

The influence of summer-bearing and everbearing strawberry varieties on crop productivity

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Abstract

Strawberries (*Fragaria × ananassa*) are one of the most important fruit crops in global horticulture, valued both for their high nutritional content and significant economic contributions. They are rich in vitamins, antioxidants, and essential nutrients, making them a popular choice among consumers. Due to their market demand and profitability, choosing the most suitable to cultivate under specific environmental conditions is critical for growers. This study focuses on the performance and profitability of two main types of strawberry varieties: Summer-bearing and everbearing. In particular, it examines their adaptability to the unique climatic and soil conditions present in the Western Region of Romania, an area known for its diverse agricultural landscapes. The research provides an in-depth analysis of various studies on Summer-bearing varieties such as 'Alba', 'Asia', and 'Aprika', which have shown strong adaptability and high yields in similar environments. These varieties are known for producing large, high-quality fruits during a concentrated harvest period. The study also includes everbearing varieties such as 'Hademar', 'Favori', and 'Bravura', which are characterized by their extended fruiting periods and ability to produce multiple harvests throughout the season. By comparing these varieties, the study aims to provide valuable insights into the most profitable cultivation strategies for strawberry growers in the region. The findings could assist growers in selecting the most suitable varieties based on yield potential, resistance to local pests and diseases, and overall market viability, ultimately enhancing both productivity and profitability.

Keywords: Production, Multiple Harvesting, Superior Quality

Introduction

Strawberries are among the most consumed fruits worldwide, valued for their taste, versatility, and substantial health benefits. They are rich in nutrients such as vitamin C, fiber, and antioxidants, which contribute to immune function and reduce oxidative stress, supporting overall health [4], [8].

In addition to their vitamin content, strawberries contain bioactive compounds like flavonoids, phenolic acids, and anthocyanins, which have been associated with reduced risks of chronic diseases, including cardiovascular disease and certain cancers, due to their antioxidant and anti-inflammatory properties [1], [15].

Western Romania has a temperate-continental climate with Mediterranean and oceanic influences. Summers are warm, averaging 20-25°C, while winters are cold, around 0-5°C. Annual rainfall averages 500-700 mm, with increased precipitation in spring and autumn, supporting diverse agriculture.

The cultivation of strawberries is primarily divided into two categories: Summer-bearing and everbearing varieties. Summer-bearing varieties produce one concentrated crop, usually in early summer, offering higher per-harvest yields. However, these varieties face challenges related to climate variability and require precise labor management during the short harvest period [6], [10]. Summer-bearing strawberries are also more resistant to some soil-borne diseases, especially when cultivated in high-tunnel systems that provide environmental control [11], [3].

Everbearing strawberries, on the other hand, offer an extended harvest period from late spring through early fall, providing a continuous supply of fresh fruit. However, their yields per harvest are generally lower than those of Summer-bearing varieties, and they are more prone to diseases such as *Botrytis cinerea* due to their prolonged fruiting period [9], [5]. The extended harvest cycle also increases labor requirements for fruit picking and quality management [12]. To address these challenges, new cultivation practices, such as the use

of disease-resistant cultivars and advanced irrigation systems, have been developed to enhance yield stability and reduce disease risks [7],[14].

Table 1 shows the export quantities of goods (measured in kilograms) from June 2023 to June 2024 to various countries, with Hungary, Italy, Moldova, and Poland being key importers. Notably, export volumes fluctuate across months, with significant amounts recorded for Poland, Belgium, and Moldova in certain periods, while other countries like Germany report minimal or no exports

Table 2 shows the export values in euros to various countries from June 2023 to June 2024. Notably, the export values to Hungary and Moldova experienced significant increases in February and April 2024, while exports to Italy rose sharply in March 2024. These fluctuations suggest varying demand patterns across the months, with particular surges seen in specific regions during these timeframes.

Table 1. List of importing markets for fresh strawberries exported by Romania, by quantity

Importers	2023-M06	2023-M07	2023-M08	2023-M09	2023-M10	2023-M11	2023-M12	2024-M01	2024-M02	2024-M03	2024-M04	2024-M05	2024-M06
	Exported quantity, Kilograms	Exported quantity,	Exported quantity, Kilograms	Exported quantity, Kilograms	Exported quantity, Kilograms	Exported quantity, Kilograms	Exported quantity,	Exported quantity, Kilograms	Exported quantity, Kilograms	Exported quantity, Kilograms	Exported quantity, Kilograms	Exported quantity, Kilograms	Exported quantity, Kilograms
World	7,902	0	260	276	96	155	0	1,783	1,152	13,478	67,154	869	2,949
Hungary	6,412	0	0	0	0	0	0	5	0	3,957	32,714	0	2,190
Italy	1,380	0	0	0	0	0	0	700	0	8,473	509	867	759
Macao, China	0	0	0	116	0	0	0	0	0	0	0	0	0
Moldova, Republic of	0	0	260	160	96	155	0	203	1,152	1,048	13,378	0	0
Poland	0	0	0	0	0	0	0	875	0	0	20,553	0	0
Belgium	110	0	0	0	0	0	0	0	0	0	0	0	0
Germany	0	0	0	0	0	0	0	0	0	0	0	2	0

Sources: ITC calculations based on Eurostat statistics.

Table 2. List of importing markets for fresh strawberries exported by Romania, by value

Unit : Euro thousand

Importers	Exported value in 2023-M06	Exported value in 2023-M07	Exported value in 2023-M08	Exported value in 2023-M09	Exported value in 2023-M10	Exported value in 2023-M11	Exported value in 2023-M12	Exported value in 2024-M01	Exported value in 2024-M02	Exported value in 2024-M03	Exported value in 2024-M04	Exported value in 2024-M05	Exported value in 2024-M06
	World	16	0	1	1	0	1	0	6	6	31	139	1
Hungary	11	0	0	0	0	0	0	0	0	8	67	0	4
Italy	3	0	0	0	0	0	0	3	0	17	1	1	1
Macao, China	0	0	0	0	0	0	0	0	0	0	0	0	0
Moldova, Republic of	0	0	1	0	0	1	0	0	6	5	28	0	0
Poland	0	0	0	0	0	0	0	1	0	0	42	0	0
Belgium	0	0	0	0	0	0	0	0	0	0	0	0	0
Germany	0	0	0	0	0	0	0	0	0	0	0	0	0

Sources: ITC calculations based on Eurostat statistics.

The aim of this research is to assess the productivity and quality of various strawberry cultivars under specific environmental conditions in Romania. By analysing the performance of Summer-bearing and everbearing varieties, the study aimed to identify cultivars best suited for fresh market production and processing, providing insights into effective selection for high yield and quality.

Materials and methods

The research was conducted over the 2020–2021 period in Cetariu, a region located in the Northwestern part of Romania, in Bihor County. This area, characterized by its specific climatic and soil conditions, provided a suitable environment for examining the growth performance of different strawberry cultivars. The experimental design was monofactorial, which included six distinct cultivars considered as variants, tested in three repetitions to ensure reliable and replicable results. Each variant consisted of a group of 30 plants, carefully managed to assess their productivity, disease resistance, and adaptability to the local conditions.

The statistical analysis of the data was performed using ANOVA (Analysis of Variance), a robust method to evaluate differences between the cultivars in terms of yield and other agricultural traits. This approach enabled to detect statistically significant variations and understand better how each cultivar performed under identical environmental conditions.

The biological material used in the study comprised six different strawberry cultivars, categorized into two primary types based on their fruiting habits: Summer-bearing and everbearing. The Summer-bearing varieties included 'Alba', 'Asia', and 'Aprika', known for producing a single, concentrated harvest in early summer. In contrast, the everbearing varieties 'Favori', 'Hademar', and 'Bravura', produced fruit throughout the growing season, from late spring through early fall, thus providing a continuous yield over a more extended period.

In this experiment, the control was established as the mean yield of all six cultivars. By using this approach, researchers could more accurately compare the performance of each cultivar relative to the average yield, highlighting any that significantly outperformed or underperformed in terms of productivity and resilience. This setup provided valuable insights into the suitability of each cultivar for regional cultivation, contributing to a better understanding of which varieties might be the most suitable for cultivation among local farmers in order to maximize yield and quality under the specific environmental conditions of Northwestern Romania

Results and Discussion

To establish the efficiency of Summer-bearing and everbearing varieties, Table no.5 presents strawberry yield during the harvest period for the Summer-bearing varieties.

From this table, it can be observed that the 'Alba' cultivar stood out with the highest strawberry yield, showing a production increase of 78.7% compared to the control, with a statistically very significant positive difference. The 'Asia' and 'Aprika' varieties recorded strawberry quantities above the experimental average, with 3.3 t/ha for the 'Asia' cultivar and 2.6 t/ha for the 'Aprika' cultivar. In both cases, the differences were statistically significantly positive.

Regarding the everbearing varieties, all recorded yields below the control level, ranging from 47.2% for 'Favori' to 59.6% for 'Hademar' of the control yield.

For all three varieties, the difference from the experimental average was statistically significantly negative. It is well-known that for Summer-bearing varieties, the harvest takes place within a relatively short interval, while the harvest period for everbearing varieties is much longer, from May to September/October. Depending on the climatic conditions in the area, the harvest period for everbearing varieties may be continuous or occur in waves.

The table no 4 shows the total strawberry yield for the six varieties studied, and in this case, the 'Alba' cultivar achieved the highest strawberry yield, with over 5 t/ha more than the experimental average. The difference was statistically significantly positive.

Similarly to the previous case, the 'Favori' cultivar had the weakest performance, achieving only 68.2% of the control yield. The difference from the experimental average was statistically significantly negative.

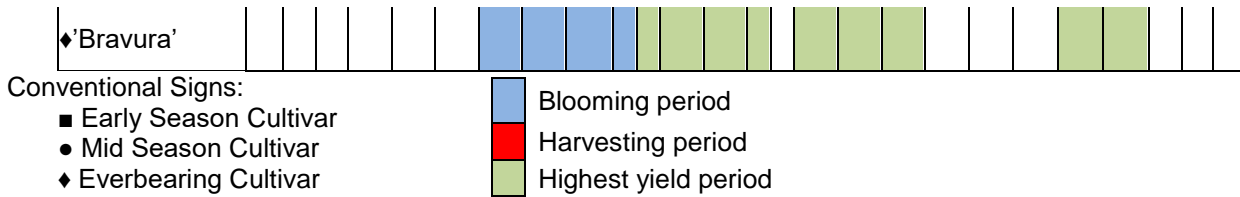
The 'Bravura' cultivar obtained a strawberry yield 3.42 t/ha lower, with this difference being statistically significantly negative.

The other varieties recorded yields close to the experimental average, either slightly higher or lower, but the differences did not exceed the p=5% threshold and were not statistically significant

Table 3 provides essential information regarding the differences in key phenological stages, including the onset of flowering, the initiation of fruiting, and the completion of the fruiting period. These data are crucial for understanding the growth dynamics and productivity potential of each cultivar under study.

Table 3. Phenological Stages

Cultivar/Months	J			F			M			April			May			June			July			August			September			O	N	D
				D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3						
Decades																														
■'Alba'																														
■'Asia'																														
●'Aprika'																														
◆'Favori'																														
◆'Hademar'																														



For assessing the quality levels of both Summer-bearing and everbearing varieties, Table 9 provides the total yield (t/ha) of each cultivar, alongside the yield categorized by quality grade. The data demonstrate that among Summer-bearing varieties, 'Asia' performed exceptionally well in producing extra-quality fruit, achieving an impressive 61.47%, followed closely by 'Alba' at 50.31%. Within the everbearing varieties, 'Bravura' stood out, with 54.79% of its total yield rated as extra quality. Of all six varieties in the study, 'Favori' yielded the lowest proportion of extra-grade strawberries, achieving only 44.11%.

Table 4. The strawberry yield from the first harvest

Crt. No.	Variant	Absolute production t/ha	Relative production %	± d t/ha	Significance
1	Average	10,72	100,0	0,00	Mt
2	'Alba'	15,90	148,3	5,18	xx
3	'Asia'	12,20	113,8	1,48	-
4	'Aprika'	11,50	107,3	0,78	-
5	'Favori'	6,73	62,8	-3,99	00
6	'Hademar'	10,70	99,8	-0.02	-
7	'Bravura'	7,30	68,1	-3,42	0

DL 5% = 2.45

DL 1% = 3.49

DL 0.1% = 5.05

Table 5. Strawberry total production

Crt. No.	Variant	Absolute production t/ha	Relative production %	± d t/ha	Significance
1	Average	8.9	100.0	0.0	Mt
2	'Alba'	15.9	178.7	7.0	xxx
3	'Asia'	12.2	137.1	3.3	x
4	'Aprika'	11.5	129.2	2.6	x
5	'Favori'	4.2	47.2	-4.7	00
6	'Hademar'	5.3	59.6	-3.6	00
7	'Bravura'	4.3	48.3	-4.6	00

DL 5% = 2.75

DL 1% = 3.92

DL 0.1% = 5.67

Quality Analysis Table Interpretation

Class 2 strawberries, typically considered lower in market value, are also noteworthy in understanding the quality of each cultivar. 'Bravura', for instance, displayed the highest proportion of Class 2 production at 26.02%, suggesting that a significant portion of its yield may not meet premium market standards. This high proportion of Class 2 yield indicates variability in quality, which might require further sorting or processing after harvest to optimize for quality consistency. Managing this variability can support market flexibility by allowing cultivars like 'Bravura' to cater to both high- and mid-range markets.

Table 6. Total yield and quality grade

Cultivar	Total Production	Extra Class		Class 1		Class 2	
		t/ha	%	t/ha	%	t/ha	%
'Alba'	15.9	8	50.31	7.1	44.65	0.8	5.03
'Asia'	12.2	7.5	61.47	3.4	27.86	1.3	10.65
'Aprika'	11.5	6.5	56.52	4	34.78	1	8.69
'Favori'	6.8	3	44.11	2.3	33.82	1.5	22.05
'Hademar'	10.8	5	46.29	4.1	37.96	1.7	15.74
'Bravura'	7.3	4	54.79	1.4	19.17	1.9	26.02

The careful evaluation of both total yield and quality grading in this study emphasizes that the 'Alba' and 'Asia' cultivars stand out not only for their high productivity but also for a considerable share of their output qualifying as extra-grade quality. This dual characteristic renders these cultivars exceptionally well-suited for premium fresh markets where top-tier quality is essential. The high-grade output from 'Alba' and 'Asia' aligns with consumer preferences in high-value segments, enhancing their market appeal for fresh consumption.

'Favori', while showing a comparatively lower overall yield, produces a larger proportion of Class 2 quality fruit. This makes it particularly appropriate for market channels that can manage diverse quality grades, such as the processing sector or bulk wholesale distribution, where the focus may be less on visual perfection and more on volume and price competitiveness. This allows 'Favori' to be strategically positioned in segments where Class 2 quality can still deliver economic value.

'Bravura' and 'Hademar', with balanced yields across both extra-grade and Class 2 quality categories, demonstrate notable versatility. This adaptability suggests that they could serve a dual-purpose role, catering to both fresh markets requiring premium quality and processed markets where consistency in yield is prioritized over grade. The ability of these cultivars to perform well across different quality categories highlights their potential to fulfill the demands of various market segments, from high-quality fresh sales to value-oriented processed products. This multifaceted performance across yield and quality metrics reflects a broad applicability, making these cultivars attractive choices for producers aiming to meet diverse consumer demands across the fresh and processed strawberry markets. A similar study by Kowalski et al. (2022) found comparable results regarding strawberry yield and quality, focusing on the differences between June-bearing and everbearing cultivars. Their research highlighted how environmental factors influenced total yield and fruit quality, with June-bearing varieties showing higher yields and everbearing varieties offering better quality fruit over extended harvesting periods,

Conclusions

Following the conducted research, the main conclusions are as follows:

- Strawberries are highly appreciated globally for their flavour, nutritional value, and bioactive compounds, which contribute to reducing risks of chronic diseases.
- Strawberry cultivation is split into Summer-bearing and everbearing varieties, each with distinct harvest periods and management requirements.
- Summer-bearing varieties yield high amounts of fruit in a single, concentrated harvest, making them ideal for markets with seasonal demand.
- Everbearing varieties produce fruit continuously over an extended season, catering to markets needing a steady supply but yielding less per harvest.
- Advances in strawberry cultivation techniques, such as disease-resistant varieties and high-tunnel systems, help improve yield and quality across both types.
- In Romania, Summer-bearing varieties have shown high adaptability to local climates, yielding significant productivity and high-quality fruit.
- Statistical analysis in the study highlights that the 'Alba' cultivar outperformed others, showing the highest yield of 15.9 t/ha and extra-grade fruit proportion.
- Everbearing varieties, though yielding lower quantities, provide steady production over multiple harvests, suited for both fresh and processed markets.
- Quality analysis reveals 'Alba' and 'Asia' as top choices for premium markets due to their high yield 15.9 t/ha /12.2 t/ha and quality output.
- Variability in quality among cultivars, especially in everbearing types, indicates potential flexibility for different market types, from premium to processing markets.

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