SUMMARY OF PHD THESIS

"THE STUDY OF THE MAIN QUALITY CHARACTERISTICS OF VEGETABLE SEEDS DURING THE STORAGE PERIOD TO OPTIMIZE PRESERVATION CONDITIONS"

Key words: seed, pea, storage, germination, germination velocity, seed vigor

The seed is a special agricultural product, from two points of view: as a source of nourishment for humans and animals, and especially as a perpetuating material for plants, and also, in the context of their cultivation, as a biological material used in establishing the crops.

When the seed is used for establishing new crops, its importance grows, since it is the one carrying the caracteristics that the new plants to be generated will also have. The better the seed is able to posess a set of morphological, anatomic, physiological, chemical and biochemical characteristics that define the quality of the seed, the better these characteristics will be able to be manifested.

A quality seed is evaluated by using certain indices, such as moisture, physical purity, germination, state of health etc., but the final test is passed based on how the crop is established with this seed.

The seed quality is determined by an entire chain of factors (objective and subjective), such as: the natural environmental conditions, the work of establishing the crop, the maintainance work, harvesting the seeds, their conditioning, method of packaging, storage and marketing.

From the moment of its reception, the seed has a special biological value, attested by a quality certificate, and in the end gets an economic value which ensures the economic efficiency that renders visible any production activity.

For this reason, the PhD thesis had the **aim** of studying the storage conditions, as well as studying the evolution of the seeds' main quality indices during storage, for the optimization of the seeds' storage and for ensuring the biological value for as long as possible.

In order to achieve the research aim set, the following **objectives** have been established:

- the evaluation of the storage conditions of pea seeds in the county of Galați; case studies;

- the evaluation of the main quality indices of pea seeds, focusing on the germination;

- the study of some biochemical indicators involved in the seed storage process and especially in determining the seeds' vigor.

The aim and objectives set will offer us a full picture of some biological and biochemical processes that will interest both scientific reseachers and practitioners from the seed industry and the production farms.

The studies and research were carried out within the PhD program offered by the Doctoral School of Engineering Sciences, of the Institution Organizing Doctoral Studies - IOSUD of USAMV Iaşi, within the Doctoral School of Engineering Sciences, the Horticulture domain, Vegetable growing specialization.

The research activity was carried out on the field, at companies that store and sell seeds, as well as at the Vegetable growing Discipline, within its research laboratory.

The PhD thesis is structured in two parts:

- part I - Present knowledge regarding the quality of seeds during storage;

- part II – Results of own studies and research.

Chapter 1 - The importance of a quality seed in the agricultural production, comprises of seven sub-chapters that present:

- The seed as a biological and genetic factor in establishing the crops;

- Defining the main quality indices of seeds;

- The physical and biological determinations for the quality evaluation;

- The germination as a main quality index that determines the seeds' capacity of storage;

- The metabolism of germination;

- The seed's vigor – as a complex quality indicator and its importance;

- The chemical composition of the pea seeds.

Chapter 2 - Seed conditioning, packaging and storage, presents:

- The seeds' conditioning;

- Packaging;

- The seeds' storage.

The two chapters of part I of the present thesis build a knowledge synthesis at a national and international level regarding the importance of a quality seed and what are the indicators according to which this quality is defined, as well as the technological flow strictly focusing on the seed as an object of study. For the most part, this synthesis is based on the

provisions of national and international legislation regarding the seed, as well as on the information of great importance found in the literature published on this subject.

Part II is presented over the course of four chapters.

Chapter 3 - The aim and objectives of the research. The biological material used and the general methodology of work is structured in three sub-chapters:

- The research aim and objectives;
- The biological material used;
- The general research method.

Regarding the research aim and objectives previously presented, this sub-chapter discusses the motivation behind the present scientific work, based on the current circumstances referring to the seed storage conditions and the necessity of an analysis of the seeds' quality depending on the diversity of the seed samples, the cultivar, the seeds' age, as well as their chemical and biochemical composition.

The biological material is represented by several seed samples taken from different producers, samples taken depending on the cultivar and samples aged between 1 to 5 years. The samples taken depending on the cultivars came from the following varieties: Ambrosia, Television, Ran 1 – unwrinkle grain, Skinado, Ran 1 – wrinkle grain and Kelvedon Wonder. The Kelvedon Wonder variety was used as biological material in the study of how the age of the sample influenced the seeds' biological quality.

The general work methodology included several research packages:

- a case study that analyzed the technical-administrative and economic conditions from two seed companies;
- experience no. 1 – the study of the main germination indicators and their dynamics depending on the cultivar and the storage period;
- experience no. 2 – the study of the main biochemical indicators and their evolution depending on the cultivar and the storage period.

The study of the germination was carried out on series of eight samples taken from different seed producers, at the reception done by the two economic operators. Also, this study was done on six seed samples taken from the cultivars previously mentioned, the same as for the samples from the four different years (2012-2015).

The germination was studied based on the germination index, the germination rate, the germination velocity and the coefficient of velocity of germination.

The study of the main chemical and biochemical indicators according to each cultivar ws comprized of three groups of analyses: (1) moisture, as hand fibers; (2) crude protein, lipids, reducing sugars and starch; (3) catalase, amylase and the water retention capacity.

Chapter 4 - Results regarding the seeds' storage conditions based on two case studies, is structured in three sub-chapters:

- Research aim and objectives;
- Material and research method;
- Results obtained.

The aim of the research was to analyze the way in which the two seed producing companies from the county of Galaţi, SC GVA Marcom SRL and SC Diaplant Interagro SRL, were organized, based on the following studies, that have represented the objectives of this study:

- The study of the location of the storage facility SC GVA MARCOM SRL;
- The study of the organizational chart with the economic operators' staff;
- The study of the facilities and their equipment;
- Evaluation of the seed storage capacity;
- The study of the environmental conditions during the seeds' storage;
- Analysis of the quantities of seeds rolled;
- The study of the technological flow of storage.

The results of the analysis have shown that the two companies have an extremely advantageous location, in a vegetable growing area of tradition and with remarcable results in the vegetable production.

The two companies have an appropriate and complete establishment plan, employing a qualified staff (secondary and higher education), with excellent experience in the activity of storing, packaging and selling vegetable seeds.

The facilities of the two companies are modern, sectorized on different types of activities and have the necessary equipment as well (a micro laboratory for seed analysis, packaging and sealing machines, management and quantitative evidence tools, etc.).

The storage capacity is not very big, but it is sufficient for the storage of the planned quantitites of seeds; the facilities and the organization of the storage ensure a good circulation of products and staff, under a very strict discipline.

The environmental conditions are classically ensured, based on natural ventilation, without necessity of regulating the storage temperature.

The storage facility manages only the quantities of seeds and of the variety that ensures the necessary quantity of seeds solicited by vegetable farmers or other consumers.

The technological flow is established by a program of activities that respects the legislation in force regarding the storage, packaging and circulation of seeds.

Chapter 5 - Results regarding the seeds' main quality indices, focusing especially on the germination, is also structured in three sub-chapters:

- Aim and objectives of the experiment;
- Material and research method;
- Results obtained.

The specific purpose of the research reported in this chapter is to analyse in detail the seeds' quality, focusing especially on the germination of pea seeds. In order to achieve this purpose, the following objectives have been established:

- the study of the main quality characteristics based on which the seeds' reception is done;
- the study of the germination process for a selection of six cultivars;
- the study of the germination process depending on the storage period.

In order to achieve these objectives, we have established the way in which the germination evolves, depending on the cultivar and the seeds' storage period.

The results are established according to the three objectives attained, within three experiments.

In the first experiment, the quality of seeds upon reception was studied, in the case of eight samples taken from each of the two economic operators.

Regarding the moisture, physical purity, germination, the sanitary state and the organoleptic aspect can draw the following conclusions:

In the synthesis, the moisture level was under the maximum hreshold of 14% for the majority of the samples, except for two samples received from economic operator no. 1. The seed lot corresponding to these two samples was returned to the producer for correcting the moisture level.

The physical purity varied between relatively small limits and it surpassed the minimum admitted limit of 98%.

Regarding the germination, three out of the 16 samples have not fulfilled the standard of minimum 80% and, as a result, the seed lots corresponding to these samples with germination levels of under 80% were returned to the seed producer.

The phytosanitary state was appropriate in the case of 12 samples, and in the case of four samples, it was deemed unsuitable because of the presence of small holes made by the pea weevil. The seed lots corresponding to these samples were not accepted to be received.

The organoleptic aspect was appropriate, even though some samples containing stained seeds were reported, but the stains were not determined by pathogens.

In the second experiment, the germination of six cultivars was studied: Ambrosia, Television, Ran 1 – unwrinkle grain, Skinado, Ran 1 – wrinkle grain and Kelvedon Wonder.

For the entire selection of cultivars, the germination was studied by using the following indicators: the germination index (in dynamics), the germination velocity, the coefficient of velocity of germination and the quality of the germination process.

The germination process was monitored starting from the fifth day from the beginning of the experiment (when the seeds were placed to germinate).

The dynamics of the germination indices started from values of about 71-88% and reached values of about 81-98%. The evolution model of this dynamics, for all six cultivars, was that of an upward curve, with the concavity towards the Ox axis. Some differences between the six cultivars were recorded when the germination indices were expressed, depending on different calendar dates, which demonstrates that the cultivar factor influences the values of the germination indices and their dynamics.

The germination velocity, as a major indicator in the evaluation of the seed's vigor upon germination clearly differed depending on the cultivar, but the dynamics of this indicator was relatively similar. In the fifth day after the seeds were placed to germinate, the germination velocity recorded maximum values (about 18-22%) and gradually declined until the last evaluation of the germination at similar values (about 8-10%). The experimental data shows that the cultivar factor had a clear influence, which means that the varieties also determine the seeds' vigor, for some of the varieties the vigor being stronger, whereas for some others, it could be more reduced.

The coefficient of velocity of germination, through which the germination is compared at some point with the final germination, highlights objectively the seed vigor for each cultivar. The reported data shows that upon the last reading of the germination values, the highest values of the coefficient of velocity of germination were recorded in the case of the Ambrosia (10,0%), Skinado (9,5%) and Kelvedon Wonder (9,5%) cultivars.

The quality of the germination process highlighted the fact that beside the normal germs, depending on which the value of the germination index is reported, some abnormal germs or dead (ungerminated) seeds also appeared.

In the case of the seeds with the lowest germination (but above 20%) some abnormal germs were obviously reported (with maximum values of 8-14%). The cause of these anomalies or dead seeds may probably be found, for the most part, in the technical deficiencies of the harvesting and conditioning processes, but the experimental results show that these anomalies have in their origin the morpho-anatomical charcateristics of the seeds, determined by the cultivar.

The study of the germination process depending on the storage period was carried out in the third experiment reported in this chapter.

The results present the germination dynamics and its rate for four samples from 2012-2015, analyzed in February 2016. The seeds from all four samples belong to the Kelvedon Wonder cultivar. The seed storage was done under the same conditions.

The experimental data shows that the storage period has influenced the two germination indicators. Between the samples taken in 2014 and 2015 there are no clear differences regarding the germination indices and their dynamics. In the fifth day after the seeds were placed to germinate, the germination index was a little over 80%, in the case of both samples, and finally reached values of 93,8-93,9%, 5-6 days after, which shows that the 2014 sample presents a similar germination to that of the 2015 sample.

The 2013 sample starts off with a germination index of 74,8% (in the fifth day from the start of the experiment) and ends up reaching a value of 83,2%, five das after the beginning of the process of recording the germination, which shows that the germination dynamics, even though it is slower, ends up reaching values that qualifies the seed to be commercialized.

The 2012 sample (stored for four years) starts off with a germination index of 60,3% and ends up reaching a germination index of 70,1%, after 5-6 days, which disqualifies the seed qualitatively from being commercialized.

The germination rate differed in the case of the four samples, even though the seeds from 2014 and 2015 had similar rates, starting from the maximum value of 4,4-4,9% in the first day of determination, reaching up to 0% at the end of the testing. The seeds from 2013 presents a small rate in the first day of the evaluation of this index, and afterwords reaches values of 1,3% și 3,3%, in the following days, probably due to a slowdown of the germination dynamics, so that after this, it reaches a rhythm that ensures in the end an index that corresponds to the standard.

The seeds from 2012 represent a special case, which had a rate of 8,4%, at the first evaluation, after which decreseas towards values of 0% și 1,0%, without obtaining the germination index that would qualify the seed to be commercialized.

Chapter 6 – Results regarding the influence of the cultivar on the main chemical and biochemical indices, has a structure similar to the one of the previous chapter, namely:

- Research aim and objectives;
- Material and research method;
- Results obtained.

The specific purpose of the research was to establish to what extent the cultivar determines the quality of the metabolic substrate of seeds, namely the chemical and biochemical composition of seeds. As previously shown, the objectives are grouped in three activity packages, through which three groups of chemical and biochemical indicators are determined. The work methodology established the methods and techniques used for the following determinations: moisture (seeds' moisture content), ash, total fibers, crude protein, total lipids, catalase, amylase and the moisture retention capacity.

The results are structured in three groups, as follows:

- The results regarding the influence of the cultivar on the moisture level, the ash and the total fibers, which show that these indicators differ within the selection of six cultivars used as biological material in the previous chapter. The seeds' moisture content recorded values between 9,7% and 13,4%, while the average is of 10,8%; it is clearly shown that the six cultivars have different values regarding the seeds' moisture content.

The seeds' ash content was on average of 1,8%, with variations between 1,4% and 2,4%, and the total fibers content varied between 5,8% and 8,7%, with an experimental average of 7,23%. These data lead us to the conclusion that the cultivar has a clear influence over the two chemical components: minerals salts and fibers.

- Results regarding the influence of the cultivar on the seeds' crude protein, total lipids, reducing sugars and starch content, which show that the aforementioned indicators are clearly different depending on the cultivar analyzed. Therefore the crude protein represents on average 23,10%, with clear variations between 20,20% and 27,40%. Also, lipids, unexpectedly, are on average of 6%, with small but clear variations between varieties, namely between 5,10% and 6,50%.

The reducing sugars and the starch are some important substances in the first days of life from the germination and seedling development period. The reducing sugars varied withing large limits, from 10,20% up to 18,30%, with an average of 14,60%, and the starch

also varied within large limits, from 30,65% up to 48,30%, with an experimental average of 38,29%.

- The results regarding the influence of the cultivars on the catalase and amylase enzymes, which clearly demonstrate that in this case as well, the seed's composition concerning these particular enzymes also varies depending on the variety. So, the catalase varied between 23,6 ppm and 36,6 ppm, with an average of 32,4 ppm, and the amylase recorded values between 24,0 ppm and 29,0 ppm, with an average of 25,4 ppm.

The chemical composition, especially concerning the sugars and the proteins, as well as the two enzymes, could explain the differences found in the germination, considering the fact that these substances represent the substrate for the energy needed for germination, as well as the ones that act as a catalyst for the chemical reactions and ensure the reactions that provide the necessary energy needed for the germination.

At the end of the thesis, the general conclusions of the thesis are presented, which show that the objectives set for the thesis were completely achieved.