

ABSTRACT

Keywords: vegetable species, culture vessels, substrates, harvest potential.

The researches for elaborating this doctoral thesis with the title "**Studies and research on the possibilities of growing vegetable plants in pots and containers** " was done between 2016-2019, in the laboratory and the experimental field of the Vegetable discipline at the Horticulture Faculty in Iasi .

The motivation of these investigations arises from the desire to evaluate the possibility of realizing vegetables in a culture system in pots and containers under the conditions in Romania.

The purpose of the research for the accomplishment of the doctoral thesis, is to study the possibilities of growing vegetable plants in pots and containers, and to establish the basic technological factors for these crops.

In order to achieve the proposed purpose, the following objectives have been set:

1. The choice of species and varieties;
2. Establishing the type of pot or container;
3. Establishing the substrates used and how to prepare them.

To achieve the objectives and the purpose, within the scientific research, were used, both general methods such as documentary studies, analysis and synthesis of information, observation and comparison, experiment, but also methods with specific character imposed by the variants of experiments.

The researches were carried out, for a period of three years, 2016-2019, in a special experimental polygon arranged at the Didactic Station of the University of Agricultural Sciences and Veterinary Medicine Iasi.

According to the research program, two distinct series of experiments were organized: one, in containers (large vessels) using six species of vegetable plants possibly suitable for containers and three types of substrate and a second series, in pots (small vessels) using six other vegetable species, on the same type of substrate.

The method of setting up the cultures from pots and containers was adapted to the experimental protocol by the established variants. For the container experience, the following experimental factors were established: the cultivated species (factor A), the culture vessel (factor B) and the substrate (factor C).

Factor A, represented by the species cultivated in containers, had six graduations, corresponding to the six species used: cherry tomatoes, peppers, beans, dwarf beans, oregano and lovage. Factor B, represented by the type of vessel/ container used, had two graduations, corresponding to the two sizes of vessels used: 60 L and 25 L. Factor C, represented by the substrate used to set up the culture in containers,

had three graduations, respectively: substrate 1 (S₁): 35% garden soil; compost 35% (plant compost 80% compost 20%); peat 20%; 5% sand and 5% perlite; substrate 2 (S₂): 35% garden soil; 20% compost; (80% vegetable compost + compost 20%); peat 35%; 5% sand and 5% perlite; and substrate 3 (S₃): commercially available standard substrate.

For the pot experience, the following experimental factors were studied: cultivated species (factor M), type of vessel used (factor N) and substrate (factor P). Factor M, represented by the species cultivated in pots, had six graduations, corresponding to the six species used: hot pepper, basil, parsley for leaves, salad, dill and thyme. Factor N, represented by the type of vessel/pot used, had two graduations, corresponding to the two sizes of the used vessels: 2.5 L and 5 L. Factor P, represented by the substrate used to set up the crop in pots, had three graduations, similar to the experience in containers, respectively: substrate 1 (S₁): garden soil 35%; compost 35% (plant compost 80% + compost 20%); peat 20%; sand + perlite 10%; substrate 2 (S₂): 35% garden soil; 20% compost; (80% vegetable compost + compost 20%); peat 35%; sand + perlite 10%; and substrate 3 (S₃): commercially available standard substrate.

Specifically, the research must establish which species are suitable for this type of culture, in what kind of vessels and on which substrate for growth and development. The influence of each factor separately, as well as of their combinations, was evaluated by specific indicators that will be presented within each experience. In principle, the growth and development indicators and the production indicators were considered. During the experimental periods in the field, the plants were provided with the best conditions for growth and development through specific care works, provided in the specialized literature: irrigation, fertilization, protection against diseases and pests, etc.

The thesis is divided into two parts and nine chapters:

Part I - The current state of knowledge, comprises three chapters:

Chapter 1 - The importance of growing vegetables in pots and containers

Chapter 2 - Brief history on vegetable cultivation systems

Chapter 3 - Presentation of the technological framework for growing vegetables in pots and containers

Part II - Results of own research, comprises five chapters:

Chapter 4 - Purpose and objectives of the research, the material and the general working methodology

Chapter 5 - Study of the conditions of natural and administrative-organizational framework.

Chapter 6 - Research on the suitability of some species of vegetables for cultivation in containers and pots

Chapter 7 - Research on the type of culture vessels

Chapter 8 - Research on substrate type

Chapter 9 - General conclusions and recommendations

The bibliography includes a number of 94 bibliographic references, both from Romania and abroad.

The first part of the doctoral thesis consists of three chapters and refers to the current state of knowledge regarding the cultivation of vegetable plants in pots and containers.

The first chapter of the thesis is structured in four sub-chapters on the importance of vegetable crops from a food, decorative, agrotechnical, social and economic point of view and the risk factors that may occur in this culture system.

The second chapter is divided into three subchapters and deals with the history of vegetable cultivation systems, focusing on conventional, unconventional and innovative cultivation systems.

The third chapter is structured in two sub-chapters, focusing on the presentation of the technological flow, as well as highlighting some basic technological factors regarding the culture of vegetables in pots and containers.

The second part of the thesis has a number of five chapters and includes its own contribution based on the research activity.

Chapter 4 comprises three sub-chapters and presents the purpose and objectives of the research, the material and the general working methodology.

The fifth chapter comprises four sub-chapters and presents the study of the natural and administrative-organizational framework conditions in which the researches were conducted. It follows from this chapter that the pedoclimatic conditions for the cultivation of vegetables in the proposed system have been properly met. Also, the technical-administrative conditions optimally allowed the research to be carried out.

The sixth chapter comprises four subchapters and presents research on the suitability of the vegetable species studied for cultivation in pots and containers. Therefore, known as the growth and development conditions that the plants have in the conditions of cultivation in pots and containers, it is assumed that the species will have different reactions to the normal conditions in the field or greenhouse and solariums. The results were structured in the following major directions, regarding: the phenological, morphological and agro-productive characterization of the vegetable plants used. The phenology of the cultivated vegetable plants was expressed by several characteristics related to the main growth phases, respectively: the emergence, the repetition, the duration of the vegetation period and possibly the decorative one and/or their maturation.

The results obtained show that the plants have properly undergone the phenophases analyzed.

The results regarding the morphological and agro-productive study of the plants cultivated in pots (containers and pots) was obtained comparatively, depending on the phenophases of growth and development. And these results

showed that from the morphological point of view the plants had a better evolution compared with those cultivated in the traditional way.

Thus, the results of the production for the container culture, compared to those of the field, were the following, respectively: cherry tomatoes obtained a production of 1315.4 g/pl, which exceeds by 33% the field production of 927 g/pl; Pepper obtained a yield of 946.0 g / pl, which is 10% higher than a field crop (860 g/plant); beans obtained a production of 734.2 g/pl which exceeds 39% the field production, respectively 527 g/pl; the dwarf beans obtained a yield of 197.3 g/pl, which exceeds 49% compared to the field; oregano obtained a production of 138.1 g/pl, which exceeds 29% compared to the field production, respectively 107 g/pl, and the lovage obtained a production higher than the field production by 12%, respectively 240.0 g/pl versus 215 g/pl.

The six species grown in pots, obtained the following production results, compared with those in the field: the chilli produced a production of 197.0 g / pl, which exceeds the production in the field of 134.0 g / pl, with 47% ; basil obtained a production of 190.1 g/pl, which is 38% higher than a field crop (137.0 g/plant); the parsley for the leaves achieved a production of 113.3 g / pl, which exceeds the field production of 95 g / pl, by 19%; the salad obtained a production of 171.1 g / p, less by 8.5% compared to a field crop (200.0 g/plant); the dill produced a production of 61.5 g/pl, which exceeds the field production of 50.0 g/pl, with 23% and the thyme obtained a production of 191.5 g/pl, which exceeds with 9% the field culture (176.0 g/ plant). The productive characterization of the vegetable plants studied, highlighted some peculiarities regarding their productive potential, under the conditions of cultivation in pots and containers.

The seventh chapter presents results regarding the influence of the type of culture vessels, but also the establishment of the optimum dimensions of the vessels, under the given experimental conditions. The purpose of this chapter was achieved by following objectives, namely: characterizing the culture vessels used according to their size; this objective provided us a complete picture, necessary for the cultures that were made and, in particular, it allowed us to calculate the volume of substrate and to evaluate the amount of harvest made by each crop in the four types of culture vessels; In this way, the productivity of each type of vessel used is known; based on this data the amount of harvest per unit of volume will be calculated, as well as the consumption of substrate for a unit of harvest. Thus, vessels with a calculated volume of over 30 liters were considered large vessels or containers, and those with a calculated volume of less than 10 liters were considered pots. All vessels had a truncated shape and a large base at the top. One of the containers has a height of 25 cm, a diameter of 45 cm and a calculated volume of about 31 L, and the useful volume filled with substrate was 25 L, that is to say it has a utilization rate of about 75%. The second container has a height of

30 cm, a diameter of 70 cm and a calculated volume of 80 L, of which a volume of 60 L is used, respectively 75%.

The other two vessels used as pots have the following dimensions, respectively: one of the pots has a height of 22 cm and a diameter of 20 cm; based on these dimensions the calculated volume was 6 L, and the useful one used for the 5 L substrate, 80% of the total volume. The second pot was smaller, having a height of 20 cm, a diameter of 15 cm, resulting in a calculated volume of about 3 L; the useful volume was 2.5 L, approximately 80%.

Regarding the evaluation of the amount of harvest carried out by each crop in the four types of culture vessels, the productions of each type of vessel used are established; based on these data, the quantity of harvest per unit of volume was calculated, as well as the consumption of substrate for a unit of harvest.

The results obtained regarding the quantity of harvest per unit volume for the six vegetable species studied in the container culture showed that the vegetable plants grown in the 25 L pots obtained a higher production, compared to those grown in the 60 L. For example, the production of cherry tomatoes was 925, 4 g/vessel of 60 L and 1705.3 g/vessel of 25 L. On the other hand, the production per unit of volume g/L was 15.4 g in the 60 L and 68.2 g/L in the 25 L. Another indicator, substrate consumption for one crop unit (mL or cm³ for 1 gram of crop), was 64.8 g/mL in the 60 L vessel and 14.7 mL/g in the 25 L.

So at least for cherry tomato cultivation, 25 L pots are more efficient. A similar situation is observed in the other plants grown in the two types of containers. In conclusion, the consumption of substrate per unit of harvest detailed in the chapter, varies within obvious limits from the vessel of 60 L to the 25 L. Therefore, the consumption of substrate per unit of harvest (mL/1g) is lower for the plants grown in the 25 L pot.

Chapter 8 is structured into four chapters that focus on substrate type research. The purpose of this chapter was achieved by following the objectives, namely: the agrochemical characterization of the substrates and the study of the influence of the substrates used on the crop. The agrochemical characterization highlighted the main agrochemical indicators that competed to ensure the optimum conditions for the growth and development of the plants. The analyzes considered the following agrochemical indices: pH, humidity, clay, organic matter, humus, organic carbon (C. org.), Calcium carbonate (CaCO₃), phosphorus in aluminum hydroxide (P_{Al}), potassium in aluminum hydroxide (K_{Al}). The analytical values obtained in the laboratory were interpreted according to the limits of the levels of soil/substrate supply with nutrients, established based on the experiences with the vegetable plants. Concerning the study of the influence of the substrates used on the crop, interesting results were obtained regarding the growth and development of the species in pots and containers; the results obtained have a special impact on this culture system. Vegetable plants grown in pots and containers had a

harmonious growth and development underlined by the substrates used. These results are presented separately for each species and also for each type of vessel, detailed in this chapter.

In chapter nine, the general conclusions of the thesis are presented, from which it follows that the purpose and the objectives set were fully achieved. The recommendations made are in accordance with this culture system highlighted by the results obtained.

In conclusion, following the research carried out, it can be stated that the system of culture in pots and containers is possible to be adopted in our country, paying a special attention to choosing of the species and varieties, type of cultivation vessel (its dimensions) and, mainly, to substrates used.