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IDENTIFYING CULTIVARS FOR ORGANIC FARMING: A CASE STUDY ON SOLANACEOUS VEGETABLES IN ROMANIA

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Abstract

Organic farming is a key priority for the European Union, aiming for 25% of agricultural land under organic cultivation by 2030. In Romania, organic farming expanded by 67% between 2012 and 2022, increasing the need for cultivars suited to non-chemical systems. This study evaluates eleven tomatoes (Solanum lycopersicum), five pepper (Capsicum annuum), and five eggplant (Solanum melongena) cultivars, traditionally bred for conventional farming, assessing their yield, fruit quality, and adaptability under organic conditions in southern Romania. Results indicate that Darsirius tomato maintained stable yields (2.85 kg/plant organic vs. 3.05 kg/plant conventional), while Regal pepper exhibited stable productivity (140.16 g/fruit organic vs. 142.18 g/fruit conventional) and superior nutritional quality. Rebeca eggplant showed strong pest and disease resistance. Ema de Buzău recorded the highest dry matter content (10.82%), and Andrada had the highest lycopene concentration (12.7 mg/100g organic). These findings support selecting robust cultivars for organic farming, aiding sustainable agriculture and food security in Romania.

***Key words**: Capsicum annuum, organic farming, sustainable agriculture, Solanum lycopersicum, Solanum melongena.*

INTRODUCTION

The overuse of chemical inputs in agriculture over the past century has led to severe environmental consequences, including soil degradation, climate change, and water contamination. In response, there is a growing shift toward ecological farming practices aimed at mitigating damage and promoting sustainability. Organic farming has become a key priority for the European Commission, with an ambitious target of converting at least 25% of agricultural land to organic cultivation by 2030 (European Commission, 2021).

Organic farming relies on natural fertilizers and pest control methods while restricting synthetic inputs, genetically modified organisms, and other non-natural practices (Willer et al., 2019). Across Europe, efforts to transition agriculture toward sustainability emphasize environmental responsibility, food quality, and social welfare (Fortea et al., 2022). In Romania, the organic sector is expanding rapidly due to supportive agricultural policies and increased consumer demand (Stoica et al., 2022). According to Eurostat, Romania ranked 9th in the EU for organic agricultural area in 2015, with organic farming covering 1.66% of total farmland - a figure that has since grown substantially (Eurostat, 2018).

With the expansion of organic agriculture, there is a rising need for crop cultivars optimized for nonchemical farming systems. Research indicates that plant phenotypes express differently under organic versus conventional conditions, necessitating dedicated breeding efforts (Lammerts van Bueren et al., 2011; Mason and Spaner, 2006; Reid et al., 2011; Wortman et al., 2013; Barcanu et al., 2020). The debate continues on whether organic-specific cultivars should be developed or whether conventional varieties can be adapted to organic conditions. A common approach to assessing adaptation is testing genotype-by-system interactions by cultivating conventional hybrids under organic management (Wortman et al., 2013).

At the Vegetable Research Development Station Buzău, we are evaluating selected tomato (*Solanum lycopersicum* L.), pepper (*Capsicum* spp.), and eggplant (*Solanum melongena* L.) cultivars bred for conventional farming to assess their performance under organic conditions. This research aims to identify promising varieties that can support the transition to more sustainable agricultural practices.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at 45°08'60.00"N and 26°49'59.99"E, under a temperate climate with an average annual precipitation of 530 mm, approximately 60% occurring during the Solanaceae growing season. Weather conditions were monitored from May to October 2023 and compared to multiannual data. The crops were cultivated on sandy loam soil (pH 6.9), with 3.10% humus and 8.3% organic matter content.

Genotype Resources

Genotypes were sourced from the Vegetable Research and Development Station (VRDS) Buzău. The study included eleven tomato genotypes (*Solanum lycopersicum* L.) classified as indeterminate (Siriana, Ema de Buzău, Flaviola, Hera, Andrada), determinate (Măriuca, Darsirius, Chihlimbar, Kristinica, Florina), and semi-determinate (Ovidia). Additionally, five *Capsicum* spp. Cultivars - three sweet peppers (Regal, Cantemir, A50) and two hot peppers (Roial, Decebal) - along with five eggplant genotypes (*Solanum melongena* L.) (Rebeca, Iarina, Romanița, H13Bz, H2Bz) were included.

For differentiation, genotypes grown under organic conditions are denoted with 'O', while those cultivated in the conventional system are marked with 'C' throughout the study. Seedlings were started in alveolar trays with 50 cm^3 peat cubes and grown under controlled greenhouse conditions before transplanting in May. Plants were arranged in a randomized complete block design (70 cm inter-row, 30-35 cm intra-row spacing) with drip irrigation for efficient water and nutrient delivery. An innovative fence system using *Helianthus tuberosus* shoots supported pepper and indeterminate tomatoes, while windbreaks with corn, *Jerusalem artichoke*, and *Phaseolus* sp. were established.

Fertilization and Pest Management

The conventional system used chemical fertilizers (NPK 20-20-20, NP 15-50 + 2MgO, NPK 9-18-27+ 2MgO), while organic crops received four applications of NOV@ (21% organic carbon, 5% K_2O, 0.6% betaine) and foliar fertilization with Fylloton (*Ascophyllum nodosum*-derived). Pest management employed biocontrol agents (*Metarhizium anisopliae, Verticillium lecanii, Bacillus subtilis, Trichoderma* spp.) and companion planting with *Ocimum basilicum, Tagetes patula, Tropaeolum majus*, and others.

Fruit Quality Assessment

Fruit quality was evaluated for firmness (N), total soluble solids (TSS, °Brix), titratable acidity (TA, citric acid %), TSS/TA ratio, dry matter (%), lycopene, and β-carotene content. Peppers were analyzed at red maturity stages, while tomatoes and eggplants were assessed at harvest maturity. Five randomly selected fruits per genotype were analyzed in triplicate.

Analytical Methods

Dry Matter (%): Determined using AOAC 930.04 (2005).

Total Soluble Solids (TSS, °Brix): Measured via digital refractometer (KERN OPTICS ORF 1RS) following AOAC 932.12.

Lycopene & β-carotene (mg/100g): Extracted with hexane:acetone (4:6 v/v) and quantified spectrophotometrically (Nagata & Yamashita, 1992).

Firmness (N): Assessed using a TR Turoni 53205 electronic penetrometer.

Statistical Analysis

Statistical analysis was performed using ANOVA, with Duncan's test applied for mean comparisons.

RESULTS AND DISCUSSIONS

The 2023 growing season was characterized by higher mean temperatures and precipitation deficits, impacting crop performance. Climate variability highlights the importance of breeding resilient cultivars for organic farming (Brezeanu et al., 2020; 2022).

Solanaceous fruit yields in organic and conventional systems

Tomato yields varied significantly across genotypes and farming systems (Figure 1). Siriana had the highest yield in both conventional (4.64 kg/plant) and organic (4.16 kg/plant) systems, while Ovidia exhibited the lowest organic yield (2.25 kg/plant). No statistically significant differences were observed between systems, though Darsirius maintained similar yields in both conditions (2.85 kg/plant organic vs. 3.05 kg/plant conventional).

These findings suggest that genotype selection plays a crucial role in ensuring stable yields across farming systems. Previous studies indicate that the yield gap between organic and conventional systems is largely genotype-dependent (Bàrberi, 2015; Murariu et al., 2021;

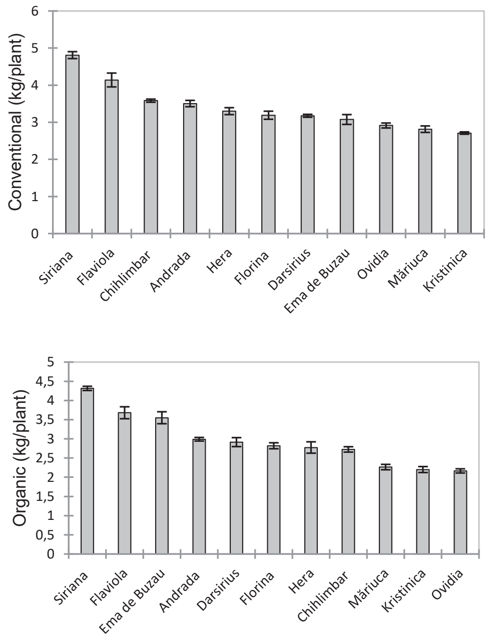

Figure 1. Tomato yield in both farming systems

For peppers (Figure 2), A-50 achieved the highest conventional yield, while Regal excelled in organic farming. Hot pepper cultivars (Roial and Decebal) had the lowest organic yields. Differences in yield are influenced by genotypic tolerance (Udriște et al., 2024) to environmental stresses and soil nutrient availability, as noted in previous research on *Capsicum* spp. (Hallmann & Rembiałkowska, 2012).

Eggplant results (Figure 2) showed Rebeca performing best in both systems, while specialty cultivars Iarina (slim-green) and Romanița (white) recorded the lowest yields. Specialty eggplants often prioritize aesthetic and culinary traits over productivity, which may explain their lower yield performance (Kumar et al., 2020).

Tomato yields in organic farming were comparable to conventional systems, suggesting that some genotypes perform well under low-input conditions. However, multi-season trials are needed to confirm long-term stability (Bàrberi, 2015).

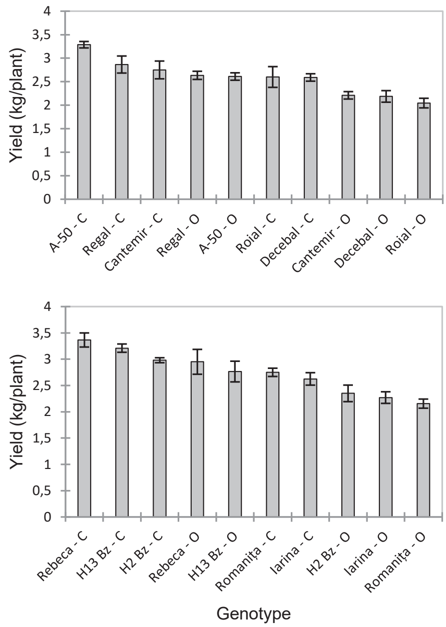

Figure 2. Pepper and aubergine yield in both farming systems

Peppers showed greater system-dependent variation, with higher yields in conventional systems but enhanced antioxidant content in organic farming (Scalzo et al., 2005; Soare et al., 2017).

Eggplants demonstrated strong adaptability, performing well in both systems. This resilience suggests that eggplants could be a suitable crop for organic expansion, given their natural resistance to biotic stress (Kumar et al., 2020).

Physicochemical properties of Solanaceous fruits

Tomato quality assessments (Table 1) revealed significant cultivar-based differences in firmness, dry matter (TDM), betacarotene and lycopene content. The highest firmness (7.18 N) was observed in Florina O, while Ema de

Buzău C had the softest fruits (1.18 N). Firmness is a key quality attribute influencing storage and transportability, and these values align with previous reports showing that processing tomatoes tend to have firmer textures than fresh-market varieties (Tigist et al., 2011; Flores-Velasquez et al., 2022).

The TDM content varied significantly, with Ema de Buzău O showing the highest (10.81%) and Florina O the lowest (4.72%). Dry matter content is directly related to sugar and organic acid concentrations, influencing taste and nutritional quality (Beckles, 2012; Dinu et al., 2023). Organic tomatoes often have higher dry matter content due to slower growth rates and reduced nitrogen availability (Zhao et al., 2012).

Tabel 1. Comparative physicochemical properties of tomatoes and peppers in conventional and organic farming

Genotypes	Firmness (N)	TSS (% Brix)	TDM %	FW (g)	Lycopene (mg/100 g)	β-carotene (mg/100 g)
A-50 M - O	8.053	6.003	9.647	168.900	6.633	8.803
A-50 M - C	8.231	5.941	9.750	171.860	5.931	8.311
Roial M - O	6.860	8.390	14.580	24.990	3.630	7.330
Roial M - C	7.030	9.050	14.190	26.720	3.130	6.930
Chihlimbar O	5.445	5.425	6.905	191.710	0.015	16.115
Ema de Buzau O	1.180	6.140	10.810	9.880	8.310	9.310
Decebal M – O	7.900	8.160	11.670	33.130	0.010	4.810
Chihlimbar C	5.560	5.100	6.960	211.330	0.010	15.210
Ema de Buzau C	1.225	6.085	10.015	10.750	6.215	8.815
Regal M - O	8.880	5.950	4.110	140.160	3.820	6.220
Decebal M - C	7.941	7.981	11.980	38.980	0.011	4.111
Andrada C	4.571	4.881	6.450	290.950	9.221	3.611
Andrada O	4.448	5.048	6.333	249.310	12.718	3.718
Cantemir M – O	10.002	3.842	7.808	118.600	5.202	4.802
Regal M - C	8.952	5.822	4.249	142.180	3.312	5.812
Cantemir M - C	10.562	3.722	7.929	121.450	4.802	4.302
Florina O	7.192	4.392	4.728	171.880	7.312	4.712
Florina C	7.183	4.423	4.867	200.690	5.213	4.513
Hera O	2.981	5.391	7.470	153.390	5.511	3.811
Mariuca O	5.765	4.695	7.635	85.630	5.515	3.815
Hera C	3.156	5.156	7.584	169.350	4.106	3.406
Darsirius C	5.672	4.852	6.788	121.110	6.902	2.902
Darsirius O	5.625	4.835	6.615	111.770	7.525	3.325
Kristinica O	3.702	4.542	6.699	128.580	5.702	4.702
Mariuca C	5.850	4.740	7.700	100.750	4.320	3.120
Flaviola O	2.792	7.992	6.669	27.860	4.012	5.022
Kristinica C	3.761	4.631	6.849	138.560	5.201	4.101
Flaviola C	2.781	6.231	6.780	32.380	3.241	4.511
Siriana O	3.925	4.435	4.945	131.060	3.505	3.205
Siriana C	4.000	4.400	4.980	158.870	2.910	2.910
Ovidia O	1.313	4.513	7.237	56.470	0.013	1.713
Ovidia C	1.471	4.121	7.310	89.570	0.011	1.211

Dry matter and sugar content play crucial roles in flavour development and consumer acceptance. Ema de Buzău had the highest TDM, supporting previous research that smaller fruits often have higher dry matter concentrations (Beckles, 2012).

Lycopene content was highest in Andrada O (12.71 mg/mL), while Chihlimbar O exhibited the highest β-carotene levels (16.11 mg/mL). Ovidia lacked lycopene, likely due to genetic mutations affecting carotenoid biosynthesis (Pankratov et al., 2016; Yoo et al., 2017).

These findings are consistent with studies showing that organic tomatoes tend to accumulate higher antioxidant compounds due to enhanced stress responses (Baranski et al., 2014).

Lycopene and β-carotene content were highly genotype-dependent, with yellow and orange cultivars lacking lycopene due to genetic mutations (Agarwal & Rao, 2000). Organic farming may enhance carotenoid accumulation due to increased oxidative stress responses (Baranski et al., 2014).

Pepper firmness varied by cultivar and maturity stage (Table 1), with Cantemir C showing the highest firmness (10.56 N). Firmness is a critical indicator of postharvest quality and consumer preference, as noted by Palacio and Sánchez (2017).

Dry matter content was highest in Roial C (14.58%) and lowest in Regal C (4.24%). Higher dry matter values indicate better storage potential and richer flavour (Conforti et al., 2007).

Lycopene was detected only in red fruits, with A-50 O containing the highest level (6.63 mg/100g). Previous research confirms that lycopene biosynthesis increases with ripening and is influenced by genotype and growing conditions (Hallmann & Rembiałkowska, 2012). β-carotene content was highest in red peppers, reinforcing findings that carotenoid accumulation is strongly correlated with fruit maturity and light exposure (Kurina et al., 2021; Lanoue et al., 2024).

Eggplant firmness and dry matter content varied significantly, with Rebeca, H13Bz, and H2Bz showing superior firmness, while Iarina and Romanița had softer textures. Firmness is an essential parameter for marketability, as firmer fruits have longer shelf lives (Kumar et al., 2020).

Dry matter ranged from 5.16% (Romanița) to 10.12% (Rebeca). Higher dry matter is linked to enhanced flavour and nutritional density, particularly in organic crops where stress conditions promote secondary metabolite accumulation (Alsina et al., 2021).

Overall, these results highlight the need for tailored genotype selection for organic farming.

CONCLUSIONS

The study highlights the potential of specific Solanaceous cultivars for organic farming, addressing both yield stability and fruit quality. Darsirius tomato and Regal pepper demonstrated consistent productivity across both organic and conventional systems, while Rebeca eggplant exhibited strong resistance to pests and diseases. Nutritional quality varied significantly among cultivars, with Ema de Buzău showing the highest dry matter content and Andrada having the highest lycopene concentration. These findings support the selection of robust, adaptable cultivars for sustainable organic agriculture. Future research should focus on multi-season trials and breeding efforts to optimize crop performance under organic conditions.

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