THE BEHAVIOR OF SOME WATERMELONS HYBRIDS IN PEDOCLIMATIC CONDITIONS FROM SCDCPN DĂBULENI

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Abstract

Citrullus lanatus belongs to the Cucurbitaceae family and is mainly cultivated in warm areas, representing a basic crop for them. Watermelon fruits are intended for fresh consumption, but can also be used for various preparations such as syrup, jam, or pickles. The study of the seven watermelon hybrids was carried out at the Research - Development Station for Plant Culture on the Dăbuleni Sands, in the period 2023 - 2024, with the aim of evaluating their behavior by determining the qualitative and morphological characteristics of the fruits. Among the analyzed hybrids, 5 are with red core ('Karistan F1', 'Kandemir F1', 'Mirsini F1', 'Lusitana F1' and 'Pata Neagră F1') and two with yellow core ('Peace F1' and 'Royal King F1'). Following the determinations, the 'Kandemir F1' hybrid stood out for the size of the fruits (12.55 kg - 11.22 kg) and the diameter of the fruits (25.68 cm - 26.66 cm). From a biochemical point of view, the 'Mirsini F1' hybrid with the percentage of soluble dry matter (12%) and the 'Peace F1' hybrid with 14.38% of total dry matter stood out. The obtained results provide information regarding the degree of adaptation of the different watermelon hybrids to the pedo-climatic conditions in the area of sandy soils in the south of Oltenia.

Key words**: **watermelon, cultivar, physical charcaterisitcs, sandy soils

INTRODUCTION

Citrullus lanatus (Thunb.) Matsum and Nakai known as watermelon is a herbaceous plant belonging to the Cucurbitaceae family (Mujaju et al., 2010) which includes 118 genera and 825 species (Bates et al., 1990), being cultivated widely in many African countries (Hakimi & El Madidi, 2015). Due to the constant growth of human population, the demand for high-yielding, disease-resistant and high-nutrition food crops, including watermelon, is intensifying. To meet this demand, numerous research and cultivation programs are being researched on the conservation and collection of genetically diverse watermelon germplasm, the characterization of quality traits and metabolites and breeding programs (Assefa et al. 2020). The assortment of watermelons must be enriched periodically due to the appearance on the market of new varieties and hybrids, but also to satisfy the constantly changing demands of consumers (Ciupureanu et al., 2017). The objective of our research is to identify new varieties adapted to the ever-changing climatic conditions and increasingly different market requirements. For this, we studied seven hybrids from the existing assortment on the market, from the point of view of behavior on the sandy soils of the south of the country.

MATERIALS AND METHODS

The experiment was established on the sandy soils of the SCDCPN Dăbuleni research field. The plant material used to establish the experience in the two years of study 2022 – 2023 was represented by seven cultivars of watermelons of which 5

cultivars with red core respectively 'Karistan F1', 'Kandemir F1', 'Mirsini F1', 'Lusitana F1', 'Pata Neagră F1' and 2 cultivars yellow cored 'Royal King F1' and 'Peace F1'. The physical properties of the fruits were evaluated, such as fruit height and diameter (cm), shape index, fruit weight (kg), skin thickness (cm), skin weight (kg), core weight (kg), core percentage (%), according to the methodology described by Ionică M.E. (2014). The chemical properties of the fruits were also evaluated according to the methodology described by Ionică M.E. (2014). Soluble dry matter (SUS) was determined by the refractometric method, the results being expressed as percentages (%). To determine the content of total dry matter (SUT), the gravimetric method was applied based on the removal of water by evapotranspiration from the average analytical sample used, keeping it in the oven at a temperature between 85-105°C. The results were expressed in percentage of total dry matter (%). The determination of titratable acidity (TA) was carried out using the method described by Ionică (2014), the results were expressed in grams of malic acid/100g of fresh substance. To determine the vitamin C content, the iodometric method described by Croitoru (2021) was applied, which is based on the oxidation of ascorbic acid with excess iodine, the results being expressed in mg of ascorbic acid. Carbohydrates were determined according to the Fehling Soxhelt method described by Croitoru (2021), the results being expressed in percentages.

The obtained data were processed statistically, using the statistical analysis program (StatPoint Technologies, Warrenton, VA, USA).

RESULTS AND DISCUSSIONS

Watermelons, being heat-loving plants, tolerate drought and high temperatures more easily, having the lowest hydrothermal coefficient (0.7-0.8); the minimum temperature supported is between 0 and 4°C, with a minimum biological temperature of 12-14°C and a maximum biological temperature of 30-35°C (Voinea et al., 1977; Ceaușescu, 1979; Nanu et al. , 2023). Pedoclimatic factors such as temperature, light, water and nutrients can affect the development of physiological processes and fruit size (Katsumi et al., 1999).

Table 1 shows the climatic conditions in the research area during the vegetation period in the two years of the study. According to the data below, we can see that during the growing season the lowest value of the average temperature was recorded in May, respectively 16.75°C and an absolute minimum temperature of 7.4°C also in the same month. The highest average value of the average temperature for the two years of the study was recorded in July, namely 25.97°C. Regarding the amount of precipitation, it can be observed that the highest amount in the two years of the study was recorded in May, with an average value of 97.80 l mm.

Table 1. Climatic conditions recorded during May-August, 2023-2024

The climatic element	The period 2023-2024			
	May	June	July	August
Mean temperature (°C) 2023-2024	16,75	23,20	25,97	25,63
Absolute maximum temperature (°C) 2023-2024	28,80	38,40	41,48	41,06
Absolute minimum temperature (°C)2023-2024	7,40	11,75	10,22	10,55
Rainfall (mm) 2023-2024	97,8	54,2	48,10	11,85
Multiannual average temperaures (°C) (1995-2024)	16,943	21,594	23,367	22,745

Table 2 Phenological observations on watermelon hybrids studied during 2023-2024

Cultivar	Stadiile fenologice		
	Date of ♂ flower appearance	Date of ♀ flower appearance	Date of binding fruit
'Karistan F1'	08.06 - 10.06	12.06 – 13.06	15.06 – 17.06
'Kandemir F1'	06.06 - 07.06	07.06 – 10.06	12.06 – 13.06
'Mirsini F1'	07.06 - 10.06	09.06 – 11.06	13.06 – 16.06
'Lusitana F1'	06.06 - 03.06	07.06 – 07.06	12.06 – 10.06
'Pata Neagră F1'	07.06 - 07.06	09.06 – 10.06	12.06 – 13.06
'Royal King F1'	06.06 - 03.06	07.06 – 07.06	12.06 – 10.06
'Peace F1'	06.06 - 03.06	07.06 – 07.06	12.06 – 10.06

Table 2 presents information on the initiation of the main phenological stages in the grafted watermelon cultivars studied in the two years. The appearance of male flowers (♂) started in 2023 the earliest on 06.06 at 'Kandemir F1', 'Lusitana F1', 'Royal King F1' and 'Peace F1' hybrids, and in 2024 on 03.06 in Lusitana F1, 'Royal King F1' and 'Peace F1'. Female flowers(♀) appear no later than 12.06 at 'Karistan F1' in 2023, and in 2024 on 12.06 at 'Karistan F1' and 11.06 at 'Mirsini F1'. The first bound fruits appeared 2023 on 12.06 in the hybrids 'Kandemir F1', 'Lusitana F1', 'Pata Neagră F1', 'Royal King F1' and 'Peace F1' and the latest on 15.06 in 'Karistan F1', and in 2024 the earliest on 10.06 in 'Lusitana F1', 'Royal King F1' and 'Peace F1', and the latest on 17.06 at 'Karistan F1'. In the specialized literature Ciupureanu and collaborators, reported in 2017, an onset of the phenological stages of flowering and setting of the first fruits included in the intervals 10 - 13.06 respectively 20 - 24.06. From the analysis of the data in table 3, it appears that in 2023 the highest fruit weight of 12.55 kg was recorded for the fruits of the 'Kandemir F1' hybrid and the lowest of 5.41 kg for the 'Peace F1' hybrid. The highest fruit height of 35.67 cm was recorded for the fruits of the 'Mirsini F1' hybrid and the lowest, of 24.34 cm, for the fruits of the 'Pata Neagră F1' hybrid. The fruit diameter in 2023 was between 20.08 cm for the fruits of the 'Peace F1' hybrid and 25.68 cm for the 'Kandemir F1' hybrid. The shape index in 2023 had an average value between 1.05 for the fruits of the 'Lusitana F1' hybrid, and 1.58 for 'Mirsini F1'. From the point of view of the weight of the peel and core of the fruit, in 2023 the 'Kandemir F1' hybrid stood out with 4.90 kg of peel and 7.65 kg of core. Peel thickness showed average values between 0.90 cm in 'Peace F1' and 1.66 cm in 'Kandemir F1'.The highest kernel percentage was calculated for the fruits of the 'Kandemir F1' hybrid with an average value of 61.02%, and the lowest with an average value of 49.48% for 'Royal King F1'.

Table 3. The morphological characteristics of watermelon hybrids fruits studied in 2023

Cultivar	Fruit weight (kg)	Fruit height (cm)	Fruit diameter (cm)	Shell thickness (cm)	Shell weight (kg)	Pulp weight (kg)	Pulp percent(%)	Brix (%)	IF
'Karistan F1'	10,42	31,08	24,50	1,52	4,10	6,31	60,64	11,00	1,27
'Kandemir F1'	12,55	33,94	25,68	1,66	4,90	7,65	61,02	10,38	1,32
'Mirsini F1'	11,34	35,68	22,65	1,34	4,85	6,49	57,22	11,92	1,58
'Lusitana F1'	9,48	28,10	24,98	1,30	3,93	5,45	58,20	11,66	1,13

'Pata Neagră F1'	7,68	24,34	23,32	1,36	3,59	4,09	53,02	11,86	1,05
'Royal King F1'	8,85	29,48	23,32	1,34	4,46	4,38	49,48	12,40	1,27
'Peace F1'	5,41	24,80	20,08	0,90	2,14	3,26	52,00	11,06	1,24

IF= Shape index.

Table 4. The morphological characteristics of watermelon hybrids fruits studied in 2024

Cultivar	Fruit weight (kg)	Fruit height (cm)	Fruit diameter (cm)	Shell thickness (cm)	Shell weight (kg)	Pulp weight (kg)	Pulp percent(%)	Brix (%)	IF
'Karistan F1'	9,73	31,42	23,40	1,14	3,59	6,00	62,72	10,06	1,35
'Kandemir F1'	11,22	32,58	26,66	1,72	4,44	6,79	60,23	11,48	1,22
'Mirsini F1'	9,99	33,46	21,60	1,18	3,21	6,78	67,03	12,44	1,55
'Lusitana F1'	8,73	27,68	25,48	1,74	3,01	5,72	65,89	12,16	1,09
'Pata Neagră F1'	5,72	23,38	22,43	1,30	2,57	3,15	54,67	10,34	1,05
'Royal King F1'	5,57	25,04	20,80	1,02	2,33	3,24	58,13	10,88	1,20
'Peace F1'	5,39	24,76	20,58	1,06	1,78	3,60	66,34	10,40	1,20

IF= Shape index.

Table 4 shows the average values of the main characteristics of the fruits of watermelon hybrids, analyzed in 2024. According to the data from the table above, the highest and lowest average fruit weight of 11.22 kg and 5.57 kg respectively was recorded in 2024 in the same hybrids as in 2023 'Kandemir F1' and 'Peace F1' respectively. The height of the fruits in 2024 showed average values between 23.38 cm and 33.46 cm for 'Pata Neagră F1' and 'Mirsini F1' hybrids. The highest average fruit diameter value of 26.66 cm was recorded for 'Kandemir F1' and the lowest for the fruits of the 'Peace F1' hybrid, respectively 20.58 cm. The thickness of the shell presented in 2024 average values between 1.02 cm and 1.74 cm for 'Royal King F1' and 'Lusitana F1' respectively. The highest average value of peel and core weight of 4.66 kg and 6.79 kg, respectively, was also recorded in the fruits of the 'Kandemir F1' hybrid, as in 2024; but from the point of view of the core percentage, the fruits of the 'Mirsini F1' hybrid stood out with 67.03% core, the lowest core percentage of 54.67% being recorded at 'Pata Neagră F1'. The data obtained regarding the biometric characteristics of the fruits are consistent with those in the specialized literature, where Nanu et al., in 2023, reported for the cultivars analyzed, an average fruit height value of 34.73 cm. Atli et al., in 2021 reported an average fruit height between 15.17 cm and 26.83 cm, much lower than those obtained from the research carried out. Regarding fruit diameter, Atli et al., (2021) reported an average of this characteristic with values between 14.49 cm and 19.19 cm, lower than those obtained in the study period 2023-2024; and a shell thickness between 8.77 mm and 15.25 mm. Analyzing the data from the two years of the study, it can be seen that during this period the 'Kandemir F1' hybrid stood out in terms of the highest average value of fruit weight and diameter, respectively 12.55 kg (2023) and 11.22 kg (2024); and 25.68 cm (2023) and 26.66 cm in 2024. For the height of the fruits, the cultivar 'Mirsini F1' stood out in the two years with values between 35.67 cm (2023) and 33.46 cm (2024). 'Kandemir F1' stood out for the highest percentage of core with 61.02% in 2023 and in 2024 'Mirsini F1' with 67.03%. Toma et al., in 2016, obtained

fruits with an average weight of 6.35 kg at 'Dulce de Dăbuleni', 7.18 kg at 'Oltenia' and 6.36 kg at 'De Dăbuleni'.

With the help of correlations, were examined the relationships between the biometric characteristics of the fruits, the results being reproduced in table 5.

Analyzing the data from the table we can see that in both years of the study, positive correlations were calculated between fruit height and fruit weight (r= 0.86 and r=0.90 respectively), and between fruit diameter and weight (r= 0.73 respectively r=0.71).

A positive correlation was also calculated between the diameter and the weight of the fruit core (r= 0.95 respectively r=0.96), but also between the weight of the core and the percentage of the core (r= 0.45 respectively r= 0.57). In the specialized literature, Buriev, 2023 reported positive correlations between fruit weight and age, respectively r=0.98.

Tabel 5. Correlations between the fruit characteristics of the watermelon cultivars studied in the two years 2023-2024

Characteristic / Year	Fruit weight (kg)		Fruit height (cm)		Fruit diameter (cm)		Shell thickness (cm)		Shell weight (kg)		Pulp weight (kg)		Pulp percent(%)	
	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
Fruit weight (kg)	1	1												
Fruit height (cm)	0.86	0.90	1	1										
Fruit diameter (cm)	0.73	0.71	0.33	0.48	1	1								
Shell thickness (cm))	0.70	0.47	0.45	0.24	0.71	0.78	1	1						
Shell weight (kg)	0.86	0.83	0.74	0.78	0.66	0.77	0.60	0.58	1	1				
Pulp weight (kg)	0.95	0.96	0.81	0.85	0.67	0.59	0.67	0.35	0.65	0.64	1	1		
Pulp percent(%)	0.14	0.33	0.15	0.31	0.00	0.01	0.10	-0.14	-0.37	-0.22	0.45	0.57	1	1

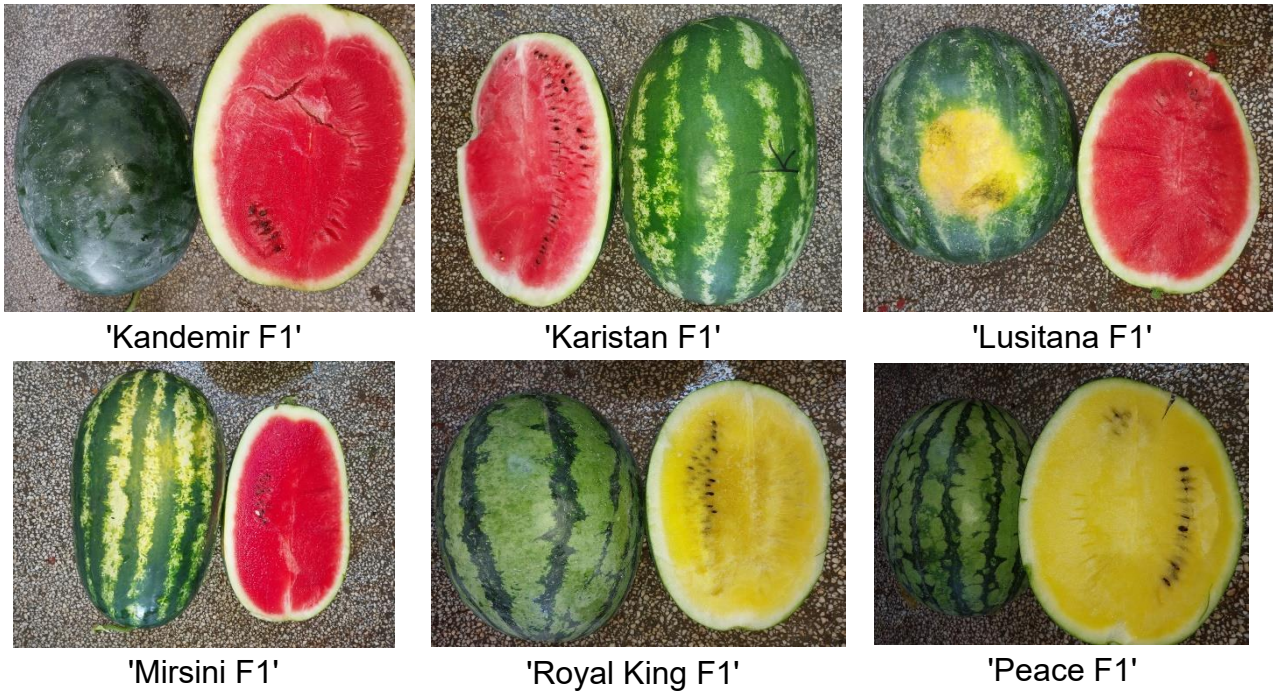

Figure 1. Some of the watermelon hybrids, studied in the period 2023 - 2024

Table 6 The biochemical content of watermelon fruits studied in the period 2023-2024

Cultivar	Water (%)	Total dry substance (%)	Soluble dry substance (%)	Soluble carbohydrates (%)	Titratable acidity (g malic acid per 100 g s.p.)	Vitamin C (mg/100 g s.p)
'Karistan F1'	91,96	8,04	9,80	8,43	0,35	13,20
'Kandemir F1'	89,86	10,14	11,10	9,54	0,35	14,08
'Mirsini F1'	90,82	9,90	12,00	10,42	0,29	15,40
'Lusitana F1'	90,03	9,97	11,10	9,54	0,34	14,08
'Pata Neagră F1'	90,04	10,23	11,10	9,54	0,37	18,48
'Royal King F1'	90,04	9,96	10,30	8,86	0,34	16,20
'Peace F1'	89,43	10,57	10,60	9,11	0,35	15,84

Regarding the nutritional properties of watermelon fruits, table 6 shows the average values of the results obtained regarding their biochemical content. Analyzing the data from the table, it can be seen that the highest average value of soluble dry matter content (SUS .%), was recorded during the study period in the fruits of the hybrid 'Mirsini F1', respectively 12.00% and the lowest in ' Karistan F1 ' respectively 9.80%. From the point of view of the content of total dry matter (SUT, %), the highest value was recorded in the fruits of the ' Peace F1 ' hybrid, respectively 14.38%, and the lowest in 'Karistan F1', respectively 8.04%. Atli et al., in 2021 reported for the watermelon genotypes studied, a total dry matter content that varied from 5.57% to 8.03%. These values are lower than those reported by Schulteis et al., 2007; Yuan-feng et al., 2013 in which the total dry matter content of watermelons varied between 10.6%-12% and 12%-12.5% respectively.

Titratable acidity recorded the highest value of 0.37 g malic acid/100g fresh substance, in the fruits of the 'Pata Neagra F1' hybrid and the lowest value in the fruits of the 'Mirsini F1' hybrid. The vitamin C content recorded the highest value of 18.48 mg in the fruits of the 'Pata Neagră F1' hybrid, and the lowest of 13.20 mg in the fruits of the 'Karistan F1' hybrid. Carbohydrates showed the highest value of 10.42% in the fruits of the 'Mirsini F1' hybrid, and the lowest in the fruits of the 'Karistan F1' hybrid, respectively 8.43%. Following the observations made in the two years of the study, the 'Mirsini F1' hybrid stood out in terms of the highest average value of soluble dry matter content and carbohydrates, respectively 12.00% and 10.42%, followed by 'Peace F1' with the highest total dry substance content, respectively 14.38%, and Pata Neagră F1' with the highest vitamin C content, respectively 18.48 mg / 100 g of fresh substance, but also for the highest value of titratable acidity, respectively 0.37g malic acid/ 100g fresh substance.

The results obtained are in accordance with the data from the specialized literature, where Croitoru et al., (2013) reported values between 8.80 and 16.72 mg/100 g of fresh vitamin C substance for the studied cultivars, 8.00% and 10, 50% soluble solids. Nanu et al., 2023, reported for the studied cultivars a content of soluble dry matter and total dry matter of 10.97% and 11.38% respectively, 12.03 mg vitamin C, 9.84% carbohydrates and 0.26 mg malic acid / 100 g of fresh substance.

CONCLUSIONS

The data regarding of the main vegetation phenophases showed that the first set fruits appeared in 2023 on 12.06 for the hybrids 'Kandemir F1', 'Lusitana F1', 'Pata Neagră F1', 'Royal King F1' and 'Peace F1', and in 2024 the earliest on 10.06 for 'Lusitana F1', 'Royal King F1' and 'Peace F1'.

Analyzing the data on the biometric characteristics of the fruits (average of the years of study), the 'Kandemir F1' hybrid stood out in terms of the highest average value of the weight and diameter of the fruits, respectively 12.55 kg (2023) and

11.22 kg (2024); and 25.68 cm(2023) and 26.66 cm in 2024 respectively.

Regarding the content of soluble dry matter and total dry matter, the 'Mirsini F1' hybrid stood out with 12.00% SUS and 14.38% SUT in the fruits of the 'Peace F1' hybrid in the two years of the study.

The behavior of watermelon cultivars in terms of production and quality characteristics is different, depending on the area of cultivation and the climatic conditions of the year of cultivation.

REFERENCES

Assefa, A. D., Hur, O. S., Ro, N. Y., Lee, J. E., Hwang, A. J., Kim, B. S., ... & Noh, J. J. (2020). Fruit morphology, citrulline, and arginine levels in diverse watermelon (Citrullus lanatus) germplasm collections. *Plants*, *9*(9), 1054.

Atlı, E., Solmaz, İ., Sarı, N., & Kelebek, H. (2021). Determination of Some Agronomic and Fruit Quality Characteristics of Some Watermelon Accessions from Turkish Watermelon Germplasm. *Turkish Journal of Agriculture-Food Science and Technology*, *9*(8), 1322-1328.

Bates DM, Robinson RW, Jeffrey C (1990). Biology and utilization of the Cucurbitaceae, Cornell University Press, USA.

Buriev, K. (2023). Growth dynamics of the fruit of members of the Cucurbitaceae family. In *E3S Web of Conferences* (Vol. 452, p. 01020). EDP Sciences.

Ceaușescu I., (1979). Cultura legumelor. Editura Ceres, București.

Ciupureanu, M. G., Ciuciuc, E., & Popa, D. (2017). ESTABLISHING THE CROP ASSORTMENT OF WATER MELON (CITRULLUS LANATUS) DEPENDING ON THE ELEMENTS THAT DEFINE THE PRODUCTION. Scientific Papers-Series B, Horticulture, (61), 333-337.

Croitoru Mihaela (2021). Chimie și biochimie vegetală. Lucrări practice de laborator, Editura SITECH, Craiova.

Hakimi, F., & El Madidi, S. (2015). Variability of agro-morphological traits in some Moroccan watermelon landraces (Citrullus lanatus Thunb. Matsum. and Nakai). *International Journal of Current Sciences*, *17*, 90-96.

Ionică ME (2014). Methods of analysis and quality control of fresh and diverse processed fruits and vegetables (in Romanian). Ed Universitaria.

KATSUMI HIGASHI, KAZUSHIGE HOSOYA, HIROSHI EZURA. 1999. Histological analysis of fruit development between two melon (*Cucumis melo reticulatus* L.) genotypes setting a different size of fruit. *Journal of Experimental Botany*. Elsevier. Oxford. **50**(339): 1593-1597.

Mihaela, C., Toma, V., Elena, C., Răţoi, I., & Cristina, V. (2013). Researches regarding biochemical composition of plants and fruits cultivars of watermelons to some obtained on sandy soils in the conditions of biological agriculture. *JOURNAL of Horticulture, Forestry and Biotechnology*, *17*(2), 117-124.

Mujaju C, Sehic J, Werlemark G, Garkava-Gustavsson L, Fatih M, Nybom H (2010). Genetic diversity in watermelon (Citrullus lanatus) landraces from Zimbabwe revealed by RAPD and SSR markers. Hereditas 147: 142-153.

Nanu Șt., Marinescu Gh., Felfoldi Z., Paraschivu A. N., (2023). Cultura pepenilor verzi și a pepenilor galbeni în câmp. Editura SITECH, Craiova.

Nanu, Ș., Frătuțu, F. C., Paraschiv, A. N., & Sfîrloagă, L. M. (2023, September). The behavior of some watermelon cultivars (Citrullus lanatus (Thunb.) Matsum. et Nakai) in the pedo-climatic conditions of southwestern Romania. In *IX South-Eastern Europe Symposium on Vegetables and Potatoes 1391* (pp. 51-58).

Voinea M., Andronicescu N., Perciali Gh., (1977).Criterii pentru zonarea legumiculturii. Editura Ceres, București.