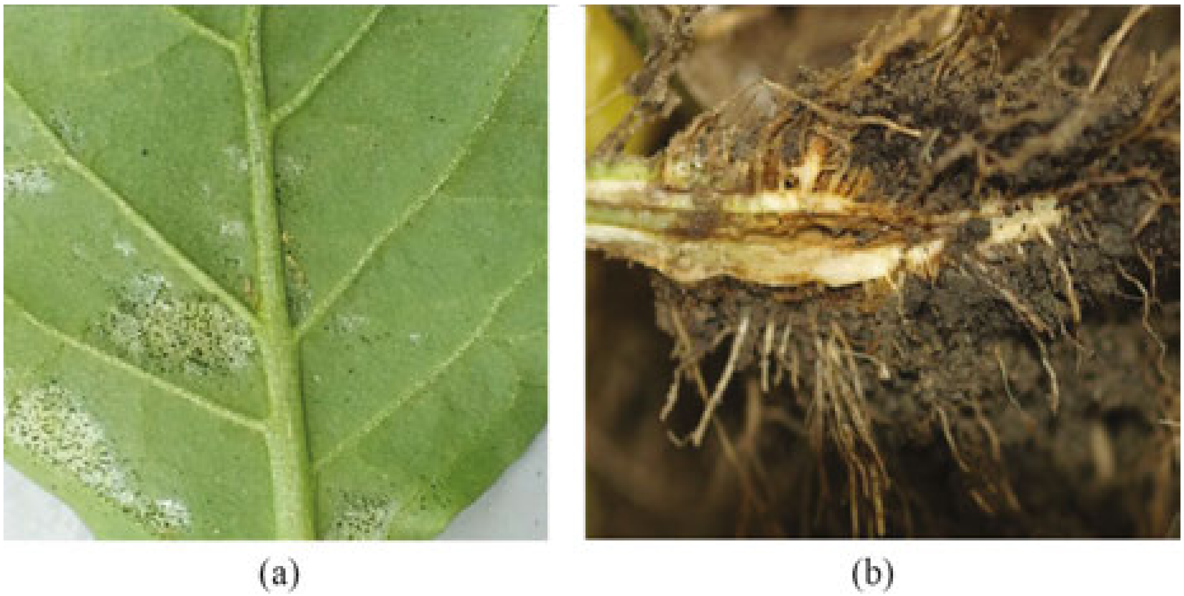

Figure 4. (a) Eggplant leaf affected by *Thrips tabaci* (photograph by Stoleru Vasile). (b) Tomato root affected by *Thrips tabaci* (photograph by Stoleru Vasile).

Pests of agricultural crops can cause damage directly (lower leaf surface, destroying fruit), (**Figure 4a**) or indirectly (gale or gates run for various soil diseases, such as *Rhizoctonia* sp. or *Fusarium* sp.), because many pests performing the biological cycle in soil (**Figure 4b**).

Prognosis and warning are performed by the centers dealing with plant protection, and they establish, at the right moment, the imminent danger of setting off massive pest attacks.

2.1.7. Management practices when it comes to pest control

Cultural activities in organic farming may be considered as specific as crop production practices that implemented in the initial stages of the organic farm plan to reduce the likelihood of insect pest infestation. These measures are based on disrupting the biological cycle of the pest as follows: an unavailable crop to pests in space and time; unacceptable crop to pests by interfering with location; reducing the pest on the crop by natural enemies, etc.

Cultural practices are among the oldest techniques used for pest suppression, and many of the practices used in conventional and organic farming today have their roots in traditional agriculture. Effective deployment of cultural tactics is information intensive; it requires knowledge of pest–crop interactions and about the natural enemies of the pests.

2.1.8. Intercropping system

Intercropping is the practice of growing two or more crops (usually different families) in the same area. Strip cropping is a derivation of intercropping and is the practice of growing two or more crops in alternating strips across a field. Both practices serve to increase biodiversity and make the habitat less suitable for pest development (**Figure 5a, b**).

(a) (b)

Figure 5. (a) Intercropping management of the runner bean with maize (photograph by Hamburda Silvia). (b) Intercropping management of the runner bean with sunflower (photograph by Hamburda Silvia).

2.1.9. Tillage management

Much of the pest population from both soil and foliar can be influenced through tillage practices. Tillage systems reduce insect pressure in succeeding crops. Fields are usually tilled in the fall or early spring when many kinds of insects are in the overwintering stage within the soil or in crop residues. Direct destruction of the insect or its overwintering chamber, removal of the protective cover, elimination of food plants, and disruption of the insect life cycle generally kills many of the insects through direct contact, starvation or exposure to predators, and weather.

Crop irrigation by sprinkler reduces the number of pests in crops [30]. Irrigation by culverts reduces the number of galas in the soil and thus causes interruption of the biological cycle of soil insects.

2.1.10. Mulches

Mulch is a layer film of material applied to the soil surface for the following reasons: to conserve moisture, to improve the fertility and health of the soil, to reduce weed growth, and to pressure soil land crop infestation with different pests [31].

Mulch is usually but not exclusively organic in nature (**Figure 6a**). It may be non-biodegradable (e.g., plastic sheeting) or biodegradable (e.g., bark chips). It may be applied to bare soil or around existing plants. Mulch consisting of manure or compost is incorporated naturally into the soil through the activity of worms and other organisms [32].

(a) (b)

Figure 6. (a) Organic cabbage mulched with phacelia (photograph by Stoleru Vasile). (b) Organic cabbage mulched with biodegradable plastic (photograph by Stoleru Vasile).

All mulch types suppress insects in comparison with bare soil. Different colors of plastic have been tested; clear, white, yellow, or aluminum (reflective) colors may provide some additional suppression of aphids and whiteflies [33]. Blue and yellow may bring in more pests. Plastic can be painted the desired color (**Figure 6b**). Before choosing a mulch type, farmers should check with their certifier bodies to see whether the practice is allowable by organic regulations [34].

2.1.11. Optimum crop health

The driving force behind the sustainability and environmental preservation derived through organic farming comes through healthy living soil. Microbes in the soil process organic matter to provide a balance of minerals and nutrients which are utilized by plants to achieve healthy, vigor crop growth. When this balance is achieved, the associated health of the crop gives it a heightened ability to withstand pest and disease attack. Good crop husbandry and hygiene also make a significant contribution to the health of the crop and the prevention of pest problems.

2.1.12. "Host weed" removal

Numerous dangerous species find favorable conditions for the summer or winter diapause on the spontaneous vegetation from the forest skirt, the borderline of strip ground, roads, or railways or the less cared for agricultural crops. So, the cabbage aphid has as host plant the cole, and the Colorado beetle has as host plant the black nightshade—*Solanum nigrum* [8].

Storing crops in hygienic conditions generally represents an additional source of pest infestation. (e.g., the bean weevil (*Acanthoscelides obsoletus*), pea weevil—*Bruchus pisorum*). They can be fought against either by storing the products in refrigerated storerooms for a certain period of time or by vacuuming the products in a special room [35].

2.2. Curative measures

Curative care or curative measure is the health care given for environmental conditions where a measure is considered achievable, or even possibly so, and directed to this end. Curative care differs from the preventive method, which aims at preventing the appearance of pests, which concentrates on reducing the degree of the attack.

2.2.1. Physical–mechanical methods

According to specific regulation (EU 834/2007), in OA, it can be used following measures: thermotherapy, heliotherapy, radiotherapy, ultrasounds, nets, fences, or traps.

Thermotherapy is recommended only if the vegetal remains are highly infested with pests and, as much as possible, after collecting and removing the remains from the cultivated area. In OA according to EU Regulation 834/2007, this method is restrictive and can be applied only in problematic crops. If this is not possible, in situ burning may be used, but only after a thorough investigation of the opportunity of such a measure and registering it in the farm register and announcing the local organization of environmental protection (EU 889/2008).

Heliotherapy. The method is very simple and has been the subject of thorough research studies carried out at the Central Food Technological Research Institute in India [1]. This method consists of exposing the infested seeds to a temperature of 60°C for 10 min [17]. In order to do so, seeds are put in a dark color polyethylene bag with high molecular and density weight, which, at its turn, is tightly covered by another transparent low density polyethylene bag. The entire operation is carried out on a plane surface exposed to sun. The two foils act as a condenser making the temperature inside the seed bag quickly increase leading to the pests' death.

Radiotherapy is used for sterilizing males with the aid of X-rays and gamma radiations. Achieving the dominant lethal mutations has led to obtaining a biological method called autocide.

Figure 7. Ultrasound for pest control (photograph by Stoleru Vasile).

Scientifically, literature mentioned the effects of X-ray irradiation applied on six floriculture insect pests (*Tetranychus urticae*, *Myzus persicae*, *Bemisia tabaci*, *Liriomyza trifolii*, *Spodoptera litura*, and *Frankliniella intonsa*) placed in the bottom sections of rose and chrysanthemum pots. After irradiation with an X-ray dose of 150 Gy, the development of nymphs and adults of *M. persicae* and eggs, nymphs, and adults of *B. tabaci* was prevented at every position in the pots. *T. urticae* nymphs irradiated at 200 Gy newly emerged adults laid eggs in the bottom section of rose boxes only. *L. trifolii* adults irradiated at 200 Gy were completely inhibited. Radiotherapy method depends on dose of X-ray irradiation, insects, and crops [10].

Other physical or mechanical methods refer to installing various barriers, such as: nets for carrot fly, ultrasounds for soil insects (**Figure 7**), metallic fences for snails (**Figure 8**), layers for aphids and Lepidoptera's insects (**Figure 9**), traps or rollers (carrot fly, thrips) (**Figure 10**), flooding, and crushing the eggs of caterpillars or even the adults.

Figure 8. Metallic fence for protection against the snail (photograph by Stoleru Vasile).

Figure 9. Early crops protected with Agryl P_{17} (photograph by Stoleru Vasile).

Figure 10. Thrips and whitefly plaque applied in tomato crops (photograph by Stoleru Vasile).

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Flooding provides better results in fighting against underground pests (mice, moles, crickets, etc.) by flooding their galleries. The impossibility of knowing the exact side of their galleries reduces the method's practical value and limits its use [36].

2.2.2. Biotechnical methods

Installing food bait traps. They can consist of parts of plants, fruits, tubercles, or feed and are placed on the ground or in storehouses. After collecting the pests, traps are removed, soaked in boiling water or burnt [31, 37].

Installing pheromone traps. Pheromones are chemical substances secreted and spread outside the body and determine a response only from the individuals of the same species (**Figure 11**). There are multiple types of pheromones, according to the role they fulfill: sexual, alarm, aggregation, path marking, recognition, and social regulation (e.g., ATRAGAM and ATRA-POM are a sexual pheromone used for *Autographa gamma* and *Cydia pomonella*) [8, 38].

Table 4 presents other products that can be applied in organic farming, based on the pheromones.

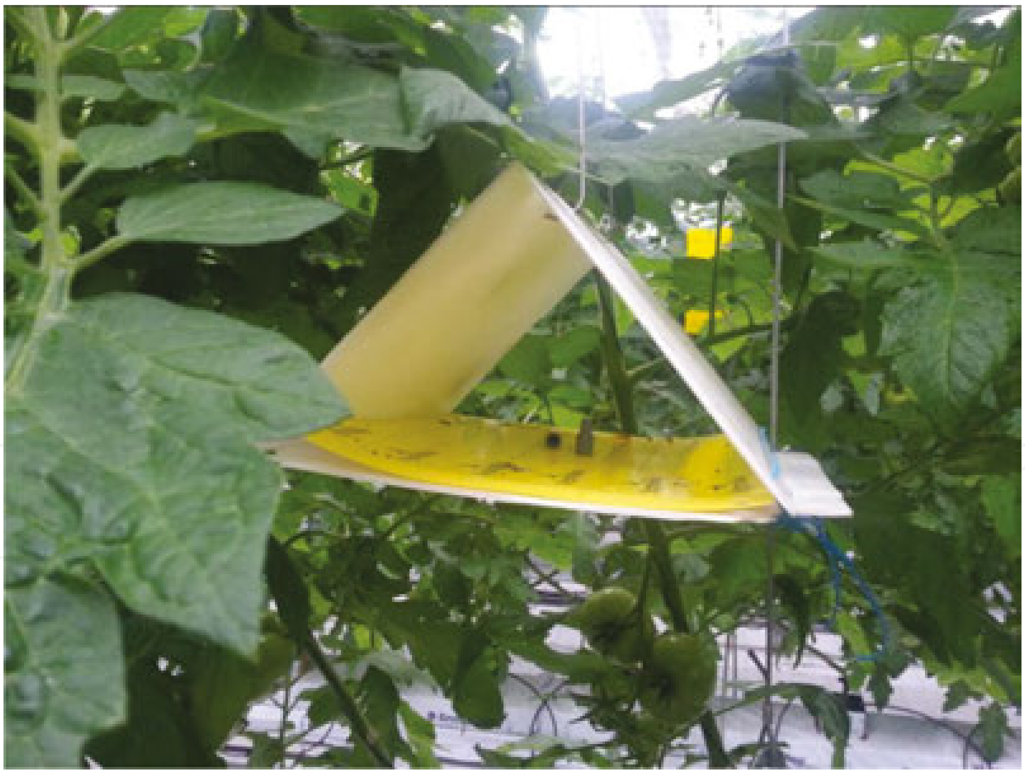

Figure 11. Attractive traps for pests control in tomato crops (photograph by Stoleru Vasile).

Natural enemies (predators and parasites). This category includes methods in order to attract animals that eat insects and other harmful living animals.

Name of product	Pest	Crop	Pheromone/attractant	Application
Codling Moth Pagoda Trap with lure®	Codling moth	Apples	Pheromone attracts male moths, for monitoring only	8 traps/ha
Rollertrap®	Range of insects	Various	Two sided sticky trap	Yellow and blue
Pheromone trap®	Butterflies and moths	Protected and field crops	Monitors butterfly and moth population	5–8 traps/ha
Agralan Envirofleece®	Various pests	Protected and field crops	Polypropylene fleece, physical barrier to pests	17–30 g/m^2

Table 4. Pheromones and attractants for organic farming.

The effect of control pest in OA is to increase functional biodiversity, that is, to use wild flowers to attract parasitoids into the cabbage field—or to retain them if we release them—to increase natural pest control, directly through the added plants and the organisms that use them as resources and indirectly through the reduction of pesticides.

Creating proper shelters and feed for the useful fauna (frogs, green lizards, snakes, insectivore insects, and mammals), including their artificial breeding, have positive effects for farmers. Snakes can be used against rodents; hedgehogs counteract the attack of shell-less snails, mice, mole crickets, and also the Colorado beetles [39].

Predators catch and eat their prey. Some common predatory arthropods include ladybird beetles, carabid (ground) beetles, staphylinid (rove) beetles, syrphid (hover) flies, lacewings, minute pirate bugs, nabid bugs, big-eyed bugs, and spiders.

Entomophagy predators are species of animals which consume other animals, pests in particular.

The main species of insects and nematodes used for fighting against harmful insects are presented in **Table 5**. This method of biological control is widely used in horticulture, especially in protected areas, such as flower, orchard, and vegetables crops (**Figures 12–17**).

Name of products	Pests controlled	Crops	Parasites/predators	Application/dose
Aphipar®	Aphids (cotton aphid, peach and potato aphid, tobacco aphid	Protected crops	*Aphidius colemani* parasitic wasp	Preventive = 0.25 ex./m^2, curative light = 1 ex./m^2, curative heavy = 2 ex./m^2 (7 days interval, 3–6 application/year)
Ervipar®	Aphids (potato aphid, glasshouse potato aphid)	Protected crops	*Aphidius colemani* parasitic wasp	Preventive = 0.25 ex./m^2, curative light = 0.5 ex./m^2, curative heavy =2 ex./m^2 (7 days interval, continuously application)
Aphidend®	Aphids	Protected crops	*Aphidoletes aphidimyza* (gall midge)	Curative light = 1 ex./m^2, curative heavy = 10 ex./m^2 (continuously application)

Name of products	Pests controlled	Crops	Parasites/predators	Application/dose
Chrysoperla®	Aphids, whitefly, various thrips, caterpillars	Various	*Chrysoperla carnea* lacewing	Preventive = 0.5 ex./m², curative light = 1 ex./m², curative heavy = 5 ex./m² (continuously application)
Aphilin®	Aphids	Protected crops	*Aphelinus abdominalis* parasitic wasp	0.1–0.5 adult/m² for preventive use
Ervibank®	Aphids	Protected crops	*Aphidius ervi* parasitic wasp	Preventive = 0.5 ex./m² on interval of 14 days
Tricho-strip®	Caterpillars (lepidopteran eggs)	Protected crops	*Trichogramma brassicae* parasitic wasp	Preventive: min. 8 × 5 ex./m² each 7 days, curative light: min. 8 × 10 ex./m² each 7 days, curative heavy: min. 8 × 20/m² each 7 days
Fightacat®	Caterpillars (lepidopteran eggs)	Various	*Trichogramma evanescens* parasitic wasp	Preventive: min. 8 × 5 ex./m² each 7 days, curative light: min. 8 × 10 ex./m² each 7 days, curative heavy: min. 8 × 20/m² each 7 days
Anagrus®	Leafhopper	Protected	*Anagrus atomus* parasitic wasp	Preventive = 0.1 ex./m², curative heavy = 0.5 ex./m² (7 days interval)
Minex® Fightamine® Minusa®	Leaf miners	Protected crops	*Dacnusa sibirica* and *Diglyphus isaea* parasitic wasps	Preventive = 0,25 ex./m², curative light = 0.5 ex./m², curative heavy = 2 ex./m² (continuously application)
Miglyphus®	Leaf miners	Protected crops	*Diglyphus isaea* parasitic wasps	Preventive = 0.1 ex./m², curative heavy = 1 ex./m² (continuously application)
Cryptolaemus®	Mealy bug	Protected crops	*Cryptolaemus* sp. Australian ladybird	*Greenhouses:* 5 beetles per infested plant, *outdoors:* 1250–12,500 beetles per hectare *orchards:* 2500–5000 beetles per hectare
Spidex® Spidex-T® Fightamite A®	Mites (two spotted spider mite and carmine spider mite	Protected crops	*Phytoseiulus persimilis* predatory mite	Curative light = 0.5 ex./m², curative heavy = 2 ex./m² (continuously application every week)
Fightamite B®	Mites (two spotted spider mite)	Protected crops	*Feltiella acarisuga* (*Therodiplosis persicae)* predatory midge	250 adults/1000 m²
Typhlodromus®	Mites (red spider mite, two spotted spider mite, strawberry mite, broad mite, fruit tree spider mite)	Protected and outdoor crops	*Typhlodromus pyri* predatory mite	250–500 adults/1000 m²
Fightascale®	Soft scale insect	Protected crops	*Metaphycus helvolus* parasitic wasp	1 adult/m²
Entonem® Nemasys®	Sciarid flies	Various crops,	*Steinernema feltiae* nematode	200–400 ex./m²

Name of products	Pests controlled	Crops	Parasites/predators	Application/dose
Entomite®	Soil-living insects, thrips, collembola, nematodes, sciarid files	Various	*Hypoaspis aculeifer* or *Hypoaspis miles* predatory mites	Preventive = 100 ex./m^2, curative light = 200 ex./m^2, curative heavy = 500 ex./m^2 (one application)
Nemaslug® Slugsure®	Slugs	Various	*Phasmarhabditis hermaphrodita* nematode	500–1000 ex./m^2
Thripex® Fightathrip®	Thrips (various), spider mites	Protected crops	*Amblyseius cucumeris* predatory mite	Preventive = 50 ex./m^2, curative light = 100 ex./m^2(application at 14 days), curative heavy = 100 ex./m^2 (one application/week)
Thripor® Fightabug®	Thrips (various)	Protected crops	*Orius laevigatus*, *Orius insidiosus* or *Orius majusculus* predatory bug	Preventive = 0.5 ex./m^2, curative light = 1 ex./m^2, curative heavy = 10 ex./m^2 (one application/14 days)
Larvanem® Nemasys H®	Vine weevil	Various	*Heterorhabditis megidis* nematode	Curative light = 500,000/m^2, curative heavy = 1,000,000/m^2 (one application)
En-strip®	Whitefly	Protected crops	*Encarsia formosa* parasitic wasp	Preventive = 1.5–3 ex./m^2, curative light = 3–6 ex./m^2, curative heavy = 9 ex./m^2 (one applic./week)
Fightafly B®	Whitefly, leafhopper, leaf miner, spider mite	Protected crops	*Macrolophus caliginosus* predatory bug	Curative light = 10 ex./m^2, curative heavy = 50 ex./m^2 (one applic./14 days)

Table 5. Parasites and predators permitted for organic pest control.

Figure 12. *Encarsia formosa* for greenhouse crops (photograph by Stoleru Vasile).

Figure 13. Applying the parasite wasp to a cucumber crop (photograph by Stoleru Vasile).

Figure 14. *Trichogramma* eggs plaques made in a laboratory (photograph by Stoleru Carmen).

Figure 15. Application of *Trichogramma* plaques for white butterfly eggs (photograph by Stoleru Carmen).

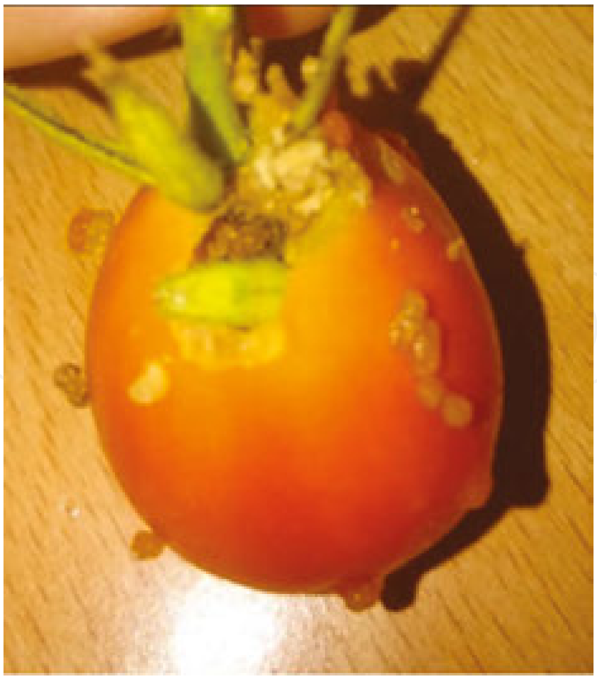

Figure 16. Tomato fruit damage by *Helicoverpa armigera* (photo by Deleanu Florina).

Figure 17. Whitefly in on the flower crop (photograph by Stoleru Vasile).

Biological methods. Biological control consists of using organisms and products against other living beings. The methods correspond to the future approaches; they are characterized by high selectivity and improbability levels regarding the fact of inducing the pest resistance phenomena, as well as a good capacity of self-perpetuation.

Economically speaking, these methods are more expensive, at least initially, when they have to be projected and produced, or when special installations are necessary and they require a lot of manual work for operation or for the uphill works. But in the end, does not the environment's health and ours implicitly deserve a bonus from the beneficiary?

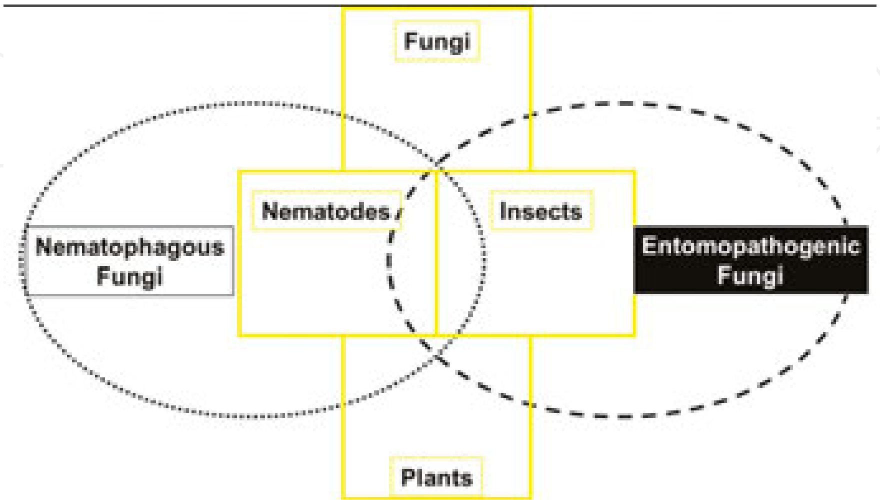

Figure 18. Multitrophic lifestyle of fungal parasites [38].

Figure 19. *B. bassiana* parasitism for *Bemisia tabaci* control (photograph by Sellitto Michele).

Microbiological control is a modern, efficient method but still quite expensive; it consists of using certain preparations based on living organisms (viruses, bacteria, fungi) that parasites and kill some of the pests.

Nowadays, more than 500 species of insect parasite fungi are known. Their advantage is that they spread out easily through spores and they are resistant to unfriendly conditions for long periods of time (**Figure 18**). In general, the relation between pests and their parasites are affected by global change, abiotic and biotic stresses to crops [40].

Beauveria sp. and *Metarhizium* sp. are two pathogenic fungi for insects which can penetrate the host insect through its exoskeleton due to its production of chitinolytic enzymes (**Figures 19** and **20**). Once inside the host, the fungus develops and feeds, causing its host's death.

The infested insects, still living, experience limited motion ability and the incapacity to feed themselves; moreover, they represent a source of infection for other insects [37].

Figure 20. *B. bassiana* on palm carbide (*Rhynchophorus ferrugineus*) (photograph by Sellitto Michele).

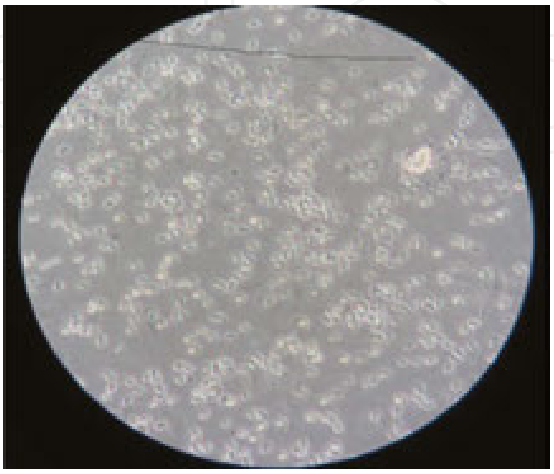

Figure 21. Conidi of *Pochonia chlamydospores* (photograph by Sellitto Michele).

Different studies have shown that *Beauveria* sp. and *Metarhizium* sp. actively control species from the following genera Coleoptera (*Melolontha* sp., *Diabrotica* sp.), Lepidoptera (*Tuta absoluta*), or Orthoptera [aphids, greenhouse whitefly, thrips, [41, 42] etc].

Pochonia sp. is a hyphomycete that acts as a parasite of nematode eggs. Its antagonistic activity is related to the production of proteolytic and chitinolytic enzymes that degrade the cellular structure of nematodes, especially that of eggs and females in the early stage (**Figures 21** and **22**).

Figure 22. Tubers of a potato attacked by nematodes (photograph by Aurelio Ciancio).

Arthrobotrys sp. is a fungus that parasitizes nematodes. The nematodes' biocontrol activity is related to the production of ring-like structures which swallow when a nematode pass by and catches it. Afterwards, the nematode is degraded by enzymes and used by the fungus as feed.

The combination between *Pochonia* sp. and *Arthrobotrys* sp. represents the most effective biological control method for the nematodes from a genera *Meloidogyne* sp., *Globodera* sp., and *Heterodera* sp. (**Figures 23** and **24**).

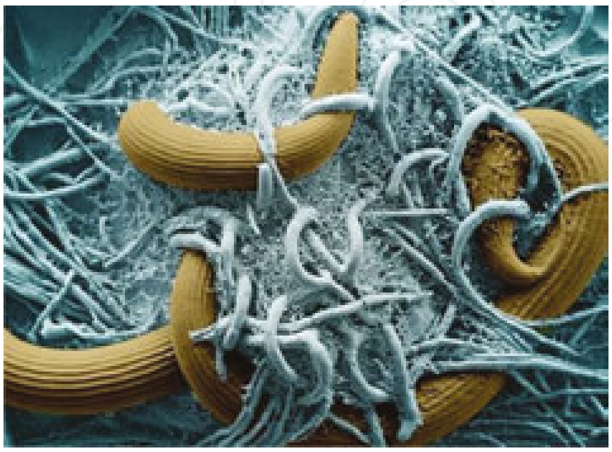

Figure 23. Adult of a nematode parasited by *Pochonia chlamydospores* (photograph by V.M. Sellitto, 2014).

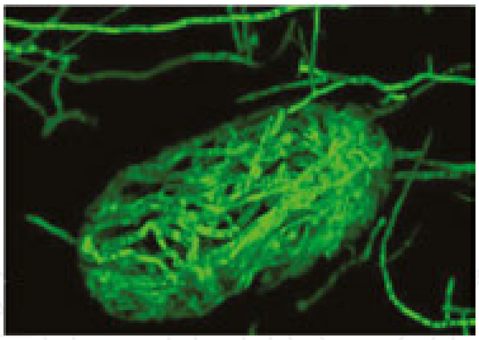

Figure 24. Egg of a nematode parasited by *Pochonia chlamydospores* (photograph by L. Lopez-Llorca, 2015).

The literature dealing with this subject mentions tests that proved that the use of these fungi, on soils sterilized using chemical products and solarization and steam, has maintained the soil and the level of nematodes below the damaging threshold for many years, compared to the soils where these fungi were not present [43].

Lecanicillium lecanii is a pathogenic fungus for numerous species of insects. This fungus acts as follows: the fungus spores lie and remain on the insects' exoskeleton, and then, they germinate and mechanically penetrate the insects' exoskeleton, due to their production of chitinolytic enzymes. From the industrial products containing entomopathogenic fungi, we mention the following: Muscardin M 45® and *Beauveria* spores (from *B. bassiana*), Boverin® (from *B. densa*), and Mitecidin® (from *Streptomyces aureus*), which act against the Colorado beetle and other coleopters (**Table 6**). Applying myco-insecticides, Naturalis-L® (*Beauveria bassiana*) and PreFeRal®WG (*Paecilomyces fumosoroseus*), were applied against adult *Rhagoletis cerasi* (Diptera: Tephritidae). In the first case, *B. bassiana* significantly reduced the number of damaged fruit (efficacy: 69–74%), whereas damage was not significantly reduced with PreFeRal®WG (efficacy: 27%) [44].

Name of product	Pest	Crop	Microorganisms	Dose/application
Vertalec®	Aphids	Protected crops	*Verticillium lecanii* fungal spores	2 g/L
Mycotal®	Whitefly, thrip larvae	Protected crops	*Verticillium lecanii* fungal spores	curative light = 0.1% (2–3 applic.), curative heavy = 0.1% (3–4 applic.)
Novosol FC® Dipel WP® Bactura WP®	Caterpillars	Vegetables, fruit, ornamentals	*Bacillus thuringiensis* var. kurstaki	1–1.6 kg/ha, depending of crop
Thuricide®	Caterpillars	Various	*Bacillus thuringiensis* var. *kurstaki*	2–4 tsp/gal water
Bactospeine®	Caterpillars	Various	*Bacillus thuringiensis* wettable powder	1–1.6 kg/ha, depending of crop

Table 6. Biological control agents used in organic farming.

Once the fungus is in, it develops and digests the insect from the inside until it kills it. Infested insects die in 4–6 days and are then covered with a whitish efflorescence, depending on the fungus sporulation. Thus, these insects become a source of infection for other insects. In addition, *Lecanicillium lecanii* can colonize certain tissues of the host plant, achieving an induced systemic resistance.

Many studies have shown that *L. lecanii* controls aphids, whitefly, and Thripidae genus. Other studies have proven that *Lecanicillium* sp. also controls certain nematode species as well as certain plant diseases, such as the gray mold (**Table 7**).

No.	Commercial name	Biological composition	Dose
1.	Pochar Linia Greenpower®	*Glomus* sp., *Pochonia* sp., *Arthrobotrys* sp.	2–3 l/ha in time and after transplantation
2.	Lecan Linia Greenpower®	*Glomus* sp., *Lecanicillium* sp.	2 l/ha or 0.2% foliar
3.	Metab Linia Greenpower®	*Glomus* sp., *Metarhizium* sp., *Beauveria* sp.	2 l/ha at the root or 0.2% foliar

Table 7. Microbiological products to control pests from vegetable crops.

From the bacteria used to fight against insects, *Bacillus thuringiensis* (**Figure 25**) and *B. subtilis* are the most popular (**Figure 26**).

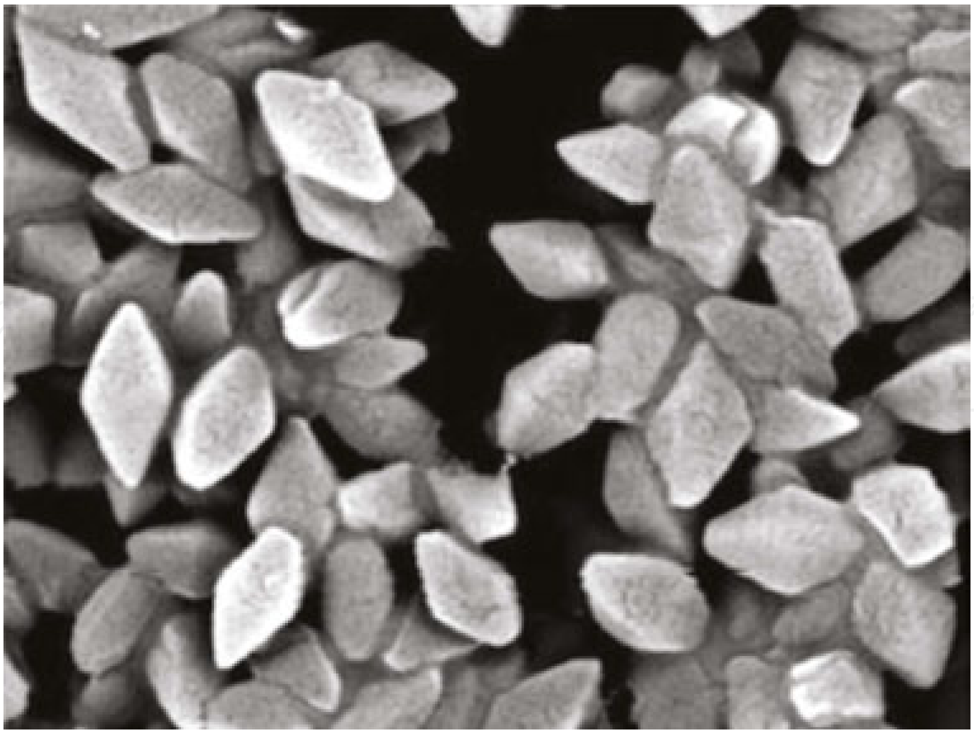

Figure 25. *Bacillus thuringiensis var. kurstaki (photograph by V.M. Sellitto).*

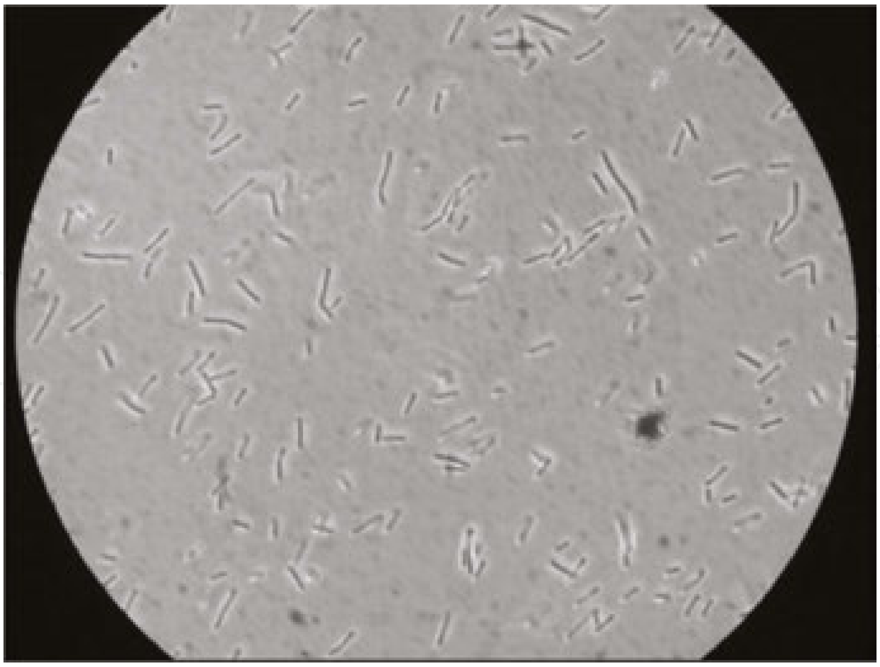

Figure 26. *Bacillus subtillis* (photograph by V.M. Sellitto).

During the last years, strains of *B. thuringiensis* were studied for their effect on the insect, through different toxins (**Table 8**).

No.	Toxins	Activities
1	Cry toxins	Pore formation on cell membrane; cytolysis activity
2	Vip toxins	Wide spectrum of insect activity
3	Thuricin	Bacteriocin
4	Hemolysin	Lysis of vertebrate red blood cells
5	Beta-exotoxins	Inhibition of RNA polymerase
6	Phospholipase-C	Cell membrane alteration

Table 8. Toxins produced by strains of *Bacillus thuringiensis*.

It laid at the basis of the process of obtaining numerous commercial products: Agritol®, Dipel®, Thuricide®, Novodor 3FC®, Vectobac®, Bactospeine®, Thuringine®, Entobakterin®, Thurintox®, or Foray®. These products are highly efficient in counteracting the larvae of certain butterflies from vegetables crops [37].

Out of more than 300 viruses that cause diseases for more than 175 species of insects, polyhedric viruses are the most known; they are used at obtaining certain preparations industrially, such as Biotrol VHZ® and VSE®, Vitex® (against caterpillars), and Virin-ENS® (recommended in fighting against the cabbage moth). Nuclear polyhedrosis viruses (NPV) and granulosis viruses (GV) are available to get rid of some caterpillar pests (*Mamestra brassicae, Helicoverpa armigera, Autographa gamma, Pieris brassicae, and Euproctis chrysorrhoea*) [45] (**Figure 27**).

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Figure 27. Uninfected (bottom) beet armyworm (*Spodoptera exigua*) and beet armyworm killed by the nuclear polyhedrosis virus. Photograph credit: David Nanace, USDA ARS.

Genetic methods. The works of ameliorating plants have as their main objective the production of cultivars endowed with greater resistance. This is why the forms providing higher mechanical resistance are promoted (with thicker cuticle or suber, with a waxy protective layer or with abundant porosity), physiological or chemical (by growing the content of substances with repellent or insecticide effect).

Several aphid species can proliferate in winter lettuce crops, such as *Nasonovia ribisnigri* (Mosley), *Myzus persicae* (Sul.), *Aulacorthum solani* (Kalt.), *Macrosiphum euphorbiae* (Th.), and *Hyperomyzus lactucae* (L.). *N. ribisnigri* is the most damaging one because it preferentially develops in the lettuce heart [46, 47]. In addition to feeding damage and the loss of product quality due to their presence when the lettuce is marketed, aphids are also vectors of viruses, such as the lettuce mosaic virus. Finally, slugs (*Deroceras* sp. and *Arion* sp.) and snails can also cause feeding damage to lettuce in winter.

Complete resistance to the aphid *N. ribisnigri* and partial resistance to *M. persicae* are conferred by a dominant gene called Nr, which has been introduced in many European cultivars [48]. However, this resistance was recently bypassed by a new *N. ribisnigri* biotype named Nr:1 [49].

2.2.3. Using plants to fight against pests

This method relies on certain plants' feature of secreting in the earth or in the air certain substances with repulsive or destructive effects on pests. By and large, these plants can be cultivated in the field, as border or associated with the crops. The important species with insecticide effect are presented in **Table 9**.

Biochemical methods. The products used for protecting plants against harmful insects can be classified according to the raw material used, into two categories: vegetal insecticides and mineral insecticides.

Species	Controlled pests
Yarrow (*Achillea millefolium*)	Aphids, mites, psyllids, thrips
Queen of poisons (*Aconitum* sp.)	Coleopteran larvae
Sweet flag (*Acorum calamus*)	White cabbage butterfly
Onion (*Allium cepa*)	Mites, ants, storehouse pests
Garlic (*Allium sativum*)	Thrips, storehouse pests
Birthwort (*Aristolochia clematitis*)	Bed bug
Absinthium (*Artemisia absinthium*)	Nematodes, caterpillars, fleas
Mugwort (*Artemisia vulgaris*)	Fleas, Colorado beetle
Lamb's quarters (*Chenopodium album*)	Colorado beetle, white butterfly
Hemlock (*Conium maculatum*)	Coleopteran larvae
Coriander (*Coriandrum sativum*)	Aphids, spiders, Colorado beetle (repellent effect)
Spurge (*Euphorbia* sp.)	Caterpillars, aphids
White sweet clover (*Melilotus albus*)	Colorado beetle
Mint (*Mentha* sp.)	Colorado beetle
Tobacco (*Nicotiana tabacum*)	Aphids, mites, Colorado beetle
Black nightshade (*Solanum nigrum*)	Aphids, mites, Colorado beetle, cabbage butterfly
Yew (*Taxus baccata*)	Various insects
Field penny-cress (*Thlaspi arvense*)	Bed bug (repellent)
Common nettle (*Urtica dioica*)	Aphids, mites
Mullein (*Verbascum phlomoides*)	Colorado beetle

Table 9. Plants used in organic farming with a repellent effect.

Vegetal insecticides. Insecticides of natural origin are substances which can cause the death of insects interfere in the development or reproduction being responsible to attract or repel them. Today, worldwide, there are more than 1450 species of plants with insecticide effects, from which only approximately 50 are useful [1]. As far as our country is concerned, too little from the 200 species credited with this action have been or are being effectively used in this purpose, and even fewer have been studied from this point of view.

Stinging nettle (*Urtica dioica*). Action: it stimulates plant growth, it slows down the attack of certain insects, counteracts aphids, and spiders before the formation of leaves and flowers [37].

Fern (*Dryopteris filix-mas*). Leaf purine and decoction, undiluted, are used against shell-less snails (every time needed). At the same time, this product, diluted 10 times with water, is used for the late spring treatments against aphids.

Wormwood (*Artemisia absinthium*). This plant can be used as an undiluted purine (caterpillars, lice), cold extract diluted twice for Solanaceae against the larvae of the Colorado beetle [37], or decoction is used undiluted against the cabbage fly [2].

Tansy (*Tanacetum vulgare*) is used as an undiluted infusion every time it is needed against ants, aphids, fleas and other insects.

Wild garlic (*Allium ursinum*). Wild garlic infusion is used undiluted, by repeatedly aspersing the plants every 3 days against aphids and mites. Purine is also used undiluted against the carrot fly (*Psila rosae*), but only during its flight period.

Garlic (*Allium sativum*). It can be used in the treatment of mites and also in seed treatments. Garlic in its natural state is eventually cultivated in rows, has a nematode effect (*Meloidogyne* sp.), and drives away the striped field mouse.

Scientific name	Common name	Scientific name	Common name
Leptinotarsa decemlineata	Colorado beetle	*Acyrthosiphon pisum*	Pea aphid
Mamestra brassicae	Cabbage moth	*Pieris brassicae*	Large white
Pieris rapae	Small white	*Trialeurodes vaporariorum*	Greenhouse whitefly
Gnorimoschema lycopersicella	Tomato pinworm		

Table 10. The action spectrum of the *Chrysanthemum cinerariaefolium* extract.

Pyrethrum (Chrysanthemum cinerariaefolium, Pyrethrum cinerariaefolium). Pyrethrum is a contact insecticide having paralyzing effect and a wide range of actions. The great advantage, ecologically speaking, is that it completely decomposes into harmless compounds in only 48 h after application [50]. Pyrethrum is noticed on a large number of insects and mites with a soft body or when they are still in a larval stage, as a solution with concentration of 0.1% (**Table 10**). The extract of pyrethrum cannot recommend mixture with alkaline products, Bordeaux mixture [1, 39].

Derris powder (*Derris* sp.). Derris powder is applied to a large number of aphids, nematodes, and insects, more vulnerable as their ingestion capacity is larger (larvae). Its toxicity for warm blooded animals is null, while for the other ones, it is lethal, used as decoct of ground fresh or dried roots, in a solution of 0.01%.

Gliricidia (*Gliricidia sepium*). Action: repellent, parasitic, rodenticide, mixed with grain, left from place to place on a field or put in warehouses; in a few days, it kills the rodents [9, 51].

Neem (*Azadirachta indica*). It is a repellent, hormonal disruptive (it blocks the larval metamorphosis process), nematocide and antimicotic. Azadirachtin is extracted from this plant's seeds, the active substance of NeemAzal T/S®.

The preparations destroy the eggs, larvae, and adults of more than 200 species of field or storehouse pests in the case of beans, cereals, tomatoes, and field plants from the most various classes: nematodes, ants, bed bugs, grasshoppers, etc. Neem oil is used in fighting against certain pests on plants, and ground marc has a nematode effect [33].

Bitter wood (*Quassia amara*). The active substances of this preparation act as contact and ingestion insecticide but are slower than pyrethrum. It is used in fighting against many pests: aphids, flies, cabbage aphids, etc.

Decoct is made from 100 to 150 g chips of bitter wood at 10 l water. The bitter wood decoction can be improved by adding an equal amount of solution of potassium soap in a concentration of 1–2.5% [51].

Traditionally, in organic fruit growing, the apple sawfly *Hoplocampa testudinea* Klug is controlled by the use of extracts of bitter wood of 6 g/ha/in 500 l. For a good efficiency, the bitter extract can be mixed with Nemmazal T/S® [52, 53].

Name of product	Pests	Crops	Agent for control	Dose/concentration
Savona®	Whiteflies, thrips, aphids, mealy bugs, leafhoppers	Various	Fatty acid	1–2%, one applic./week
Liquid Derris®	Various biting and sucking insects	Various	Rotenone derived from *Lonchocarpus utilis and L. urucu*	0.8–1 l/ha
Bug-Me-Not Bloom and Leaf Astringent Spray (CP) ®	Various insects	Various	Insect repellent based on neem extract	Insect repellent, 4–6 tsp./10 l
Bug-Me-Not Root and Soil Granules (CP) ®	Various insects	Various	Insect repellent based on neem extract	Insect repellent, 4–6 tsp./10 l
AquaPy®	For insects in grain stores	Store	Natural pyrethrum. organic products (e.g., grain) must be removed before use	1 l/3000 m^3
Jet 5®	For cleaning glasshouses /polytunnels	Store	Peroxyacetic acid	0.2%

Table 11. Commercial products permitted to use in organic farming.

2.2.4. Repellent mineral products

Potassium alum. This preparation is used as solution with a concentration of 0.4% with good efficacy against lice and caterpillars. At the same time, aspersing the soil with this solution is quite efficacious against shell-less snails. Basalt flour. It is used as a powder. Its action against pests is explained because of a change of the pH at the surface of aerial organs from weak acid (preferred by most pests) to weak alkaline or mechanical action on the insect's body, their eyes, and trachea [2].

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2.2.5. Insecticide mineral preparations

Potassium soap is successfully used against mites (red spider) and the cabbage aphid. The treatment is applied alone or in combination with other products (horsetail extract) by repeatedly aspersing the plants with various solution types: 200–300 g soap at 10 l water (lice); 200–300 g soap + 0.5 l alimentary alcohol + 1 table-spoonful of lime and 1 table-spoonful of cooking salt at 10 l of water, against the red spider and the larvae of the Colorado beetle [39].

The preparation is used as solution with concentration of 1–2% with good efficacy against lice and leaf fleas, found under the name Neudosan® or Savona® [9], like as other products presented in **Table 11**.

Acknowledgements

The authors wish to thank Mr. Dean Hufstetler for reviewing article.

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