RESEARCH ON THE TOMATO GENOTYPES BEHAVIOR GROWN IN GREENHOUSE CONDITIONS AT VRDS BACAU

CERCETĂRI PRIVIND COMPORTAMENTUL GENOTIPURILOR DE TOMATE CULTIVATE ÎN CONDIȚII DE SERĂ LA SCDL BACĂU

ANTAL TREMURICI Andreea[1,2*], AMBĂRUȘ Silvica[1], BREZEANU P.M.[1], BUTE A.[1,2], CATANĂ Andreea Beatrice[1], SEVERIN Denisa[1], TELIBAN G.C.[2], STOLERU V.[2],

*Corresponding author e-mail: antal_andreea97@yahoo.com

Abstract. *Tomato can be grown in a wide range of climates, including open fields as well as greenhouses. They are one of the more challenging horticulture crops to grow since there are several steps that need to be taken to ensure a strong, fruitful crop. The need to increase organoleptic qualities and preserve the standard of fresh and processed tomatoes on the market has sparked a rise in interest in traditional tomato types. The variety of tomato fruit forms, colours, and sizes, as well as the native germplasm's commercial quality, have been noted to make it an appealing source of high agronomic relevance for breeding programmes. Ten accessions were provided by VRDS Bacau, and then it was sown and transplanted in greenhouse conditions under a randomised block design with three replications. This process was performed in order to evaluate the phenotypic traits of tomatoes like time of flowering and fruiting, fruit weight, height, diameter, dry matter content, TSS, water, and titratable acidity. Lycopene, beta-carotene, and water, are abundant in the local communities under study. The local populations with indeterminate growth that were examined in this study revealed minor variations in the varieties and proved that they could be used as pre-breeding material in future variety development for fruit shape, size, colour, and flavour desirable for the local market.*

Key words: plant growth, phenotyping, greenhouse, tomato quality

Rezumat. *Tomatele pot fi cultivate într-o gamă largă de climate, atât în câmp deschis, precum și în sere. Acestea sunt una dintre culturile horticole cele mai dificile de cultivat,*

[1]Vegetable Research and Development Station – Bacau, Romania

[2] Iasi University of Life Sciences „Ion Ionescu de la Brad", Romania

deoarece există mai mulți pași pe care trebuie urmați pentru a asigura o recoltă rezistentă și fructuoasă. Necesitatea de a crește calitățile organoleptice și de a păstra standardul tomatelor proaspete și procesate de pe piață a stârnit o creștere a interesului pentru tipurile tradiționale de tomate. Varietatea formelor, culorilor și dimensiunilor fructelor de tomate, precum și calitatea comercială a germoplasmei native, au fost remarcate pentru a face din aceasta o sursă atrăgătoare de mare relevanță agronomică pentru programele de ameliorare. Zece genotipuri au fost furnizate de SCDL Bacău, au fost semănate și transplantate în condiții de seră sub formă de bloc randomizat în trei repetiții. Acest experiment a fost efectuat pentru a evalua trăsăturile fenotipice ale tomatelor, cum ar fi greutatea fructelor, înălțimea, diametrul, conținutul de substanță uscată, SST, apă și aciditatea titrabilă. În cadrul populațiilor locale studiate, licopenul, beta-carotenul și apa prezintă valori ridicate. Populațiile locale cu creștere nedeterminată examinate au evidențiat variații minore ale soiurilor și au demonstrat că acestea ar putea fi utilizate ca material de pre-ameliorare în dezvoltarea viitoare a soiurilor pentru forma, mărimea, culoarea și aroma fructelor dorite pentru piața locală.

Cuvinte cheie: cresterea plantelor, fenotipare, seră, calitatea tomatelor

INTRODUCTION

With an annual production of around 60 million tonnes (Li *et al.*, 2015), tomato is one of the most popular, important, and widely grown vegetables in the world (Choudhury *et al.*, 2013). In Romania, they are grown as forced and protected crops on about 50,000 hectares, which is comparable to 60–65% of the cultivable land in greenhouses (FAOSTAT 2021; Stoleru *et al.,* 2020; INS, 2019). This agricultural plant can be perennial or semi-perennial under specific circumstances (such as rejuvenation pruning, weeding, irrigation, and frost protection), but economically, it is regarded as an annual (Geisenberg and Stewart, 1986). A few of the species have been crossed to produce numerous varieties that are either intended to produce a field crop for a single harvest or, particularly when protected, a succession of fruits for the fresh market over an extended period of time.

Its high consumption rate is primarily a result of its many uses and sensorial qualities, including flavour, texture, and aroma. The fruit is a source of bioactive substances like vitamin C and A, polyphenols, and carotenoids, particularly lycopene (60%), lutein (10%), and beta-carotene (6%) (Kotková *et al.*, 2011; Meléndez-Martínez *et al.,* 2010). The tomato fruit are a base cuisine and can be used as a raw material for processing or for in-nature consumption in salads and homemade sauces, soups, and stews. Both in their natural state and in their derivatives, fruits can be regarded as a significant dietary source of nutrients with antioxidant properties. Nutritionists advise eating it because it contains lycopene, which gives ripe tomatoes their red colour, vitamins A and B complex, as well as minerals like phosphorus and potassium, as well as folic acid and calcium, among others. According to scientific literature, a serving size (200 g) of fresh tomatoes contributes primarily to the intake of fibre and antioxidant compounds, providing 30 to 36% of the Recommended Dietary Allowance (RDA) for vitamin C. However, it also contributes in a moderate amount to the reference intake values of minerals, providing 10% of the Adequate Intake (AI) for K and 5–10% of the RDA for P and Mg (Mohammed *et al*., 2020; Frusciante *et al*., 2007).

It is noteworthy that the concentration of those nutrients increases with fruit maturity (Erba *et al.,* 2013; Santos *et al*., 2016). The genotype, ripening stage, cultivation practices (water availability, mineral nutrients), and climate (especially light and temperature) all affect the antioxidant activity of tomato fruits. According to several epidemiological studies (Giovannucci et al., 2002; Klipstein-Grobush *et al*., 2000), consumption of tomatoes reduces the risk of chronic diseases, including cancer and cardiovascular disease. The different application of labour that results from the various systems and methods of cultivation, the high yields, and the resulting income make this crop economically significant (Inculet and Stoleru, 2021; Testa *et al.,* 2013).

Given the significance of tomatoes for the economy and human health, as well as the challenges retailers have in implementing the right procedures, it is crucial to comprehend how the fruit's physical, chemical, and nutritional properties change while it is kept under commercially specified conditions. Premature harvesting limits the development of the distinctive flavour and aroma of tomatoes, while harvesting at the full ripening stage results in poor transport and storage capacities and undesirable organoleptic quality (Gonçalves *et al.,* 2020; Pieczywek *et al.,* 2018).

The sustainable production of fruits and vegetables in greenhouses offers a practical substitute for supplying a growing world population with food that is both safe and nutrient-dense. Most commercial tomatoes, especially in northern European countries, are produced in greenhouses that allow better control of agronomic and environmental factors. Agronomic practices have been recognized as a critical factor in determining the nutritional quality of crops. In this way, some researchers found the environment to be an important source of variation. Figàs *et al*. (2018) reported that the Mediterranean long-shelf-life tomato under greenhouse conditions compared to open field cultivation had a lower carotene content in fruit but a higher concentration of glucose and antioxidant activity. Growing tomatoes in greenhouses gives interested producers the chance to create an accessible product when there aren't as many available. It extended the season during which tomatoes are available and raised consumer interest in the surrounding area. Cultures of tomatoes in protected areas are carried out between

March 25 and September 15, with the aim of producing early productions by the end of May at a lower cost. According to the Food and Agriculture Organisation of the United Nations (FAO), advantages of greenhouses include the following: protection against extreme climatic conditions; controlled heating, cooling, shading, and CO2 enrichment; out-of-season harvests; improvements in crop quality; ground structure preservation; ability to sow selected materials; considerable production increases; reduced production costs; more efficient use of the growing area; and lowered use of pesticides. There are tens of thousands of tomato varieties on the market, but only a select number are suitable for production in greenhouses.

The study aimed to evaluate the performance of ten indeterminate genotypes of tomato under greenhouse conditions at the Vegetable Research and Development Station in Bacau. During the experiment season, some phenotypic investigations were conducted, such as the number of days until the first flowers appeared, the number of days until the first fruit developed, the number of days until maturation, and the type of inflorescence. In this research, we also discuss some physicochemical characteristics such as fruit weight, height, diameter, dry matter content, TSS, water, lycopene, beta-carotene, and titratable acidity.

MATERIAL AND METHOD

The research was carried out in a greenhouse established at the Vegetable Research and Development Station in Bacau in 2022. The experiment was conducted in a greenhouse that was 3000 square metres in size, covered with plastic film, and had a length of 30 metres.

The experiment was divided into five beds, with two rows on each bed. The distances between the rows are 70 cm, and the distance of the passageway between variants is 100 cm. The placement in the plot consisted of ten local population (LP1÷LP10) of 3 repetitions for each version, with 6 tomato plants in each experimental plot and a distance of 35 cm between them. The total number of seedlings planted was 180.

The seedling was manually planted when it was mature in the second half of April, when it was 43 days old and healthy. Periodic observations on the resistance of pests and diseases and the advancement of plant development in protected areas were completed during the vegetation period. Around the plants and periodically, manual weeding was carried out as needed. Mospilan treatments were used to combat pests and diseases. Green Plant were used for fertilising the plants.

Biological and phenological observations were recorded, including the number of days till the appearance of the first flowers, the number of days till the development of the first fruits, the number of days till the first harvest, as well as the type of inflorescence and the number of tied flowers in the inflorescence.

With a few adjustments, the quantitative and qualitative results followed the descriptors developed by IPGRI (The International Institute for Plant Genetic Resources). A few morphological details, such as the fruits' height and diameter, were recorded. The quality parameters of local populations of tomato were evaluated for dry matter (DM), total soluble solids (TSS), water, titratable acidity (TA), lycopene, and beta-carotene content. The fruits were harvested when the physiological stage of maturity was achieved. The experimental work was done in the laboratories of Vegetable Research and Development Station Bacau.

The fruits' height and diameter were measured biometrically with an electronic calliper that displays precise and readable data (in inches and millimetres), and the weight was approximated with a balance Kern with three decimals. Fruit harvesting was started in the second decade of July and it was finished in the second decade of September. The fruits were harvested when physiological stage of maturity was achieved.

Using a high-precision portable refractometer, the total soluble solids content (TSS) was measured. The results were represented in Brix in accordance with 932:12 procedures (AOAC, 2005). Freshly obtained samples were dried for 24 hours at 70 ± 2 °C in a forced air-drying oven (Biobase) to produce a consistent mass in order to calculate the dry matter content (Stoleru et al., 2020; Caruso G et al., 2019). The water content indicated deviations from 100%.

By titrating 10 mL of tomato juice against a 0.1 N NaOH solution and using phenolphthalein as an indicator until the end point was reached, the titratable acidity of the tomato juice was determined. In order to estimate titratable acidity as a percentage of malic acid, the acid content of the fruit sample was determined by multiplying the volume of 0.1 N NaOH used to neutralise the acid level in the sample by a correction factor of 0.0067. The following formula was used to determine the titratable acidity: % malic acid = mL NaOH x F x 25 x 2 x 0,0067.

The maturity index (MI) of the samples was calculated with the following formula: ◦Brix of sample/titratable acidity, MI = TSS/TA.

Flavour index (FI) was calculated with the following formula: $FI = TA + [(TSS/(20 \times TA)]$. Where: TA = titratable acidity, TSS = total soluble solids (Hernández-Suárez et al., 2008).

Statistical techniques were applied to the morphological data that had been gathered. The IBM SPSS Statistics software, version 26.0, was utilised for statistical analysis. To determine whether there was a significant difference between the variations' means, Tukey's test was applied. When $p \leq 0.05$, differences between groups were considered significant. The results were displayed as means with standard deviations.

RESULTS AND DISCUSSIONS

Phenotypic and morphological characteristics of tomato accessions

The development of phenology governs the growth and yield of plants. The most significant phenological events that impact agricultural yield are the number of days till blooming, fruiting, and maturity. Temperature affects crop productivity and phenological development in significant ways. High temperatures also cause crops to mature early. Harvesting starts 85 to 125 days after seeding. It may take 30 to 70 days, depending on the number of clusters per plant and the variety. At this stage, the fruits may be cut without affecting the seeds, and this stage can be recognised by the colour of the fruit, which changes from intense green to green-yellow.

In table 1, it can be seen that the time required for flowering to begin varied between 70.67 and 76.33 days; the time it took for fruit to develop varied between 80.00 and 85.33 days; and the beginning of maturation was achieved faster in the LP9 variant, at 116.67 days. The number of days was calculated from the date of emergence of the first plant of each variant. The type of inflorescence varied for each variant between 1.11, and 2.22, which means that the variants had one or two ramifications. Flowers ranged in number from 4.56 for LP9 to 8.33 for LP4.

Table 1

Phenological investigations of tomato

Variant	Days to flowering	Days to fruiting	Days to maturation	Type of inflorescence	No. Of flowers
LP1	70.67±0,60d	81.33±0,44bc	123.67±1,74abc	1.33±0,17bc	7.11±0,61ab
LP2	75.67±0,17ab	82.67±0,33b	127.00±0,58ab	1.33±0,17bc	6.78±0,94ab
LP3	72.67±0,73cd	82.67±0,44b	119.33±0,88cd	1.11±0,11c	8.22±0,98a
LP4	76.33±0,17a	85.33±0,17a	128.33±1,33a	2.22±0,15a	8.33±1,30a
LP5	73.33±0,17c	81.33±0,17bc	119.67±1,83cd	2.11±0,11a	6.00±0,50ab
LP6	74.00±0,00bc	82.67±0,44b	119.33±0,93cd	1.00±0,00c	6.78±0,32ab
LP7	74.00±0,76bc	82.00±0,76bc	120.67±2,89bcd	1.22±0,15bc	6.56±0,63ab
LP8	75.67±0,33ab	83.00±0,58b	120.67±1,48bcd	1.22±0,15bc	6.00±0,33ab
LP9	72.67±0,17cd	80.00±0,00c	116.67±0,17d	1.11±0,11c	4.56±0,24b
LP10	77.00±0,76a	82.00±0,76bc	120.33±0,73bcd	1.89±0,26ab	9.00±1,19a

Values represent the average ± standard error. Within each column, different letters mean significant differences between variants, according to Tukey's test at p ≤ 0.05. LP1-Local population 1, LP2-Local population 2; LP3-Local population 3, LP4-Local population 4, LP5-Local population 5, LP6-Local population 6, LP7-Local population 7, LP8-Local population 8, LP9-Local population 9, LP10-Local population 10.

Fruit diameter was significantly different among the genotypes. Fruit diameter ranged from 61.23 to 94.73 mm (Table 2). The largest fruit was recorded from the genotype LP5 (9.43 cm), whereas the smallest fruit was from the genotype pink dark (6.12 cm). Yesmin et al. (2014) reported fruit diameters ranging from 3.64 to 5.71 cm from winter tomato cultivars. Fruit diameter ranging from 3.74 to 5.34 cm was also recorded in cultivated tomatoes, as reported by Kouam et al. (2018). In another study, the fruit diameter ranged between 6.50 and 8.45 cm (Felföldi et al., 2022). We found a little bit more fruit in this experiment. It could be due to the influence of genotypes themselves. The height of the fruit also significantly varied among the genotypes. It ranged from 54.55 to 83.25 mm (Table 2). The highest fruit was measured (8.32 cm) from the genotype LP4, and the genotype LP10 produced the shortest (5.45 cm) fruit. Corduneanu et al. (2018) reported that the fruit mass varied from 158.64 to 335.10 g. Similar results were found in our investigation, with values ranging from 127.91 to 345.39 g. LP5 achieved the greatest values, while LP7 obtained the lowest.

Table 2

Quantitative traits of tomato fruits

Variant	Fruit diameter (mm)	Height of the fruit (mm)	Fruit mass (g)
LP1	68.67±1,47cde	55.36±1,11d	170.70±9,15bcd
LP2	85.62±3,47ab	71.11±1,86b	317.26±26,71a
LP3	70.78±1,46cd	58.60±1,29cd	181.68±10,33bcd
LP4	84.78±2,56b	83.25±2,41a	339.69±25,31a
LP5	94.73±2,60a	71.49±1,47b	345.39±18,93a
LP6	77.62±1,87bc	63.66±1,08c	226.86±13,84b
LP7	61.23±1,03e	56.15±0,79d	127.91±6,28d
LP8	71.13±1,50cd	71.32±0,96b	199.42±9,30bc
LP9	64.76±1,58de	55.93±1,34d	137.17±9,03cd
LP10	72.03±2,08cd	54.55±1,28d	174.44±12,26bcd

Values represent the average ± standard error. Within each column, different letters mean significant differences between variants, according to Tukey's test at p ≤ 0.05. LP1-Local population 1, LP2-Local population 2; LP3-Local population 3, LP4-Local population 4, LP5-Local population 5, LP6-Local population 6, LP7-Local population 7, LP8-Local population 8, LP9-Local population 9, LP10-Local population 10.

Biochemical parameters of tomato accessions

The water content of tomato fruits ranged from 92.87% to 96.57% with an average of 94.53% (Athinodorou *et al.*, 2021). The remaining constituents include ~5-7% inorganic compounds, organic acids (citric and malic), sugars (glucose, fructose and sucrose), solids insoluble in alcohol (proteins, cellulose, pectin, polysaccharides), carotenoids and lipids. Our results confirmed in table 3 that the water content of tomato fruits is between 94.41% (PL3) and 96.11% (PL7).

Table 3

Mean values of physiological characteristics of the tomato fruit

Variant	TSS º Brix	Dry matter %	Water %
LP1	5.32±0,17ab	4.67±0,14ab	95.33±0,14ab
LP2	4.72±0,47abc	4.71±0,19ab	95.29±0,19ab
LP3	4.39±0,34bc	4.52±0,32ab	95.48±0,32ab
LP4	6.01±0,24a	5.59±0,42a	94.41±0,42b
LP5	5.18±0,51ab	5.25±0,35a	94.75±0,35b
LP6	4.92±0,18abc	4.41±0,27ab	95.59±0,27ab
LP7	3.60±0,25c	3.89±0,37b	96.11±0,37a
LP8	4.82±0,28abc	4.69±0,14ab	95.31±0,14ab
LP9	4.63±0,14abc	4.57±0,04ab	95.43±0,04ab
LP10	4.43±0,10bc	4.45±0,16ab	95.54±0,16ab

Values represent the average ± standard error. Within each column, different letters mean significant differences between variants, according to Tukey's test at p ≤ 0.05. LP1-Local population 1, LP2-Local population 2; LP3-Local population 3, LP4-Local population 4, LP5-Local population 5, LP6-Local population 6, LP7-Local population 7, LP8-Local population 8, LP9-Local population 9, LP10-Local population 10.

The content of soluble solids is one of the main characteristics of the fruits. Regarding to the genotype factor, the dry matter content varied within low limits, being between 3.89 % and 5.59 %, the values obtained showing, however significant statistical differences. The highest value, of 5.59%, was obtained by PL4, while the lowest value, of 3.89%, was registered by PL7. According to Apahidean *et al*. (2016) the dry matter content of ripe fruit ranges from 5.5-7.5%, 3-4% glucose and fructose glucose, 1-1.3% antide and 0.5-0.7 minerals, from the fresh substance.

The TSS is a refractometric index that indicates the proportion (%) of dissolved solids in a solution. It is the sum of sugars (sucrose and hexoses; 65%), acids (citrate and malate, 13%) and other components (phenols, amino acids, soluble pectins, ascorbic acid and minerals) in the tomato fruit pulp. Dorais *et al.* (2001) registered that the concentration of sugars may vary from 1.66 to 3.99% and 3.05 to 4.65% of the fresh matter, as a function of the cultivar and cultivation conditions, respectively. The results obtained in our study highlight that the highest sugar content, of 6.01 ^{o}Brix, was recorded for PL4, with no significant statistical differences, and the minimum value was obtained by LP7 with 3.60 ^{o}Brix. Studies have evidenced that temperatures near 23°C improve the quality of the fruit and also increase the content of dry matter.

Table 4

Mean values of fruit quality characteristics

Variant	Titratable acidity (% malic acid)	Lycopene mg 100 g^{-1}F.W.	β-carotene mg 100 g^{-1}F.W.	Maturity index	Taste index
LP1	0.29±0,000d	6.39±0,33c	8.21±0,03ef	18.16±0,55a	1.09±0,03a
LP2	0.35±0,000c	4.92±0,02e	6.73±0,02g	13.50±13,50cd	1.02±0,03a
LP3	0.39±0,000b	5.49±0,02de	7.50±0,01fg	11.28±0,92d	0.97±0,04a
LP4	0.40±0,009b	9.34±0,02a	13.96±0,01a	15.23±0,55abcd	1.10±0,05a
LP5	0.44±0,000a	6.45±0,01c	9.03±0,04cd	11.78±1,16d	1.04±0,04a
LP6	0.27±0,0003de	6.03±0,23cd	8.37±0,36de	18.06±0,52ab	1.08±0,05a
LP7	0.26±0,006e	6.44±0,03c	8.93±0,05cde	13.77±1,07bcd	1.01±0,07a
LP8	0.27±0,009de	7.89±0,01b	11.41±0,02b	17.62±0,62abc	1.13±0,01a
LP9	0.28±0,003de	6.59±0,22c	9.24±0,36c	16.81±0,78abc	1.10±0,02a
LP10	0.29±0,003d	6.07±0,02cd	8.42±0,01de	15.05±0,48abcd	1.05±0,03a

Values represent the average ± standard error. Within each column, different letters mean significant differences between variants, according to Tukey's test at $p \leq 0.05$. LP1-Local population 1, LP2-Local population 2; LP3-Local population 3, LP4-Local population 4, LP5-Local population 5, LP6-Local population 6, LP7-Local population 7, LP8-Local population 8, LP9-Local population 9, LP10-Local population 10.

For both the industry and the consumer base of fresh fruit, fruit colour is a crucial factor. Tomatoes are coloured by a combination of green pigments called chlorophylls, yellow pigments called xanthophylls, and carotenoids, primarily lycopene and b-carotene. The green colour of the immature fruits is due to a mixture of chlorophylls, levels of which decrease with the maturing of the fruit.

When the fruit begins to mature yellow (b-carotene) is produced, which becomes more apparent with the decrease in the content of chlorophyll. Afterwards there is a rapid increase in the concentration of lycopene, which gives the fruit a red colour. In our study the beta-carotene values ranged between 6.73 for LP2 and 13.96 mg 100 g-1F.W. for PL4, which has the highest value (tab. 4). The genotypes studied influenced the lycopene content which values varied within relatively low limits, with values between 4.92±0.02 mg·100 g−1F.W. for PL2 and 9.34±0.02 mg·100 g−1F.W. in the case of PL4, the differences being significant in terms of statistical analysis. Referring to the content of lycopene, Stoleru *et al*. (2020) demonstrated that the values for tomato fruits ranged between 8.91 and 10.27 mg·100 g−1F.W.

Among the acids present in the tomato fruit, the main acids are citric and malic, with citric acid being predominant over malic acid (Bertin *et al*., 2000). Any change in the contents of citric and/or malic acid will alter the content of titratable acid and will change the degree of acidity of the fruit, altering its flavour. In a study conducted in Mexico, eight tomato genotypes of different colours were studied, and one of those had a significant amount of malic acid (350 g^{-1}F.W.), while the rest of the genotypes ranged from 60 to 59 g^{-1}F.W. In our research, the proportion of acid malic was between 0.26 % for PL7 and it raised to 0.44% for PL5.

An important parameter that differentiates tomato flavour among varieties is the maturity index (MI) which is the TSS/ TA ratio and is key for determination of fruit flavour. LP6 has a maturity index of 18.06, while LP 3 has an index of 11.28 (tab. 4). The results obtained are in concordance with Mendez *et al.* (2011), who obtained values of MI in thirteen tomato accessions ranging between 10.55 and 17.96. Maturity index (TSS/TA) with a higher value gives a smoother flavour of fruits and vegetables, whereas lower values are correlated with acid, so a worse flavour. Taste index is another important parameter in determining the flavour quality correlated with MI. In our research, values for taste index ranged between 0.97 (LP3) and 1.13 for LP8. These results are similar with the results found by Dobrin *et al*. (2019), Figàs *et al*. (2018) and Mendez *et al*. (2011).

CONCLUSIONS

1. Studying the behaviour of different tomato genotypes in greenhouse conditions is an important area of research for improving tomato production, especially in regions with challenging climates or limited arable land. Such research can provide insights into the best genotypes for greenhouse cultivation, which can increase yields, improve quality, improve handling and storage durability, improve pest resistance, expand processing techniques, and lead to the development of new tomato-based products.

2. All the studied varieties had large fruits with a mean weight over 222.05 g, a diameter of more than 61 mm and a height of the fruit more than 54 mm.

2. The results showed that physicochemical quality of tomatoes varieties assessed as dry matter, total soluble solids, titratable acidity are depending on variety. The local populations studied are rich in lycopene, beta-carotene, and water, which demonstrate that they provide a wide range of nutrients that play a fundamental role in human health.

3. Local population 1 has the shortest period to flower, with a number of roughly 71 days, making it the earliest population in terms of timing. Local population 9 had the lowest value, 80 days, for the amount of time until the first fruit appeared. Additionally, the number of days needed for the fruits to ripen was lowest for the same local population, coming out at roughly 117 days.

4. Some of the studied tomato genotypes (LP1, LP3, LP4, LP5, LP9) have been identified with qualitative characteristics (earliness, firmness, taste and nutrients) that recommend them to be suitable for cultivation in protected areas.

Acknowledgments*: Doctorat program under Iasi University of Life Sciences and ADER 6.3.20/ 27.07.2023 - Research on improving vegetable cultivation technology in new types of protected spaces in order to achieve safe yields and reduce the intensity of chemical treatments within the context of climate change.*

REFERENCES

1. **Apahidean Al. S, Apahidean Al. I., 2016 –** *Legumicultura*, Ed. Risoprint, Cluj-Napoca, 243-247.
2. **Athinodorou F., Foukas P., Tsaniklidis G., Kotsiras A., Chrysargyri A., Delis C., Nikoloudakis N., 2021 –** *Morphological diversity, genetic characterization, and phytochemical assessment of the cypriot tomato germplasm.* Plants, 10(8), 1698.
3. **Bertin N., Guichard S., Leonardi C., Longuenesse J. J., Langlois D., Navez, B., 2000 –** *Seasonal evolution of the quality of fresh glasshouse tomatoes under Mediterranean conditions, as affected by air vapour pressure deficit and plant fruit load.* Annals of Botany, 85(6), 741-750.
4. **Caruso G., De Pascale S., Cozzolino E., Cuciniello A., Cenvinzo V., Bonini P., Colla G., Rouphael Y., 2019** – *Yield and Nutritional Quality of Vesuvian Piennolo Tomato PDO as Affected by Farming System and Biostimulant Application*. Agronomy. 2019; 9(9):505.
5. **Choudhury S., Islam N., Sarkar M.D., Ali M.A., 2013 –** *Growth and yield of summer tomato as influenced by plant growth regulators.* Int. J. Sustain. Agric. 5, 25–28.
6. **da Silva D.J.H., Abreu F.B., Caliman F.R.B., Antonio A.C., Patel V., 2008 –** *Tomatoes and tomato products: nutritional, medicinal and therapeutic properties. Chapter: Tomatoes: origin, cultivation techniques, and germplasm resources*. Publisher CRC Press, 3-26.
7. **Dobrin A., Nedelus A., Bujor O., Mot A., Zugravu M., Badulescu L. 2019 –** *Nutritional quality parameters of the fresh red tomato varieties cultivated in organic system*. Scientific Papers. Series B. Horticulture, 63(1), 439-443.
8. **Dorais M., Gosselin A, A.P. Papadopoulos., 2001 –** *Greenhouse tomato fruit quality*. Hortic. Rev. 26: 239-306.
9. **Erba D., Casiraghi M. C., Ribas-Agustí A., Cáceres R., Marfà O., Castellari, M., 2013 –** *Nutritional value of tomatoes (Solanum lycopersicum L.) grown in greenhouse by*

different agronomic techniques. Journal of Food Composition and Analysis, 31(2), 245-251.

10. **Felföldi Z, Ranga F, Roman IA, Sestras AF, Vodnar DC, Prohens J, Sestras RE., 2022 –** *Analysis of Physico-Chemical and Organoleptic Fruit Parameters Relevant for Tomato Quality*. Agronomy,12(5):1232.
11. **Figàs M. R., Prohens J., Raigón M. D., Pereira-Dias L., Casanova C., García-Martínez M. D., Soler, S., 2018 –** *Insights into the adaptation to greenhouse cultivation of the traditional Mediterranean long shelf-life tomato carrying the alc mutation: A multi-trait comparison of landraces, selections, and hybrids in open field and greenhouse*. Frontiers in Plant Science, 9, 1774.
12. **Figàs M.R, Prohens J., Raigón MD, Pereira-Dias L., Casanova C, García-Martínez M.D., Rosa E., Soler E., Plazas M., Soler S., 2018 –** *Insights Into the Adaptation to Greenhouse Cultivation of the Traditional Mediterranean Long Shelf-Life Tomato Carrying the alc Mutation:* A Multi-Trait Comparison of Landraces, Selections, and Hybrids in Open Field and Greenhouse. Front. Plant Sci. 9, 1774.
13. **Frusciante L., Carli P., Ercolano M. R., Pernice R., Di Matteo A., Fogliano V., Pellegrini N., 2007 –** *Antioxidant nutritional quality of tomato*. Molecular nutrition & food research, 51(5), 609-617
14. **Geisenberg C., Stewart K., 1986 –** "*Field crop management*", in Atherton, J.G. and J. Rudich (eds.), The Tomato Crop: A Scientific Basis for Improvement, Chapman & Hall, London, pp. 511-557.

15 **Gonçalves D. C., Morgado C. M., Aguiar F. C., Silva E. P., Correa G. D., Nascimento A. D., Cunha Junior L. C., 2020 –** *Postharvest behavior and lycopene content of tomatoes at different harvest times*. Acta Scientiarum. Technology, 42.

16. **Hernández-Suárez M., Rodrígues-Rodrígues E.M., Diaz Romero C., 2008 –** *Chemical composition of tomato (Lycopersicon esculentum) from Tenerife*, the Canary Islands. Food Chem., 106, 1046–1056.
17. **Inculet C.S., Stoleru V., 2021 –** *Tehnologia de cultivare a tomatelor*. Editura ”Ion Ionescu de la Brad” Iasi.
18. **Kotíková Z., Lachman J., Hejtmánková A., Hejtmánková, K., 2011 –** *Determination of antioxidant activity and antioxidant content in tomato varieties and evaluation of mutual interactions between antioxidant*s. LWT - Food Science and Technology, 44(8).
19. **Kouam E. B., Dongmo J. R., Djeugap J. F., 2018 –** *Exploring morphological variation in tomato (Solanum lycopersicum): A combined study of disease resistance, genetic divergence and association of characters.* Agricultura Tropica et Subtropica, 51(2), 71-82.
20. **Li H., Xu L., 2015 –** *The development and prospect of agricultural robots in China*. Acta Agriculturae Zhejiangensis 2015; 27(5): 865–871.
21. **Meléndez-Martínez A. J., Fraser P. D., Bramley P. M., 2010 –** *Accumulation of health promoting phytochemicals in wild relatives of tomato and their contribution to in vitro antioxidant activity.* Phytochemistry, 71(10).
22. **Méndez I., Vera G. A. M., Chávez S. J. L., Carrillo R. J. C., 2011 –** *Quality of fruits in mexican tomato (Lycopersicon esculentum Mill.)* Landraces. Vitae, 18(1), 26-32.
23. **Mohammed A. E., Smit I., Pawelzik E., Keutgen A. J., Horneburg B., 2020 –** *Organically grown outdoor tomato: fruit mineral nutrients and plant infection by Phytophthora infestans.* Organic Agriculture, 10, 125-134.
24. **Pieczywek P. M., Nowacka M., Dadan M., Wiktor A., Rybak K., Witrowa-Rajchert D., Zdunek A., 2018 –** *Postharvest monitoring of tomato ripening using the dynamic laser speckle*. Sensors, 18(1093), 1-20.

25. **Santos G. G., Mattos L. M., Moretti, C. L., 2016 –** *Quality and occurrence of mycotoxins in tomato products in the Brazilian market.* Enzyme Engineering, 5(3), 1-7.
26. **Sinesio F., Cammareri M., Moneta E., Navez B., Peparaio M., Causee M., Grandillo S., 2010 –** *Sensory quality of fresh French and Dutch market tomatoes: a preference mapping study with Italian consumers*. J. Food Sci. 75, S55–67.
27. **Stevens M. A., 1972 –** *Citrate malate concentrations in tomato fruits: genetic control and maturational effects*. J. Am. Soc. Hortic. Sci. 97: 655-658.
28. **Stoleru V., Inculet S. C., Mihalache G., Cojocaru A., Teliban G. C., Caruso, G., 2020 –** *Yield and Nutritional Response of Greenhouse Grown Tomato Cultivars to Sustainable Fertilization and Irrigation Management*. Plants (Basel, Switzerland), 9(8), 1053.
29. **Testa R., di Trapani A. M., Sgroi F., Tudisca S., 2014 –** *Economic sustainability of Italian greenhouse cherry tomato.* Sustainability, 6(11), 7967-7981.
30. **Yesmin L., Islam M. S., Rahman M. M., Uddin M. N., Ahmad S., 2014 –** *Inbred and hybrid seed production potentiality of tomato (Lycopersicon esculentum) genotypes and their yield performance during summer*. Bangladesh Journal of Agricultural Research, 39(1), 13-21.
31. *****, AOAC, 2005 –** *Official Methods of Analysis of AOAC Int*ernational, 21st ed.; AOAC: Gaithersburg, MD, USA.
32. *****, FAO Statistical Databases:** (FAOSTAT 2021) Available at: http://www.fao.org/faostat/en/#home
33. *****, INS. 2019 –** *Vegetal Agriculture Production for Main Crops*. Vol. 85.