SUMMARY

According to the studies, agriculture uses 92 % of the total sweet water consumed in the world. In the world, irrigated agriculture is the main user of water extracted from sources, 70… 80 %, and in other developed countries up to 90 % (*Buhociu, 2013*). According to the Romanian Waters Administration, the use of potable and non-potable water in Romania has decreased in recent years, from 17.5 billion cubic meters in 1990, to just over 6.5 billion cubic meters. Just like then, 85 % of the volume of water is used in industry and agriculture. The volume of water used in agriculture has fallen by almost 90% over the last 22 years due to poorly managed infrastructure and low interest in irrigation in Romania. This coupled with the extensive use of synthetic chemical fertilizers for massive harvesting, leads in the future to increased soil salinisation and their degradation to the detriment of future crops.

Vegetables, the basis of human nutrition, have high demands on water and nutrients. In order to ensure them, the grower/horticulturist intervenes through the intake of water and fertilizers. Globally, 60 % of the soils have low or very low fertility, 29 % of soils have moderate fertility and only 11% have high fertility. Pesticides, herbicides and fertilizers have a damaging effect on soil by destroying fauna.

Drip irrigation is localized with low flow rates. Drip irrigation and/or fertilization ensure that current needs are met without compromising future resources. This type of irrigation has a conservative character by reducing the amount of fertilizers and chemicals needed, reducing water consumption by increasing the capacity of the roots to retain and store water, reducing the risk of disease and pest multiplication by decreasing or avoiding, with some chemical treatments, reducing pollution, low drainage of chemicals in the fresh water reserve, elimination of soil erosion, application of nutrients can be controlled at the exact time they are needed and in the desired quantity, with low costs.

The aim of the PhD thesis is to streamline the fertilization and dripping process in protected areas by optimizing the specific equipment used in the vegetable crops in order to obtain qualitatively suitable crops by methods involving the rational use of water and nutrients.

Starting from following up and analyzing the state of the art and the concept of equipment and appliances used for the fertilization and dripping process, it was recommended to optimize the exploitation of equipment for fertilization by spreading on the surface of the solid granular chemical fertilizers and equipment dripping. Both equipments were designed and developed at the University of Agricultural Sciences and Veterinary Medicine from Iaşi.

The paper is elaborated in two parts, "***The Stage of Knowledge***" and "***Own Research***", being structured on chapters. The starting part of the paper refers to the current state of the knowledge of the topic, including the introduction of two chapters, and then, in the second part, to present the own researches, structured in chapters followed by the bibliography.

In **chapter I** of the PhD thesis "***General notions regarding the fertilization technology and drip irrigation of vegetable crops***" reference is made to the general aspects regarding the fertilization of vegetable crops, the description of the concept of fertilization in relation to the soil. Another aspect discussed is that of drip irrigation, making it a small history of it, the method by which the relationships that are created between water and soil are applied, the water forms that are found in the soil, the quality of the irrigation water, the consumption of water of vegetable crops. In fact, greater attention is paid to the advantages and disadvantages of drip irrigation.

Chapter II of PhD thesis elaborates on the "***Current state of research on technologies and equipment for fertilization and drip irrigation of vegetable crops***". Thus, the first subchapter deals with general aspects regarding the fertilization technology of vegetable plants. Further, reference is made to the types of fertilizers used in the vegetable crops, then methods of fertilizer application, so that in another subchapter there are treated ways of fertilization of the vegetable crops in general, the subchapter 5 deals with the particularities of the fertilization of the vegetable crops in greenhouses and solariums.

Sixth subchapter deals with general aspects of fertilizer technology. Here it is mentioned the technology of administration of different types of fertilizers (organic solids, solids and amendments, the technology of liquid and liquid chemical fertilizers). Then start the classification of machinery and equipment for fertilization by type of fertilizer given criteria so that eight references section and address current trends in the construction of equipment for fertilization of vegetable crops.

Subchapter nine deals with the general aspects of the drip irrigation to plants where it is vegetable discusses crop irrigation time, the watering, the interval between irrigations, irrigations time of application, number and duration of watering. Here too, reference is made to the dripper technique, which is the nucleus of the drip irrigation system, and to the dripping technology of vegetable crops. In this regard, information on irrigation systems, how to place them in vegetable crops and component parts is being developed. This part also includes the fertilization technique, with the application methods.

Subchapter ten addresses drip irrigation equipment, with reference to the characterization of each component of a drip irrigation system, and shows current trends in their construction and operating technology.

In **chapter III**, called "***The purpose and objectives of the PhD thesis***", the purpose of the doctoral thesis and the objectives that have been pursued for its elaboration are addressed.

In order to achieve the goal, to optimize the exploitation of equipment for fertilization by spreading on the surface of the granular solid chemical fertilizers and drip irrigation equipment, it was customary to: research and study the literature for the purpose of informing the effect on the soil and vegetable crops of supplementary nutrients and irrigation water; experimental testing in laboratory conditions for the determination of working parameters of irrigation installations; setting up a tomato crop and pepper crop in protected space that will benefit from fertilizer intake through drip irrigation, chemical fertilization and microorganisms fertilization; experimental field trials to determine the degree of efficiency of the fertilization plant compared to conventional methods of fertilization of vegetable crops in protected areas; optimizing the fertilization plant to achieve results that highlight the advantages of the method in front of classical fertilization in vegetable crops; realization of gravity and centrifugal scattering equipment; determining the amount of gravity scattered fertilizer using different transmission ratios following the use of the equipment by conducting experimental testing under laboratory conditions; processing and interpreting experimental data for a final conclusion.

Chapter IV of the doctoral thesis, called "***Material and method of research***" sets out the elements needed to achieve the objectives of the thesis and characterize the general framework in which the experiences have been realized. The experiments were performed both in laboratory and field conditions.

Experimental research in protected areas aiming at the optimization of drip irrigation equipment, fertilization through irrigation water and fertilization by spreading of granular solid chemical fertilizers was carried out in Horticultural Farm no. 3 "Vasile Adamachi" of the Didactic Station from Iaşi. Experimental research on the optimization of drip irrigation equipment and fertilization through irrigation water was carried out in the Vegetable Sector of the farm, and those aimed at the fertilization by spreading of granular solid chemical fertilizers were carried out in the fruit-growing sector of the same farms.

The chapter presents the cropping technology of the studied vegetable species, namely the *Minaret F1* hybrid and the *Brillant F1* sweet pepper hybrid. *Minaret F1* is a fast-growing, semi-finished and uniform fruit early tomato hybrid, being recommended for greenhouse and sunflower cultivation or in open field. *Brillant F1* is a block-type hybrid bumble hybrid from ZKI, generative, for extensive and intensive free crops. In order to establish the solar culture, the preparation of the land was made in autumn by clearing the previous crop and removing the vegetal remains. Culture technology included basic fertilization, seedlings, planting, caring, phasing, irrigation, plant maintenance and planting, ventilation of protected area, plant childhood, defoliation and harvesting of fruit.

The experience was set up in a semi-circular solar cell of 135 m^2. The drip irrigation and fertilization system, consisting of fertilizer tank, automatic watering system and water distribution system, was designed and developed at the "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine from Iaşi, department of Agricultural Mechanization.

The method of conducting research to determine the influence of fertilization concomitantly with drip irrigation targeted the establishment of a tomato and sweet pepper culture grouped in five experimental variants, resulting in a density of 31,740 plants/ha.

The experience was one of a one-factor type, influencing the fertilization regime with four graduations: fertilization through irrigation water, spreading fertilization on the soil surface, fertilization with microorganisms and non-fertilized.

The laboratory experiments were carried out on a stand at the Horticultural Machinery Laboratory at "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine from Iaşi. 10 types of drip irrigation tape were used, with a working pressure ranging from 0.025 to 0.2 MPa. Experimental laboratory investigations aimed at reproducing a drip water cycle for two hours at eight working pressures from 0.025 MPa to 0.2 MPa. The method implied that during the watering process, as the pressure increased, the watering strips and the water flow on each line were monitored.

In order to determine the degree of uniformity of the administration of solid chemical fertilizers, equipment for the administration of solid chemical fertilizers was designed and built within the Mechanization disciplines of the "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine from Iaşi. The equipment consisted of a two-wheeled frame coupled to a two-wheeled tractor by means of a drawbar. It presents three work units placed on the frame and the fertilizer is distributed through distribution devices. The equipment has a total width of 0.11 m, allowing it to be used inside the protected areas and the width of the spreading band is 4 - 5 m. From a construction standpoint, the equipment consists of fertilizer distribution sections, support wheels, transmission mechanism. Each of the three sections consists of a box, shaker, distributor, driving tube. By using different chain wheels, were obtained three transmission ratios (0.6; 0.48; 0.4). Fertilizer spreading on the soil surface was achieved by means of a gravitational and centrifugal device.

Common to the two methods of administration is that the fertilizer is administered through the internal distribution of the cassette distribution devices, having a rotary shaker in the form of a finger and a distributor.

The gravity device is a pallet plate, powered by the three work units, whereas the centrifugal device consists of a flat, four-blad flatbed, placed under the central work unit.

Under laboratory conditions, the research were carried out at the Horticultural Machinery Laboratory at "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine in Iaşi, and aimed at determining the amount of fertilizer administered at the three sections work, over a linear distance of 100 m, using three transmission ratios.

For the gravity distribution of the fertilizer under field conditions, tests were performed using three transmission ratios available: $i_1 = 0.6$; $i_2 = 0.48$; $i_3 = 0.4$ and three different speeds, 6.2 km/h, 6 km/h and 6.6 km/h, resulting in an average speed of 6.27 ± 0.176 km/h. For each test was used a strip of land of 103 m length and a width of 3 m. In order to assess the distribution of the size of the fertilizer granules, a 30 cm / 30 cm square frame was used randomly in different locations to determine the number and diameter of the granules within the bounded perimeter. This was done by photographing the frame at each position. For each test were obtained 25 square frame positions.

For the centrifugal distribution method, was used a strip of land with a length of 30 m and a width of 3 m; the length was divided into three zones with a length of 10 m each, resulting in three repetitions. The spin speed of the centrifugal disk was n_1 = 800 rpm, n_2 = 1000 rpm and n_3 = 1250 rpm, respectively the speed before displacement was: v_1 = 1.2 km/h, v_2 = 2.26 km/h and v_3 = 5.08 km/h. In order to determine the density of the fertilizer grains, 10 samples of 4 g were randomly selected, photographed and analyzed using the Image J. software. The granules were classified into five classes of dimensions: 0 - 1.5 mm; 1.5 - 2 mm; 2 - 2.5 mm; 2.5 - 3 mm; 3 - 5 mm. The number of granules in each dimensional class was determined, and then the percentage for each class was calculated. The total volume of the fertilizer resulted by multiplying the volume of each granule by the number of grains in that class. The volume mass was obtained as a ratio between the mass (4 g) and the total volume.

This chapter presents the material and the method used to perform the statistical analysis of the obtained data.

Chapter V of the Ph.D thesis entitled "***Experimental research for establishing quality indicators of dripping installations and equipment for dripping and managing solid chemical fertilizers in protected areas***" refers to the experiences of a stand at the Horticultural Machinery Laboratory at "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine from Iaşi, which pursued the reproduction of a drip water cycle for one hour at eight working pressures, from 0.025 MPa to 0.2 MPa. The results obtained for ten band types at the eight pressures used show that, in addition to the increase in flow rate as the pressure increases, some watering strips did not withstand pressures above 0.175 MPa. Another topic covered by this chapter is the experimentation under laboratory conditions of the machine for the administration of solid chemical fertilizers in protected areas, designed and built within the Mechanization disciplines of "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine from Iaşi. The equipment has been adapted to allow a maneuvering on the driving wheel to blindly traverse a linear 100 meter distance translated into 65 turns for three transmission ratios obtained by mounting three different chain wheels. The fertilizer quantities for each transmission ratio obtained from the tests revealed differently collected quantities, depending on the work section.

In **Chapter VI**, "**Experimental research on the optimization of the working process for drip irrigation and the administration of solid chemical fertilizers of vegetable plants in protected areas**", the experimental researches on the optimization of the working process for drip fertilizer of vegetable plants are discussed. Show the influence of the method of fertilizer application on morphological (biometric) indices in tomatoes and peppers in protected areas. The relevant indexes on this subject refer to the influence of the method of fertilizer on plant height, the number of fruit per plant, on the fruit mass, the diameter and the length of the fruit, and the most important of the indices refer to the influence of the method of fertilizer on production obtained.

This chapter deals with the experimental research on the optimization of the working process for the administration of solid chemical fertilizers by gravity and centrifugal distribution under field conditions, experiments carried out in a three year old plum plantation, using a plate spreader. Determination of the degree of uniformity of solid chemical fertilizers administered by the gravitational method was achieved using three transmission ratios of the chain wheels and an average displacement speed of 6.27 ± 0.176 km/h.

Experimental research on the optimization of the working process for the administration of solid chemical fertilizers by centrifugal distribution was a polyfactorial experience, in which the influence factors, each with three graduations, were represented by the centrifugal disk speed: a_1 = 800 rpm; a_2 = 1000 rpm; a_3 = 1200 rpm and travel speed: b_1 - 1.2 km/h; b_2 - 2.26 km/h; b_3 - 5.08 km/h.

To evaluate the density of the fertilizer granules, 10 samples of 4 g were selected under random laboratory conditions, photographed and analyzed using the Jimage software. The granules were classified into five classes of sizes: 0 - 1.5 mm; 1.5 - 2 mm; 2 - 2.5 mm; 2.5 - 3 mm; 3 - 5 mm. The number of granules in each dimensional class was determined, and then the percentage for each class was calculated. Fertilizer quantities were calculated using the mean bulk volume of the granules and the total volume obtained based on the image analysis.

The same image processing procedure based on Image J software was applied to determine the particle diameter distribution during field tests.

Chapter VII entitled "***General Conclusions and Recommendations***" contains a quintessence of the partial conclusions on the theoretical and experimental research, as well as the recommendations that follow.