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INTEGRATED SYSTEMS IN PLANT PROTECTION MANAGEMENT: FIRE BLIGHT OF ROSACEOUS PLANTS (*Erwinia amylovora* (Burrill) - Winslow) IN AN APPLE ORCHARD IN SIBIU COUNTY

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Abstract

Integrated protection represents a modern approach, denoting a protection strategy of agro-ecosystems; and it represents a complex system employing all appropriate methods in a manner as consistent and smooth as possible, in order to maintain the biocenotic balance of agrosystems and to keep pathogens at a level at which they do not cause economic damage (so-called level of eco-efficiency). A biocenotic approach to issues of agrosystem protection against disease attack requires an acknowledgement of all aspects regarding the evolution of pests in time and space, so as to be able to intervene at the right time with all possible means. And such protection measures are not supposed to restrain existing tendencies in the agrosystem. Therefore, this implies the awareness that any applied protection measures do not affect solely a certain pathogen, but the entire plant and animal community, as well as the soil and water.

Key words**:** *economic damage threshold, plant protection management, quarantine disease*

INTRODUCTION

The main objective is represented by the development of an integrated protection system of apple tree crops against the fire blight of rosaceous plants.

One of the safest ways of achieving a sustainable agriculture is the introduction of an integrated plant protection (integrated management or integrated control), which is based on a combination of agro-phytotechnical, physical, mechanical, biological and chemical methods, with an emphasis on the non-chemical ones, and an application of control measures in the context of the given agrocoenosis only when justified economically and environmentally. For a correct application of plant protection measures and, in particular, for a decrease in the number of chemical interventions as a replacement of calendaristic treatments or according to plant phenology, one has to employ the knowledge regarding pest biology and ecology, as well as some economic and environmental criteria. Among the current methods in use, one has to emphasise – along those mentioned above – prognosis and warning; selection and improvement; interspecific relationship between zoophagous organisms and pests; and the economic damage threshold (PED). An integrated protection requires a continuous adaptation of the combat system to the environmental conditions of the area and the specific conditions of each plot, which are approximate and must thus be improved according to forecasts and warnings, as well as correlated with the absence or presence of biological products, selective pesticides, etc. It is obvious that by using the concept of thresholds, there are two environmental advantages, namely:

a. The use of a small amount of pesticides and, therefore, a reduction of pollution caused by them. b. A better preservation of environment, because thresholds only support a certain number of weeds, diseases and pests. Highly important in this case is the flora and fauna conservation, which is useful to the agricultural ecosystem. And in order to

decrease or even eliminate some of the negative effects of pesticides, the whole system should be analysed from several perspectives, thus enabling the development of an efficient and complete combat scheme. Plant diseases, by means of the damage they cause - 25-30% out of the total annual world production, maintain the scourge of hunger, which affects half of humankind. However, it is well known that through the integration of various control methods, a greater efficiency can be achieved in this respect [7]. These aspects are basically captured in folk wisdom; and there is a famous Romanian idiom according to which, it is man who blesses a place. Integrated protection refers to the harmonious combination of preventive and curative measures, as well as methods and their integration in plant culture technology, but only when justified economically and environmentally. In the field of integrated protection the economic damage threshold (PED) plays a crucial role because it represents the attack level at which treatments must be made. However, this is only valid when it comes to common pests, and not for the quarantine ones, such as the *Erwinia amylovora* bacterium, which causes a disease known as fire blight of rosaceous plants or as apple tree burn. Combat of plant diseases mainly comprises two major steps: prophylaxis (prevention, preventive measures) and theory (curative and therapeutic measures). However, one cannot always make a clear distinction between the two steps, since some measures have both a preventive and a therapeutic effect. The control is performed by means of several methods: genetic (by improving plant resistance to pests), agro-phytotechnical (by means of tillage and crop maintenance), physico-mechanical (thermal disinfection of seeds, vegetal surgery, seed decontamination, etc.), biological (by use of antagonistic organisms and natural products) and chemical (through the use of pesticides). A unilateral and excessive use of chemotherapy has given rise over time to negative effects for the entire environment [3]. Therefore, it is recommended that chemotherapy as part of integrated control is only used as an additional measure, to complete other actions, and only against those diseases that cannot be contained by any other means.

MATERIALS AND METHODS

The study was conducted in a private orchard with a surface of 344 hectares, planted with apple trees of several varieties: Jonathan, Florina, Golden, Strakrimson, Prima, Bistrita Golden, Generos, Gold Parmen, Patul. In 2012 several controls (inspections) were carried out, according to such phenological phases as „pre-blooming", „full bloom" and „post-blooming", so during the entire growing season, when symptoms were visible [10]. Attack symptoms occurred at the beginning of June. The evidence samples generated by the bacterium in 2012 were not sent for analysis to the Central Phytosanitary Laboratory Bucharest, since the symptoms were only present on those plots on which the disease had been confirmed by the Central Phytosanitary Laboratory in previous years.

RESULTS AND DISCUSSIONS

The entire area suspected of contamination is composed of the following constituents:
- 182 ha in the 1st locality
- 20 ha in the 2nd locality
- 45 ha in the 3rd locality
- 35 ha in the 4th locality

Total surface of apple orchard: 282 ha.

Table 1. Surfaces confirmed by the Central Phytosanitary Laboratory Bucharest

Localities within the county	Contaminated surface (ha)
1st locality	1,2
2nd locality	73,0
3rd locality	20,78
4th locality	26,0
TOTAL	120,98

The most important apple pathogens are those that cause diseases, namely: *Monilinia fructigena*, *Venturia inaequlis* and *Podosphaera leucotricha*. However, the most damaging one is the rosaceous fire blight or apple burn (*Erwinia amylovora Burrill Winslow*). Fire blight is a serious disease [5;

6] caused by an oligophagous bacterium attacking rosaceous plants of important commercial and economic value: fruit trees such as the apple, pear and quince, but also ornamental plants. In Romania the fire blight of rosaceous plants was first reported in 1992 in two different locations: Brăila and Mărăcineni Argeş [1]. However, in Sibiu County it was first detected in 1997, whereas in 2000 it was found in all Romanian counties [4].

The damages caused by the fire blight of rosaceous plants are enormous: desiccation of trees and loss of orchards, whose production is based on the entire lifetime of tree species (15-20 years), the pathogen being able to destroy a tree in only six months after the infection has taken place. The integrated protection of fruit tree orchards and nurseries is achieved by means of all measures contained in the integrated control scheme; and is to be performed by use of chemical means only under certain circumstances.

Since the challenge of reducing the negative impact of fire blight upon such cultures is a highly complex one, it is advisable to approach it from the perspective of a plurality of measures/methods:

- abidance by phytosanitary law and compliance with quarantine regulations ;
- avoidance of establishing plantations on soils which are wet and exposed to cold currents;
- use of healthy propagation material;
- culture hygiene after fall of leaves;
- removal of affected parts from the trees crown (by using tilts around trees);
- burning of all infected material;
- the elimination of vector insects represents an important measure of disease prevention;
- usual pruning will be performed during the period of vegetative repose;
- disinfecting used tools is mandatory for those orchards/trees that are affected (3% bleach, 4% formalin, 10% sodium hypochlorite);
- fertilization is performed as part of the entire complex, given the facts that nitrogen in excess renders apple, pear and quince trees more likely to be affected by fire blight;
- in case of warnings, chemical treatments (Table 2) will be performed with approved plant protection products.

Table 2. Surfaces treated in 2012 and estimated (expected) to be treated in 2013

Locality	Treated in 2012 (ha)		Expected to be treated in 2013 (ha)	
	Physical*	Conventional**	Physical*	Conventional**
1st locality	23	92	75	375
2nd and 3rd localities	111	351	120	600
4th locality	23	92	75	375

* physical treatment (real surface treated)
** conventional treatment (real surface treated x number of treatments on the respective surface)

On the affected tree farm both preventive and curative measures were applied. Cuttings were performed during the period of vegetative repose and during vegetation (at the first symptoms of disease).

Pruning was performed at a minimum of 50 cm below the point where symptoms occured;

- branches were destroyed immediately after pruning, implying a minimal degree of transportation, so as to prevent the bacterium from spreading;
- the tools used were disinfected with copper sulphate after every pruning;

After each pruning, phytosanitary treatments with plant protection products were applied

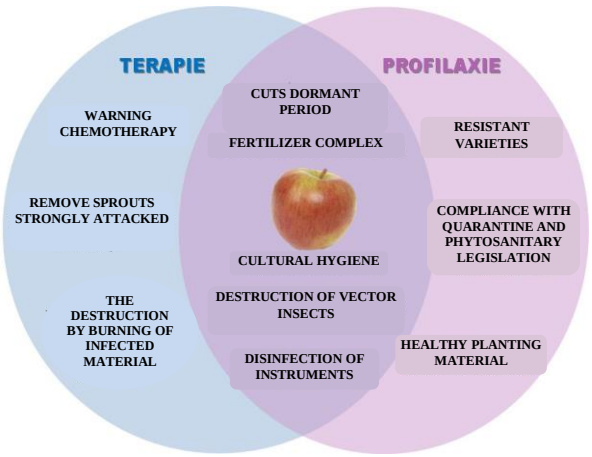

Fig 1. Scheme of integrated protection management (original)

The phytosanitary treatments were applied in the warning bulletins issued by the Forecasting and Warning Station belonging to the Phytosanitary Unit Sibiu. The plant

protection products employed were those approved for combatting the bacterium. The phytosanitary treatments were applied during the vegetative repose, namely before, during and after blooming, as well as at the moment of fruit growth.

Both the contaminated trees/crops, where the disease was confirmed, but also the trees in their surrounding area were treated. Thus, a new protection zone was created, therefore enabling the containment of the bacterium within the same perimeter for several years. On all of these areas the integrated management was applied, by combining agro-phytotechnical, physical, mechanical and chemical methods.

Economic and phytisanitary impact. Perspectives

The damages produced in orchards of apple, pear and quince trees place Romania among the worst affected countries, although the disease occurred in this region later than in other countries, which are less affected.

All holders of seedy tree species belonging to the *Rosacea* family, which are the bacterium's favourite host plants, have the obligation to check regularly whether there are any specific attack symptoms, such as bark cracks, gummy leaks, scurgeri gomoase, 'shepherd's crook' tip bending, inflorescence burn, twig desiccation and application of phytosanitary treatments.

The severity of the disease, together with the ignorance of some tree owners, and the lack of state support to owners of fruit orchards containing large areas covered by species sensitive to the bacterium *Erwinia amylovora*, are the main causes for the real situation.

Bacterial fire control is mostly based on measures of prevention of the pathogen, as well as on the introduction of the disease into non-endemic regions. The commercial implications of bacterial outbreaks are in fact exacerbated by the limited effectiveness of current control measures.

This pathogen causes considerable damage on sensitive host plants. It does not only destroy the crop of the current year, but it is also extremely dangerous for the plant itself. If weather conditions are favourable to the pathogen during blooming, the yield will be significantly reduced or even nullified. The following year would be affected as well due to damaged fruit branches. When it comes to sensitive host plants, the disease spreads very fast; and infected trees can hardly be saved, even if pruning is performed immediately after the acknowledgement of symptoms, and if a chemical treatment with approved plant protection products is applied.

CONCLUSIONS

Trees – no matter if scattered or in organized orchards – which are sensitive to the *Erwinia amylovora* bacterium (fam. *Rosaceae*) – can be very difficult to keep under control; and it requires a careful monitoring of plant health throughout the entire vegetation period, and if necessary, the application of preventive and curative measures at the right time.

In order to fight against the disease, an integrated programme is recommended, including chemical control, sanitary measures, pruning, eradication, controlled tree nutrition and employment of tolerant or resistant crops.

Fire blight is a serious threat to the EPPO Region (European and Mediterranean Plant Protection); and *Erwinia amylovora* represents an important organism on the EPPO list [2; 8]. Moreover, it is also listed as a quarantine organism for the numerous countries which are not affected by this quarantine disease [9].

The pathogen represents a huge risk for apple, pear and quince industries, as well as for nursery gardens and many sensitive ornamental plants.

The presence of fire blight in a certain country embodies an important constraint for exporters of host plants aimed for planting. Risks are even higher for Mediterranean regions due to climatic conditions, which are favourable to the development of the disease, as well as to the existence of wild host plants.

This pathogen has caused severe damage in the Mediterranean countries where it is present, a large part of susceptible crops having suffered considerable losses; and thus being on the brink of extinction.

In conclusion and on a quite pessimistic note, one must underline that the damages that this pathogen risks to inflict on ecosystems in general are rather unpredictable.

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