

CHOICE OF STRAWBERRY VARIETIES BY THE ROMANIAN GROWERS

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Abstract

Strawberry is an early species, producing at short time after planting, according to crop technology and variety. Strawberry growing is profitable by extending the ripening and delivering periods, using economically feasible techniques and new valuable varieties. Strawberry fruit quality is defined by several characteristics and is influenced by genetic factors, crop location and growing methods. The purpose of the study was to identify the Romanian strawberry growers' needs, limitations and pathways in order to put forward the traits which can influence the choice of varieties by the strawberry growers, as a solution for their sustainability. The main limitation identified was the strawberry varieties used in their crops, beyond the dominance of unprotected consecrated crop technologies with low-density. In this respect we have highlighted some traits of strawberry varieties which can influence the future choices of Romanian growers: harvesting season, desired characteristics of fruit quality, and plant architecture related to production potential and stress factors.

Key words: strawberry, variety, choice, growers.

INTRODUCTION

Strawberry (*Fragaria x ananassa* Duch.) is a perennial herbaceous plant characterised by the adaptability to growing conditions. It is the only fruit species whose history is entirely known [9]. His appearance, as new species, is the result of interspecific crossing between *Fragaria chiloensis* L. originated from South America and *Fragaria virginiana* Duch. originated from North America [32]. According to Staud (1999), "the large-fruited garden strawberry was developed in Europe between 1714 and 1759" [34].

The strawberry is one of the most fascinating species that was spread on all continents. The reasons are connected to the agronomic success and consumer's preference. First of all, strawberry is characterised by a huge plasticity in growing and developing, which was 'exploited' over time through agronomic techniques [4]. Due to high production potential, commercial success, fruit quality, the high content of C vitamin, ellagic acid, folic acid, and other nutrients [21; 22; 23; 25],

strawberries is one fruit species with important economic interests, particularly in agri-food industry and medicine, as a recent concept in health [7; 12; 21; 33].

From the end of 18th century till now a tremendous number of cultivars were created by the breeding programs over the world [14]. Mezzetti (2013) appreciates the remarkable progress in understanding this species over the last decades, and as tangible results many valuable varieties were created. Another idea highlighted by the author is that the research results regarding nutritional value of fruit and vegetables can be used to human health [27].

Strawberry is an early species, producing fruits in a short time after planting, according to crop technology and variety. Strawberry growing is profitable by extending the ripening and delivering periods, using economically feasible techniques and new valuable varieties which produce consistent and competitive [3; 5; 26; 34].

The purpose of the study was to identify the Romanian strawberry growers' needs, limitations and pathways in order to put

forward the traits which can influence the choice of varieties by the strawberry growers, as a solution for their sustainability.

MATERIALS AND METHODS

The study was carried out in 2016 and it was performed within a research project financed by the Bridge Grants Romanian Program. In this respect the qualitative research was used with case studies method - linked to the specific Romanian strawberry growing areas. The techniques used for data collection were the following: observation, documents analysis, focus group, and finally the analysis and interpretation of qualitative data.

Whether in the quantitative research there are used various tools in view to collect data, in qualitative research the main instrument is the researcher [15]. In this case, the researcher had decided what questions to ask, in which order, noting his own observations and received responses.

The entry into research space was done through a series of preliminary presentation meetings, participating in some informal activities, and giving informal technical advices in strawberry crops.

The findings of qualitative research were related to the rigor of the research process, on the quality of data collected, on the depth and complexity of data analysis, to which are added the researcher abilities [10].

RESULTS AND DISCUSSIONS

Considerations about strawberry growing and variety choosing

Even though today, strawberry growing in the world is in fully development and varietal assortment has known a continue dynamic, the area harvested in Romania for the last decade (2004-2014) registered a downtrend (-132 ha). However, the reported data for decade 1994-2004 highlight an uptrend (+954 ha) (Table 1).

Analysing the area harvested in other countries with long tradition in strawberry growing, we can highlight different specific trends. Thus, Poland has maintained his positive trend over the last 2 decades,

(+6,184/+285 ha) in comparison with France which registered a downtrend over the last 2 decades (-2,528/-417 ha). It is very interesting to notice the positive trends for the strawberry area harvested in United States of America in both decades, respectively +1,041 ha for the decade 1994-2004, and +3,438 ha for the decade 2004-2014 (Table 1)

Table 1. The evolution of strawberry area harvested for the last two decades (ha)

Country	1994	2004	2014	Differences 2004-1994	Differences 2014-2004
Romania	1,600	2,554	2,422	+954	-132
Poland	46,204	52,388	52,673	+6184	+285
France	5,737	3,609	3,192	-2128	-417
United Kingdom	5,250	3,450	4,535	-1800	+1085
United State of America	19,760	20,801	24,239	+1041	+3438

Source: <http://www.fao.org/faostat>

Analysing the yield at the surface unit in connection with the area harvested over the last 20 years for Romania and the countries with long history in breeding and growing strawberry, we are remarking a constant increasing of the yield in each country even the area harvested has increased or decreased. Concerning the yield of strawberry crop, it is important to notice the difference between the level of the strawberry yield in Romania, in comparison with the yield registered in France, United Kingdom and United States of America. The yield of strawberry crop in Romania has known an uptrend (+ 1.66 t/ha) for decade 1994-2004, and downtrend for the last decade 2004-2014 (- 0.29 t/ha) (Table 2).

Table 2. The evolution of strawberry yield for the last two decades (t/ha)

Country	1994	2004	2014	Differences 2004-1994	Differences 2014-2004
Romania	7.69	9.35	9.06	+1.66	-0.29
Poland	3.65	3.54	3.84	-0.11	+0.3
France	14.29	14.81	18.46	+0.52	+3.65
United kingdom	7.90	15.22	23.02	+7.32	+7.8
United State of America	37.87	48.27	56.59	+10.4	+8.32

Source: <http://www.fao.org/faostat>

The huge level of the yield registered in 2014 in France (18.46 t/ha), United Kingdom (23.02 t/ha) and United States of America

(56.59 t/ha) reflects the advancements in growing systems despite of many economic or environment restrictions, and also in identifying the new and durable varieties adapted to the different integrated crop management strategies (Table 2).

In Romania, according to the last official data provided by the county directorate for agriculture, the important strawberry crops are located in following counties: Satu-Mare, Vâlcea, Gorj, Dolj and Bihor, covering small areas from North-West and South-West. In 2016, the total strawberry area harvested reported for the mentioned regions was 1,723 ha.

Over the world, the most used crop system is under permanent and temporary structures like greenhouses, higher or smaller tunnels. Nevertheless, in Romania strawberry is cultivated in open field and multiannual crops. According to county directorates for agriculture above mentioned, 98.99% from total strawberry area harvested is in open field and multiannual crops. Small areas (1,01%) are harvested from protected crops in high tunnels (0.94% multiannual crops and 0.07% annual crops). The most frequent used varieties, in all regions, are the following: Elsanta, Premial, Magic, Coral, but also other few varieties were reported, respectively: Benton, Marmolada, Aiko, Talisman, Senga Sengana, Idea, Alba, Albion, Select, Portola, Elegance, Dana, Elsignore, Clery, Joly. So, the most cultivated varieties (approx. 70% of the total) were Premial and Magic (Romanian varieties), followed by Senga Sengana and Elsanta (foreign varieties). In the last decade it began to be launched in new crops other Romanian varieties like Real, along with Mira and Alba, and for small areas were registered the following varieties: Joly, Clery, and Albion.

Beyond the tradition linked to this species and the conservatism of some growers, the assortment of varieties was changed by the impact of strawberry fruits imported from other EU countries or other international markets. On the other hand, the proximity of a research or extension institutions plays an important role in grower's decisions.

Even if the range of strawberry varieties that

are used in Romania seems to be substantial and appropriate, many of the varieties listed in the Romanian Official Catalogue for Varieties of Agricultural Species do not fulfil the current needs of growers and consumers, and the choice of new varieties often is a serious problem for farmers growing strawberry.

But how growers can choose the appropriate variety to their specific conditions?

A competitive strawberry variety should achieve some important overall characteristics: high yields (600 - 1,000 g per plant) of medium or large fruit (for fresh consumption respectively processing); uniformly coloured skin; regular shape and balanced taste; the edible part (false fruits) should have a good behaviour during the transportation and handlings; an advantage for June-bearing varieties is the short harvesting period (15-25 days) and uniformity of fruits size during the harvesting process; a valuable variety, grown in an appropriate crop management, preserves the shape of the fruit during the harvesting, especially for those which have conic or globose conic shape; last but not the least traits should be the resistance or tolerance to abiotic stress factors (for open field crops, e.g. sudden changes in temperature, humidity and light) and biotic stress factors (pests and diseases).

The strawberry breeders are in a permanent searching for particular characteristics of varieties, according to growers' needs and consumers' demands. Cultivar trials and germplasm collection, which involve representative strawberry cultivars and selections, are organised and managed to collect data and information or particular pathways to new varieties.

Today, three characteristics on strawberry fresh fruits quality seems to be more prioritized by the breeders and growers on one hand and preferred by the consumers on the other hand: fruit firmness, nutritional value and flavour [1; 12; 27; 31]. Each of characteristics is influenced by the regional climatic specificity. Also, the regional climatic differences can influence the preference of consumers to the skin colour, shape or aroma of the fruit [27; 34].

New created varieties/genotypes with their

superior characteristics can successfully replace those consecrated, but, unfortunately they are not known enough by growers and consumers. Strong demand for strawberries fresh-fruits in Europe or over the world has a strong impact on developing of new growing systems which can valorize the potential of the variety [26; 27; 36].

There were identified some specific influences that may define the future choice of Romanian farmers concerning the strawberry varieties.

Extending harvesting season through appropriate varieties

Strawberry varieties are classified in: June-bearing (short-day), Everbearing and Day-Neutral. June-bearing varieties produce one large harvest on the year (early, middle and late varieties), Everbearing two and sometimes three harvests on the year (spring, late summer and autumn). Day Neutral varieties produce fruits throughout the year if the growing conditions are appropriate [2].

Strawberry fruit can achieve his specific size and maturity around 30 days. The length of this period is strong dependent on the most important crop factors: soil composition, light, temperature, place of cultivation [18; 36].

Each type of variety, Day-neutral or June-bearing, has his own specificity that contributes to the extension of harvesting period [19].

Till the present, in Romania, commercial strawberry crops are preponderant organised with June - bearing varieties. The explanation is given by the Romanian consumers' behaviour according to which the strawberry domestic commercial production provides to the market the first fresh fruit and consumers associate the strawberry fruits with the first fresh fruit ripened in the spring season. The study results shown, on the other hand, that the Romanian consumer's preference for the late summer and autumn seasons fruits like apples, peaches, grapes, seems to be the cause of June-bearing varieties growing.

Day-neutral varieties are not very much cultivated in Romania, excepting experimental trials and small areas in home gardens for domestic consume.

Beyond the sensorial characteristics of fruits

and traditionalism, the Romanian consumer is opened to new products and new varieties to the extent that the market is providing. Here comes the role of Romanian breeders and growers, which may interfere with the consumer preferences or choices.

The extension of harvesting period by using new June-bearing and Day-neutral varieties with different harvesting seasonality and different growing technique, adapted to specific regional conditions, represent a package of solutions linked to the consumer satisfaction on one hand, and on another hand to the grower economic interest.

Demanded attributes of strawberry fruit quality

In Romania, the strawberry production is regional or locally marketed. As main crop type, the open field crop delivers fruits to the markets from late May to late June when the weather started to be characterised by higher temperatures. So, the fruits appearance based on firmness, size, shape, colour and flavour has to be favourable and preserved during the transportation and storage.

The fruit firmness is a specific fruit characteristic developed by the variety and strong influenced by the crop conditions, during the fruits growing, till maturity [6]. Fruit firmness is much more associated with the modern varieties. The fruits firmness is the result of flesh fruit firmness and fruit skin strength. Also the strawberry fruit firmness is an important characteristic linked to handling, transportation, shelf life and resistance to fruit [8; 20; 14]. 'Elsanta' variety has gain the better position of most cultivated varieties in Europe, and also in Romania, mainly due to its fruit firmness and acceptable appearance after transportation and storage [19; 20; 36]. In terms of influences to the fruit firmness given by the fertilizers with calcium, the research results performed in this field do not confirm the belief that the foliar supplemental applications with calcium will increase the fruit firmness. Based on these findings, the concentration of calcium from leaf and fruit cannot be used as element in prediction of fruit firmness for the analysed varieties. According to some research results, "the calcium concentrations of fruit or leaves were

not factors in firmness determination, on any of the cultivars” [13].

The genotype influences the nutritional quality of strawberry fruits and the nutritional value can be increasing by breeding [1; 11; 24; 27]. The research results show that the total antioxidant capacity and the level of antioxidants were different on fruit extracts according to genotype. Despite the importance of these findings, there were not many genotypes characterised [32; 35]. The relevant previous researches highlighted improvements in fruit nutritional quality on breeding material resulted from inter-specific crosses [12; 14; 24; 35]. According to Mezzeti (2013), the fruits of new selected strawberry genotypes with higher content of bioactive compounds can conduct to the valuable nutritional and nutraceutical fruit content [27]

Beyond the influence of growing conditions, further researches will enrich the knowledge to improving the nutritional characteristics of strawberry fruits in direct correlation with the genotypes [3; 5; 22; 23; 25].

Fruit aroma of strawberry is a unique and complex characteristic. Till now, over 360 volatile compounds have been noticed on strawberry, most of them being esters [35]. The volatile compounds, which differ as quantity and quality, are linked also to the variety and depend on the evaluation method, the maturity stage and postharvest storage conditions [16]. The aroma volatile depends on balance of sugar and acids [33]. The mechanism that make possible the aroma volatiles synthesis is not completely known. Future investigations will provide the pathways connected to the genetic and environmental interventions to improve or optimize the flavour during transport and storage [28; 30; 31]. The fruit maturation after harvest involves specific changes of aroma, in each variety investigated [35].

The various flavour of fruits is a result of strawberry genetic variability. The chemical diversity identified on fruits of different varieties is remarked and more, “certain profiles are more highly preferable” [31]. The volatile profiles of fruits of different varieties explain the consumer responses or

preferences. The varieties less preferable has volatile profiles with lower level of esters and higher level of γ -decalactone and hexanoic acid [35]. The diversity of strawberry genotypes is linked to the volatile phenotypical profiles [31].

Strawberry plant architecture related to production potential and stress factors

“Plant architecture describes the spatial distribution of vegetative and reproductive organs and their developmental phase” [17].

The plant growth is influenced by the variety types, crowns types, plants ages and growing conditions [17].

The strawberry plant develops a rosette from the growing point of the short stem called ‘crown’. In the early spring, young leaves, and then the inflorescences arise from the apical meristems of the crown. Branch crowns formed during the late autumn, along with the main crown, will ensure the yield of the strawberry plant. Main crowns and branch crowns are similar from structural point of view.

The varieties develop a different size of flowers and a different quality and number of flower parts, in accord with the position into the flower cluster. Bigger flowers develop bigger fruits and a good quality of floral parts shows the specific characteristic of fruit variety. Also, the number of inflorescences and their place to the crown can lead to the estimation of earliness, to the number of yields and total yield potential of the strawberry plant [29].

The quality of strawberry planting material is also an important factor that influences the strawberry yields and fruits quality, as expression of variety potential [26].

From plant propagation stage to differentiation and postharvest processes, the ‘life quality’ of plants belonging to different varieties is strongly influenced by biotic and abiotic stress factors. The quality of plant life, expressed in marketed potential yield of the variety, represents the balance between the level of controlled/influenced factors and stages of specific biological and physiological processes.

The main abiotic stress of strawberries plants is generated by the environmental factors. The

photoperiod influences the vegetative and reproductive growth and development. The light intensity and quality influences the bud flowers and number of inflorescences. The temperature influences the behaviour of vegetative and generative organs of strawberry plants on Short-Day and Day-Neutral varieties. Type of substrate, nutrient level and ratio between some nutrients affect the plant architecture, growth inflorescences development and number of flowers [5; 17; 28; 29]. The water supply and the salinity of water influence the number of branch crowns and flowers in strawberry plant [3].

The main biotic stress factors connected to the variety are diseases and pests. The strawberry breeding programs have continuously, as essential part, the breeding for diseases and pests [18]. The grower's 'fight' with disease and pests is expensive one if they don't understand the correlation between causes and effects in the interaction variety/plant – environment factors. Nevertheless, the choice of varieties improved with constant diseases and pests resistance successfully completes the strawberry production system.

The grower decision should be governed by following elements: crop location, growing methods, and specific abiotic and biotic stress factors.

CONCLUSIONS

Despite the fact that the strawberry crop is grown, over the world, under permanent and temporary structures like greenhouses, higher or smaller tunnels, the crop systems most used in Romania are open field and multiannual crops (98.99%), while protected crops have very small surfaces (1.01%).

The most cultivated varieties in Romania (approx. 70% of the total) are Premial and Magic (Romanian varieties), followed by Senga Sengana and Elsanta (foreign varieties). In the last few years it started to be launched in new crops other Romanian varieties like Coral and Real, along with Mira and Alba, and for small areas were registered varieties such as: Joly, Clery, and Albion.

New created varieties/genotypes, with superior characteristics, can successfully

replace those consecrated, but, unfortunately they are not known enough by growers and consumers.

The specific influences that may define the future choices of Romanian growers' concerning strawberry varieties are the following: extending harvesting season, demanded attributes of fruits quality, and plant architecture related to production potential and stress factors.

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