SUMMARY

of the doctoral thesis entitled:

CONTRIBUTIONS REGARDING THE INFLUENCE OF THE SOWING PERIOD AT SUNFLOWER

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Sunflower (*Helianthus annuus* L.) belongs to the Asteraceae botanical family and represents for Europe and Romania the most important oleaginous plant. Statistical data from recent years show us that in the European Union, Romania was the country with the largest area cultivated with sunflower.

In our country, the first notes about the cultivated area come from 1910 when 672 ha were cultivated, reaching in recent years to be cultivated for about 1 mil. ha.

The conception of the optimal timing of sowing evolved at the same time with the breeding of sunflower. The transition from low-oil and thick-shell populations to varieties and later hybrids characterized by thin pericarp and high oil content have made it to study this technological component more.

Studies has shown that the most important factor influencing seed germination is temperature, which is followed by moisture. In our country, the first research on the minimum germination temperature of sunflower seeds was carried out by Olteanu in the period 1940-1942 within the Institute of Agronomic Research of Romania (IARR). Such research has continued to nowadays.

In the context of the last years when the climate is constantly changing, farmers must set when to start sowing according to the thermal criterion, respectively when the thermal conditions for seed germination are met.

From the studies undertaken so far that have had as subject the period of sowing at sunflower, it turns out that a number of aspects must be considered such as: avoid overlapping the moment of flowering with periods of heat, reduce the attack of diseases and pests, increase the grain yield and oil content, increase the content of oleic or linoleic acid.

The importance, opportunity and actuality of the research topic addressed in the doctoral thesis result from the impact of climate change we are currently assist, which require finding solutions so that the cultivated plants find the most favorable conditions for growth and development as a premise for obtaining high and quality yields, making the best use of the resources available to plants, in particular the water factor, avoid overlapping critical periods in plant life, such as flowering phenophase, with periods that induce water and thermal stress. Add to the above, the progress made in sunflower breeding which may have effects on the sowing period of new homologated hybrids to be quantified by research and studies carried out in the current climate context.

Purpose and objectives of research. The goal of the doctoral thesis was to find out the influence of the sowing period on the phenological, morphological particularities and yielding capacity of sunflower plants and to find out the effect of low temperatures on seed germination. To achieve the intended purpose, research was carried out both in field conditions and in the laboratory.

Field research was carried out from the need to know the behavior of sunflower hybrids with different precocities (early, mid-early, mid-late and late) at different times of sowing, depending on the temperature realized in the soil (5°C, 7°C and 9°C) in the climate and soil conditions of the Dobrogean Plateau in terms of vegetation period, morphological characteristics, the degree of attack of diseases and pests and the yield obtained quantitatively and qualitatively. This requirements result from the fact that in the context of climate change we have assist in recent years, farmers are concerned about sowing sunflowers earlier to avoid the flowering phase overlapping with a period of high temperatures and low humidity in the summer.

Laboratory research has been conducted from the need to find out the behavior of sunflower seeds at different low temperatures (3°C, 4°C, 5°C, 6°C, and 7°C) in the germination phase. In the research carried out, in addition to the control variant, two variants of seed treatment with biostimulator products from the Romanian market were tested, products that are intended to improve and accelerate germination.

The objectives of the doctoral thesis were:

- to set the optimal sowing time for the agricultural area in the center of Dobrogea;
- to find out the influence of the sowing time on important characteristics such as:
  - the vegetation period from sowing to flowering;
  - morphological traits of plants;
  - the attack degree of diseases and pests;
  - yield components;
  - grain yield;
  - yield quality;
- to establish the influence of low temperature in the germination period of sunflower seeds.

The originality and innovative character of the research results from the choice of the moment of sowing according to the temperature in the soil at the time of sowing and not by calendar, at a specific time interval between sowing moments, compared to sowing at the recommended temperature of 7°C in the soil, being analyzed the effect of sowing earlier at 5°C and later at 9°C. Another element of originality is the proposal and the establishment of a scale for assessing the attack degree for spring pests, which is not existent worldwide. Another novelty is the research of the effect of low temperatures on the germination of sunflower seeds.

Conditions of experimentation. The research carried out for the elaboration of the doctoral thesis was carried out during 2021, 2022 and 2023, under field conditions, unirrigated, within the farm PFA Todica Dumitru, the parcels within which the experiences were made being located in the Beidaud commune area of Tulcea county. Also, for the elaboration of the doctoral thesis were conducted research in laboratory conditions with controlled temperature to find out the effect of low temperatures on seed germination.

Structure of the doctoral thesis. The doctoral thesis is structured in two sections, namely:

- *Bibliographic study*, which contains: Chapter I. The current status of knowledge regarding the sunflower sowing period, which includes 8 subchapters and the conclusions related to the chapter;
- *Propre research*, which contains: The purpose and objectives of the research; Chapter II. Research on the influence of the sowing period in sunflowers; Chapter III. The influence of low temperatures on the germination of sunflower seeds in laboratory conditions; General conclusions and Recommendations.

Also, the doctoral thesis has a table of contents in Romanian and English, abstracts in Romanian, English and French, introduction, bibliography, annexes and the list of publications with results obtained within the research carried out for the elaboration of the doctoral thesis. In total, the doctoral thesis has 182 pages, 63 tables, 28 figures and 36 photos.

Chapter I presents the current status of knowledge regarding the influence of the sowing period on the sunflower crop, namely on: percentage of emergence in the field, duration of the period from sowing to emergence, yield and yield components, yield quality, biological traits of the plant, and on diseases and pests that attack sunflower plants.

Chapter II presents the material and method for the field experiment as well as the results, discussions and conclusions of the chapter.

The field experiences were bifactorial of type 3 x 6, the experimental factors being the following:

1. Factor A: The moment of sowing, with 3 graduations, namely:
   a1. Soil temperature of 5°C (M1);
   a2. Soil temperature of 7°C (M2);

a3. Soil temperature 9°C (M3)

2. Factor B: Sunflower hybrid, with 6 graduations, namely:
   b1. P64LE99 – late hybrid;
   b2. FD15E27 – mid-late hybrid;
   b3. FD20CL70 (HS7083 before approval) –mid-latehybrid;
   b4. DS003 – mid-late hybrid;
   b5. DS002 – mid-early hybrid;
   b6. DS001 – early hybrid.

In the years 2021 and 2023 of experimentation the following observations and determinations were made:

- Observations on the vegetation period:
  - Date of flowering.
- Morphological determinations:
  - Plant height (cm);
  - Stem diameter (mm);
  - Number of leaves per plant.
- Determinations on the attack degree of biotic factors:
  - The attack degree of the brown-black spot (*Alternariasterster halstedii*);
  - The attack degree of sunflower rust (*Puccinia helianthi*);
  - The attack degree of broomrape (*Orobanche cumana*);
  - The attack degree of spring pests: maize leaf weevil (*Tanymecus dilaticollis*) and darkling beetle (*Opatrum sabulosum*).
- Determinations of yield compomonents and grain yield:
  - Head diameter (cm);
  - Number of grains/head;
  - 1.000 grains weight – TGW (g);
  - Yield (kg/ha).
- Determinations of yield quality:
  - Oil content (%);
  - Oil yield (kg/ha);
  - Content in fatty acids (%);
  - Hectoliter weight – MH (kg/100 l).

In 2022, following the compromise of some experimental plots at the first two sowing moments and of a uneven density in the experimental plots, the determinations were performed only for the plant height, stem diameter, grain yield, hectoliter weight and attack of broomrape.

Chapter III presents the material and method for the laboratory experiment in which there was studied the influence of low temperatures on the germination of sunflower seeds, as well as the results, discussions and conclusions of the chapter.

The research was carried out using 5 temperature factor graduations (3°C, 4°C, 5°C, 6°C, and 7°C), 3 graduations of sunflower hybrids (FD23CLP84, FD15E27, and

FD18E41) and 3 graduations of seed treatment (untreated variant, treated with Kerafol 2 l/t, and treated with Germinoseed 10 l/t).

In addition to the subchapter in which the effect of low temperatures on the germination percentage was assessed, there are also 2 subchapters in which the effect on the radicle length and the effect on microbial activity on seed level was followed.

General conclusions. As the sowing is delayed and temperatures rise, respectively the sowing is carried out at a higher temperature, the duration of the period from sowing to flowering expressed in days decreases. This means that with the increase in temperature, the thermal need for flowering, respectively the thermal time required for flowering, is fulfilled in a smaller calendar period of time, in a smaller number of days that have higher temperatures. The difference of caledar days from the first moment of sowing to the second moment was on average of 15.7 days and from the second moment to the last one was of 6.7 days.

The plant heigh, the stem diameter and the number of leaves per plant had close values between sowing moments but not between years of the study, because climatic conditions differed from one year to another. Depending on the time of sowing and the year of experimentation, sunflower hybrids can be can be characterized as follows:

- the plant heigh had the highest values at sowing at 9°C, followed by sowing at 5°C and sowing at 7°C, the differences between the moments being about 1 cm;
- the stem diameter had the highest value at sowing at the earliest - 15.5 mm, followed by sowing at the latest - 15.4 mm, and sowing at the optimal moment - 15.2 mm;
- the number of leaves ranged from 28.7 (sowing to 7°C) to 28.8 (sowing to 5°C) to 29.7 (sowing to 9°C).

The influence of the moment of sowing on diseases of the sunflower is important because after the flowering period it is difficult to apply treatments with fungicides.

The attack produced by *Alternariasterster helianthi* was similar in the first moments of sowing and decreased at the last moment due to a higher vegetative mass of the earlier sown plants that maintained a moisture higher at plant level. The attack produced by *Puccinia helianthi* increased with the delay of sowing.

The timing of sowing did not significantly influence the attack produced by *Orobanche cumana*, a slight increase in the attack upon with sowing delay being put on the fact that the seeds of the broomrape germinate at higher temperatures. In contrast, at the hybrid level, differences were observed due to genetic resistance.

Spring pests attacked less sunflower plants upon with the increase of temperatures due to the fact that in early spring there are not many food sources. The differences between sowing moments were higher in 2021 than in 2023. On average across all experience, the attack degree was 6.3% in 2021 and 5.1% in 2023. Among the hybrids tested there were no statistically insured differences.

Yield components have differed from one year to another and from one moment of sowing to another under the influence of climatic factors:

- head diameter ranged from 14.6 cm (sowing at 5°C) to 15.0 cm (sowing at 7°C) to 15.1 cm (sowing at 9°C);
- the number of grains per head ranged from 840 (sowing at 5°C) to 914 (sowing at 9°C) to 958 (sowing at 7°C);
- the mass of the beans ranged from 39.7g (sowing at 9°C) to 41.1 g (sowing at 5°C) to 44.0 g (sowing at 7°C);
- the 1.000 weight grains ranged from 50.7g (sowing at 7°C) to 51.0 g (sowing at 5°C) to 51.5 g (sowing at 9°C);
- grain yield ranged from 2128 kg/ha (sowing at 9°C) to 2253 kg/ha (sowing at 5°C) to 2285 kg/ha (sowing at 7°C).

The oil content decreased with the delay of sowing under the influence of higher temperatures, water stress from the period of grains filling, but also the period shorter than the leaves are green. The hybrid factor had a greater influence on the oil content compared to the sowing moment. The oil content is not directly proportional to the oil production, so the higher production of grains at sowing time 2 has mostly canceled a lower oil content.

The percentage of oleic acid increased, and linoleic acid decreased with the delay of sowing because the oleic acid content increases in warm climatic conditions, and linoleic acid in cool conditions.

The hectolitre mass had the same value for sowing at 5°C and at 7°C and higher at sowing at 9°C.

The analysis of variance (ANOVA) found that the sowing moment, hibryd and interaction between the two factors had a different influence on the elements analyzed as follows:

- the sowing moment had a very significant influence on the attack degree of brown-black spot, rust, broomrape, head diameter, the number of grains per head, seed weight per head, 1.000 grains weight; distinctly significant on oil yield; significant on the attack degree of spring pests, grain yield; insignificant on hectoliter weight;
- the hybrid had a very significant influence on the attack of brown-black spot, rust, broomrape, head diameter, number of grains per head, seed weight per head, 1.000 grains weight, grain yield, oil yield and hectoliter weight; significant on the attack degree of spring pests;
- the interaction between the sowing moment and hybrid had a very significant influence on the attack of the brown-black spot, rust, broomrape; significant on the attack degree of spring pests; insignificant on the head diameter, the number of grains per head, seed weight per head, 1.000 grains weight, grain yield, oil yield and hectoliter weight.

The temperature influenced the percentage of sunflower seed germination and radicle growth because higher temperatures support metabolic and enzymatic activity, helping the seeds absorb the water needed to trigger the germination process and activating the enyimatic szstem of the seed. The higher the temperature, the higher the seed germination percentage and the length of the radicle was regardless of the seed treatment applied or the hybrid used. The untreated variant had the highest percentage of germinated seeds and the longest length of the radicle. The FD23CLP84 hybrid obtained a higher germination percentage at the first four temperatures tested, making it more suitable to be grown in cold areas or very early.

The differences in the length of the radicle increased from one temperature to another.

The number of fungus colonies on the seeds decreased as the temperature rise, but at the last temperature tested the value increased. Most infected seeds were at the variant treated with Kerafol, followed by untreated and the variant treated with Germinoseed. At higher temperatures the percentage of germination of infected seeds was higher than at lower temperatures. The untreated variant had on average the lowest percentage of germinated infected seeds, followed by Germinoseed and Kerafol treated.

The decision to choose a sowing moment must be made taking into account the results obtained in several years of study, not just from one, in the area of origin of the interested farmer.

Recommendations. Studies regarding sowing period should be carried out regularly in all important sunflower growing areas to provide up-to-date, local information to farmers in each agricultural area.

In a certain region, farmers should sowing sunflower around the same time to reduce the spread of attack of diseases and pests from one plot to another. A minor infection in a plot can be canceled by a strong infection in a neighboring plot.

Although sunflower is known as a crop with good flexibility of the sowing period, the results of the research carried out have demonstrated the superiority of sowing at the recommended temperature of 7^{o}C made for 3 consecutive days at the depth in the soil of 7 cm and at 7 AM, with the tendency of heating. As such, it is recommended that the sowing of the sunflower is carried out after the termic time and not after the calendar one.

In areas where the attack of the broomrape (*Orobanche cumana*) is manifested, it is recommended the sowing to be early associated with good genetic resistance of the cultivated hybrid and its resistance to imidazolinonic herbicides.

Considering that the hybrid determines a specific behavior in the process of seed germination under low temperature conditions, the availability of such information would be more than useful to the sunflower grower.