SUMMARY

Key words: tomatoes, greenhouse, *in vitro*, *in vivo*, essential oils

Microorganisms such as bacteria, fungi, viruses and protozoa are the etiological agents of many plant infectious diseases. Recently, there has been a high interest in the use of essential oils as controlling agents, which has been attributed to several factors, including the general rebirth and attractiveness of 'natural' products, the desire to use antimicrobial compounds with better safety and toxicity profiles, and, more importantly, the existence of alternatives to pesticides.

Regardless of the reasons which lead to this raise of interest, there are currently hundreds of reports of *in vitro* antimicrobial activity of essential oils in the scientific and medical literature, including reviews of the medicinal properties of some of the most popular oils.

The thesis titled *Research on the use of biocontrol products in greenhouse tomatoes in the N – E region of Romania* is structured in two parts, comprising 10 chapters, followed by References and the list of scientific papers, and pursues the following main objectives:

1. updating data on tomatoes, greenhouse production systems, specific greenhouse pests and pathogens, the use of essential oils as alternatives to plant protection products;
2. comparing the controlling methods of each production system;
3. comparing the profitability of conventional, hydroponic and organic cultivation systems of greenhouse tomatoes;
4. determining consumers' attitudes towards organic tomatoes;
5. *in* vitro testing of essential oils, at different concentrations, and homemade fungicides on four pathogenic fungi as alternatives to fungicides;
6. *in vivo* testing of essential oils, at different concentrations, on a pathogenic fungi.

Part I contains data on the current stage of research of essential oils as organic methods for controlling pathogens in greenhouse tomato crops. *The first chapter* deals with the classification, systematic and origin of tomatoes, followed by their economic importance, both at global and national level. *The second chapter* presents the three greenhouse tomato systems, conventional, hydroponic and organic, as well as the diseases reported in each system. In *the third chapter* are highlighted

the main constituents of essential oils, their role and mechanisms of action as antimicrobial agents.

Part II encompasses the personal contribution, organized in seven chapters.

The fourth chapter follows the planning and achieving of economic indicators for greenhouse tomatoes. The research was carried out on the basis of data collected from three private greenhouse tomato growers in conventional, hydroponic and organic systems during three agricultural years, 2014 – 2015, 2015 – 2016 and 2016 – 2017, and presented comparatively. The purpose of this comparative economic analysis is the technical and economical substantiation of the methodologies for the elaboration of production costs and estimation of capitalization prices, the level of profitability for the tomato crop and the calculation of the gross margin for conventional, hydroponic and organic horticulture.

On the basis of the presented information, annual practical guidelines necessary for the elaboration of rural development projects under the NRDP, on the measures regarding the organic agriculture can be made. By applying the expected results, the information can be used in the development of technical and economic knowledge of operators and to develop the agricultural consultancy. Also, information bulletins used to substantiate business plans can be developed in the negotiation process between producers, wholesalers, processors and other market agents, as well as decision-makers in the support of horticultural production.

The fifth chapter is a case study on the organic tomato market in the N – E area of Romania conducted in July – September 2017, in order to outline an image of the current trends and needs of consumers regarding organic tomatoes in Romania. The objectives of the market study are to determine:

1. the factors that influence the availability of consumers to pay for organic tomatoes;
2. the consumers'appreciated characteristics of tomatoes;
3. the consumers'opinion on pesticides being used in food production.
4. the maximum monetary amount that consumers are willing to pay for organic tomatoes;
5. the potential for developing green markets based on consumers' willingness to pay.

In *the sixth chapter* are described the pests and pathogens reported in each tomato cultivation system, as well as, comparatively, the annual controlling methods applied by the operators.

The *in vitro* antifungal activity of 22 essential oils, at 0.1%, 1% and 10% concentration, and 4 homemade fungicides on four pathogenic tomato fungi is

investigated in *the seventh chpater*. The purpose of this experiment is to find alternatives to fungicides currently used to control the major tomato pathogens: *Phytophthora parasitica* Dastur., *Passalora fulva* (Cooke) U. Braun & Crous, *Fusarium oxysporum* f. sp. *lycopersici* Snyder & Hansen and *Verticillium dahliae* Kleb. All the fungus was tested following the same materials and method in order to make comparisons. The mycelial growth was measured every 24h for 36 days for *Phytophthora parasitica*, 26 days for *Passalora fulva*, 13 days for *Fusarium oxysporum* f. sp. *lycopersici* and 59 days for *Verticillium dahliae*, until the mycelium has reached the edge of the Petri dish or until no growth has been recorded. To determine the efficiency of each treatment, the ANOVA Two-Way, 1-Way Repeated Measure ANOVA, as well as *post hoc* Paired Samples T-Test were chosen as statistic methods, using IBM SPSS Amos v20.

The results of the experiment are analysed in *the eighth chapter*, which emphasizes the sensitivity spectrum of the four analyzed fungus in regards to the essential oils and homemade fungicides.

Data show that oregano, thyme, palm oil and cloves essential oils have had an effect of over 50%, up to 100%, at a concentration of **0.1%** on *Passalora fulva*. Cinnamon essential oil also had an inhibitory effect on *Phytophthora parasitica* (79%) and *Verticillium dahliae* (43%).

At **1%** oil concentration, *Phytophthora parasitica* was inhibited by cloves (83%), lemongrass (48%), palmarosa (52%), thyme (61%), oregano (92) și cinnamon (91%) essential oils. *Passalora fulva* was inhibited by citronela (65%), fennel (95%), tea tree (50%) and oregano (75%) essential oils, and cloves and palmarosa essential oils showed cidal effect. Only oregano essential oil inhibited *Fusarium oxysporum* f. sp. *lycopersici*, with a treatment efficiency of 61%. *Verticillium dahliae* was affected up to 80% by thyme essential oils and up to 89% by cloves essential oil, while cinnamon essential oil killed the fungus.

The oils which inhibited *Phytophthora parasitica* at **10%** concentration are of cinnamon (83%), citronela (90%), cloves (66%), coriander (85%), mayam (53%), lemongrass (54%), palmarosa (92%), turmeric (47%). Cloves, cinnamon, mayam, lemongrass palmarosa, thyme and oregano essential oils killed *Passalora fulva* while anise essential oil showed a 48% inhibition and turmeric essential oil, a 60% treatment efficiency. *Fusarium oxysporum* f. sp. *lycopersici* was affected by a small number of oils, but all demonstrated a cidal effect, i.e. cinnamon, cloves, thyme, oregano and lemon. Only four essential oils killed *Verticillium dahliae*, and these are of cinnamon, cloves, palmarosa and oregano. Citronela, fennel and lemongrass essential oils showed an inhibitory effect of 87%, 61% and 64%.

There have been situations where the fungus growth has been stopped by the essential oils at different concentrations for a defined number of days, during which

the pathogens have metabolized the oil constituents. After the time required for detoxification, the growth was no longer inhibited.

The experiment outlined in *chapter nine* aimed at identifying alternatives to fungicides to control *Passalora fulva*, the casual agent of tomato leaf mold. The essential oils having the best fungicidal profiles were tested *in vivo*, follwing the *in vitro* testing of the phytopathogenic fungi. The selected essential oils were of cloves (*Syzygium aromaticum* L.), coriander (*Coriandrum sativum* L.), turmeric (*Curcuma longa* L.) and oregano (*Origanum vulgare* L.). Since the concentration of 10% is too strong and damages the tomato leaves, the oil concentrations applied were of 0.1% and 1%.

Only 25% of conidia were killed as a result of **0.1%** cloves essential oil treatment. Oregano essential oil recorded, as well, a low efficiency, of 31%. On the other hand, the coriander and turmeric treatments exceed 50%, reaching 57.89% and 81.25% efficiency.

Regarding percentages of non-viable and viable conidia found after the treatments with essential oils at the **1%** concentration, these were relatively uniform, the values being in the range of 75% (oregano essential oils) and 82.13% (cloves essential oil).

The *last chapter* sums up the general conclusions of the entire data collected in the present paper.