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BIO CULTIVATION AND CAPITALIZATION OF *PREMIAL* STRAWBERRIES IN CONDITION OF NOWADAYS CLIMATE CHANGE

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ABSTRACT

In the present paper is analysed the behaviour of *Premial* strawberries in the condition of actual climate change. The fruits were ecologically cultivated at a private farm located in Arges County, Romania and the results refer at the productions obtained in last four years (2018 - 2021). The entire concept and technology match the ancient local tradition of fruit trees cultivation as regard the bio cultivation of horticultural plants. As a direct consequence of the abnormal weather conditions, *Premial* strawberries have recorded a secondary production which represents an uncharacteristic feature for this cultivar. The second production of strawberries was less quantitative than springtime production, but improved in some qualitative indicators, such as the taste and flavour. Another aspect of the autumnal production refers at the fruit size which was smaller than of strawberries collected in springtime and at the fruit shape which was irregular and the overall consideration highlights its lack of uniformity as regard the visual characteristics. The *Premial* strawberries were analysed and processed at the Institute "Horting", Bucharest. The analysed bio-chemical indicators performed at fresh fruits were: dry matter, total carbohydrates, acidity, ascorbic acid, total phenols and anthocyanins. The strawberries were naturally dehydrated at 50°C, following two processing directions: dried fruits and powder. After dehydration, final humidity and weight reduction were calculated. The products obtained after dehydration were packed under vacuum in free BPA

plastic bags and stored in accurate conditions. Values of the meteorological parameters were statistically processed in various regressions and graphs.

KEYWORDS: convective dehydration, fruits processing, meteorological parameters, nutrients, organic cultivation, second fruiting, statistical processing.

INTRODUCTION

Nowadays, the climate change represents a real challenge for farmers. The price of the so-called progress is so high and its effects are irreversible. The consequences of wisdom's lack are everywhere seen and felt by every human being, animal and plant. The various type of pollution, well-known greenhouse effect, depletion of the ozone layer and of non-renewable resources, etc. are the tribute we have to pay for our modernism, consumerism, greed and recklessly. The weather is changeable and it's hard to issue a long-term forecast due to the abnormal and quick weather changes which produce several damages to the open-field cultivated plants. Sudden extreme temperatures, extended droughts, hailstone rains, acid rains, heavy winds, late frost, early hoarse, etc. conduct to serious losses of yield. Fruit tree cultivation became a risky horticultural concern. Important orchards holding precious collections of fruit trees and shrubs were destroyed or largely affected by such climate accidents. The specialists are searching new opportunities to create safe conditions for plants cultivation. Researchers, engineers and farmers do their best to find the most suitable species and varieties to cope the adverse weather conditions, in order to be enough resistant to the stress and tolerant to pest attack. By the other hand, emergent technologies are tested and the proposed endowments are exposed in a various range of advantages and prices. The strawberry (*Fragaria x ananassa*) cultivation around the world is one of the most profitable and appreciated by the consumers. The plant size and its rusticity offer a good adaptability to the crop. In Romania the strawberry is widely cultivated on open-field and when it's pursuing early or off-season production, the farmers choose its protected cultivation (mainly polythene house). The modern farms are using vertical strawberry cultivation which represents an intelligent use of the space.

Strawberries are one of the most popular fruits in Europe and America (https://web.extension.illinois.edu/strawberries/facts). Strawberries are available in different forms, from frozen to jelly which makes them widely versatile when it comes to adding them into different meals (https://www.saberhealth.com/news/blog/health-benefits-of-eating-strawberries). A study conducted from the Clinical Nutrition and Risk Factor Modification

Centre found that those who added strawberries into a low-cholesterol diet had lower oxidative damage and blood lipids, both of which contribute to heart health and diabetes (Cox, 2021). Additionally, other studies show that consuming strawberries regularly lowers cholesterol from anywhere between 4-10%, with some findings lowering cholesterol as much as 13% (Moll and Fogoros, 2019). Strawberries are low in carbohydrates because they are very high in water content (Bjarnadottir, 2019). Strawberries are a great source of Vitamin C, which is an antioxidant that can repair wounds and regrow tissue. Vitamin C is responsible for keeping our bones, teeth and skin healthy (https://www.saberhealth.com/news/blog/5-vitamin-c-benefits); it can help protect against cold and flu symptoms (De Bellefonds, 2019); it also supports the production of collagen (Harris, 2020) with direct effect on vision improvement and cataract's prevention (https://www.nvisioncenters.com/diet-and-eye-health/vitamin-C). A study conducted by Harvard Researchers at Brigham and Women's hospital found that women who ate strawberries and blueberries delayed memory decline by two and a half years (Maki, 2012). One reason strawberry may improve the memory is these fruits contain fistein, which is a flavonoid that can boost the pathways that control long-term memory (https://www.sciencedaily.com/ releases/2006/10/061017164401.htm). Strawberries contain also high amount of potassium which is responsible for helping nerves, lowering blood pressure by controlling sodium intake and regulating heartbeat (https://medlineplus.gov/potassium.html) and folate, known as vitamin B9, which is important because it helps form the RNA and DNA in our bodies (https://www.webmd.com/diet/health-benefits-folate). It is vital that pregnant women get enough of folate because a deficiency can cause anencephaly. Strawberries are very rich in fibre: roughly 26% of a carbohydrate in a strawberry is fibre. Fibre is responsible for maintaining the good gut bacteria in the digestive track which can help to maintain weight and stay healthy (https://strawberryplants.org/strawberry-nutrition-facts). Great content of antioxidants was found in strawberry; they help prevent free radicals that harm body functions. Foods with antioxidants are a great way to lower risk of heart disease and cancer (Wang, 2021). Dehydrated strawberries represent a very valuable food product; they must follow the parameters of the nutritional components and the appearance of fresh fruits. Consumption of dehydrated fruits offers great health benefits, such as: mineralization, detoxification, alkaline blood reaction, boosting immunity.

MATERIALS AND METHODS

The strawberries analysed in this paper in 2020 and 2021 were provided by the private farm "Florin Pomicultorul" (44.8421, 25.0871), located in Tiganesti village (44°50′10″N

25°4′59″E), close to Topoloveni city, in the Arges county, Romania (Figure 1). The area has an ancestral tradition of fruit trees cultivation due to its favourable pedoclimatic conditions, mountain closeness - the South chain of Carpathians and abundance of hydro-graphical basins. The subject of this study is a Romanian strawberry variety, named *Premial* which was created in 1993 at the Institute of Research-Development for Fruit Trees Cultivation, Pitesti-Maracineni from Arges County, Romania.

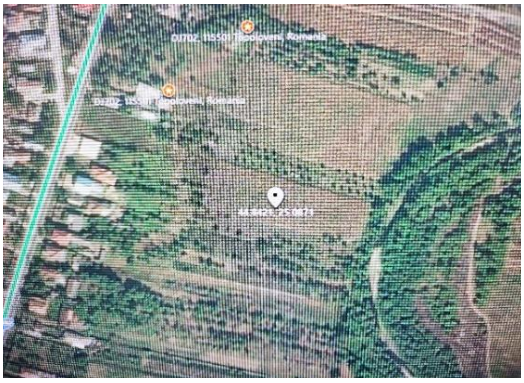


Figure 1: The field cultivated with *Premial* strawberry in Tiganesti, Arges County.

Premial was obtained by hybridization and it is an early variety, resistant to frost (until minus 30°C) and diseases. The plant grows as a semi-vigorous, scattered shrub. Its fruits are ripping in the second decade of May in the hilly areas and even earlier in the South part of Romania. The fruits are medium to large (20 g), spherical-conical, uniformly coloured in bright red, glossy; the pulp is red, consistent, juicy, pleasant to the taste, with high content of vitamin C. The average yield per plant is 500 g. *Premial* has an average productivity of 18 tons per hectare (http://fermierulargesean.ro/cultura-profitabila-in-care-directorul-institutului-de-la-maracineni-ar-investi-toti-banii).

The private farm, "*Florin Pomicultorul*" has supplied the organic strawberries of *Premial* cultivar in June 2020 & 2021 and in September 2020.

Premial strawberries have been analysed and capitalized at the Institute of Research - Development for Processing and Marketing of Horticultural Products - "*Horting*", Bucharest in 2020 and 2021.

The methods used for analysing the main bio-chemical indicators of fresh straw-berries have been: dry matter was determined according to STAS 5956 -71; carbohydrates were determined using *Bertrand* method (Heinze and Murneek, 1940; Kumar et al., 2014); the acidity, expressed in grams of mallic acid per 100 grams of fruit, was determined according to STAS 5952-79; ascorbic acid (Vitamin C) was determined according to SR ISO 6557-2/2008; phenolic compounds, expressed in grams of gallic acid per 100 grams of fruit, were determined using *Folin-Ciocalteu* method (Johansen, 1940; Yi and Wetzstein, 2010; Vaidya et al., 2013; Meena et al., 2017); anthocyanins, expressed in milligrams of cyanidin, 3-glucoside per 100 grams of fruit, were determined using the differential pH method (Perkins-Veazie and Collins, 1993; Giusti and Wrolstad, 2005, Özgen et al., 2017).

Premial strawberries have been processed by convective dehydration at the temperature of 50°C and packed as dried fruits and powder.

The values of the main meteorological parameters were collected from official weather sites and statistically processed in various regressions and graphs. The comparisons were made between yearly and multiannual average values. The results pointed out the nowadays climate changes, analysing a time period of 14 years, in the interval of 2008-2021.

RESULTS AND DISCUSSIONS

Cultivation features

*Premia*l is a strawberry's variety which was created and certified in 1993 at the Institute of Research - Development for Fruit Trees Cultivation, Pitesti - Maracineni from Arges County, Romania. The strawberries cultivation has followed the rules and regulations of Organic Farming in the E. U. In the field of fruit cultivation, the terms of "bio agriculture", "ecological" or "organic farming" represent the same concept and they are synonyms used by country preference at the level of E.U. member states. The role of organic farming is to produce cleaner food, more suitable for the human body, in full correlation with the environment conservation and sustainability's concept. One of the main purposes of organic farming is to promote fresh and authentic agri-food products that respect natural and environmental factors. Compared to the conventional agriculture, the bio cultivation of fruit trees and shrubs has certain particularities. From the seed phase to harvest, transport and storage, the horticultural material must be ecologically grown, according with the requirements of organic farming, as follows: the conversion period from conventional to organic farming is 3 years, in the case of fruit plants; the soil must be suitable to the development of microorganisms favourable to plants' growth; synthetic chemicals, such as granular or foliar fertilizers, growth regulators (stimulants or inhibitors) and any pesticides are strictly prohibited; fertilizers obtained from animal and poultry manure must come from organic farms (animals and birds must be freely grown and naturally fed, without the administration of antibiotics, hormones, etc.); the amount of nitrogen contained in natural fertilizers must not exceed the dose of 170 kg / ha / crop; the use of ionizing radiation is strictly prohibited. These rules pursue the European Community's Regulation no. 889/2008 / 2015, title II, chapter I, article 3 (II) and the European Union's regulation no 848/ 2018 of the European Parliament and of the Council of 30 May 2018 relating the organic production and labelling of ecological products.

Strawberry thrives best in temperate climate and the weather conditions found in our country are suitable for its cultivation. Strawberry is a short-day plant which requires exposure to about 10 days of less than 8 hours sunshine for initiation of flowering. In winter, the plants do not make any growth and remain dormant. The exposure to low temperature during this period helps in breaking dormancy of the plant. In spring when the days become longer and the temperature rises, the plants resume growth and begin flowering (https://www.indiaagronet.com/crop%20info/strawberry). The propagation of *Premial* variety is done by means of runners that are formed after the blooming season. A single plant of *Premial* strawberry usually produces after first year 5 runners and in the next years between 12 to 18 runners. They can be used to fill plant gasps, to set up a new strawberry crop or for sale. For planting one hectare are necessary 2400-2700 strawberry runners.

The surface cultivated with *Premial* strawberries in Tiganesti village was of 5200 m^2.

Relating the planting technology of *Premial* strawberries, the land was prepared by deep ploughing followed by harrowing. Liberal quantities of organic manure were incorporated in the soil before plating. Soil maintenance was done with the cultivator *Ruris* 731K. Strawberries have been planted on flat beds wide of 40 cm, distanced at 120 cm, using a runner at every 15-20 cm, in the springtime of 2016 and 2017.The behaviour of *Premial* cultivar was analysed starting with 2018 when the plants were well established in the soil.

As concern the special horticultural practices requested by strawberry cultivation, in winter the soil was covered with a mulch to protect the roots from cold injury. The mulch has an important role: it keeps the fruits free from soil, reduces decay of fruits, conserves soil moisture, lowers soil temperature in hot weather, protects flowers from frost in mild climates and protects plants from freezing injury in cold climates. Several kinds of mulches are used, but the most common is straw mulch and it was used in case of *Premial* cultivar, as well. One month before the harvest, the weeds were no longer removed and on them was spread a straw layer, in order to protect the plants and fruits from injury and spoilage (pest attack). Actually, the name “strawberry” has been derived from this fact. After harvest, the plants are mowed. Relating the irrigation schedule, since strawberry is relatively shallow-rooted, it is susceptible to drought conditions. Planting early in autumn allows the plants to make good vegetative growth before the onset of winter. However, in this case it is necessary to ensure that newly planted runners are irrigated frequently after planting, otherwise the mortality of the plants becomes high. Autumn till mid springtime the irrigation is given rarely, in case of lack of rain or snow, correlated with the temperature and air humidity. At fruiting stage, the irrigation it’s very necessary, helping the plant to produce larger fruits. In case of *Premial* strawberries was used drip watering; 16 mm thick drippers were installed every 10 cm.

As regard the application of manures and fertilisers, strawberry requires moderate amounts of nitrogen. Addition of organic matter to the soil improves the water holding capacity of the soil and also gives better runner formation. Application of adequate amounts of organic fertilizers gives higher yield of early berries. In November, 4 tons of organic farm manure (cattle and sheep manure) were applied to the cultivated area (0, 52 hectare).The plants of *Premial* cultivar were fertilized with the foliar stimulator, *Cropmax* and with *DelCaMag* (dolomite) which are allowed in the organic farming. The dolomite was applied in February - March, in amount of 1.5 tons / 0.5 hectare. It is recommended to be applied immediately after rainfall. The strawberry plants were three times fertilized with *Cropmax* in the amount of 0.5 l / 0.5 hectare from beginning of fruit ripping till harvest.

Relating plant protection measures, the bio cultivated plants require special attention because they cannot be treated with ordinary pesticides, used in the conventional agriculture. Red spider mites, slugs and cutworms are important pests of strawberry. Against them, *Bio-insect*, *Etamin* and *Mesurol* (granules) were used. Five diseases of strawberry are noticeable: white spot (*Mycosphaerella fragariae*), red spot (*Diplocarpon earliana*), red stele (*Phytophthora fragariae*), grey mould (*Botrytis cinerea*), black root rot (a disease complex in strawberry caused by multiple pathogens). Strawberry also can suffer from virotic diseases known as yellow edge, crinkle and dwarf. Strawberry throws some chlorotic plants which result from genetic segregation. These should not be confused with virus affected plants and should be rouged out. The main smart measure to prevent the attack of such pathogens is to increase the immunity of plants. *Premial* strawberries have been straightened by the application of *Bio-protect* and *Bio-humus*, alternatively used.

As concern the harvesting and yield, the fruit ripens during May and June. For local market the fruit should be harvested when fully ripe, but for transport to distant markets, it should be harvested when still firm and before colour has developed fully all over the fruit. Harvesting should be done preferably daily. Since fruit is highly perishable, it is packed in flat shallow containers of various types (cardboard, bamboo, paper trays etc.) with one or two layers of fruits. Harvesting should be done early in the morning in dry conditions. Washing the fruit bruises and spoils its lustre. The yield varies according to the plant age, health and strength and to the weather condition, as well. In 2018, the yield of *Premial* strawberries was 3.2 tons/ 0.52 hectare, in 2019 was 5.6 tons/ 0.52 hectare, in 2020 was 7.4 tons/ 0.52 hectare and 2021 the production was 8.2 tons/0.52 hectare. Due to the nowadays climate change, *Premial* cultivar produced second fruiting at the end of summer and beginning of autumn and this represents an abnormal feature for this variety which blooms and fruits only once a year, in the springtime. In autumn, the plants produced smaller yield than springtime. The fruits of second yield had a smaller size and a lack of uniformity, but their sensory qualities were very appreciated, mainly for their taste, flavour and colour.

A serious aspect recorded in last years was the intensification of weather accidents, such as late frost, hailstone rain, hoar-frost, storms, high temperatures during cold season and drought at the key vegetative stages (blooming, fruiting, ripening). In the village of Tiganesti, in the springtime of 2019 (23^{-rd} and 26^{-th} of April) a late-frost of minus 4°C, followed by other of minus 7°C, have seriously affected the strawberry plants; the flowers of first blooming wave have thawed. In the same year, in the period 28 May - 5 June, the rainfalls were daily recorded. High amount of water concentrated in a short period of time can damage the rooting system of plant, can weaken the plants to the pest attack and decrease the sensory parameters of fruits, mainly their taste and flavour. The year 2019 has represented a huge challenge for the farmers of Arges County: in the period 5 June - 28 August no rainfall was recorded and the drought produced lot of negative effects in agriculture. In 2019 and 2020 the hailstone rain produced serious damages to all crops; the ice size was of 3-4 cm, but the ice pieces did not fall down in big amount. Nowadays, the anti-hailstone rain systems represent a wise and even a must-have investment for fruit trees and shrubs cultivation. At the Institute of Research and Development for Fruit Trees Cultivation from Pitesti-Maracineni, in March and

April 2020, due to the late frost, significant damages were reported. To the majority of fruit trees and shrubs was installed an advance (in plants growing and development (10-14 days), caused by the abnormal temperatures recorded in Arges county and at the level of whole country in January (with 2.3° C above the ordinary average), February (with 3.4° C warmer than the multiannual average), March (with 2.3° C above ordinary average) till the mid of April. In the Southern and Eastern part of Romania, between 16^{-th} of March and 7^{-th} of April, were recorded 5 waves of late frost with temperatures below the minimum critical level, producing 10% damage in almost all fruit species. In some cases, more than 90% of floral organs have been affected. The first wave of late frosts (on 16^{-th} of March were recorded minus 6.2° C and on 17^{-th} of March minus 7.1° C; these low temperatures appear at mid of March once at every 33 years) occurred after two weeks with exceptionally high temperatures (the highest temperature was recorded on 13-th of March 23.3° C; for mid of March this value was reached once in 100 years). So, the thermal amplitude has been of 30.4 ° C. (Chitu et al., 2020).

Relating the post-harvest handling and marketing, strawberries are highly perishable and hence a great deal of care in harvesting and handling; the marketing also requires to be organised carefully. Usually, the fruit is picked in the early morning and sent to the market in the afternoon of the same day or is picked in the late afternoon, stored overnight in a cool place, and sent to market the following morning.

Capitalization of *Premial* strawberries

After reception (Figures 2 and 3), the strawberries were sorted, weighted, washed and spread on the dryer trays (Figure 4).

Figure 2: June reception of *Premial* strawberry (after main harvest).

Figure 3: September reception of *Premial* strawberry (after second harvest).

Figure 4: Halved strawberries prepared for dehydration in 2020 and 2021.

For strawberries' dehydration has been used the Professional Dryer B. Master (https://www.taurodryers. com/en/b-master-line/b-master), as appears in the Figure 5.

Figure 5: *Premial* strawberry dehydration in the *B. Master* Dryer.

Fruit dehydration is an ancient method of fruit preservation by heat which retards cell oxidation and inhibits the natural ageing and discoloration that can occur during food preparation, such as the enzymatic browning reaction (Yadav and Singh, 2014) which appears after cutting different kinds of fruits. In case of organic fruits, especially those with lighter colour of pulp, the browning phenomenon requests a specific attention.

Among the drying techniques, the most commonly used in the food industry is the traditional air-drying method, done by convective dehydration. This method has a long-time performance, extending the shelf-life of the dried fruits. Fruit dehydration is the technological process to reduce water content to a certain level in order to prevent or slow down the activity of microorganisms, without destroying fruit tissues or depreciating their nutritional value (Petkovic et al., 2019). Excess of water to be removed by dehydration varies depending upon the nature of the raw material, as well as the capitalization's direction.

Enzymatic browning is also caused by the presence of phenolic compounds, especially tannins, tyrosine and chlorogenic acid (e.g., freshly cut fruit oxidizes under the action of polyphenol oxidase), but to inactivate the enzymes is hard to control. The browning phenomenon could be limited by the judicious management of the parameters of the drying process. Of them, the main parameter is represented by the drying temperature which can be set at maximum 50°C for the organic fruits. Le Maguer (1988) and Ponting et al. (1966) have reported enzymatic browning and flavour deterioration above 49°C.

Fresh strawberries contain about 90% water, while the maximum moisture of the finished product is about 7-15%, determined by its destination. The water must be partially and gradually removed, not suddenly, because, this case will appear irreversible qualitative degradations. The usual agent used to dehydrate the fruit is the hot air which serves both for the transfer of heat from the heating source to the product and for the circulation of evaporated water.

The main factors influencing the drying process are: raw material, shape and crushing degree of the raw material, drying methods, dehydration time, temperature, humidity, speed, air distribution & circulation.

The nature of the raw material and the mode of division (cubes, noodles, halves or slices, etc.), particularly influence the drying rate and, therefore, the time of this operation. Drying of uncrushed fruit will keep a higher level of antioxidant bio-active components then drying the crushed fruits (Oszmianski and Lachowicz, 2016).

The strawberries have been dehydrated as entire (Figure 6), halved and crushed fruits. The products obtained after dehydration were weighted and packed under vacuum in free BPA plastic bags as dried fruits and powder (Figure 7) and stored in accurate conditions.

Fig. 6. Whole fruits on tray.

Fig. 7. Strawberries powder.

The values of the main bio-chemical indicators recorded in 2020 and 2021 of fresh fruits are comparable. As regard the bio-chemical analyses performed at the fresh strawberries (Table 1), the primary production of 2020 recorded the highest amount of carbohydrates, while the secondary production recorded highest amount of Vitamin C (ascorbic acid) and phenolic compounds, mid values of dry matter and carbohydrates and smallest quantity of anthocyanins. The anthocyanins are unstable are very sensitive when long-term exposed to high temperature and light intensity and for this reason the autumnal production obtained smaller amount of these bio-compounds. The analysed strawberries (June and September 2020 and June 2021) were dehydrated 27 hours at 50° C, without adding anti-caking agents, preservatives or other treatment. Thus, the final products were wholly natural and healthy. Even if the dehydration parameters remained the same, the mass kinetics was different (Table 2). The biggest weight reduction was recorded at *Premial* strawberries harvested in June 2021, followed by those of September 2020. The explanation of these results is based on the water loss process: as the fruit has smaller amount of carbohydrates and dry matter and higher amount of Vitamin C, the water contained in its tissues is easier released. The dried strawberries got very close percentage of final humidity making them suitable for packing.

Table 1: Main bio-chemical indicators of *"Premial"* organic strawberries - at the initial stage (fresh fruit).

DATE	Dry matter [^{o} BRIX]	Carbo-hydrates [%]	Acidity [g of malic acid /100 g]	Ascorbic acid [mg/100g]	Phenolic compounds [mg GAE/100g]	Anthocyanins [mg cyd, 3-glucoside/100g]
2020. 06. 03	9.9	6.11	0.87	56.98	124.43	18.97
2020.09.21	8.8	5.45	0.99	81.7	147.87	15.97
2021.06.18	7.5	4.36	0.89	60.57	123.72	21.63

Table 2: Dehydration parameters and mass kinetics of "*Premial*" organic strawberries.

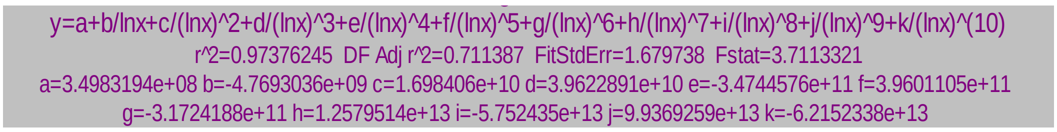
DATE	Drying temperature [°C]	Drying time [h]	Weight reduction [%]	Humidity of dried fruits [%]
2020. 06. 03	50	27	88.75	12.97
2020.09.21	50	27	90.02	12.81
2021.06.18	50	27	92.63	12.43

Challenges of climate change and statistical processing of meteorological parameters

To determine the parameters that express the influence of one or more factors on a process, the statistical methodology focuses on the regression function. The estimation of the parameters of the elementary function that describes the dependence between the effect (y) and the factors (x) is done by using the Regression Method (Stan, 2013). The validation of the model is performed with the help of the F test, followed by t-test.

In statistics, the coefficient of determination denoted R^2 or r^2 represents the proportion of the variation in the dependent variable that is predictable from the independent variable(s). The coefficient of determination normally ranges from 0 to 1. An R^2 of 1 indicates that the regression predictions perfectly fit the data (https://en.wikipedia.org/wiki/coefficient of determination). Prediction within the range of values in the dataset used for model-fitting is known informally as interpolation. Prediction outside this range of the data is known as extrapolation of individual parameters.

In the Figure 8 is represented the regression of monthly average amplitude correlated with monthly amplitude of extreme temperatures in 2018. The below statistic processing is based on the data found in the Table 3.



Details of linear regression.

Eqn $y=a+b/\ln x+c/(\ln x)^2+d/(\ln x)^3+e/(\ln x)^4+f/(\ln x)^5+g/(\ln x)^6+h/(\ln x)^7+i/(\ln x)^8+j/(\ln x)^9+k/(\ln x)^{10}$

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9737624543	0.7113869973	1.6797380307	3.7113320947

Parm	Value	Std Error	t-value	95% Confidence Limits		P>|t|
a	3.49832e+08	8.57661e+07	4.078905462	-7.3993e+08	1.43959e+09	0.05518
b	-4.7693e+09	1.25104e+09	-3.81225865	-2.0665e+10	1.11267e+10	0.06243
c	1.69841e+10	5.9916e+09	2.834645240	-5.9146e+10	9.31146e+10	0.10518
d	3.96229e+10	2.71973e+10	1.456869215	-3.0595e+11	3.85197e+11	0.28247
e	-3.4745e+11	1.53531e+11	-2.26303925	-2.2982e+12	1.60335e+12	0.15197
f	3.96011e+11	2.79454e+11	1.417089162	-3.1548e+12	3.94681e+12	0.29218
g	-3.1724e+11	4.64772e+11	-0.68257591	-6.2227e+12	5.58824e+12	0.56533
h	1.25795e+13	3.58725e+12	3.506728593	-3.3001e+13	5.81599e+13	0.07258
I	-5.7524e+13	1.09236e+13	-5.26605643	-1.9632e+14	8.12733e+13	0.03422
j	9.93693e+13	1.73632e+13	5.722988603	-1.2125e+14	3.19989e+14	0.02920
k	-6.2152e+13	1.08088e+13	-5.75015989	-1.9949e+14	7.51865e+13	0.02

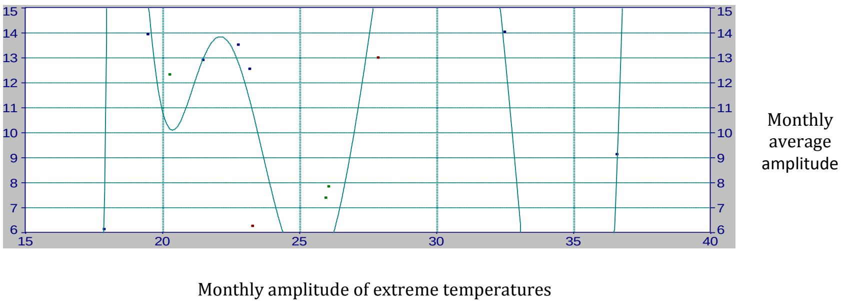


Figure 8: Regression of thermal amplitudes in 2018.

Pick values of extreme temperatures amplitude were recorded in March (36.6° C), September (32.5° C) and January (26.1° C), while pick values of monthly average were recorded in September (14.04° C), August (13.94° C) and October (13.52° C).

In the Figure 9 is represented the regression of monthly average amplitude correlated with monthly amplitude of extreme temperatures in 2019. The below statistic processing is based on the data found in the Table 4.

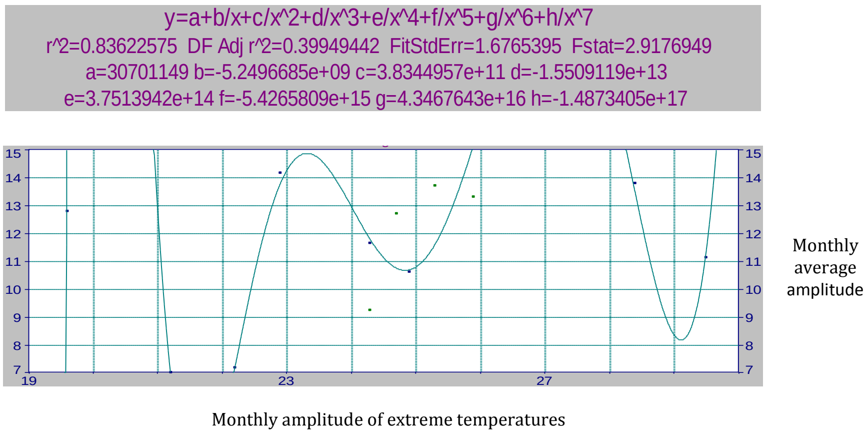


Figure 9. Regression of thermal amplitudes in 2019.

Pick values of extreme temperatures amplitude were recorded in February (29.5° C), September (28.4° C) and Mars (25.9° C), while pick values of monthly average were recorded in August (14.17° C), September (13.8° C) and October (13.7 °C).

In the Figure 10 is represented the regression of monthly average amplitude correlated with monthly amplitude of extreme temperatures in 2020. The below statistic processing is based on the data found in the Table 5.

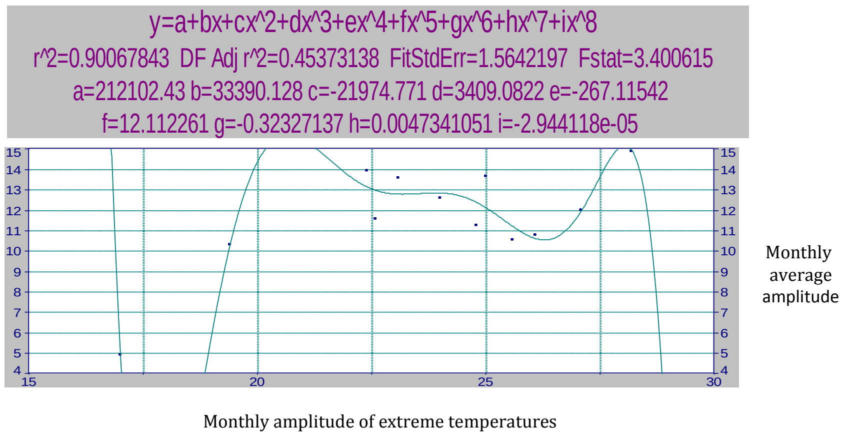


Figure 10: Regression of thermal amplitudes in 2020.

Pick values of extreme temperatures amplitude were recorded in April (28.2 °C), June (27.1°C) and Mars (26.1 °C), while pick values of monthly average were recorded in April (14.92 °C), August (13.96 °C) and September (13.66 °C).

In the Figure 11 is represented the regression of monthly average amplitude correlated with monthly amplitude of extreme temperatures in 2021. The below statistic processing is based on the data found in the Table 6.

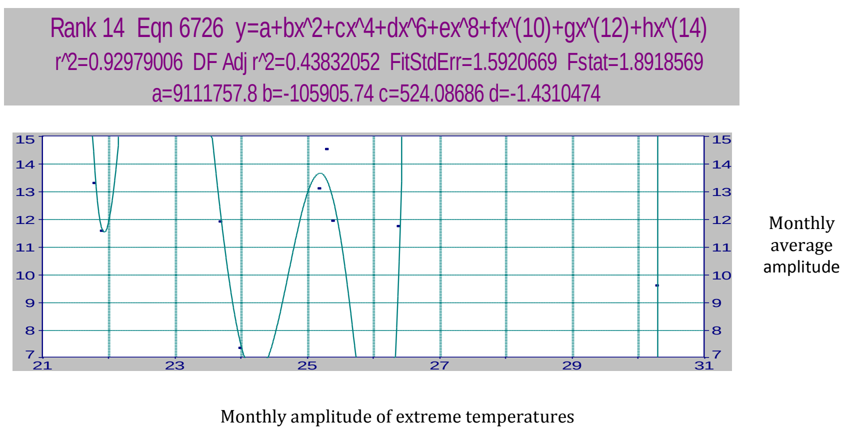


Figure 11: Regression of thermal amplitudes in 2021.

Pick values of extreme temperatures amplitude were recorded in February (30.3° C), April (26.4° C) and June (25.4° C), while pick values of monthly average were recorded in August (14.53° C), July (13.3° C) and September (13.11° C).

Observation 1

The thermal amplitude represents the difference between the maximum and minimum temperatures. Extreme temperatures represent the highest (T_{max}) and lowest (T_{min}) recorded in a certain period of time. Analysing the meteorological data, in spring (Mars, April) and autumn (September, October) were recorded the highest amplitudes in the last four years. Significant amplitudes of summer months, mainly August, determined the plants to produce second fruiting at the beginning of autumn.

In the Figure 12 is represented the regression of monthly average temperatures correlated with monthly rainfall amount (l/ m^2) in 2018. The below statistic processing is based on the data found in the Table 3.

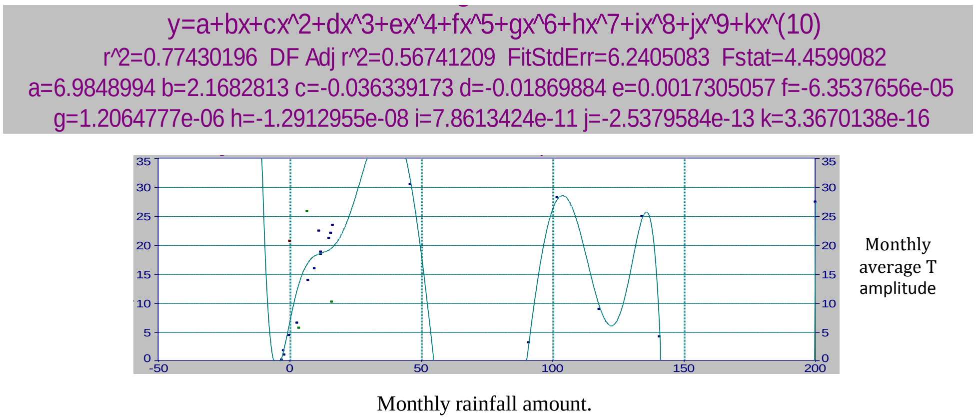


Figure 12: Regression of temperature with rainfall amount in 2018.

Highest amounts of rainfall were recorded in June (200 l/m^2 correlated with an average temperature of 21.23° C), February (140.8 l/m^2 correlated with an average temperature of 1.12° C) and May (134.2 l/m^2 correlated with an average temperature of 18.54° C).

In the Figure 13 is represented the regression of monthly average temperatures correlated with monthly rainfall amount (l/ m^2) in 2019. The below statistic processing is based on the data found in the Table 4.

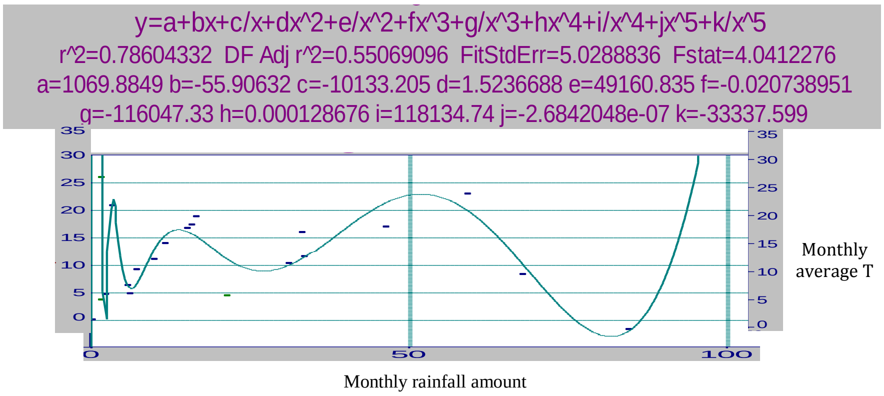


Figure 13. Regression of temperature with rainfall amount in 2019.

Highest amounts of rainfall were recorded in June (264 l/m^2 correlated with an average temperature of 22.43°C), January (84.8 l/m^2 correlated with an average temperature of minus 0.27°C) and November (68.2 l/m^2 correlated with an average temperature of 9.8°C).

In the Figure 14 is represented the regression of monthly average temperatures correlated with monthly rainfall amount (l/ m^2) in 2020. The below statistic processing is based on the data found in the Table 5.

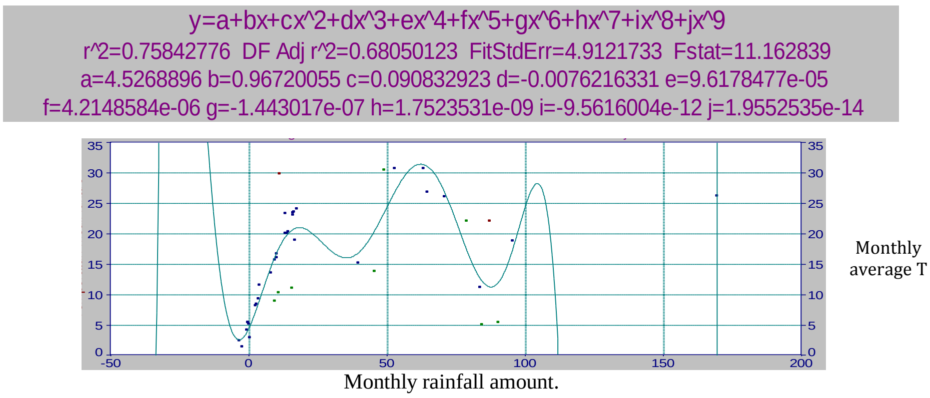


Figure 14: Regression of temperature with rainfall amount in 2020.

Highest amounts of rainfall were recorded in June (169.6 l/m^2 correlated with an average temperature of 20.33° C), October (95.6 l/m^2 correlated with an average temperature of 13.56° C) and December (90.4 l/m^2 correlated with an average temperature of 2.96° C).

In the Figure 15 is represented the regression of monthly average temperatures correlated with monthly rainfall amount (l/ m^2) in 2021. The below statistic processing is based on the data found in the Table 6.

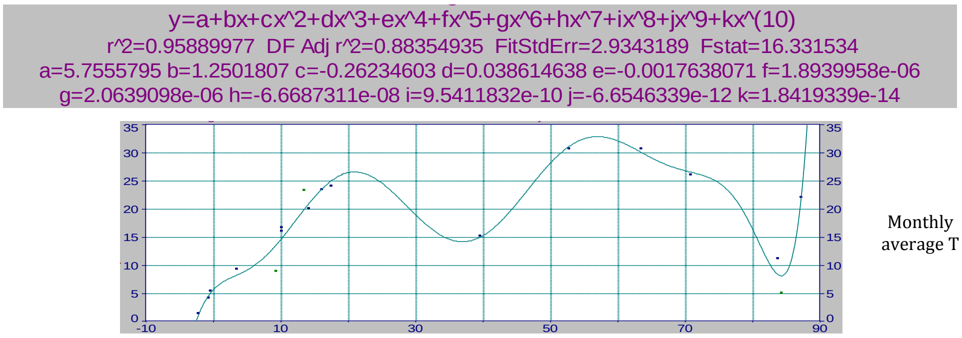


Figure 15: Regression of temperature with rainfall amount in 2021.

Highest amounts of rainfall were recorded in May (87.3 l/m^2 correlated with an average temperature of 16.12° C), January (84.4 l/m^2 correlated with an average temperature of 1.46° C) and Mars (83.8 l/m^2 correlated with an average temperature of 5.48° C).

In the Figure 16 is represented the regression of yearly average temperatures correlated with yearly rainfall amount (l/ m^2) in the period 2018-2021. The below statistic processing is based on the data found in the Table 7.

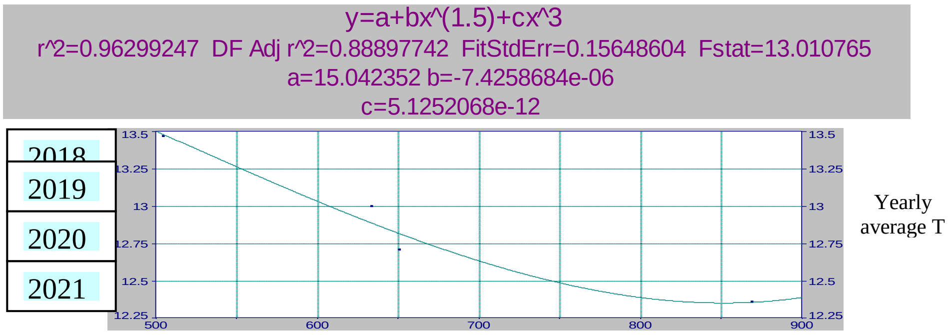


Figure 16: Regression of temperature with rainfall amount in the period 2018-2021.

From 2018 till 2021 the amount of rainfall has substantially decreased. A real problem for the open-field cultivated crops is the lack of rain or water excess at the main vegetative phases of vegetation. As the values show, the largest amounts of water were recorded in May and June, exactly at blooming and ripening stages. In the period 2018-2020, in June was recorded even an exceeding of litres per square meter, with direct effect on the on the plants' health & yield and on quality of fruit sensory parameters (taste, flavour, texture).

For strawberry's cultivation, the interval April-June represents the period that mostly matters in the crop's life, especially as regard the fruiting capacity and sensory parameters.

In the Figures 17-19, the months April, May and June are highlighted and analysed, in order to find out some correlations between the values of the main meteorological parameters and the nowadays climate change and its influence upon the crops' cultivation.

During 2018-2021 the lowest temperatures recorded in the period April-June have a downward orientation and, in the period analysed in this study, the average of lowest temperatures has reached the value of 3.6° C in 2021, in comparison with 2018 when this value was of 6.1° C.

For the processes which are developing at the strawberry's key vegetative phases, this value represents a factor of stress for the plant: the flowers and unripe fruits can be aborted and the sensitivity of shrub to pest attack increases. As regard the rainfall regime, the orientation is again downward; in 2021 the quantity of litres per square metre, being near half (65.93 l/m^2) of the amount recorded in 2018 (115.13 l/m^2), as is shown in the Figure 17.

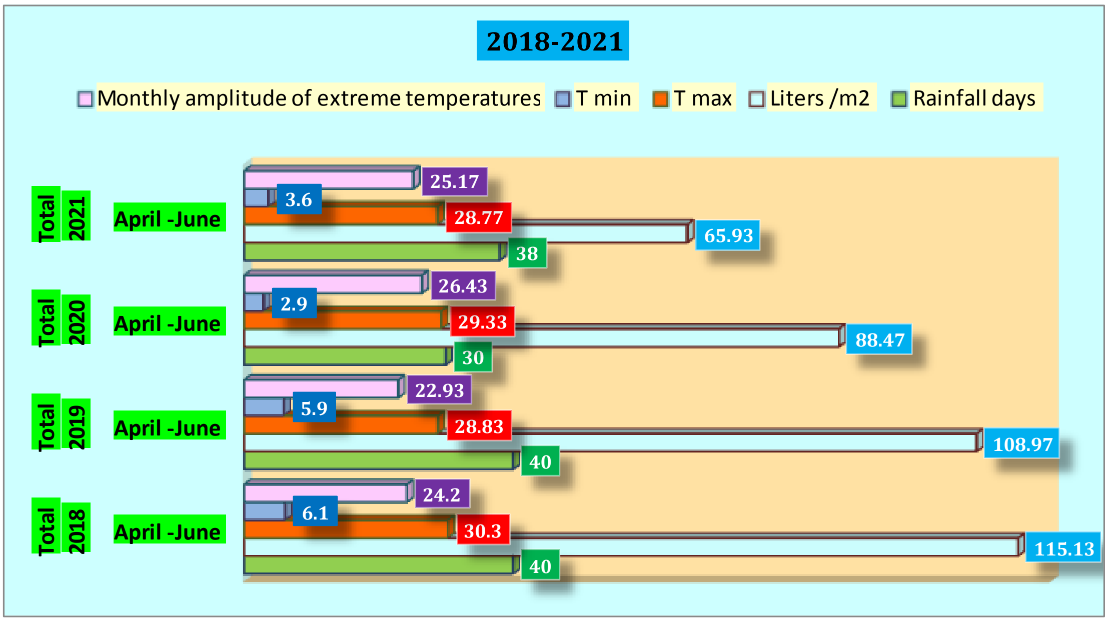


Figure 17: Extreme temperatures and rainfall regime in the interval April-June.

Concerning the maximum temperatures, in 2021, in the period April-June, was recorded an average of 21.14° C, with near 4 degrees less than average of 2018 (25° C). The average of minimum temperatures in 2021 was with near 3 degrees less than the average of 2021 (12.17°C). Both curves of maximum and minimum temperatures average have a downward orientation, between 2018 and 2021. Due to this fact, the monthly average amplitude lost 1 degree in 2021 (11.87° C) in comparison with 2018 (12. 83° C), as is represented in Fig. 18.

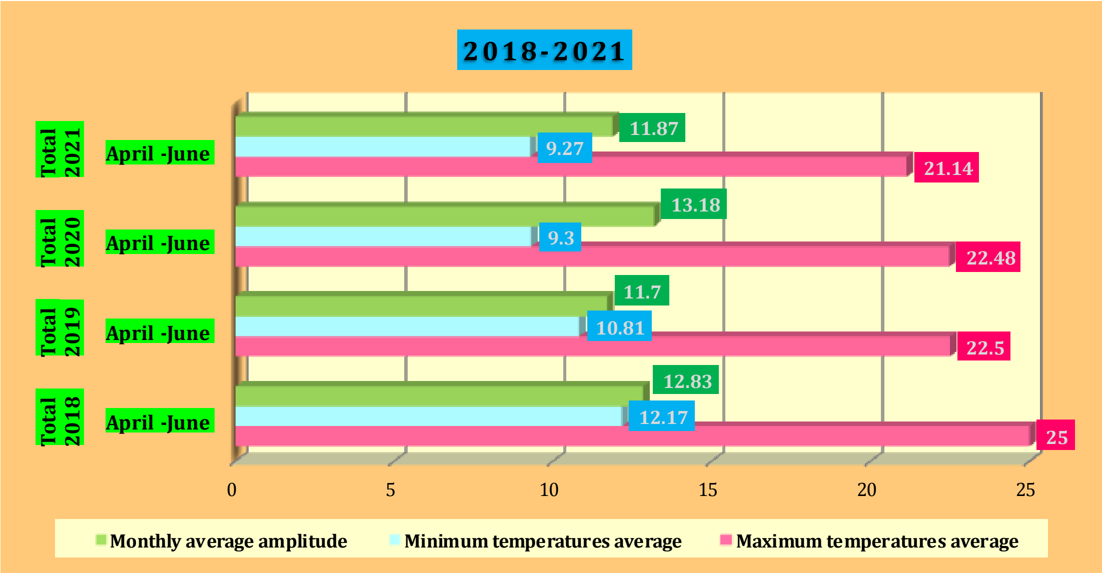


Figure 18: Extreme temperatures and rainfall regime in interval April-June.

An important aspect analysed in this study is the number of days which are below or at the same value with the average of minimum temperatures and the number of days which are above or at the same value with the average of maximum temperatures, in the period April-June. During 2018-2021, the number of days with same or higher temperature than the average of maximum temperature exceeded the number of days which same or lower temperature than the average of minimum temperatures, with light exceptions in 2019 (April), 2020 (May) and 2021 (June), as appear in the Figure 19.

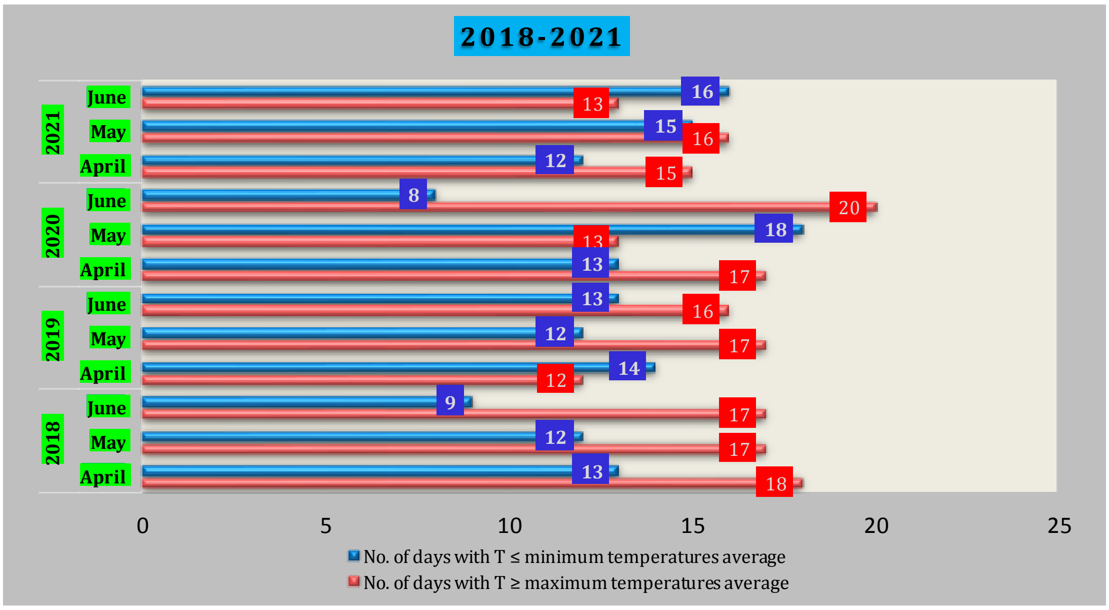


Fig. 19. Tendency of temperature in the period April - June in the period 2018-2021.

Table 3: Values of main meteorological parameters of 2018 at Pitesti monitoring station.

Month	Rainfall days	Liters of water/ m2	T max	T min	Monthly amplitude of extreme temperatures	T_{max} average	T_{min} average	Monthly Average amplitude	Days with T≥ T_{max} average	Days with T≤ T_{min} average
December	10	91	10.2	-7.7	17.9	3.23	-2.93	6.16	12	13
November	9	16.2	18.2	-7.8	26	10.28	2.89	7.39	13	16
October	1	0.3	26.9	4.1	22.8	20.81	7.29	13.52	16	14
September	2	6.6	33.1	0.6	32.5	25.87	11.83	14.04	19	10
August	5	46.1	33	13.5	19.5	30.53	16.59	13.94	14	12
July	14	101.8	31.2	10.9	20.3	28.28	15.95	12.33	18	12
June	17	200	31.9	8.7	23.2	27.50	14.95	12.55	17	9
Mai	14	134.2	30.2	8.7	21.5	25	12.07	12.93	17	12
April	9	11.2	28.8	0.9	27.9	22.51	9.49	13.02	18	13
Mars	18	118	21.3	-15.3	36.6	8.98	-0.16	9.14	16	14
February	19	140.8	13.1	-10.2	23.3	4.26	-2.02	6.28	15	9
January	5	3.6	16.5	-9.6	26.1	5.72	-2.15	7.87	12	12
Total (2018)	**123 of 365days**	**869.8**	**24.53**	**-0.26**	**24.79**	**17.74**	**6.98**	**10.76**	**15.58**	**12.17**

*** The values of meteorological parameters of 2018 were downloaded from the website: www.ogimet.com**

Table 4: Values of main meteorological parameters of 2019 at Pitesti monitoring station.

Month	Rainfall days	Liters of water/ m2	T max (°C)	T min (°C)	Monthly amplitude of extreme temperatures	T_{max} average	T_{min} average	Monthly average amplitude	Days with T≥ T_{max} average	Days with T≤ T_{min} average
December	8	2.5	19	-5.3	24.3	9.68	0.44	9.24	15	14
November	16	68.2	21.2	0	21.2	13.3	6.3	7	13	14
October	7	33.5	27.5	2.2	25.3	21.06	7.35	13.71	18	11
September	2	3.5	32.1	3.7	28.4	25.85	12.05	13.8	17	12
August	1	2	34.7	11.8	22.9	31.02	16.85	14.17	19	10
July	7	59.5	34.5	9.8	24.7	28.1	15.37	12.73	17	13
June	16	246.4	32.1	12.5	19.6	28.84	16.02	12.82	16	13
May	13	46.7	27.8	3.5	24.3	22	10.34	11.66	17	12
April	11	33.8	26.6	1.7	24.9	16.68	6.06	10.62	12	14
Mars	6	31.3	23.6	-2.3	25.9	15.36	2.03	13.33	17	13
February	6	21.8	19	-10.5	29.5	9.48	- 1.67	11.15	15	9
January	14	84.8	10.7	- 11.5	22.2	3.33	- 3.87	7.2	11	15
Total (2019)	**107 of 365 days**	**634**	**25.73**	**1.3**	**24,43**	**18.72**	**7.27**	**11.45**	**18.33**	**12.5**

*** The values of meteorological parameters of 2019 were downloaded from the website: www.ogimet.com**

Table 5: Values of main meteorological parameters of 2020 at Pitesti monitoring station.

Month	**Rainfall days**	**Liters of water/m2**	**T_{max} (°C)**	**T_{min} (°C)**	**Monthly amplitude of extreme temperatures**	**T_{max} average**	**T_{min} average**	**Monthly average amplitude**	**Days with T≥ T_{max} average**	**Days with T≤ T_{min} average**
December	14	90.4	10.8	-6.2	17	5.43	0.5	4.93	12	13
November	6	10.8	16.9	-2.5	19.4	10.32	0	10.32	16	8
October	12	95.6	27	1.4	25.6	18.9	8.22	10.58	14	15
September	4	64.6	32.9	7.9	25	26.96	13.30	13.66	18	12
August	10	49	35.2	12.8	22.4	30.58	16.62	13.96	17	14
July	6	11.3	36	12.9	23.1	29.90	16.28	13.62	18	13
June	14	169.6	32.7	5.6	27.1	26.33	14.32	12.01	20	8
May	12	79.1	30.1	6.1	24	22.09	9.47	12.62	13	18
April	4	16.7	25.2	-3	28.2	19.03	4.11	14.92	17	13
Mars	10	45.5	22.5	-3.6	26.1	13.82	3	10.82	17	14
February	9	15.8	18.5	-6.3	24.8	11.14	-0.14	11.28	12	15
January	3	2.5	14.4	-8.2	22.6	8.26	-3.31	11.57	15	15
Total (2020)	**104 of 366 days**	**650.9**	**25.18**	**1.41**	**23.78**	**18.56**	**6.86**	**11.69**	**15.75**	**13.16**

*** The values of meteorological parameters of 2020 were downloaded from the website: www.ogimet.com.**

Table 6: Values of main meteorological parameters of 2021 at Pitesti monitoring station.

Month	**Rainfall days**	**Liters of water/ m^2**	**T_{max}** (°C)	**T_{min}** (°C)	**Monthly amplitude of extreme temperatures**	**T_{max} average**	**T_{min} average**	**Monthly average amplitude**	**Days with T≥ T_{max} average**	**Days with T≤ T_{min} average**
September	5	13.5	29.6	4.4	25.2	23.35	10.24	13.11	17	13
August	7	63.5	35.6	10.3	25.3	30.75	16.22	14.53	16	14
July	3	52.9	35.9	14.1	21.8	30.84	17.54	13.3	16	14
June	17	70.9	33.6	8.2	25.4	26.14	14.18	11.96	13	16
May	10	87.3	28	4.3	23.7	22.08	10.16	11.92	16	15
April	11	39.6	24.7	-1.7	26.4	15.22	3.48	11.74	15	12
Mars	11	83.8	17.3	-4.6	21.9	11.27	-0.32	11.59	13	14
February	6	9.4	21.4	-8.9	30.3	8.98	-0.62	9.6	13	10
January	18	84.4	12.4	-11.6	24	5.13	-2.21	7.34	14	11
Total (2021)	**88 of 273 days**	**505.3**	**26.5**	**1.61**	**24.89**	**19.31**	**7.63**	**11.68**	**14.77**	**13.22**

*** The values of meteorological parameters of 2021 were downloaded from the website: www.ogimet.com**

Table 7: Average values of meteorological parameters in the period 2018-2021 at Pitesti weather monitoring station.

Year	Percentage of rainfall days (%)	Liters of water/m^2	T $_{max}$ (°C)	T $_{min}$ (°C)	Monthly amplitude of extreme temperatures	T_{max} average	T_{min} average	Monthly average amplitude	Days with T≥ T_{max} average	Days with T≤ T_{min} average
2018	33.7	869.8	24.53	-0.26	24.79	17.74	6.98	10.76	15.58	12.17
2019	29.32	634	25.73	1.3	24,43	18.72	7.27	11.45	18.33	12.5
2020	28.42	650.9	25.18	1.41	23.78	18.56	6.86	11.69	15.75	13.16
2021	32.23	505.3	26.5	1.61	24.89	19.31	7.63	11.68	14.77	13.22
Total of 45 months	**30.92**	**665**	**25.49**	**1.01**	**24.48**	**18.58**	**7.19**	**11.40**	**16.11**	**12.76**

Comparisons between the values of the main meteorological parameters during 2018-2021 and 2007-2018 are presented in the Table 8 and Figures 20-24. As the values show, the multiannual rainfall amount (l/m^2) in 2007-2018 was with near 16% higher than the water amount recorded in the interval of 2018-2021. The multiannual average temperatures increased in the last four years with near 1.5° C, due the increase of multiannual minimum temperatures with near 1 °C, while the multiannual maximum temperatures recorded very close values. Thus, the thermal amplitude in the period 2007-2018 was with near 1% higher than the amplitude of 2018-2021. The weather information collected between 2007-2021 highlight the climate change and the weather tendency to drought and higher temperatures in cold season, determining a lighter contrast between winter and summer.

Table 8: Average values of multiannual meteorological parameters in the period 2007-2021 at Pitesti weather monitoring station.

Interval of time	Multiannual rainfall amount (l/m^2)	Value of multiannual average temperatures (°C)	Value of multiannual maximum temperatures (°C)	Value of multiannual minimum temperatures (°C)	Value of multiannual weather amplitudes (°C)
2007-2018*	771,1	11.4	25.6	0.2	25.4
2018-2021	665	12.89	25.49	1.01	24.48
165 months	718.05	12.14	25.55	0.6	24.94

*** Values of meteorological parameters of 2007-2018 were provided by the National Meteorological Agency**

(Website: www.meteoromania.ro)

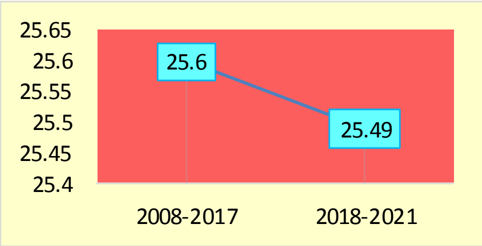


Fig. 20: Multiannual average of maximum temperatures

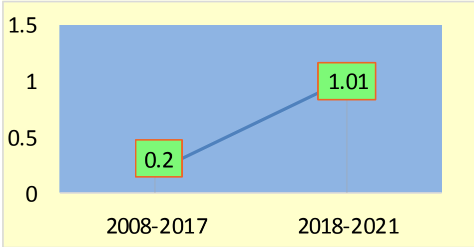


Fig. 21: Multiannual average of minimum temperatures

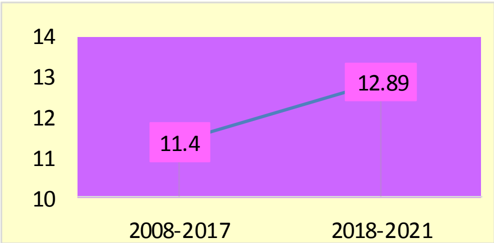


Fig. 22: Multiannual average of average temperatures.

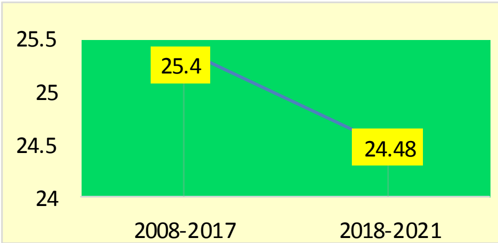


Fig. 23: Multiannual thermal amplitudes.

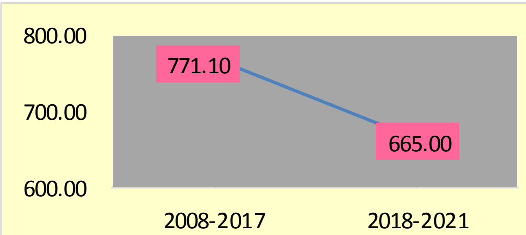


Fig. 24: Multiannual rainfall amount.

Observation 2

There are four key vegetative phases, between April and June, in which the lack of sufficient water, even for a very short period, has a devastating impact on crops, being able to destroy them in a proportion of up to 80%. These are: inflorescences issue, fruit formation and growth, fruit ripening and the period after harvest. Two or even three of these stages take place during May.

Observation 3

A specific element of the strawberry is that it has small size and a rather poorly developed root system. For this reason, it is particularly sensitive to drought and lack of nutrients (without a sufficient amount of water in the soil, the nutrients have not the proper mobility to be reached by the plant's roots).

Observation 4

Warm temperatures recorded at the end of winter and beginning of spring confuse the plants that conclude their vegetative rest too quickly, leading to earliness in the induction of the floral primordia. The thermal shocks produced by the late frost of mid spring conducted to significant plant injury, directly affecting plants blooming and fruiting. These abnormalities consume plant resources, being reflected at the level of its strength and yield.

CONCLUSIONS

- Due to the nowadays climate change, *Premial* strawberries, organically cultivated, produced second fruiting at the end of summer and beginning of autumn and this represents an abnormal feature for this cultivar which bloom and fruit only once a year, in the springtime.
- In autumn, the plants produced smaller yield than springtime. The fruits of second yield had a smaller size and a lack of uniformity, but their sensory qualities were very appreciated, mainly for their taste, flavour and colour.
- The primary production of 2020 has recorded the highest amount of carbohydrates, while the secondary one recorded highest amount of Vitamin C and phenolic compounds, mid values of dry matter and carbohydrates and smallest quantity of anthocyanins.
- The strawberries were naturally dehydrated 27 hours at 50° C, without adding anti-caking agents, preservatives or other treatment. Thus, the final products were wholly natural and healthy. The biggest weight reduction was recorded at *Premial* strawberries harvested in June 2021, followed by those of September 2020. In the water loss process, as the fruit has smaller amount of carbohydrates and dry matter and higher amount of Vitamin C, the water contained in its tissues is easier released.
- Statistical processing of the meteorological parameters was done using the method of linear regression. Analysing the meteorological data, in Mars, April September and October were recorded the highest thermal amplitudes in the last four years. The significant amplitudes of summer months, mainly August, determined the plants to produce second fruiting at the beginning of autumn.
- From 2018 till 2021, the amount of rainfall has substantially decreased, in 2021 the water amount being near half of that recorded in 2018.
- Due to the decrease of rainfalls and drought tendency, even in the hilly areas of Romania, the irrigation system for strawberry's cultivation became compulsory.
- During 2018-2021, in the period of April - June, the average of maximum tempera -

tures decreased with near 4° C in 2021 in comparison with 2018; the average of minimum temperatures decreased with near 3° C in 2021 in comparison with 2018. The monthly average amplitude lost 1 degree in 2021 in comparison with 2018.

- Warm temperatures recorded at the end of winter and the beginning of spring have lead to earliness in the induction of the floral primordia. Thermal shocks produced by the late frost of mid spring conducted to significant plant injury, affecting its blooming and fruiting.
- The multiannual rainfall amount in 2007-2018 was with near 16% higher than the amount of 2018-2021. The multiannual average temperatures increased in the last four years with near1.5° C, due the increase of multiannual minimum temperatures with near 1° C, while multiannual maximum temperatures recorded very close values. Thus, the thermal amplitude in the interval 2007-2018 was with near 1% higher than the amplitude of 2018-2021.
- The weather information collected between 2007-2021 highlight the climate change and the weather tendency to drought and higher temperatures in cold season, determining a lighter contrast between winter and summer.

ACKNOWLEDGEMENTS

We are grateful to the National Agency of Meteorology which supported this scientific paper by providing accurate information relating the values of the main meteorological parameters in the period 2008-2017 at weather monitoring station Pitesti, Arges County, Romania.

REFERENCES

1. Bjarnadottir, Adda. (2019). “Strawberries 101: Nutrition Facts and Health Benefits.” Red Ventures, Health line Media.https://www.healthline.com/nutrition/foods/strawberries.
2. Chitu E., Balaluta L., Mazilu I., Chiuta F. (2020). Influența condițiilor climatice din primavara 2020 asupra speciilor pomicole cultivate la ICDP Pitesti-Maracineni. https://icdp.ro/wp-content/uploads/2020/06/Revista-BS-I-1.pdf. nr. 1/2020.
3. Cox, Alicia. (2021). “10 Surprising Ways Strawberries Can Benefit Your Health.” Reader’s Digest Magazines, Best Health Magazine. https://www.besthealthmag.ca/list/strawberry- health-benefits.
4. De Bellefonds, Colleen. (2019). “9 Ways Strawberries Can Protect Your Heart, Brain, Immunity and More.” Hearst Magazine Media, Prevention. https://www.prevention.com/ food/nutrition/healthy-eating/a26537540/health-benefits-of-strawberries.

5. Giusti MM, Wrolstad RE. (2005). Characterization and measurement of anthocyanins by U.V.- visible spectroscopy. Unit F1.2. In: R.E, Wrolstad, S.J, *Handbook of food analytical chemistry*. Wiley New York; 19-31.
6. Harris, Kate. (2020). “Why vitamin C is important for your eyesight.” A. Vogel, avogel. co.uk. https://www.avogel.co.uk/health/eyes/why-vitamin-c-is-important-for-your-eyesight.
7. Heinze P.H. Murneek A.E. (1940). Comparative accuracy and efficiency in determination of carbohydrates in plant material. Research bulletin 314. University of Missouri, College of agriculture, Columbia, USA.
8. Johansen, D.A. (1940). Plant Micro technique. McGraw-measurement with the Folin phenol reagent. J. Hill Book Co. New York: 523.
9. Kumar C. S., Mythily R., Venkatachalapathy R., R. Venkatachalapathy, Chandraju S. (2014). Bio-chimic conversion of Maida (polysaccharides) to reducing sugars by acid hydrolysis and its estimation using standard methods. Int. Food Res. J. 21(2):523-526.
10. Le Maguer M. (1988). Osmotic dehydration: review and future directions. Proc. Int. Symp. On progress in food preservation organized by CERIA, Centre of Ed. and Res. on Food and Chem. Industries, Brussels, Belgium.
11. Maki J. (2012). “Berries keep your brain sharp.” Harvard University, The Harvard Gazette. https://news.harvard.edu/gazette/story/2012/04/berries-keep-your-brain-sharp.
12. Meena S., Sarma R.K., Dwivedi V. (2017). Trans-cryotomes insight into terpenoid and carbazole alkaloid biosynthesis and functional characterization of two terpene synthases in curry tree (*Murraya koenigii*). Sci Rep. 7:44126.
13. Moll J., Fogoros, J. Richard N. (2019). “Can Strawberries Lower Your Cholesterol?” https://www.verywellhealth.com/can-strawberries-lower-your-cholesterol-697913.
14. Oszmiański J., Lachowicz S., (2016). Effect of the production of dried fruits and juice from chokeberry *(Aronia melanocarpa L.)* on the content and anti-oxidative activity of bioactive compounds. Molecules, 21(8).
15. Özgen M., Scheerens J.C, Reese R.N., Miller R.A. (2017). Total phenolic, anthocyanins contents and antioxidant capacity of selected elderberry (*Sambucus canadensis L.*) accessions, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2950382.
16. Perkins-Veazie PM, Collins JK. (1993). Quality evaluation and postharvest procedures for small fruits. Lane, OK: USDA-ARS South Central Agricultural Research Lab.
17. Petkovic M., Durovic I., Miletic N., Radovanovic J. (2019), Effect of Convective Drying Method of Chokeberry (*Aronia melanocarpa L.)* on Drying Kinetics, Bioactive

Components and Sensory Characteristics of Bread with Chokeberry Powder, Periodica Polytechnica Chem. Engineering, 63(4).

18. Ponting J.D., Watters G.G., Forrey R.R., Jackson R., Stanley W.L. (1966). Osmotic dehydration of fruits. Food Technol.
19. Salk Institute. (2006). "Natural chemical found in strawberries boosts memory in healthy mice."Science Daily. https://www.sciencedaily.com/ releases/2006/10/061017164401.htm.
20. Stan F. (2013). “Aplicarea Metodei regresiei în calculul indicatorilor riscului economic.” Romanian Statistical Review no 8. https://www.revistadestatistica.ro/wpcontent/uploads/ 2014/02/RRS_08_2013_a4ro.pdf.
21. Vaidya B.N., Brearley T.A., Joshee N. (2013). Anti-oxidant capacity of fresh and dry leaf extracts of sixteen *Scutellaria* species. J. Med Active Plants. 2(3):42-49.
22. Yadav A.K., Singh S.V. (2014). Osmotic dehydration of fruits and vegetables: A review. J. of Food Science and Technology -Mysore- 51(9), DOI: 10.1007/s13197-012-0659-2.
23. Yi W., Wetzstein H. (2010). Biochemical, biological and histological evaluation of some culinary and medicinal herbs grown under greenhouse and field conditions. J. Sci. Food Agric. 90:1063-1070.
24. Wang S.Y. (2021). “Antioxidants and health benefits of strawberries.” actahort.org. https://www.actahort.org/books/1049/1049_1.htm.
25. https://en.wikipedia.org/wiki/coefficient of determination.
26. http://fermierulargesean.ro/cultura-profitabila-in-care-directorul-institutului-de-la Maracineni-ar-investi-toti-banii.15 October 2021).
27. https://www.indiaagronet.com/crop%20info/strawberry.
28. https://medlineplus.gov/potassium.html (“Potassium.” U.S. Department of Health and Human Services, Medline Plus).
29. 29. https://www.nvisioncenters.com/diet-and-eye-health/vitamin-C (“How vitamin C affects your eyesight”. N Vision Eye Centres).
30. https://www.saberhealth.com/news/blog/health-benefits-of-eating-strawberries.
31. https://www.saberhealth.com/news/blog/5-vitamin-c-benefits (“5 Scientifically Proven Benefits of Vitamin C.” Saber Healthcare Group.
32. https://strawberryplants.org/strawberry-nutrition-facts (“A Look at the Nutritional Value and Benefits of Strawberries.” StrawberryPlants.org, 2020).
33. https://www.taurodryers.com/en/b-master-line/b-master.
34. https://web.extension.illinois.edu/strawberries/facts.

35. https://www.webmd.com/diet/health-benefits-folate (Health Benefits of Folate. WebMD).
36. www.meteoromania.ro.
37. www.ogimet.com.