ANNALS OF THE UNIVERSITY OF CRAIOVA

Series: ✓*Biology*
✓*Horticulture*
✓*Food products processing technology*
✓*Environmental engineering*

Vol. XXXI (LXVII) – 2026

STUDY ON THE PERFORMANCE OF NEW TOMATO HYBRIDS GROWN UNDER ORGANIC GREENHOUSE (SOLAR) CONDITIONS

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Keywords*:* morphological characteristics, protected ecological cultivation, production

ABSTRACT

The study focused on a tomato crop established in a high tunnel (solarium) in the year 2026 in the locality of Arcești Cot, Pleșoiu, Olt County. Four new tomato hybrids were evaluated: Araldino F1, Ntama F1, Wasmyia F1, and Cod F1. The experiment was arranged in a randomized complete block design with three replications. The tomatoes were grown on a reddish-brown preluvosoil with neutral pH, fertilized in the autumn with 40 t/ha of organic manure (well-rotted farmyard manure / compost). During the growing season, split fertilization was carried out using the organic product Cropmax. The obtained results highlighted three hybrids that showed remarkable vegetative growth (Araldino F1, Ntama F1, and Cod F1). These performed very well in organic tunnel cultivation during cycle II, successfully withstanding the high summer temperatures. The fruit yield obtained per plant highlighted the Cod F1 hybrid with 7.03 kg/plant, as well as the other two hybrids, Araldino F1 and Ntama F1, which produced over 5 kg/plant. All three hybrids yielded large, firm fruits with an average weight exceeding 250 g (Araldino F1 and Cod F1) and over 200 g for Ntama F1.

INTRODUCTION

Organic agriculture continues to expand globally, driven by growing consumer demand for sustainability, food safety, and transparency in production practices. Tomato production obtained from organic cropping systems presents challenges and opportunities that differ significantly from those in conventional systems. This production is regulated by standards that restrict the use of most synthetic inputs and prohibit genetic engineering, thereby increasing the necessity of breeding varieties with intrinsic stress tolerance, high nutrient use efficiency, and other traits that support natural resilience and adaptability (Code of Federal Regulations. 7 CFR Part 205—National Organic Program. Washington (DC, US); USDA Agricultural Marketing Service (AMS). Excluded methods Terminology Recommendation; USDA Agricultural Marketing Service (AMS). National List of Allowed and Prohibited Substances).

Tomatoes (*Solanum lycopersicum L*.) represent a vegetable crop of major global importance (Sadaf et al. 2012). The fruits of this species are consumed fresh

in salads or processed to obtain a diverse range of products, such as ketchup, sauces, purees, syrups, juices, etc. (Shi and Maguer, 2000). They represent a rich source of mineral elements, lycopene, vitamins, antioxidants, etc. (Dinu et al. 2023; Soare et al. 2018; Păunel et al. 2026).

This species is cultivated in all cropping systems (open field, greenhouses, and high tunnels/solariums) under both conventional and organic regimes. In recent years, soil heavy metal concentrations have risen alarmingly, reaching hazardous levels due to unsustainable agricultural practices such as irrigation with wastewater and the excessive use of chemical fertilizers and pesticides, which threatens soil biological systems (Jaishankar et al. 2014). Thus, the establishment of organic crops represents a cultivation system that ensures safety and sustainability (Hoza și colab., 2016).

Organic systems prohibit the use of synthetic fertilizers, pesticides, and genetically modified organisms, thereby requiring hybrids that exhibit strong natural resistance to pests and diseases, efficient nutrient uptake, and tolerance to environmental variability—such as drought, heat, and poor soils (Lammerts van Bueren et al. 2011).

Unlike conventional breeding, which often optimizes performance for uniform, high-input systems, organic breeding must take into account complex biotic interactions and heterogeneous environments (Lammerts van Bueren et al. 2011). A central element of this framework is represented by participatory plant breeding, a collaborative approach in which farmers contribute to the selection process under real farming conditions. This allows for a more dynamic understanding of genotype-by-environment (G × E) interactions and helps ensure that resulting varieties are agronomically relevant and socially appropriate (Kumar et al. 2023).

Organic tomato production imposes specific selection pressures, as fruit yield and quality must be maintained under conditions of limited soluble nutrient availability, high biotic pressure, and greater environmental variability than in conventional systems (Saxena et al. 2026). The increasingly frequent conversion of agricultural land to organic farming necessitates the development of crop varieties specifically adapted to this system. To date, there is a lack of research regarding the selection of tomato germplasm suitable for sustainable agroecosystems (Tripodi et al., 2025). It is highly important to select tomato cultivars capable of meeting the requirements of organic producers. This selection phase must precede the evaluation of genetic resources through experiments conducted across multiple locations and over several years. For organic growers, productivity and temporal stability are two key characteristics considered when defining an "ideotype." Consequently, ensuring resilience—a prerequisite for securing reliable harvests—is crucial, given the variability of pedoclimatic factors and cultivation conditions.

Key traits targeted for cultivars used in organic agriculture include nutrient use efficiency, broad-spectrum resistance to pests and diseases, and weed competitiveness (Lammerts van Bueren et al., 2011; Luttikholt, 2007).

The aim of this study was to observe the performance of new tomato hybrids grown in a high tunnel under an organic cropping system, monitoring morphological and yield traits.

MATERIAL AND METHODS

The experiment was located in Pleșoiu, Olt County, Arcești Cot village (44°28′30″N 24°14′19″E) in the year 2026, under an organic cropping system. The four hybrids investigated (Araldino F1, Ntama F1, Wasmyia F1, and Cod F1) are newly introduced to cultivation in our country and therefore require studies regarding their performance in different regions of Romania as well as across cropping systems specific to vegetable production. Rainfall was deficient, but because the crop was established in a high tunnel, it benefited from drip irrigation. The experiment was set up in the tunnel during cycle II (autumn cycle), in a randomized complete block design with three replications of 15 plants per replication. The soil was a reddish-brown preluvosoil fertilized in the autumn with 40 t/ha well-rotted organic manure (compost/mraniță), and during the vegetative stage, at 15-day intervals, the organic product Cropmax was applied at a rate of 20 ml / 10 L water per 100 m², sourced from Holland Farming Agro.

The crop was established using seedlings produced in a propagation greenhouse. Seeds were sown in a peat substrate on 06.05.2026, and seedlings were transplanted into the high tunnel on 13.06.2026. The planting scheme was 100 cm between rows and 30 cm between plants within the row. Standard management practices for organic farming were employed.

At planting, seedling morphological indices were determined (seedling height, stem collar diameter, and leaf count per seedling). During the growing period, at two months post-transplanting, morphological and yield traits of the hybrids were evaluated.

Statistical calculations were performed using analysis of variance (ANOVA) and the least significant difference (LSD / DL) test.

RESULTS AND DISCUSSIONS

The European Commission's climate action plan aims to halve greenhouse gas emissions by the end of this decade. In agriculture, mineral fertilization is considered a major contributor to increased greenhouse gas emissions, as it amplifies the carbon footprint of crops (Holka et al., 2022). By reducing the use of agricultural inputs and increasing carbon sequestration in the soil, organic farming could help slow down—and eventually reverse—this trend (Smith et al., 2019). Consequently, identifying crop varieties adapted to organic farming systems is a key objective for optimizing agricultural practices with the aim of reducing greenhouse gas emissions.

Analyzing the results obtained from the perspective of the morphological traits of the studied hybrids, it was found that the hybrid had a major influence on the growth process (Table 1). In general, plant height during the vegetation period serves as an indicator of plant vigor, a factor that can influence crop productivity. In the studied tomato hybrids, plant height exhibited very distinctly significant differences among them (Table 1). At planting (seedling age of 38 days), seedling height ranged between 20.7 and 24.7 cm; the Wasmyia hybrid exhibited the lowest height, while the Cod F1 hybrid recorded the maximum value.

This variation in plant height was also maintained at 60 days after transplanting (Table 2). The greatest height of 141.0 cm was observed in Ntama F1, and the lowest of 63.67 cm in Wasmyia F1. These differences are also supported by Hoza et al. (2022). It can be considered that the variations in this trait are influenced genetically as well as by adaptability to agroclimatic conditions.

The stem collar diameter of seedlings ranged from 4.7 mm in the Wasmyia

F1 hybrid to 7.3 mm in Ntama F1, recording a significant difference for this hybrid compared to the other three studied. In the field/tunnel stage, at two months after transplanting, this diameter varied from 1.30 cm in Wasmyia F1 to 2.27 cm in Araldino F1, with no statistically significant differences among hybrids, thus dissipating the difference recorded at planting.

The average number of leaves per plant at planting recorded a significant difference compared to the other hybrids only in Ntama F1 (Table 1). During the growing season, at 60 days after transplanting, very distinctly significant differences were observed for Araldino F1, Ntama F1, and Cod F1, and significant differences for Wasmyia F1. These differences correspond with plant height, demonstrating the robustness of these three hybrids, which can favorably influence fruit production per plant.

Table 1.

Morphological indices of tomato seedlings at transplanting (mean values)

Hybrid	Seedling height (cm)	Stem collar diameter (mm)	No. of leaves / plant
Araldino F1	23.0***	5.7	3.7
Ntama F1	23.0***	7.3*	5.6*
Wasmyia F1	20.7 ***	4.7	3.6
Cod F1	24.7***	6.00*	4.3
DL 5%	8.98	5.89	5.28
DL 0,1%	13.06	8.57	7.68
DL 1%	19.59	12.85	11.52

Table 2.

Morphological and yield traits of studied tomato hybrids at 2 months after planting (mean values)

Hybrid	Plant height (cm)	Stem collar diameter (cm)	No. of leaves / pl.	No. of flowers / plant	No. of fruits / plant
Araldino F1	113.0**	2.27	22.7***	65.6***	22.6***
Ntama F1	141.0**	2.17	22.3***	20.6**	11.0*
Wasmyia F1	63.6	1.30	12.0*	12.6	5.6
Cod F1	114.3**	2.07	19.7***	23.3***	23.3***
DL 5%	69.09	1.14	8	10.17	7.83
DL 0.1%	100.49	1.65	15	14.80	11.39
DL 1%	150.73	2.48	13	22.19	17.09

For a thorough evaluation of the four hybrids newly introduced to organic tomato cultivation in our country, yield characteristics were also evaluated (average number of flowers per plant and average number of fruits per plant). Four successive harvests were conducted at dynamic 7-day intervals, during which the average number of fruits per plant and the average fruit weight were determined according to each harvest (Table 3).

The fruiting capacity of the studied hybrids was not uniform, even though the cultivation technology was identical across all four hybrids. The recorded differences are attributed to the genetic characteristics of the hybrids. Differences among hybrids are highlighted by the number of flowers per plant, which ranged from 12.6 in Wasmyia F1 to 65.6 in Araldino F1, registering statistically significant positive values according

to the data in Table 2. The average number of harvested fruits was distinctly significantly positive for Araldino F1 and significantly positive for Ntama F1, with values ranging from 5.6 in Wasmyia F1 to 23.3 in Cod F1. These results are consistent with those reported by Hoza et al. (2022). The hybrids displayed differences in the average number of fruits harvested per plant across the 4 harvests (Table 3). Furthermore, average fruit weight was also recorded across the 4 harvesting stages, and it was observed that the largest fruits were obtained at the first harvest across all hybrids (Table 3). The smallest fruits were obtained from the Wasmyia F1 hybrid, which also showed lower plant vigor compared to the other hybrids (from 171 to 141 g), while Araldino F1 and Cod F1 had the largest fruits (from 356 g / 345 g to 275 g). Fruit size varied from one hybrid to another, an aspect that can contribute to diversifying the tomato assortment and satisfying diverse consumer preferences.

Table 3.

Harvest dynamics and variation in fruit number and average fruit weight (mean values)

Hybrid	No. fruits /pl. (I)	No. fruits/pl. (II)	No. fruits/pl. (III)	No. fruits/pl. (IV)	Mean wt. (g) (I)	Mean wt. (g) (II)	Mean wt. (g) (III)	Mean wt. (g) (IV)
Araldino F1	5.0	4.0	5.0*	5.0*	356***	228**	271***	284***
Ntama F1	5.3	5.3*	4.7	6.38	277***	238**	223***	232***
Wasmyia F1	4.0	4.3*	5.3*	5.0*	171**	141*	153**	143**
Cod F1	6.0*	4.7*	6.3*	7.0**	345***	253**	278***	275***
DL 5%	5.36	4.22	4.22	4.72	101.81	123.06	71.45	66.10
DL 0.1%	7.80	6.13	7.17	6.86	148.08	179.00	103.93	96.14
DL 1%	11.70	9.20	10.76	10.29	222.12	268.49	155.90	144.21

Following the calculation of total yield per plant, it was found that the highest yield was achieved by Cod F1 (7.03 kg/plant), followed by Araldino F1 (5.49 kg/plant) and Ntama F1 with 5.38 kg/plant. The lowest yield was recorded for the Wasmyia F1 hybrid with 2.71 kg/plant.

Total yield (kg/m²) followed the same trend as yield per plant, with values ranging from 9.02 kg/m² for Wasmyia F1 to 23.40 kg/m² for Cod F1. The hybrids Araldino F1 and Ntama F1 also achieved remarkable yields—higher than those recorded in 2025 under the same cultivation system (Păunel et al., 2025).

Table 4

Average yield per plant and per m² recorded for the studied hybrids

Hybrid	Yield / plant (kg)	Yield / m² (kg)
Araldino F1	5.49**	18,11
Ntama F1	5.38**	17,91

Wasmyia F1	2.71*	9,02
Cod F1	7.03***	23,40
DL 5%	2.68	
DL 0.1%	3.90	
DL 1%	5.85	

CONCLUSIONS

Following the research conducted on tomato hybrids in protected cultivation, the following conclusions can be drawn:

The studied hybrids exhibited very good vegetative growth as well as high tolerance to diseases and pests. The total number of flowers per plant highlighted the Araldino hybrid, for which cluster pruning/thinning operations must be carried out, as it produces a very large number of flowers at the expense of fruit size (65.6 flowers/plant). The average number of set fruits was lower than that of flowers and varied according to the hybrid utilized, ranging between 5.6 in Wasmyia F1 and 23.3 in Cod F1, where it was observed that the average number of flowers per plant was identical to that of fruits. This demonstrates that Cod F1 is a hybrid with very high genetic resistance to high summer temperatures, which did not impair the pollination process.

Yield per plant exceeded 5 kg/plant in three hybrids (Araldino F1, Ntama F1, and Cod F1). Yield per square meter followed a similar trend to that obtained per plant, highlighting the Cod F1 hybrid as the top performer with 23.40 kg/m², alongside Wasmyia F1 with the lowest yield. For a more comprehensive evaluation of these hybrids cultivated in organic systems, further long-term observations are recommended.

Evaluation of both the adaptability of genotypes to resource-limited systems and the stability in different environments is essential to determine their overall value in terms of their adaptation to ecological systems. For a better assessment, further observations are required in the ecological system.

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