SYNOPSIS

of the doctorate thesis :

Research regarding the effectiveness and efficiency of various classic and modern irrigation systems used for the tomato crop in greenhouse conditions

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The doctoral thesis entitled: "Research regarding the effectiveness and efficiency of various classic and modern irrigation systems used for the tomato crop in greenhouse conditions" contains a number of seven chapters plus the bibliography.

Chapter I presents the **current stage of research concerning the protected tomato crop** and contains data regarding the systematics, origin, range area and importance of tomatoes; botanical and biological particularities of the species and the plants requirements for the environmental factors; state of research regarding the tomato crop grown on substrate in protected areas.

Tomatoes (*Lycopersicum esculentum* Mill.) belongs to the nightshade family *Solanaceae,* order *Solanales,* subclass *Asteridae* (plants with a gamopetalous corolla, the number of stamens equals the number of corolla lobes), *Magnoliopsida* class (*Dicotyledonate),* Subphylum *Magnoliophyta (Angiospermae),* Phylum *Spermatophyta* (plants with seeds), subkingdom *Cormobionta* (plants that have the vegetative body in the form of a corm).

Tomatoes originated in Central and South America, Peru and Mexico. The cultivated forms stem from the *cerasiforme* variety, with small, round fruits that grow wild in the production area. Tomatoes were transferred to Europe after the landing of Christopher Columbus, first in Spain, Portugal and Italy. In the 16th century they were introduced to cultivation in England as ornamental plants named pomodoro. The word tomato derives from Nahuatl „tomatl", a language spoken by aztecs.

In the structure of the range grown in Romania for this crop, the tomatoes rated with the Standard European qualification prevail. They include round or slightly flat fruits (with a diameter of 0,8 and 1,0), the fruits' average weight is up to 130- 170g. Since 2000s, in Europe, the tomato varieties in greenhouses and polytunnels, intended for fresh consumption, has diversified with the emergence and expansion of the breeds with large fruits up to 140-180 g.

Tomatoes are cultivated for their fruits that are rich in carbohydrates, mineral salts and vitamins; they are eaten uncooked in salads, in different dishes or pickled.

Tomatoes are widespread because of their fruits that have an economic and alimentary significance, both through their energetic value and content of vitamins, mineral salts and organic acids. The fruits' energetic value is lower than other foods or vegetables (90-150 calories/100g). The alimentary value is due to its high content of vitamin A, B2, B6, C (15-30 mg%), phosphorus, potassium, iron, calcium, iodine, magnesium, carbohydrates (2,9-7%), organic acid (0,5-1,5%).

Apart from the nutrient characteristics, tomatoes contain a compound that is miraculous for medicine, named lycopene. Numerous medical studies show the direct influence this substance has on the free radicals in the human body. The free radicals are seen as very strong oxidative molecules that attack the cell walls in various tissues of the homan body; they also attack the human DNA inducing poor replication processes culminating in the rapid ageing of the human body. Lycopene is not synthesized by the human body, the only way to obtain this substance is by eating fruits and vegetables that contain lycopene.

The size of the fruits can be estimated through the mass of the fruit and can vary. In the recent years, various new elements have appeared in the national range concerning the size of the fruits.

Tomato varieties are divided into several categories, based on size.

- Cherry tomatoes with a weight of 15 – 20 g;
- Midi fruits with a weight of 20-50 g;
- Small fruits with a weight of 50-80 g;
- Medium fruits with a weight of 80-100 g ;
- Large fruits with a weight of 100-150 g;
- Very large fruits with a weight more than 150 g.

Tomatoes are thermophilic plants that do not bear lower temperatures, while being sensitive to very high temperatures that could influence the normal fructification. The minimum temperature for germination is of 12-13°C and the optimal one is of 20-30°C. The minimum vegetation temperature of 8-10°C is considered as a limitative factor for the growth and development of the tomato plants.

On the basis of the scientific arguments concerning the beneficial, nutritional and economic effect of tomatoes, the plant is cultivated in every system (greenhouse, polytunnel and field). Solutions to improve the production and quality level are being constantly sought, bearing in mind both the reduction of pollutants (excessive fertilizations, pests) and the preservation and reduction of water consumption.

The greenhouses are horticultural constructions used for the forced vegetable crops and production of seedlings. Favorable environmental conditions are ensured in this area, especially

in regards to temperatures, when the weather is cold. Looking at the construction type, greenhouses are classified in: simple greenhouses, block or hangar.

The study for the PhD thesis was conducted in a greenhouse research center that has the following characteristics: partial height of ground floor and basement; built surface area of 2.756 square metres; total surface area of 3.218,19 square metres, of which 462,19 square metres represent the basement surface area.

Chapter II presents **the types of approved structures for the protected tomato crop**, greenhouses and polytunnels. Polytunnels are special constructions made in various versions depending on their purpose. According to the construction type, there are low polytunnels – for seedlings and high polytunnels or just polytunnels for the vegetable growth.

The low polytunnels are especially intended to produce premature seedlings for vegetables and flowers, and have the purpose of protecting the plants in their first developing stage, when they only have several leafs.

The polytunnel is used for the growing of vegetable or flowers. The most recommended dimensions are: peak height (height to the top): 1,8-2m, width: 3-4m, lenght: 25-60m. The researches covered in the PhD thesis took place in a multitunnel greenhouse consisting of spans (bay) with a lenght of 100,00 m.

Chapter III comprises the thesis's objectives and it includes the main issues of the thesis and the intended aims:

- The subtend of the appropriateness of extending the modern irrigation systems of the tomato crop in protected areas
- The comparative analysis of the technical characteristics of the approved construction types for the protected vegetable crop, indicating differentiation enforcement watering systems;
- Organizing researches concerning the effectiveness and efficiency of the approved construction types for protected areas used for the vegetable crop, analyzing the related irrigation systems.
- The environmental impact assessment of the irrigation systems used in modern and classic types of protected areas used for the vegetable crop
- The effect of the irrigation regime on vegetative growth and plant's development in protected crop areas
- The assessment of the vegetation factors' influence and their contribution to the production potential and fruit quality
- The assessment of the economic and environmental effect of the tomato crop in protected areas.

Chapter IV presents **Matherial and working methods**

As regards to the location of the research center, the experimental variants have been placed in two locations:

- In the University of Agronomic Sciences and Veterinary Medicine of Bucharest within the greenhouses of the Research Center for the study of agri-food products-Hortinvest, for the greenhouse experiments.

- In the municipality of Tărtășești, Dâmbovița County, at 15 km distance from Bucharest, for the polytunnel experiments.

In relation to the organization of the researches it is shown that for the experimental variants the Cyndel tomato hybrid was used for it's organoleptic and technological features. Cyndel is a hybrid with an early production, recommended for every type of crop (greenhouse, polytunnel and field).

The experimental factors were: the type of substrate with 6 graduations, watering norm with 3 graduations, protected area with 2 graduations and crop year with 2 graduations.

The seedlings were produced in the multiplying greenhouse within the *Research Centre for the study of quality food products HORTINVEST* from UASVM Bucharest using a combination susbtrate made of 50% peat and 50% perlite.

For the greenhouse crop, mattresses with nutrient substrates were directly put into the crop's trough. Pipelines for fertigation were attached and the mattresses filled with different types of substrates were moisten up to saturation point.

For the establishment of the tomato crops in polytunnel, in the period of 2014-2015, works for space preparation were conducted so that the field was horizontal.

The maintenance works for plants consisted of: bundling leafs, weeding, trimming after 6 flowerings; defoliation of base leafs leaving one leaf under the inflorescence, limitation of the number of flowering fruits, stimulation of fruiting by bumble bee pollination.

Because the experiments were conducted in the conditions of production (in a polytunnel of 4500 square meters), the nutrient recipe was determined according to the recommendations of the company making the distribution of the substrate, based on the water analysis. The recipes were made according to the development stage of the plants – for the vegetative phase, the flowering and fruiting phase.

Throughout the whole period the pH was intended to be of 5.5-5.7, the electroconductivity of 2.8-3.0 mS / cm, depending on the vegetative phase of the tomato plants. We ensured that the values of the temperature were maintained at an optimum level, according to the plant's vegetative phase, between 22oC on day and 19oC on night. It is a known fact that the temperatures over 35°C in the fruiting phase have a negative impact on the their colouring, because of the reduction of the synthesizing of the red pigment (lycopene) in favor of the increase of the synthesizing of the yellow pigment (carotene).

Related to the humidity of the substrate on different stages of development, it is shown that the level of soil humidity in the first vegetative phases must of 68-70% of the soil capacity for water and in the fruitig phase of 78-81%. The daily consumption through evapotranspiration is from 0,5 l to 2 l/ plant.

The modern technologies of tomatoes grown on nutrient substrates are frequently used in greenhouses, and the areas cultivated in unconventional systems are constantly increasing after 1990, with a trend towards a substitution of inorganic substrates with organic ones.

In regard to the crop substrates, the most frequently used are the ones grown on mineral wool mattresses, but the ones grown on coconut and perlite fibres offer a better environmental protection.

As for the irrigation system of the protected areas used for the vegetable crop, it is shown that the irrigation system can be defined as a fertigation regime of the crop, term that reflects better the combination between the irrigation regime and the fertigation regime used in the case of the crops grown on artificial support.

Observations and determinations were conducted in the case of experimental crop and harvested fruits, for the purpose of registering basic experimental data necessary for the impact assessment of the variants on their production and quality.

The researches use in their experimentations a variable biological material, subject to influence from the environment. The result of the experiments, the crop production, represents the result of complex interaction between the plants genotype and the vegetation factors. These interactions determine important fluctuation between the experimental variants and demand that the results' analysis should be made through various methods that could provide reliable data for proven conclusions.

The results obtained through several experimental variants must be probabilistic studied through mathematical statistics.

In Chapter V the main results achieved are presented. The results obtained in the greenhouse crop and polytunnel crop are presented differentially, for every experimental year, as well as the average of the results achieved during the research cycle 2014-2015.

It is presented the influence of the irrigation regime on the tomato growth, the influence of the irrigation regime on the number of flowering fruits, as well as the tomato production obtained at the first picking and the total tomato production.

The results achieved on the plant's growth in greenhouse conditions have shown that the between the experimental variants watered with norm *a* (5440 cubic metres/hectare/ cicle) have been inconsistencies. Thus, the variants grown on mineral wool substrate (V1) and Jiffy (V2) have presented bigger vegetative growth than the rest of the variants, in 2014 and 2015. The

smallest growth was registered at V5 (matressess filled with 5 mm perlite and volume of 30 l), of 198,2 cm in 2014 and 220,4 cm in 2015 at 110 days after sowing.

In the case of the variant watered with *b* watering norm (8160 cubic metres/hectare/ cicle) a bigger increase has been determined, the biggest influence on growth was registered at the variants V1 and V2, grown on mineral wool and Jiffy substrates. The biggest growth was obtained on V2 (Jiffy substrate) and it was of 273,6 cm in 2014 and 286,25 cm in 2015. The smallest increase was registered on V4 (4 mm perlite, 30l mattresses): 201,4 cm in 2014 and on V5: 255,55 cm in 2015.

As for the variant watered with norm *c* (10880 cubic metres/hectare/ cicle), between the height did not present any inconsistencies. The substrate has retained the required quantity and the rest of the solution was eliminated through the drain pipe. The biggest increase in growth was obtained on V2 (Jiffy), of 276, 2 cm in 2014 and 283,4 cm in 2015. The smallest increase was determined on V5, of 190,3 cm in 2014 şi 230,0 cm in 2015.

The analysis of the variation of results for the average data of 2014-22015 concerning the effect of the irrigation regime on tomato growth in greenhouse We have determined that variant 1 with mineral wool substrate has presented a a very significant statistical significance, the height of the plants being in average of 239,45 cm, as compared to the average of 222,93 cm. The data's statistically analysis, taking as proof variant 1 (239,45 cm) determined that all the tomato plant's heights, grown on different susbtrates, were below this variant.. It is very significant negative meanings

The analysis of the variation of results concerning the effect of the irrigation regime on the number of tomato fruits in the greenhouse, 2014/2015, shows significant differences regarding the modification of the watering norm, depending on the crop substrate.

If we make an analysis of the total production of the production cycle, on average, in the experimental years, we have obtained bigger productions in the case of the *b* watering norm.

As regards to the early production we have determined that in the case of a watering norm, an increased early production have been obtained in the greenhouse, compared to the polytunnel.

Chapter VI presents the **economic evaluation**

The economic evaluation of the results obtained in the experiments, has allowed us to appreciate the economic efficiency of the applied technologies and to bring out the relation between effect and effort, in order to define the efficiency of the experimental processes.

The thesis culminates with the last chapter that presents the conclusion and recommendations arising from the research program carried out in the following contract: **POSDRU/ no. 159/1.5/S/132765** / 2007-2013.