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DOMAIN HORTICULTURE

Eng. Ionela Andreea DĂMUREANU (PRETORIAN)

SUMMARY OF PhD THESIS

**STUDY ON THE BEHAVIOUR OF SOME VARIETY OF PEACH ON THE SANDY
AREA OF OLTENIA IN THE CONTEXT OF CLIMATE CHANGE**

SCIENTIFIC LEADER:

Prof.univ.dr.ing. Aurelian Adrian BACIU

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In Romania, the peach culture (*Prunus Peach*) is concentrated in the south-east, south and west, where the climatic conditions are most favorable for this species.

The area occupied by peach has greatly decreased and from the latest statistics (2013) it has only 2036 ha, and, from a lack of investments in fruit growing, most fresh peach fruits on the market come from the countries of southern Europe and not from internal fruit production.

It is intended that with the launching of the fruit-growing development program, to increase the demand for fruit trees, peach implicit, allowing owners to access grants for the set up of orchards.

Cultivated as an isolated tree, the peach tree was always regarded as a typical fruit tree species in the Romanian county of Dobrogea, where it was extended to other areas of culture, including the south of the country.

Its colorful fruits, large and fragrant, are one of the most anticipated summer fruits, with many nutritional and therapeutic properties.

From peaches a wide range of products are prepared (jam, compote, nectar, puree, jam, marc, pulp, pulp moist, distillates, natural essences, jam, jelly, etc.) being suited afterwards for dehydration and freezing.

Being an early fruit tree species, peach enters the fruiting stage in 2-3 years from planting, with high yields for 20-25 years, as long as the requirements are guaranteed by environmental factors and the biological characteristics and production are observed.

Looking at the assortment of varieties of peach, it is very diverse in terms of shape and appearance of fruits, the delicious fruits can be eaten fresh from mid-June until the end of September.

This paper is a modest contribution to the literature in the field, bringing together the basic knowledge provided by other sciences, namely by horticulture (the study of varieties of peach), combined with notions of geography (climate change) and Biochemistry (enzyme activity and the peach branches conductivity during sleep), finally highlighting the most valuable of peach varieties under study in the current climate conditions in southern Oltenia.

The thesis is structured in two different parts containing six chapters totaling a number of 146 pages, 34 figures, 38 tables and 136 references.

The thesis is organized as follows:

Part I - is divided into three chapters in which were presented informations on the importance of peach cultures, peach cultures worldwide and in Romania (Chapter I),

environmental, biological and production characteristics of peach (Chapter II) and climatic changes and general (Chapter III).

Part II - contains personal contributions made within the theme and is divided into 4 chapters.

Chapter IV- shows the landscape in which the research took place.

Chapter V - presents research objectives, materials, working methods and tools used.

Chapter VI - includes data on research results and analysis of data obtained experimentally.

The doctoral thesis ends with the main conclusions of the research conducted and recommendations.

Keywords: climate change, peach, varieties.

In Chapter I it presented the economic role, food value of and the role of peaches for the human health. The origin and history of culture is presented as well as the peach crop status, nationally and globally.

Chapter II contains the description of peach requirements to environmental factors (temperature, water, light, soil) and biological characteristics and production of peaches (the root system, air system, productivity, level of fruit binding and crop technology).

In Chapter III climate changes are defined as well as the importance of their effect. Detailed statistics are proving these changes at the global and national levels as well as the measures taken to reduce pollution.

In Chapter IV are described the eco-soil conditions, geographical location, relief, hydrology and vegetation and general characteristics of the sands of southern Oltenia.

The experimental work was conducted at C.C.D.C.P.N. Dăbuleni, located in the south of Oltenia, in the south-east of Dolj county, town Dăbuleni.

C.C.D.C.P.N. Dăbuleni operates on the sandy soils in southern Oltenia, with low fertility, also called “Oltenia’s Sahara” because of the topography of the region is below the altitude of 300 m, being covered with sand dunes.

The climate is continental with a slight Mediterranean influence. The region is part of a total 2,000 hours of annual sunshine, with drought throughout the July - September period and

normal rainfall in May and June. The annual temperature average is at 11.1 degrees Celsius. Rainfalls reach an annual average of 548 mm and are distributed unevenly throughout the year.

From a climate perspective, the sandy soils is on the left banks of Jiu are framed, after Koppen, in the CFax climate province.

Chapter V describes the materials and methods used in conducting research. To find the answer to this issue, during 2013-2016 were conducted a number of observations and measurements, as follows:

1. Climatological analysis of the area;
2. Assessment of favorable sand area from the South of Oltenia through climatological indicators;
3. Influence on environmental factors on phenology of vegetative organs and flowers peach in the area south of Oltenia;
4. The influence of environmental factors by determination of enzymatic activity (peroxidase) during the latent vegetative peach;
5. The influence of environmental factors by determining conductivity of peach branches during the winter rest;
6. The influence of environmental factors by determining conductivity of peach branches during the winter rest;
7. Influence on environmental of vegetative growth;
8. Influence on environmental quality fruits and production of peaches.

Chapter VI contains research results.

1. On the climatological analysis of the study area were found the following:
 - For a period of time (1956-2015) the annual average temperature of 11.46 ° C increased, reaching 11.71 ° C for the reference period (the time required to explain climate change). In the last 10 years the average value of the air temperature was 12.86 ° C, in the last 10 years thus being an increase of 1.15 ° C;
 - In the rest period (October-February), the average maximum air temperatures have increased from the range reference to the experimental period, from 11.82 ° C (1980 to 2015) to 15,83 ° C (2013 to 2015). The same trend is observed in the other months of rest period, with consequences on peach phenology;
 - The absolute minimum temperatures values generally decreased (-16.77 ° C in January of the experimental period compared to -13.53 ° C, the average recorded during the meteorological reference period);

- In the winter months (December, January, February) absolute extremes vary irregularly, the difference between the absolute maximum temperature and minimum temperature (amplitude) was 24.96° C (reference range meteorological) of 28.83° C (2005-2015) and 29.00° C (during testing) in December, from 25.35° C; 29.2° C; 32.6° C in January, respectively, 26.57° C, 27.85° C and 24.3° C in February.

We find very large amplitudes and oscillator consequences for the optional and deep rest;

- Average monthly temperatures above 10° C as early in the spring months (March 2014), the average monthly temperature passing 15° C in April (2016), monthly average temperatures growing throughout spring.
- Annual average temperatures rising, the annual average temperature in 2014 being 12.3° C and reaching in 2015 to 12.9° C.

For 2016 there could not be yet presented an annual average, but for the average up to July we can provide data that can be compared with the same period of previous years (2014-2015), the mean of average temperatures in 2016 (January-July) exceeding the average of 12.8° C, the mean of the same months during the previous years;

- Average extreme minimum temperature ranged between -20.4 for the years 2014, 2016 and -23.1 in 2015;
- Monthly average annual maximum temperature values were 37.6 and 39.2° C 2014 C 2015;
- Monthly maximum temperatures, high throughout the year, temperatures of 15.7° C in 2014 to 19.2° C in February 2015, the maximum temperature values in January for those years.

Also, monthly maximum temperatures from May to September, the summer months during the three years (2014-2016), have been rising. The monthly maximum temperature for May rose to 30.2° C in 2014 reaching 32.9° C in 2016. In July, the hottest month of the year, the maximum temperature rose from 34.9° C in 2014 to 39.2° C in 2015, with approximately 5° C during a single year;

- Monthly minimum temperatures of the years 2014-2016, were very low during winters, temperatures dropping most to -12.5 C in 2014, -10.2 C in 2015 and -4.7° C in 2016, monthly minimum temperature values for the month of February. In March there were recorded in a few days of the month extreme values of -1.2° C in 2014, -2.3° C in 2015 and -3.1° C in 2016, and only in the month of April 2015, the value of -0.8° C;
- Analysing and comparing the average number of days after maximum and minimum temperatures daytime for three years, it was found that frost days with minimum

temperatures less or equal to 0°C, decreased in 2014 from 60 days, reaching 36 days in 2016;

- Rainfall values during the growing season (March-September) were quite low. During this period, important values were recorded in May and April in the second decade of 2014, with values of 74.8 mm and 68.8 mm. For 2015 and 2016 the highest values of rainfall were recorded in June, decade II of 2015, 83.2 mm, and the decade I of March 2016 with 62.2 mm;

2. Assessment of favorable sands in the area of southern Oltenia through climatological indicators:

Ecoclimatic indicators for temperature:

From the data presented on year fruit growing, index values were classified as follows:

- For global thermal balance, the lowest value was recorded in 2014 of 3801.3°C, followed in ascending order by that of 2015, the value of 3907.7°C and for 2016 (the growing season not yet ended), in July the value of 2706°C;
- Bilanțul termic activ, valoarea cea mai mică se înregistrează tot în anul 2014 cu 3778,4°C, valoare mai mare în anul 2015, de 3851°C, și anul 2016, până în luna iulie cu valoarea de 2671°C;

Useful thermal balance, with values from 2418,8°C 2014, followed by 2632,3°C in 2015 and 1739.2°C in 2016 (July);

Temperature coefficient values were 17.6 in 2014, 17.9 in 2015 and 17.3 2016 (for the month of July and 154 days during the growing season).

Ecoclimatic indicators for rainfall :

Annual rainfall of 994 mm totaled values in 2014, 735.4 mm in 2015 and 459.4 mm in 2016 (July);

Regarding their amount in the peach vegetation period, values of 648.9 mm were recorded in 2014, 482 mm in 2015 and 338 mm in 2016 (July);

The amount of rainfall during the growing season which was 214 days for the years 2014 to 2015 and 154 days in 2016 (July) resulted in a rainfall coefficient value of 3.03 for the year fruit of 2014, 2.25 for 2015 and 2.19 for 2016 (July);

After the calculation of De Martone, the generated values for the aridity index were 52 for 2014, 37 for 2015 and 25 for 2016 (July). According to the classification described in the previous chapter to a value of I. A., held between 30-60, the southern area of Oltenia has a humid climate.

3. Influence on environmental factors on phenology of vegetative organs and flowers peach in the area south of Oltenia

Phenology of vegetative organs peach depending on the evolution of the environment

- bud bursting vegetative buds, ranged in the year 2014 for the 7 varieties between 24.III for the variety 'Springold'(the best early variety from those taken in note) and 31.III 'Southland'(variety with the late period of ripening of the fruit from those taken in note);
- in the year 2015 bud breaking was produced starting with 27.III for the variety 'Springold' and varied as the day before on the 31.III 'Southland', with a gap of 3 days from the year 2014;
- unbudging of vegetative buds, in the year 2016 started 8 days earlier than the one in the year 2014 and by 11 days compared to the one in 2015, ranging as the date for the seven varieties între 16.III and the 18.III.2016;
- the beginning of the growth of the shoots for 2014, has varied between 11.IV and 15.IV, and took end between the date of 21.X.-29.X., for the 7 varieties;
- in the year 2015, the beginning of the growth of the shoots occurred between 13.IV - 17.IV, and ended between 16.XI-20.XI., the end of growth of the shoots taking place on 5 to 9 days later compared to the same phenophase produced in the year 2014;
- regarding to the year 2016, (up to the time of the rendition of the doctoral thesis) we could only record the beginning of the growth of the shoots, the first part of the phenophase of growth of the shoots, this occurring between 10.IV-15.IV. earlier with 1-3 days than the previous fruiting two years;
- leaf fall in the fruit-growing year 2014 took place once between 13-18.XI.2014 for the 7 varieties taken into study, duration of the vegetation period being between 231-234 days;
- in the year 2015, the vegetation period was longer in an average of 4 days, between 234-239 days depending on the variety, the leaf fall for the seven varieties ranging as the time between 16.XI and 20.XI. 2015.

Phenological organs floriferous peach depending on the evolving environmental factors during

- in the year 2014, the swelling of the flowering buds occurred beginning with the date of 17.III for the most early variety the accumulation of 46.6 °C and varied for the other

- varieties up on the 24 th.III for the best late variety of the plantation, the accumulation of the amount of 102,4°C the active temperature;
- in the year 2016, the swelling of the flowering buds occurred for the seven varieties between 13.III - 17.III, earlier with 3 - 7 days compared to 2014. And the sum of the degrees of the temperatures active was different this year compared to 2014, triggering this phenophase taking place in the accumulation of 72.5°C for the seven varieties observed, with a 25.9°C more for the best early variety of the plantation ('Springold') and by 29.9°C less for the face the best late variety ('Southland');
 - beginning of flowering for the early variety has produced the accumulation of 193,5°C in 2014 and 102,6°C in the year 2016, the end of the flowering registering the accumulation of 230,4 C in 2014 and 179 C in 2016;
 - For the best wide variety of the plantation, the beginning of flowering was triggered at 221,2°C in the year 2014, and 114,5°C, with 106.7 the C less in the year 2016, the end of the flowering occurring at 295,8°C in 2014 and 208,5°C in 2016;
 - start and end of phenophase flowering varied for the seven varieties in the year 2014 between 8-15.IV and 02.-04.IV., with 6-9 days earlier in the year 2016. End of the flowering being produced between 18-26.IV. in 2014 and 10-13.IV, in the year 2016 with a difference of 8-13 days earlier in the latter year;
 - Blossom took 10-12 days in the year 2014 and 8-9 days in the year 2016, with gaps of 1-2 days between varieties, its intensity being ranked 4 on a scale of 0 to 5 in 2014 and only 3 in the year 2016;
 - fruit maturation was achieved in the year 2014 for the best early variety 'Springold' in the 19th.VI to the accumulation of 907,1°C and at 1337,7°C on the 17th of July for 'Southland', the variety with the late period of maturation of the fruit of the seven varieties of the plantation on the experimental field;
 - in the year 2016, fruit maturation was achieved earlier by 3-4 days compared to the year 2014, in the date of 15.VI to 'Springold' and 18.VI to 'Southland', and although fruit maturation took place earlier in the year 2016, the sum of active temperatures was much higher for this phenophase compared to the year 2014 at the varieties with the period of ripening of the fruit semi-late, reaching a difference of 98,6°C temperatures, active for the most late 'Southland'.
4. Determination of enzymatic activity (peroxidase) in the period of vegetative peach latency

- in terms of the level of stress on the background of lower temperatures, the variety Southland recorded the activity of the most intense peroxidase giving it a greater resistance to stress caused by temperatures recorded in the area, proven fact observable in the period of bud phenophase. The other 6 varieties had a reduced activity of peroxidase, a level of stress lower in front of the minimum temperatures revealed in the area.

5. Rest of the winter and the resistance of the flowering buds of peach at the temperatures in the area

Observations of the buds for the fruit-growing year 2015 in the period of rest required and in the period of optional rest

- for the first determination in the date 18.01.2015, buds flowering were apparently necrosed and their development stanchied, but until a further analysis could not certify this fact.

- in the date 28.II.2015, it was noted from the measurements that all the buds flowering were necrosed since the first observations and the only buds that continued their evolution were a part of the vegetative ones.

Observations of the buds for the year fruit of 2016 in the period from the start of the required rest and during the period of optional rest

- in date 23.XI.2015 out of the total of 210 observed buds, all of them were viable, and in the continuous unfolding of the floral organogenesis.

- in the period of the optional rest, in the date 28.02.2016, a large part of the buds were necrosed but there were flowery buds viable and still evolving, leaving in 2016 the hope of fruit production.

6. The determination of the conductivity for the branches of the peach tree during the rest period of winter

- In the month of December , where temperatures between 0 and 6.5 °C amounted to 11 days, on the background of the minimum temperature of -11 °C, it was noted the variety 'Cardinal' with the highest value of 240 μS/g the variety 'Collins' 180 μS/gca being the lowest value, with a resistance lower than the other varieties.

- In the month of January , just in 5 days the temperatures ranged between 0 and 6.5 °C, and on the background of the minimum temperature of -20,4 C, the variety 'Springcrest' presented the highest value 268 μS/g and the variety 'Redhaven' the lower the 195 μS/g, thus being less resistant.

- In the month of February until the breaking threshold of the biological, with 11 days of temperatures between 0 and 6.5 °C, and minimum temperature of - 4,7 °C, the variety 'Springold' presented the highest value of 222 µS/g, thus being more resistant than the other varieties, the variety 'Jerseyland' being with the lowest value of 170 µS/g, the least resistant variety.

7. Influence on environmental of vegetative growth;

Determinations on the surface of the torso section on the experimental period 2014-2016

- there were recorded insignificant differences compared to the variety 'Redhaven' (witness), 'Cardinal', 'Collins', 'Jerseyland' and 'Southland', a significant difference, negative for the variety 'Springcrest' and distinct significant negative to 'Springold'.

Determinations regarding the amount of growth in thickness of the trunk on the experimental period 2014-2016

- the only variety, 'Cardinal' recorded insignificant differences compared to the variety 'Redhaven' (control), the variety 'Springcrest' and 'Jerseyland', significantly distinct negative to the witness cultivar, and 'Springold', 'Southland' and 'Collins' very significantly negative.

Determinations on the height of the trunk on the experimental period 2014-2016

- compared to the variety 'Redhaven' insignificant values of the registered variety, 'Cardinal', the five varieties 'Springcrest', 'Jerseyland', 'Springold', 'Southland' and 'Collins' recorded values very significantly positive.

Determinations on the height of the crown on the trial period 2014-2016

- the variety 'Cardinal' presented insignificant values compared to the witness variety 'Redhaven', 'Springcrest' distinct significantly positive, 'Springold' and 'Collins' highly significant positive values, 'Jerseyland' distinct difference significantly negative, and the variety 'Southland' very significantly negative.

Determinations on the total height of the trees on the experimental period 2014-2016.

- the variety 'Springold' presented a significant difference and the 'Cardinal' very significantly positive, the variety 'Collins' a distinctly significantly negative and varieties 'Jerseyland' 'Southland' and 'Springcrest' very significantly negative.

Determinations regarding the index of power on the study period 2014-2016

- compared to the variety 'Redhaven' they have recorded highly significant positive values varieties 'Springold', 'Springcrest' and 'Cardinal', and the variety 'Collins' 'Jerseyland', 'Southland' these presents very significant negative differences .

Determinations regarding the expansion of the crown during the period of experimentation 2014-2016

- 'Springold' is the only one which recorded insignificant values compared to the variety 'Redhaven', and 'Collins' shows values significantly distinct positive. It shows the difference significantly distinct negative variety 'Springcrest', and very significantly negative varieties 'Cardinal', 'Jerseyland', 'Southland'.

Determinations regarding the growth of the sprouts

- there were increases ranging from 63 cm in the cultivar 'Springold' and 77 cm in the cultivar 'Southland'. The increase of the highest recorded but the variety 'Collins' of 55 cm, followed by 'Cardinal' with 54 cm, an increase higher by 2 cm compared to the variety 'Redhaven'.

Determinations on the volume of the crown on the trial period 2014-2016

- the variety 'Springcrest' and 'Cardinal' recorded insignificant differences compared to the variety 'Redhaven', the 'Springold', 'Collins' cultivars differ very significantly negative and the 'Jerseyland' and 'Southland' very significantly positive.

8. Influence on environmental quality fruits and production of peaches.

- the fruit average weight has been between 108 g for the variety 'Springcrest' and 157 g for the variety 'Redhaven'.
- the highest values of the average diameter of the fruit / variety, and their height, were recorded for the cultivar 'Redhaven' followed by 'Southland', and the lowest values recorded the variety 'Cardinal', and 'Springcrest'.
- On the average production of fruit per tree, the difference between the reference variety 'Redhaven' and other varieties was insignificant for the 'Cardinal' and 'Collins' very significantly positive 'Springold', distinct significantly positive at 'Springcrest' and varieties grow very significantly negative 'Jerseyland' and 'Southland'

- on fruit production t/ ha depending on the number of trees/ ha, varieties 'Sprincrest', 'Springold', 'Cardinal' and 'Collins' recorded very significant positive values and varieties 'Jerseyland' and 'Southland' very significantly negative.

CONCLUSIONS AND RECOMMENDATIONS

-In the past 10 years, the average temperature increased by 1,15 °C against the range reference;

-The average maximum temperature of the air has increased from 11,82 ° C for the range of reference to 15,83 ° C for the period of experimentation ;

-Minimum temperatures absolute decreased in the experimental period compared to the meteorological reference period;

- Temperatures the first few months of the year, have grown and no longer meet the trees need for cold, thereby disturbing the unfolding of the phenophases;

- Oscillations in the high temperature of the spring months as the difference between the maximum temperature and minimum temperature had consequences on the deep and optional rest of peachtree;

-Average temperatures are continuing to rise throughout the spring which favors the onset of phenological stages much more quickly;

-High temperatures during the months of May - July, the period in which the fruit must grow and mature, rush these steps, blurring normal development and the loss of the fruit until reaching the stage of maturity;

- The lower and lower minimum temperatures no longer meet the needs of the plants from the cold, after which the maximum temperatures in the growing number come and reduce the photosynthetic activity of plants, with negative effects both for the increases in vegetative and fruit development;

- The lack of rainfall contributes beside the aspects of temperatures to the decrease of vegetative growth and fruit;

- The onset of the first phenological stages of vegetation earlier from one year to another are put on the higher heat in winter, by shortening the mandatory rest breaks and the submission of the last extension of the period of vegetation, is all a response of the very high temperatures during autumn;

- Growth stages of fruiting events were held earlier in the last year of experimentation and, however, the sum of active temperatures of phenological start stages was higher;

- On the determination of the enzymatic activity of peroxidase, all plants have the appropriate biochemical internal response factor induced by the physiological state in which they were;

- The determinations on the buds of the two years, shows that during the months of December-January, the period of mandatory rest (biological or deep) of the species, a large percentage or all of the flowering buds are destroyed, the effect caused by the higher temperatures in the autumn, where the hardening thereof does not take place, to which is added the requirements of plant genetic in terms of the requirement of cold, in these years of being unsatisfied, and the amplitude of temperatures of spring bringing the situation in the stage met;

- On the background of minimum temperatures in the winter months, varieties of the peach of the plantation presents the values of the conductivity of the branches varied, and these values have varied depending on the minimum temperature of the months, but has not singled out a particular variety as being much more resistant to the minimum temperatures of the area, the values are close between them for the varieties of the plantation;

- Measurements on vegetative growth have concluded that during the period of experimentation, they were quite low, the response to disruptions during the year, caused by very high temperatures in periods where it is necessary only heat, called the heat stress, the effect is also amplified by the water stress;

- Recording data on the production in a single year, not allowing the comparison with other years of the period of experimentation, and the production differences between varieties in the year 2014 have been small and insignificant. The lack of fruit production in the year 2015 and 2016 are the follow of stress caused by temperatures, lack of rainfall, and the age of the plantation, and the existing varieties that they can no longer carry the genetic characteristics in the climatic conditions of the area;

As a recommendation, this species of fruit-growing is very important, encountered increasingly rare as coming from our country, should be cultivated more in the southern area of Oltenia, where the climatic conditions are other, but through the establishment of assortments of valuable varieties which to respond to the climatic conditions present in the area, and taking account of the other factors, biological and technological, they would achieve the characteristic yield of the genetic of the variety.