

STUDY OF SOME STRAWBERRY VARIETIES IN THE ORGANIC SYSTEM IN THE PEDO-CLIMATIC CONDITIONS OF THE VLASIA PLAIN

Cristian CĂLINIȚĂ, Damian DRAGOMIR, Cătălin Viorel OLTENACU

Fruit Research and Development Station Băneasa, 4 Ion Ionescu de la Brad Blvd, District 1,
Bucharest, Romania

Corresponding author email: calinita.cristian@scdpbaneasa.ro

Abstract

During 2019-2022 a study on organically grown strawberries (*Fragaria x ananassa* Duch.) was carried out, in order to find which most suitable variety for Vlasia Plain area is. The crop was established in 2019 in open-field cultivation, with four strawberry cultivars 'Asia', 'Clery', 'Roxana' and 'Thutop', mound cropping system, with 2 rows, mulched with agrotexile and drip irrigation system. The fruits were harvested and the damaged fruits were eliminated and 20 randomly selected marketable fruits were assessed. Fruit weight, diameter and firmness, sugar content and the pH, were measured. Regarding average fruit weight, 'Thutop' had the highest value (19.75 g/fruit), while the lowest 'Clery' (12.43 g/fruit). Regarding sugar content, 'Clery' had average value of 8.8% Brix and the highest firmness of 1.1363 kgf/cm². After three years of studies, it can be drawn the conclusion that 'Thutop' recorded the best and most stable results in terms of fruit weight. 'Thutop' has large fruits so it is recommended to be sold as fresh fruit. 'Clery' is recommended for industrialization and obtaining processed products due to the high sugar content.

Key words: strawberry, organic, cultivars, biometric, preliminary.

INTRODUCTION

The study aim was to determine the behaviour analysis of four strawberry cultivars with early maturation, cultivated in organic culture, targeting diversification of strawberry assortment, at the same time to capitalize the pedo-climatic conditions from the Vlăsia Plain. The strawberries (*Fragaria x ananassa*) chosen for our research are some of the most consumed fruits in the world, appreciated especially for their flavour. Strawberry fruit quality is defined by several characteristics and is influenced by genetic and climatic factors (Maltoni et al., 2009; Temocico et al., 2008).

The strawberry (*Fragaria x ananassa*) is a plant with a very high ecological plasticity that produces fruits economically in various climatic and soil conditions. They are among the first fruits to appear on the market in early summer, and can be consumed either fresh, or processed in the form of jam, compote, gummy bears, wines, juices, yogurt, cakes and ice cream. (N. Cepoiu et al., 2006).

Strawberry is the only herbaceous fruit species and due to this biological peculiarity it can easily

be cultivated in protected areas, ensuring fresh fruit crops all year long, by combining it with another characteristic biological, remontant.

In 1988, Romania produced 39,000 tons of strawberries per year, being the 15th largest strawberry producer in the world. And after due to a period of decrease of cultivated areas the production consequently decreased to 11,750 tons. Afterward, a slightly upward trend began, reaching a production of around 22,900 tons in 2020 (FAOSTAT 2020).

In order to support the small holds strawberry production cultivated by small farmers and to increase the area cultivated with strawberries by commercial farms, a study using technological input was done.

Having as main goal the production of ecological fruits, we did not use any kind of fertilizer, growth promoters, chemical or organic substance that would influence the production and or the quality of the fruits and no phytosanitary protection substances were used. The results were directly influenced on the natural fertility of the soil, the climatic conditions specific to the area, and the natural resistance of the varieties.

MATERIALS AND METHODS

During 2019-2022 a study on organically grown strawberries (*Fragaria x ananassa* Duch.) was carried out, in order to find which is the most suitable variety for Vlasia Plain area.

In 2019, the open-field cultivation of strawberries began at Research-Development Station for Fruit Tree Growing Băneasa. The crop was established in 2019 in open-field cultivation, with four strawberry cultivars: 'Asia', 'Clery', 'Roxana' and 'Thutop', using a mound cropping system, with 2 rows, mulched with agro textile and drip irrigation system.

The plantation was located on a reddish-brown forest soil, with a loamy-clay texture, and the following chemical properties:

- in horizon A 0-20 cm: a humus content of 4.04% and a pH of 7.5, organic carbon of 6.96 (105C), Nitrogen index 3.98 and mobile phosphorus 73.45;

- in Horizon B 20-40 cm: a humus content of 3.4% and a pH of 7.48, Organic carbon of 5.45, Nitrogen index 3.43 and mobile phosphorus 72.25.

Analyzing the agrochemical fertility indicators (PH, total organic carbon, humus content, mobile phosphorus content, and nitrogen index), determined before planting, it was found that the soil was characterized by a medium to good natural fertility.

The maintenance technology applied after the establishment of the experimental crops was minimal: weeds were removed 3 times between mounds and one time from the plant alveoli, regular irrigations and mowing were performed after the end of the harvest periods.

The mound was 25 cm and 70 cm wide between rows and 30 cm between plants in a row. The mounds were covered with black 100 g/m² density agro textile foil (Figure 1). Beneath the foil, drip tubes were placed with drippers at a distance of 30 cm and a flow rate of 4 l/h.

The four strawberry cultivars used within the study originated from Italy and present the following characteristics:

'Clery' - the fruit has an average weight of 19-25 g, regular conical shape, intense red colour and a very pronounced luster. The pulp is fleshy, juicy and aromatic, with a dry matter content of 9-10% Brix and high firmness. The fruits tend to shrink towards the end of the harvest, and under

abundant irrigation conditions, the plant is susceptible to rotting (Figure 2).



Figure 1. Mounds covered agrotexile



Figure 2. Mounds with Clery variety 2020

'Roxana' - variety with very large fruits, average weight of 25-30 g, conical-elongated shape, bright red colour, and a dry matter content of 5-6% Brix.



Figure 3. Mounds with Roxana variety in 2020

'Thutup' - large fruit, flattened conical shape, with the average fruit weight of 25-28 g, a very bright surface and a homogeneous red colour, exhibiting a pleasant appearance (Figure 4).



Figure 4. Thutup variety (appearance)

Asia -, the fruit is large with an average weight of 19-30 g, elongated conical shape, bright to dark red colour, with bit of a neck under the calyx, a good shelf-life and a dry matter content of 6-10% Brix. 'Asia' is tolerant against most common root-diseases.

On each cultivar an area of six consecutive average-sized plants was demarcated.

From these areas, four fruit samples were collected for measurements and analyze during the fruiting period each year, each sample consisting of 20 fruits chosen at random from the 6 demarcated plants.

A schematically presentation of the strawberry varieties used within this study is presented in Figure 5. The structural differences can be easily observed.



Figure 5. Strawberry varieties cultivated by SCDP Băneasa

The biometric and biochemical determinations performed in the laboratory during the 3 years of study were:

- the average weight of the fruit, determined by weighing a sample of 20 fruits in 4 repetitions from each cultivar, annually with an analytical balance Kern compact laboratory balance weighing range 300 g, readability 0.001 g;

- the diameter of the fruit determined with an electronic calliper, measuring range: 0-300 mm, resolution: 0.01 mm, accuracy: +/- 0.03 mm, registering the height, small diameter and large diameter;

- the firmness of the fruits determined with a manual penetrometer FT-327 expressed in kgf/cm²;

- the sugar content of the samples, determined by the refractometric method, with the ATAGO ATC-1E refractometer, expressed in % Brix.

RESULTS AND DISCUSSIONS

This study was conducted with the aim of growing organic strawberries crops, for family farms or small farms, without the use of treatments or nutrient additives, with minimal technological input on a multi-annual strawberry crop. Furthermore, the lifespan will be determined by crop yield

The evaluation of the varieties performed from the point of view of the quality of the fruits was a very important component. Two aspects were considered: firstly, small scale cultivation, intended for personal consumption, and secondly, large scale production, intended for sale, thus providing financial benefits to producer.

The main physical properties of the fruits refer to their size, represented by the average weight and size of the fruit. Other physical characteristics that can influence the quality of the fruits are: firmness, uniformity, colour, shine, perfume, position of the achiness on the surface of the fruit.

If the size of the fruit is easy to determine, the quality expressed by the taste of the variety is more complex and depends on many factors, including the human one. Among the most important aspects to consider is the sugar content and the pH of the fruit.

In Table 1 are presented the size determinations of the studied cultivars.

If we compare the weight of the fruits obtained in the experimental field with the reference data associated with each studied cultivar, it can be observed that our specimens are much smaller. An explanation for this discrepancy is the manner in which the crop was cultivated. It can be assessed that the resulted specimens exhibited more reduced dimensions that the

standard, due to the lack of any additional fertilizers or growth stimulators.

Table 1. Average annual fruit size

Year of study	Cultivar	Weight [g]	Height [cm]	Small diameter [cm]	Large diameter [cm]
2019	Clery	11.3346	3.5550	2.0163	2.6713
	Roxana	19.1952	3.9775	2.8463	3.4401
	Asia	17.2461	3.9688	2.5250	3.2475
	Thutup	20.2308	3.9625	2.6188	3.4675
2020	Clery	14.8934	3.5863	2.7650	3.0000
	Roxana	21.0414	4.1725	2.9525	3.3413
	Asia	19.0010	4.1363	2.8238	3.1650
	Thutup	20.5951	4.0013	2.9113	3.2800
2021	Clery	11.0770	3.3985	2.4747	2.6904
	Roxana	17.3318	3.5705	2.6423	2.9354
	Asia	15.3480	3.9161	2.5566	2.8330
	Thutup	18.4149	3.6512	2.8150	3.1517

For example, in the case of ‘Clery’ variety, which produces the smallest fruits in our study, the standard description mentions fruits weighing between 19 and 25 g. The fruits obtained within our experiment, registered a weigh between 5.9 g, obtained in the last 2019 harvest and 29.63 g, obtained in the first 2020 harvest in, with a multiannual average of 12.43 g/fruit. The ‘Thutup’ variety, which stood out in size in the organic study, is also no closer to the characteristics provided by the standard description. The smallest fruit weighing 7.7 g was harvested in the fourth harvest of 2019 and in the same year, while the largest ‘Thutup’ strawberry was produced in the second harvest of the same year, weighing more than 40.56 g. The ‘Thutup’ variety has a multiannual average of 19.75 g. Other differences are presented in (Chart 1).

The firmness analysis evidenced that a smaller fruit have a better firmness than the larger ones. ‘Clery’ variety had the firmest fruits with a multiannual average of 1.1333 kgf/cm², results of the other varieties being close to each other. For ‘Thutup’ a firmness of 0.9128 kgf/cm² was registered, for Asia variety 0.8663 kgf/cm² and for ‘Roxana’, 0.8492 kgf/cm² (Table 2).

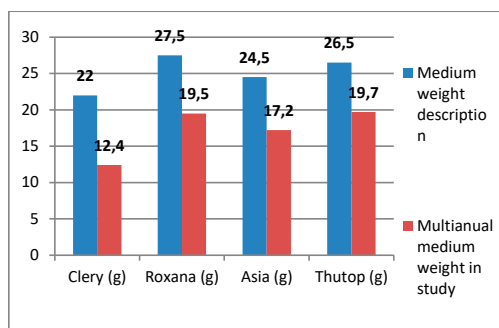


Chart 1. Weight between variety description and study

Table 2. Annual average fruit firmness

Year	Cultivar	Firmness [kgf/cm ²]
2019	Clery	1.1378
	Roxana	0.8436
	Asia	0.8606
	Thutup	0.9068
2020	Clery	1.0170
	Roxana	0.8938
	Asia	0.8925
	Thutup	0.8600
2021	Clery	1.2450
	Roxana	0.8103
	Asia	0.8458
	Thutup	0.9717

If we are going to produce organic fruit for self consumption, as is usually done on family farms, the most important aspect is not the size of the fruit but its taste, a factor influenced by the amount of sugar and its acidity.

Considering this aspect, analysis of the biochemical characteristics of the fruits, consisting of the sugar content (expressed in % BRIX) and pH, was performed using the same fruits subject to biometrically measurements Annual average results were presented in Table 3.

Table 3. Annual average sugar content and pH

Year	Cultivar	Sugar content [% Brix]	Ph
2019	Clery	9.3850	3.8700
	Roxana	8.4263	3.9150
	Asia	7.9563	3.8425
	Thutup	8.3000	3.8775
2020	Clery	8.3350	3.8537
	Roxana	6.0025	3.9200
	Asia	7.0675	3.7800
	Thutup	6.1550	3.9470
2021	Clery	8.6765	3.6386
	Roxana	7.2710	3.7500
	Asia	6.7408	3.6966
	Thutup	7.5093	3.9470

Strawberry fruit quality is defined by several characteristics and is influenced by genetic and climatic factors (Maltoni. et al., 2009; Temocico et al., 2008).

If we consider strawberry cultivars adaptability in our region, we must also mention the most important climatic factors that influenced the study in these 3 years, data presented according to the site <https://rp5.ru/> In terms of climatic conditions, the 3 year period of the experiment were not ideal for strawberry crops, large fluctuations being remarked between consecutive years. The air temperatures and precipitations registered within the studied period are presented in Table 4.

Table 4. Annual meteorological parameters

Meteorological parameters		Period	1-30 April	1-31 May	1-13 June
Air temperatures °C	Average of highs	2019	25.9	28.2	31.8
		2020	26.5	29.7	31
		2021	24.4	29.1	26.8
	Monthly average	2019	11	16.6	21.5
		2020	11.6	15.7	19.2
		2021	9.3	16.4	16.9
	Minimum average	2019	-1.7	5.5	12.9
		2020	-2.9	3.9	6.1
		2021	-4	2.4	9.7
Atmospheric precipitation (monthly amount mm)	2019	77	129	33	
	2020	19	89	11	
	2021	35	100	59	

Data from sites <https://rp5.ru/>

In 2020, during the fruiting period the temperature was quite high and little precipitation was registered. Thus, it was necessary to supplement the water supply by irrigation. On the other hand 2021 was a year with temperatures below the normal average in April and May with abundant rainfall at the beginning of June, and temperatures higher during the night, created optimal conditions for the development of *Botrytis cinerea* Pers. fungus, which caused great damage to the strawberries (Chart 2).

Holger Daugaard write in the paper Cultural methods for controlling *Botrytis cinerea* Pers. in strawberry, published in *Biological Agriculture & Horticulture* (2016): “*Botrytis cinerea* undoubtedly is the most important strawberry disease which, in conventional farming, is controlled by chemical fungicides during flowering. In organic farming, however, there is a need for the development of non-fungicide methods of control.

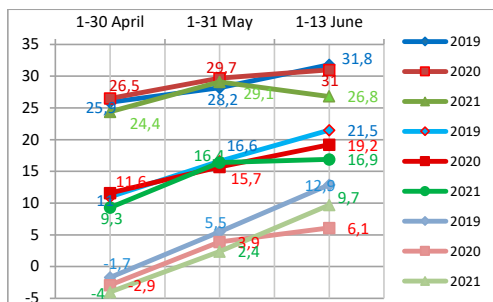


Chart 2. Evolution of annual minimum, average and maximum temperatures °C during fruit growth and harvest

Climate condition and factors could be the answer for smaller fruits obtained in 2021 according to Chart 3

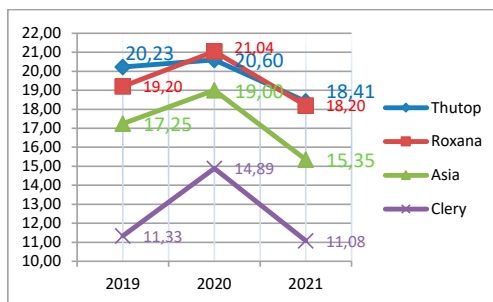


Chart 3. Annual average fruit weight

In this review cultural methods for controlling *B. cinerea* in strawberry are discussed. Although several methods have a documented effect in controlling *B. cinerea*, it is concluded that there are no methods - individually or in combination - capable of controlling this disease satisfactorily. Non-fungicide management of *B. cinerea* requires a dynamic and flexible approach to agroecosystem management.” That is why in this study we manually removed all fruits with signs of fungus contamination from the earliest stages, aiming order to reduce the sources of infection. (Figure 6)



Figure 6. *Botrytis cinerea* Pers. fungus on the 'Asia' variety, in 2021

The production of 2021 was affected in all varieties by a mixed attack the *Botrytis cinerea* fungus and the *Deroceras agreste* pest (also favoured by the humid and warmer climate of 2021). The most affected cultivar was 'Asia' variety with 31% affected fruit followed by 'Roxana' and 'Thutop' with 23% and 21% respectively. The least affected variety was 'Clery', with only 17% compromised specimens.

CONCLUSIONS

Upon complex analysis of the main factors that influence the success of organic strawberry crop cultivation, it can be concluded that: 'Clery' (Figure 7) is the most suitable cultivar for being used in organic farming for family or small farms. This variety can be cropped for personal use (fresh or processed as jams, compotes and freezers) because it tastes better due to its high sugar content (8.8 Brix average and high fruit firmness).

For commercial farms that produce organic strawberry fruit for sale, following our study the 'Thutop' variety has shown the best characteristics having large fruits, with a constant production and a good resistance to the *Botrytis cinerea* Pers fungus.



Figure 7. Clery fruit

The agricultural technology used within this study was minimal, easy to apply by anyone with low costs, which makes it very profitable and healthy. Further research is needed in order

to establish whether the crop that was used for this 3 year study could be exploited for another years in terms of crop profitability.

ACKNOWLEDGEMENTS

The research activity was carried out with the support of all employees in the research and development departments of the Research-Development Station for Fruit Tree Growing Băneasa, in the period 2019-2022. This paper was elaborated within the PNCDI project. 4553/03.10.2018 financed by Academy of Agricultural Sciences "Gheorghe Ionescu-Șișești", Section: Horticulture.

REFERENCES

- Anna F.D., Iapichino G., 2002. Effects of runner order on strawberry plug plant fruit production. Proceedings of the Fourth International Strawberry Symposium, *Acta Horticulturae*, 1 (567): 301-303.
- Borlan Z., Hera C., 1973. *Metode de apreciere a stării de fertilitate a solului în vederea folosirii raționale a îngrășămintelor*, Ed. Ceres, București, pag 64-99
- Botu I., M. Botu, (1997). *Metode și tehnici de cercetare în pomicultură*, Ed. Conphys, 240-257.
- Ghena, N., Braniște, N., Stănică, F. (2010). *Pomicultură generală*. Otopeni, RO: Invel Multimedia.
- Holger Daugaard (2016). Cultural methods for controlling *Botrytis cinerea* pers. in strawberry, *Biological Agriculture & Horticulture*.
- Ion Caraman (2005). *Cultura căpsunului*, Chisinau.
- Isac I., Coman M., Olteanu A., Voica Ghe. (2005) *Ghid pentru cultura căpsunului*. Ed. Pământul, Pitești, pg. 15.
- Maltoni, M. L., S. Magnani, M. Ranieri, W. Faedi, (2009). *Principali fattori che influenzano la qualità delle fragole*, Atti del Convegno, Ed. Rallo Officine Grafiche, Italia.
- Mladin P. M. Coman, I. Ancu, C. Diaconu, Ghe. Mladin, E. Oprea, D. Al. Ionesc, D. Mihiescu, S. O. Ionescu, Paltineanu C (coordonator) (2008). *Ghid - Pomicultura durabilă: De la genotip la protecția mediului și sanatare umana*, capitolul II., din pachetul de lucru WP 1 - *Arbuștii fructiferi*, pg. 65-94. Editura Estfalia București, ISBN 978-973-7681-43-0
- Monica Sturzeanu, Mihail Coman, Irina Ancu (2014). Influence of harvest time on fruit quality of some strawberry cultivars. *Fruit Growing Research*, Vol. XXX.