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THE INFLUENCE OF AGROECOLOGICAL CONDITIONS AND TECHNOLOGY ON QUALITY INDICATORS IN THE PLUM CULTIVARS 'ANNA SPÄTH' AND 'STANLEY' CULTIVATED IN THE SOUTH-EASTERN REGION OF ROMANIA

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Abstract

The fruit-growing sector in Romania faces continuous challenges related to climate variability, production efficiency, and market competitiveness, requiring farmers to adopt cultivars with high adaptability and profitability. This study analyzes the yield performance of two plum cultivars, 'Anna Späth' and 'Stanley', cultivated under the agroecological conditions of the Moara Domneasca Experimental Base, aiming to provide a scientific basis for economic optimization in fruit-growing farms. The data were collected during the 2024 production season, focusing on fruit yield per tree, biometric indices (fruit weight, height, diameters), physico-chemical traits (firmness, pH, soluble solids). The results indicate that 'Anna Späth' produced smaller but sweeter fruits, with an average weight of 16.5 g, mean height of 32.2 mm, and sugar content of 18.9% °Brix. In contrast, 'Stanley' recorded larger fruits, averaging 22.9 g in weight, 42.9 mm in height, and superior firmness (2.25 kgf/cm^2), though with a slightly lower sugar content of 16.5% °Brix. Morphological traits such as fruit diameters were consistently higher in 'Stanley', confirming its better structural quality and storage potential. These findings underline clear cultivar-specific differences, with 'Anna Späth' offering a sweeter profile, while 'Stanley' provides larger, firmer fruits more suitable for commercial markets. The findings support decision-making processes in farm management by identifying 'Stanley' as the most advantageous cultivar from an economic perspective, thus contributing to improved resource allocation and long-term sustainability in the Romanian plum sector.

Key words: *agroecological, fruit quality, climate resilience, farm management, plum cultivars*

INTRODUCTION

Fruit growing represents a strategic sector in Romania's agricultural economy, with plum (*Prunus domestica L.*) as the dominant species, accounting for nearly half of the orchard area and production value [12]. The adaptability of plum to diverse pedoclimatic conditions explains its prevalence, yet its economic role is increasingly challenged by climate variability, aging orchards, and market competitiveness [15,16].

The modernization of Romanian fruit farms requires the introduction of intensive orchard systems and cultivar-rootstock combinations that ensure higher yield stability, superior fruit quality, and improved profitability. Research has shown that the choice of rootstock significantly influences yield efficiency, fruit size, and adaptation to local environmental stresses [4]. Furthermore, breeding advances and the conservation of plum genetic diversity are essential for long-term sustainability, especially in the context of narrowing genetic bases in commercial production [14]. Usually in Romania plum blooms in mid-April depending on weather conditions [1].

At the economic level, plum production is characterized by large fluctuations in profitability. Studies from Romania and neighboring regions emphasize that profitability depends not only on cultivar performance but also on technological investments, market orientation (fresh vs. processing), and value-added products such as dried plums [3].

In Turkey and the Balkans, cost-benefit analyses confirm that cultivars like 'Stanley' combine high yield potential with relatively low production costs, making them more competitive in both domestic and export markets [17]; [8].

Recent experimental results also highlight the critical role of modern orchard management technologies: irrigation, fertigation, and pollination, in boosting productivity and economic returns.

Pollination alone accounts for up to 80% of fruit production value in Romanian orchards [11], while optimized fertilization and irrigation significantly enhance growth and yield in cultivars such as 'Stanley' [18].

Given these challenges and opportunities, the present study aims to compare the productive and economic performance of two major plum cultivars, 'Anna Späth' and 'Stanley', cultivated under the agroecological conditions of the Moara Domnească Experimental Base. Specifically, the research addresses the following questions: which cultivar rootstock combinations ensure superior yield efficiency and profitability? and how can these findings inform economic decision-making in Romanian fruit-growing farms?

MATERIALS AND METHODS

Location

The experiment was conducted at the Moara Domnească Experimental Base (Ilfov County, Romania), which belongs to the Research and Development Station for Fruit Tree Growing Baneasa(SCDP Baneasa), established in 2022 at the Moara Domneasca Experimental Station. The site is characterized by a temperate-continental climate with mean annual temperatures of 10-11 °C and average annual precipitation of 550-600 mm.

The study area is dominated by soils of the Luvisols class, with reddish Preluvosolsas the predominant soil type Reddish Luvisols and Stagnosols are also found in the depressional areas and in the crovs [10].

The experimental orchard was irrigated using a drip irrigation system, with an application rate of 2 L/h per emitter, operated for 2 hours in the morning and 2 hours in the evening throughout the vegetation period.

The soil profile is dominated by a clay loam texture across all horizons.

Clay content ranges from 36.18% in the C horizon to 47.39% in the Bt horizon, while sand fractions (coarse and fine) remain relatively low.

The dust fraction is highest in the Ao/Bt horizon (56.28%), indicating significant textural differentiation.

Overall, the soil structure suggests good water retention but moderate aeration (Table 1).

Table 1. The granulometric composition of the soil (Experimental Base Moara Domneasca, 2019)

Horizon	Depth (cm)	Clay (%)	Coarse sand (%)	Fine sand (%)	Dust (%)	Texture
Ao	0-40	40.55	0.36	34.33	24.75	Clay loam
Ao/ Bt	41-53	41.63	0.52	21.54	56.28	Clay loam
Bt	54-200	47.39	0.37	27.59	30.34	Clay loam
C	Over 200	36.18	0.42	32.04	32.04	Clay loam

Source: SCDP Baneasa [13].

As shown in Table 2, the soil has a moderate humus content at the surface (3.26%), which decreases with depth, balanced cation exchange capacity, and a high degree of base saturation (78–88%).

Soil reaction varies from slightly acidic (pH 6.4) at the surface to alkaline (pH 8.3) in the C horizon, creating favorable conditions for plum cultivation, although additional nitrogen fertilization is required.

Table 2. Physical and chemical properties of the soil profile (Moara Domneasca Experimental Base, 2019)

Horizons / Properties	Ao	Ao/Bt	Bt	C
Humus (%)	3.26	1.87	1.0	1.0
Soluble Ca (mg / 100 g soil)	55	32	32	30
Hydrolitic acidity (meq)	2.8	2.04	1.72	0.18
Exchangeable Bases (meq)	22.6	23.62	26.28	-
Total cation exchange capacity (meq)	28.65	28.04	30.01	-
Degree of saturation in bases (%)	78.94	84.28	87.53	-
pH	6.4	6.6	6.8	8.3
Total N (%)	0.144	0.102	0.075	0.07
Soluble P (mg / 100 g soil)	50	40	40	30

Source: SCDP Baneasa [13].

Plant Material

Two plum cultivars, ‘Anna Späth’ (Photo 1), (origin: Germany, late ripening, high sugar content, mainly for processing) and ‘Stanley’ (Photo 2), (origin: USA, mid-late ripening, self-fertile, suitable for fresh consumption and drying), were evaluated. Trees were grafted on ‘Mirobolan’ (*Prunus cerasifera*) rootstock [9].

Photo 1. ‘AnnaSpath’ variety
Source: Original SCDPB Baneasa [13].

The most popular rootstock in the plum orchards from Romania is ‘Myrobalan’ seedling, which is very vigorous, incompatible with some cultivars, causes late bearing and intensive suckering [19].

Photo 2. ‘Stanley’ variety
Source: Original SCDPB Baneasa [13].

The selection of rootstock across countries is influenced by the plum species and cultivars cultivated, soil characteristics, cultivation intensity, and the applied harvesting methods [5].

Experimental design

The orchard was established according to a randomized block design with three replications for each cultivar rootstock combination. Each experimental plot contained a minimum of 10 trees, planted at a spacing of 4 × 3 m, corresponding to a density of approximately 833 trees/ha. Standard orchard management practices (soil tillage, fertilization, pest control, irrigation) were applied uniformly across all treatments.

Data collection

During the 2024 production season, fruit quality indices were evaluated for each cultivar. A random sample of 20 fruits at commercial maturity was collected per replication to determine average biometric traits (fruit weight, height, and diameters) and physico-chemical parameters (firmness, pH, and soluble solids content, °Brix).

The analyses were conducted in the laboratory of the Research and Development Station for Fruit Tree Growing Baneasa.

Fruit sugar content was determined with a Hanna Instruments HI 96800 digital refractometer, while pH was measured using a Hanna HI 700630 pH meter. Biometric parameters (height, small and large diameter) were recorded with a digital electronic caliper,

and fruit weight was measured on an XT620M balance.
Titratable acidity (citric acid content) was assessed with a Hanna Instruments fruit juice Minititrator (230V model).
Figure 1 shows the monthly variation of average minimum and maximum temperatures.
Winter months record the lowest values (down to -5.1°C), while July reaches the annual peak (39.4°C).
Transitional months display moderate values, reflecting a continental climate with cold winters and hot summers.

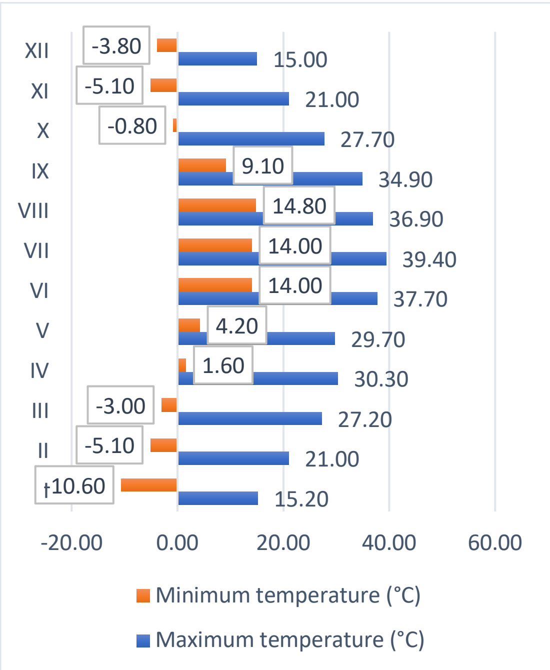

Fig. 1. Distribution of maximum and minimum temperatures in 2024.
Source: Moara Domneasca Meteorological Station [6].

Figure 2 illustrates monthly precipitation levels according to Moara Domneasca Meteorological Station [7].
The driest months are February (0.4 mm) and November (1.6 mm), while December records the highest value (119.2 mm). Spring and early summer show moderate rainfall (31-66 mm), highlighting an uneven distribution typical of continental climates.

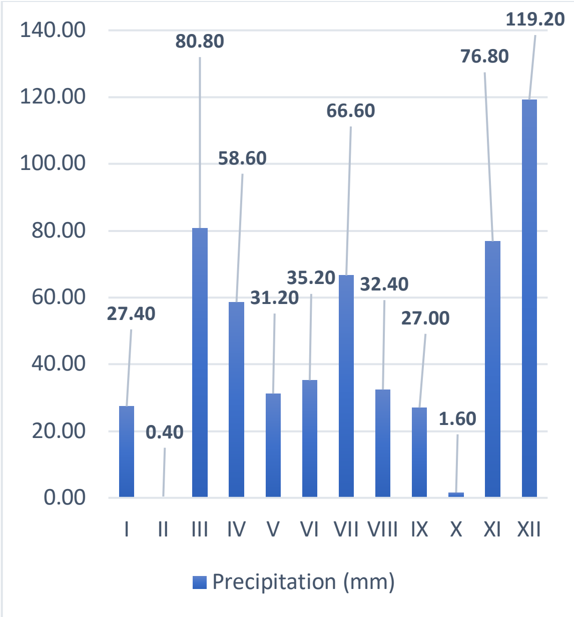

Fig. 2. Distribution of precipitation in 2024
Source: Moara Domneasca Meteorological Station [6].

In Table 3, the orchard management combined manual works (hoeing, fertilizer application, pruning, spraying, branch collection, grass cutting, irrigation) with mechanical works (transport, tractor spraying, mowing, soil tillage, equipment maintenance), ensuring efficient crop care and cost control.

Table 3. Technological works applied

No.	Manual works	Mechanical works
	Hoeing along the tree rows	Various transport operations
	Administered chemical fertilizers manually	Spraying the orchard (tractor sprayer)
	Removing dry/dead trees	Mechanical mowing
	Gathering branches into piles	Soil cultivation with rotary tiller (with sensor) along tree rows ×5
	Crown training and pruning	Tractor and equipment maintenance
	Spraying with knapsack sprayer	
	Preparing spraying solution	
	Operating the spraying machine	
	Grass cutting with trimmer (manual)	
	Operating the irrigation system	

Source: SCDP Baneasa Crop technological sheet [13].

RESULTS AND DISCUSSIONS

Inputs used in the plum tree technology

These inputs categories showed by Table 4 represent the essential items of expenditures that sustain orchard maintenance and production. From an economic perspective, fertilizers (chemical and organic) account for the main share of input use, while diesel fuel and lubricants reflect the mechanized operations applied. This structure confirms the dual nature of orchard technology, integrating both manual and mechanized practices, with a balanced distribution between energy, nutrition, and maintenance costs.

Table 4. Materials used in the crop technology

No.	Materials
1.	Diesel fuel
2.	Chemical fertilizers
3.	Oils and lubricants
4.	Spare parts
5.	Other unforeseen materials
6.	Organic fertilizers

Source: SCDP Baneasa Crop technological sheet [13].

Costs of inputs used in the plum tree technology

The cost structure from Table 5, highlights the predominance of manual works, which represent nearly half of the total expenses, followed by materials (fertilizers, fuel, spare parts) and mechanical works. This distribution indicates that, in young irrigated plum orchards, labor remains the main cost driver, while mechanization contributes comparatively less. Optimizing manual labor and improving mechanization efficiency could therefore enhance economic sustainability.

Table 5. Costs of materials used in the crop technology

No.	Category	2024 (RON/ha)
1.	Mechanical works	1,515.27
2.	Manual works	4,192.88
3.	Materials	3,625.50
Total		9,333.65

Source: The accounting documents of the unit [18].

Fruit quality parameters by plum tree cultivar

The comparative assessment of fruit quality parameters is presented in Table 6.

'Stanley' fruits demonstrated superior biometric and physical traits compared to 'Anna Späth'. 'Stanley' recorded higher fruit weight (22.91 g vs. 16.54 g), larger dimensions (height: 42.90 mm vs. 32.22 mm; diameters: 32.49 mm and 29.38 mm vs. 29.11 mm and 25.14 mm), and greater firmness (2.25 kgf/cm^2 vs. 1.23 kgf/cm^2). In terms of chemical composition, 'Anna Späth' had slightly higher soluble sugar content (18.88% vs. 16.48%) and a marginally higher pH (4.0 vs. 3.95), highlighting its sweeter profile, while 'Stanley' maintained better structural quality and marketability potential.

Table 6. Biometric and Physico-Chemical Indices of Plum Cultivars

	Anna Spath	Stanley
Weight (g)	16.54	22.91
Height [mm]	32.22	42.90
Diameter [mm]	29.11	32.49
Diameter [mm]	25.14	29.38
Firmness kgf/cm^2	1.23	2.25
pH	4	3.95
Sugar [%BRIX]	18.88	16.48

Source: Own data. Own calculations.

Losses were assessed as the difference between potential and marketable yield, being influenced not only by cultivar traits but also by climatic conditions; in 2024, irregular precipitation and high summer temperatures increased fruit drop and quality defects in 'Anna Späth', while 'Stanley's larger size and higher firmness helped reduce both field and post-harvest losses.

The evaluation of fruit quality in relation to chemical composition highlights contrasting strengths between the cultivars. 'Anna Späth', with its smaller fruit size (16.5 g) but higher soluble solids (18.9 °Brix), offers a sweeter sensory profile, favoring fresh consumption. In contrast, 'Stanley', characterized by larger fruit size (22.9 g), greater firmness (2.25 kgf/cm^2), and slightly lower sugar content (16.5 °Brix), is better suited for storage, transport, and processing. This correlation between biometric traits and chemical indices demonstrates that sweetness and marketability are inversely balanced, with 'Stanley' providing technological advantages and 'Anna Späth' emphasizing taste quality.

Distribution and marketing of plum production

The plum production obtained by Romania ensures the necessary consumption on the domestic market and at the same time represents the raw material for the processing activity [2]. Regarding the preferences of Romanian consumers on the fruit market, plums, cherries, and berries are categories that are less commonly found in consumer choices, accounting for 3.5% (plums), 2.12%, and 2% (berries) of total fruit consumption [11].

The impact of price volatility on the processing sector

Fruits are among the most widely consumed horticultural products, used either fresh or processed into a variety of food items. The European Union (EU) action plan for the circular economy could be an effective strategy to reduce the level of waste and by-products generated during fruit processing. This plan is based on the reduction, reuse, recovery, and recycling of materials and energy, so as to enhance the value and consequently the useful life of products, materials, and resources in the economy [7].

CONCLUSIONS

The comparative assessment of 'Anna Späth' and 'Stanley' plum cultivars under the agroecological conditions of Moara Domneasca during the 2024 growing season revealed significant cultivar-specific differences. 'Anna Späth' was characterized by smaller fruits but higher soluble solids content (18.9 °Brix), conferring superior sweetness and suitability for direct consumption. In contrast, 'Stanley' exhibited larger fruits, enhanced biometric traits (fruit height and diameters), and markedly greater firmness (2.25 kgf/cm), features which ensure higher storage potential, transportability, and broader technological applicability.

Although the present findings reflect the early stage of orchard development, as the trees have not yet reached full maturity. Continuous maintenance and technological care remain essential to ensure long-term productivity and sustainability.

Collectively, these results underline the critical role of cultivar–rootstock interactions in determining both productive and qualitative performance, with 'Stanley' confirming its potential as a superior cultivar for sustainable plum cultivation under Romanian agroecological conditions.

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