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Original Article

Research on the Identification of Potato Genotypes Suitable for Cultivation under the Conditions of the New Climatic Changes

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Abstract

There is presented a comparative study of potato varieties of Austrian origin in terms of production and productivity elements as well as the main indicators of the photosynthesis process under the pedoclimatic conditions in the Dejului area. The research carried out in 2017 highlights the identification some potato varieties suitable suitable for the specific climatic conditions of hot and dry summers as well and their relation with some physiological parameters that can characterize the adaptability to modified climatic conditions. The climatic changes observed in the last decades, characterized by moderate temperatures and high rainfall in May and June and frequently in the first part of July, favor the early and semi-early varieties and which can assimilate a reasonable and quality production (30-40 t/ha) without being exposed to the extreme climatic conditions of high temperatures and drought from the second part of July or from August and September, which can have serious consequences on removal from vegetative rest, of sprouting in the nestor accented dehydration.

Keywords: varieties, production, assimilation, conductance of stomata, evapotranspiration.

1. Introduction

Potato, along with rice, wheat and corn is one of the main food crops of mankind [3, 12]. Due to its nutritional value, potato is a staple food, being rightly considered ”second bread ” of the world [11] and is demanded in increasing quantities in the diet of the population [2, 4]. In the last 15-20 years we are obviously in the situation of increasing average annual temperatures, especially inside the continents but also at the North Pole where the millennial glaciers disappear one by one.

By 2001, Houghton et al., predict that the average global temperature will increase to between 1.4 and 5.8°C [7]. Hijmans estimates that between 2040 and 2069 the global average temperature (terrestrial, except Antarctica) will increase between 2.1°C and 3.2°C, depending on the magnitude of climate change [5].

The impact of climate change, especially the rise of temperatures will have an influence on agricultural production, in the sense of their decrease there are important differences between the areas of culture [9]. The effects of climate change on crop production can be complex. Depending on the temperature regime and the cultivated plant, high temperatures can lead to low yields due to the growth

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rate and increased respiration [5, 8]. Potato is grown in different ecological areas, but is best adapted to the temperate climate [4]. High temperatures (over 17°C) lead to decreased tuberization [10, 13]. Potato is also sensitive to frost and severe damage can occur when the temperature drops below 0° C [6].

Extreme climatic conditions during the potato growth period can greatly disrupt the tuber growth processes [1]. Changing the climatic conditions in potato cultivation areas requires changes in the genetic resources of the plants, as well as in the cultivation technology.

In Romania, in the last period, it has been observed that the springs are getting shorter, with an almost abrupt transition from the low temperatures specific to winter, to temperatures above 30°C, which naturally appear since the first half of May and that together with the winds increasingly frequent and more intense mediate the rapid evaporation of the soil water supply In recent years it has been observed that there are summers in which after periods of excess rainfall, usually in May-June, follow extremely long periods, from July to August, even September, when the rains are insignificant or completely missing.

Temperature is one of the most important ecological factors in the life of plants, the rate of development of the different faults of vegetative development of plants being influenced by it, all physiological processes depending on this factor, the increase or decrease of this parameter leading to the advance or delay of the phenological phases [14].

Şimon (2019) showed that in the period 2009-2018 in Cluj County, the average annual temperatures were higher than the multiannual average with values between 0.3 and 2.1°C [14].

2. Material and Method

Twelve varieties of potato of Austrian origin (Catana, Meierskana, Bojana, Martina, Sokrates, Galata, Valeria, Bosco, Marizza, Alonso, Fabiola and Red Fantasy) were tested in the spring of 2017 in a single-factor experience in three rehearsals at a farm in Someșului meadow near Dej city in Cluj County.

The classical technology was applied in the experimental field,. On October 5, 2016, 30 t/ha of manure was administered, after which the plowing was carried out at a depth of 30 cm. The preparation of the germinal bed was done with the combinator at 15-16 cm. The planting was done on April 10, 2017 with the Grimme planting machine (2 rows).

The control of the weeds was carried out by performing a hilling after 2 weeks after planting, followed by the application of the herbicide Sencor (metribuzin 600 g /L) at a dose of 0.9 L/ha.

Potato blight control was performed by three foliar treatments with the following products Alcupral (copper), Ridomil Gold 68WG (metalaxyl + mancozeb 68%), Consento (propamocarb hydrochloride 375 g/L + phenamidone 75 g/L). Potato beetle control was performed with two treatments: Actara (thiametoxam 25%) and Calypso (tiacloprid 480g/L).

The assimilation and physiological parameters measurements at the 12 potato varieties at SC DEJ were performed using the CIRAS-3 foliar gas analyzer, the determinations being carried out under semi-controlled conditions for normal CO_2 (390 μmolm-s-1), variable PAR (0), the 2000 μmolm-2s-1.

The research method used was non-destructive (the leaves were not detached from the plant) in this experience taking measurements of the net assimilation (An = μmol m-2s-1), the total conductance of the stomata on transfer (GS = mmol m- 2s-1), evapo-transpiration (Evap-mmolm-2s-1) and leaf water deficit (VPD - kPa).

The measurements of the physiological parameters were performed during the summer period (July 18, 2017) when the leaves from at the potato varieties studied were fully formed, at 3 plants of 9 readings per plant (3 at the base of the plant, 3 at the middle of the plant and 3 at the top of the plant) where the average for each variant was calculated.

In order to determine the productivity elements (the number of tubers/plant and the average mass of a tuber), 10 plants of each variety was harvested in 3 repetitions. The tubers were calibrated on two fractions: for consumption and under stas (larger than 40 mm and smaller than 40 mm), counted and weighed. Subsequently the obtained production/ha was calculated.

Relationship with vegetation factors. During the vegetation period of the potato the amount of precipitation was 364.6 mm.

The rainfall during the April-September vegetation period covered the plant's need, being between 50 and 75 mm each month, which favored normal vegetation and continuous formation and accumulation of production (Table 1).

It is considered that for a good harvest of tubers must fall in the summer months, in areas favorable to the potato culture at least 250 mm of water. Velican (1965) establishes for the vegetation period of the potato a total of 250 - 400 mm of rainwater [15]. Lonch (1958) differentiates the level of precipitation by soil and considers that on the sandy soils in June-July-August 350 mm are needed, and on the clay ones 280 mm precipitation.

For the Dej, Cluj County the sum or multiannual average of precipitation is 598.3 mm

The rainfall regime of June mainly influences the production of early varieties, the July varieties of middle-early and middle-late varieties, and that of August of late varieties. Late varieties are not cultivated in Romania

Temperature is one of the climatic elements with decisive influence on the growth of the plants, the production and the quality of the potato.

Table 1. The rainfall regime from Dej, Cluj County (2017)

Rainfall (mm)					
Month	I	II	III	Total	Days with rainfall
April	12.5	16.9	12.8	42.2	12
May	23.1	28.7	23.9	75.7	15
June	37.1	4.9	23.5	65.5	11
July	32.7	10.4	10.8	53.9	14
August	26.7	0.0	25.1	51.8	3
September	23.2	17.8	34.5	75.5	14
Total during the vegetation period				364.6	69

The maximum growth of tubers occurs at intermediate temperatures (17 - 20°) due to a constellation of factors, such as: duration of illumination, degree of water supply of the soil, growth rate of leaves and stems, distribution of assimilated, the duration of the foliage activity and so on.

The optimum temperature for the growth of tubers is 16 - 17°C, the minimum being 8°C and the maximum 29°C.Diurnal fluctuations of temperature play a particularly important role in the growth of tubers. The tubers react after about 3 days to the weather changes.

The optimal growth is manifested between17°C and 22% soil moisture on semi-weight soils and 10-12 hours insolation per day, although at the geographical location of Romania the illumination duration is over 15 hours per day after the potato emerges [10].

Zaag D. E. van der et al., 1986, showed in their studies that the cultivation of potatoes in low areas is possible when the duration of the day is about 11.5 to 12 hours [16]. Demagant and van der Zaag have shown that with increasing day length tuberization is much reduced [3].

The average decadal temperatures of the vegetation period fall within the normal limits of plant growth and the production formation, the 2017 climate year being a cooler year than the multiannual average of the climatic years recorded for the town of Dej in Cluj county (multiannual average 8.7°C).

During the vegetation period of the potato the average temperature was 16.80c. the warmest month was july with an average temperature of 21.70C (Table 2).

Table 2. The thermal regime during the potato vegetation period, in Dej, Cluj County

Month	Temperature ^{0}C			
	I	II	III	Monthly average
April	9.4	7.7	10.1	9.1
May	14.3	15.3	16.6	15.4
June	18.9	18.6	22.0	19.9
July	19.4	19.8	21.8	20.3
August	25.1	22.7	17.3	21.7
September	16.9	15.8	11.5	14.7
Average temperature during the vegetation period				16.85

3. Results and Discussions

Measurements of net assimilation and physiological parameters varied according to variety and luminous intensity, net photosynthesis increasing from the leaves at the base of the plant to the higher ones.

Of the 12 varieties of potatoes grown, the average value over the whole leaf surface registered over 16.0 µmolm-2s-1, and the average net assimilation increased from the leaves located at the base and middle towards the top of the plant, from 13.6 to 19, 1 µmolm-2s-1,1 µmolm-2s-1, there are values considered as being statistically highly significant positive , compared to the control (Table 3). Determinations regarding the total conductance of the transfer stomata (GS-mmolm-2 s1) is below 81.0 mmolm-2s-1 CO_2, lower at the potato leaves located at the base and middle, growing towards the top of the plant, at over 110 mmolm-2s-1 CO_2, these being statistically insured as being very positive compared to the control (Table 3).

The average of the experience at the 12 potato varieties recorded a foliar evapotranspiration of 2.05 mmolm-2s-1 CO_2 (Evap - mmolm-2s-1) more intense at the top of the plant, after which it gradually decreased towards the base of the plant. 2.40 to 1.75 µmolm-2s-1 CO_2, with statistically assured values appreciated as being very positive compared to the control.

The leaf water deficit (VPD kPa) was on average 2.63 kPa, lower for most potato varieties, at the leaves at the base of the plant and at the top of the plants, with values of 2.60 kPa. The water deficit in the leaf with the highest average value was obtained at the leaves located in the middle of the plant, with values of 2.69 kPa, with very significant differences compared to the control.

Table 3. The influence of assimilation and physiological parameters on the 12 potato varieties

No.	Net assimilation CO_2 (An-μmolm^{-2}s^{-1})	**Year**	**%**	**Diff.**	**Significance**
1.	The average over the entire leaf surface	16.04	100.0	0.00	**Ctr**
	The leaves at the base of the plant	13.62	84.9	-2.42	**000**
	The leaves from at the middle of the plant	15.41	96.0	-0.64	**000**
	The leaves at the top of the plant	19.11	119.1	3.06	*******
	LSD (p 5%) 0.11; LSD (p 1%) 0.15; LSD (p 0.1%) 0.19.				
No.	Total conductance of the stomata (GS- mmolm^{-2} s^{-1})	**GS**	**%**	**Diff.**	**Significance**
2.	The average over the entire leaf surface	86.12	100.0	0.00	**Ctr**
	The leaves at the base of the plant	72.39	84.1	-13.73	**000**
	The leaves from at the middle of the plant	74.36	86.3	-11.76	**000**
	The leaves at the top of the plant	111.61	129.6	25.49	*******
	LSD (p 5%) 1.93 ; LSD (p 1%) 2.58; LSD (p 0.1%) 3.37.				
No.	Evapo-transpiration at the foliar level (Evap -mmolm^{-2}s^{-1})	**Evap**	**%**	**Diff.**	**Significance**
3.	The average over the entire leaf surface	2.05	100.0	0.00	**Ctr**
	The leaves at the base of the plant	1.75	85.4	-0.30	**000**
	The leaves from at the middle of the plant	1.97	96.0	-0.08	**00**
	The leaves at the top of the plant	2.43	118.6	0.38	*******
	LSD (p 5%) 0.06; LSD (p 1%) 0.08; LSD (p 0.1%) 0.10;				
No.	Water deficit in the leaves (VPD – kPa)	**VPD**	**%**	**Diff.**	**Significance**
4.	The average over the entire leaf surface	2.63	100.0	0.00	**Ctr**
	The leaves at the base of the plant	2.60	98.8	-0.03	**0**
	The leaves from at the middle of the plant	2.69	102.3	0.06	*******
	The leaves at the top of the plant	2.61	98.9	-0.03	**0**
	LSD (p 5%) 0.02; LSD (p 1%) 0.03; LSD (p 0.1%) 0.04;				

Table 4. Measurement of physiological parameters in the 12 potato varieties, from the base of the plant. Assimilation to the leaves at the base of the potato plant

Variety / Physiological parameters	Control	Catana	Meierska	Bojana	Martina	Sokrates	Galata	Valeria	Bosco	Marizza	Alonso	Fabiola	Red Fantasy
CO_2 of reference (μmolm-s^{-1})	390	390	390	390	390	390	390	390	390	390	390	390	390
Net assimilation A-μmolm^{-2}s^{-1}	13.62	12.73	12.70	10.90	15.73	12.87	12.50	12.53	11.37	16.43	15.30	17.30	13.10
Significance	Ctr	000	000	000	***	000	000	000	000	***	***	***	0
LSD (p 5%) - 0.40; LSD (p 1%) – 0.54; LSD (p 0.1%) – 0.71.													
Total conductance of the stomata GS- mmolm^{-2} s^{-1}	72.39	145.0	86.0	57.0	82.7	49.0	48.0	50.0	30.0	86.3	97.3	88.7	49.0
Significance	Ctr	***	**	000	*	000	000	000	000	***	**	***	000
LSD (p 5%) – 7.77; LSD (p 1%) – 10.47; LSD (p 0.1%) – 13.87.													
Evapo-transpiration at the foliar level Evap - mmolm^{-2}s^{-1}	1.75	3.60	1.94	1.50	1.89	1.47	1.18	1.25	0.30	2.20	2.40	2.39	0.91
Significance	Ctr	***	-	0	-	00	000	000	000	***	***	***	000
LSD (p 5%) - 0.19; LSD (p 1%) – 0.26; LSD (p 0.1%) – 0.34.													
Water deficit VPD – kPa	2.60	2.60	2.34	2.73	2.38	2.79	2.51	2.66	2.57	2.59	2.57	2.78	2.70
Significance	Ctr	-	000	*	000	***	-	-	-	-	-	**	-
DL (p 5%) - 0.10; DL (p 1%) – 0.14; DL (p 0.1%) – 0.18													

The highest values of the net assimilation, on the leaves located at the base, recorded the Fabiola, Marizza, Martina and Alonso varieties, with an average of 16.8 to 17.30 µmolm-2s-1 CO_2, being very significant compared to control (Table 4).

The total conductance of the transfer stomata (GS- mmolm-2 s-1) at the potato leaves located at the base of the plant, in the varieties Catana, Fabiola, Marizza, Martina Alonso and Meierska has values between 80 to 145.0 mmolm-2s- 1 CO_2, being very significantly positive and significantly positive compared to the control (Table 4).

Evapotranspiration at foliar level from the base of the plant, with values between 2.20 and 3.60 mmolm-2s-1 CO_2 recorded the varieties Catana, Alonso, Fabiola and Marizza, the differences in values of evapotranspiration being very significant compared to the control (Table 4).

The highest values of leaf water deficit (VPD - kPa) at the base of the plant were recorded in the Bojana, Fabiola and Sokrates varieties with over 2.70 kPa, the water deficit being inversely proportional to the assimilation, the conductance of the stomata at the transfer and the evapotranspiration (Table 4).

The net assimilation with the highest values at the leaves in the middle of the plant recorded Fabiola, Marizza, Martina and Alonso varieties, with an average of 16.8 to 20.37 µmolm-2s-1 CO_2, the differences being very significant compared to of control (Table 5).

The total conductance of the transfer stomata (GS-mmolm-2s-1) at the potato leaves in the middle of the plant, with values of over 100 to 129.0 mmolm-2s-1 CO_2, recorded the varieties Catana, Marizza, and Fabiola differences were very significant compared to the control (Table 5).

Evapotranspiration at the foliar level in the middle of the plant with values between 2.17 and 3.70 mmolm-2s-1 CO_2 recorded the varieties Catana, Alonso, Fabiola and Marizza, being very significant compared to the control (Table 5).

The lowest values of leaf water deficit (VPD - kPa) in the middle of the plant were recorded in the varieties of Meierska and Fabiola with values of 2.33 and 2.59 kPa being statistically insured as very significant and significantly negative compared to the control (Table 5).

Table 5. Measurement of physiological parameters in the 12 potato varieties, from the middle of the plant. Assimilation to the leaves from the middle of the plant

Variety / Physiological parameters	Control	Catana	Meierska	Bojana	Martina	Sokrates	Galata	Valeria	Bosco	Marizza	Alonso	Fabiola	Red Fantasy
CO_2 of reference (µmolm-s^{-1})	390	390	390	390	390	390	390	390	390	390	390	390	390
Net assimilation An-µmol$m^{-2}s^{-1}$	15.41	13.47	13.90	11.83	18.33	13.33	13.77	14.63	15.10	18.20	16.73	20.37	14.57
Significance	Ctr	000	000	000	***	000	000	000	-	***	***	***	000
LSD (p 5%) - 0.40; LSD (p 1%) – 0.54; LSD (p 0.1%) – 0.71													
Total conductance of the stomata GS- mmolm^{-2} s^{-1}	74.4	129.0	86.3	48.3	83.7	52.7	54.0	40.0	37.7	123.3	84.3	110.3	42.7
Significance	Ctr	***	**	000	*	000	000	000	000	***	*	***	000
LSD (p 5%) – 7.77; LSD (p 1%) – 10.47; LSD (p 0.1%) – 13.87.													
Evapo-transpiration at the foliar level Evap -mmol$m^{-2}s^{-1}$	1.97	3.70	2.13	1.11	2.30	2.26	1.33	0.90	0.95	2.93	2.17	2.75	1.13
Significance	Ctr	***	-	000	**	**	000	000	000	***	*	***	000
LSD (p 5%) - 0.19; LSD (p 1%) – 0.26; LSD (p 0.1%) – 0.34.													
Water deficit VPD – kPa	2.69	2.94	2.33	2.73	2.76	2.77	2.73	2.60	2.76	2.69	2.67	2.59	2.75
Significance	Ctr	***	000	-	-	-	-	-	-	-	-	0	-
LSD (p 5%) - 0.10; LSD (p 1%) – 0.14; LSD (p 0.1%) – 0.18													

Regarding the net assimilation to the leaves located at the top of the plant, the highest values compared to the rest of the plant were the varieties Bosco, Fabiola, Marizza, Martina, Red Fantasy and Sokrates having averages over 20.0 µmol m - 2s - CO_2, being statistically insured as very significant positive to the control (Table 6).

The total conductance of stomata at transfer (GS-mmol m-2s-1) at the potato leaves located at the top of the plant, recorded the varieties Catana,

Martina and Fabiola, with values between 150 and over 190.0 mmolm-2s-1 CO_2, being statistically insured as very significant positive compared to the control (Table 6).

The most intense values of evapotranspiration from the upper leaves of the plant recorded the varieties Catana, Fabiola, Bosco, Alonso, Martina and Meierska, with values between 2.65 and 4.70 mmolm-2s-1 CO_2, being statistically very significant and significantly positive compared to the control (Table 6).

The lowest values of leaf water deficit (VPD - kPa) at the top of the plant were recorded in the Valeria, Fabiola and Meierska varieties with over 2.32 to 2.49 kPa, being inversely proportional to the rest of the parameters, being insured statistically very significant and significant negative compared to the control (Table 6).

Table 6. Measurement of the physiological parameters in the 12 potato varieties, from the upper leaves of the plant. Assimilation to the upper leaves of the plant

Variety / Physiological parameters	Control	Catana	Meierska	Bojana	Martina	Sokrates	Galata	Valeria	Bosco	Marizza	Alonso	Fabiola	Red Fantasy
CO_2 of reference (μmolm-s^{-1})	390	390	390	390	390	390	390	390	390	390	390	390	390
Net assimilation A-μmol$m^{-2}s^{-1}$	19.11	15.17	18.87	12.20	22.33	20.13	19.27	12.90	25.20	21.80	18.93	22.27	20.30
Significance	Ctr	000	-	000	***	***	-	000	***	***	-	***	***
LSD (p 5%) - 0.40; LSD (p 1%) – 0.54; LSD (p 0.1%) – 0.71.													
Total conductance of the stomata GS- mmolm^{-2} s^{-1}	111.6	198.7	104.0	64.3	171.0	100.7	60.0	69.3	116.7	94.0	103.7	152	105.0
Significance	Ctr	***	-	000	***	00	000	000	-	000	0	***	-
LSD (p 5%) – 7.77; LSD (p 1%) – 10.47; LSD (p 0.1%) – 13.87.													
Evapo-transpiration at the foliar level Evap -mmol$m^{-2}s^{-1}$	2.43	4.71	2.65	1.50	2.74	2.49	1.58	1.54	2.86	2.33	2.74	3.58	0.50
Significance	Ctr	***	*	000	**	-	000	000	***	-	**	***	000
LSD (p 5%) - 0.19; LSD (p 1%) – 0.26; LSD (p 0.1%) – 0.34.													
Water deficit VPD – kPa	2.61	2.54	2.49	2.70	2.59	2.63	2.75	2.32	2.54	2.58	2.72	2.46	2.94
Significance	Ctr	-	0	-	-	-	**	000	-	-	*	00	***
LSD (p 5%) - 0.10; LSD (p 1%) – 0.14; LSD (p 0.1%) – 0.18.													

The average net assimilation with the highest values recorded on the entire surface of the plant was obtained at Fabiola, Martina, Martizza, Bosco and Alonso, with an average of 17.1 to 20.0 μmol$m^{-2}s^{-1}$, being statistically assured as very positive compared to the control - average of experience - (Table 7). The assimilation with the lowest values was recorded in the varieties Bojana, Catana, Valeria, Meierska, Galata and Sokrates, with an average of 12.7 -15.3 μmolm-2s-1 and 15.9 μmolm-2s-1, respectively. statistically insured as being very significantly negative and respectively significantly negative compared to the control.

At the 12 potato varieties, on the whole plant, the total conductance of the stomata (GS) and the evapotranspiration (Evap) obtained positive average values in the varieties Catana, Fabiola, Martina, Marizza, Alonso and Meierska, with deficiency of leaf water (VPD) lower, limiting water loss and transportation. The most intense evapotranspiration at the foliar level (E - mmolm-2s-1 CO_2) is generally observed also in potato varieties where the assimilation was more intense, registering values over 1.50 mmolm-2s-1 at Fabiola, Martina, Alonso, Marizza, Catana and Meierska.

The lowest values of leaf water deficit (VPD - kPa) have been noted in potato varieties Meierska and Valeria, with over 2.39 to 2.60 kPa being inversely proportional to the rest of the parameters provided statistically very significant until significant negative compared with the control (Table 7).

Results regarding productivity elements: number of tubers per plant and average mass of one tuber over 40 mm in diameter.

The number of tubers formed per plant is generally determined by the variety, the size of the planted tuber, the planting density, the number of main stems, the spatial arrangement of the nest, the growth period and the pedoclimatic and phytotechnical conditions [8].

Table 7. Measurement of physiological parameters in the 12 potato varieties throughout the plant. Assimilation to the leaves of the whole plant

Variety / Physiological parameters	Control	Catana	Meierska	Bojana	Martina	Sokrates	Galata	Valeria	Bosco	Marizza	Alonso	Fabiola	Red Fantasy
CO_2 of reference (µmolm-s^{-1})	390	390	390	390	390	390	390	390	390	390	390	390	390
Net assimilation CO_2 (A-µmolm^{-2}s^{-1})	16.16	14.12	15.28	12.70	18.91	15.90	15.53	13.55	17.40	18.80	17.10	20.00	16.20
Significance	Ctr	000	000	000	***	00	000	000	***	***	***	***	-
LSD (p 5%) - 0.25; LSD (p 1%) – 0.34; LSD (p 0.1%) – 0.45.													
Total conductance of the stomata (GS- mmolm^{-2} s^{-1})	86.1	157.6	92.1	56.6	112.4	67.4	54.0	53.1	61.4	101.2	95.0	117.0	65.6
Significance	Ctr	***	*	000	***	000	000	000	000	***	**	***	000
LSD (p 5%) - 5.52; LSD 6 7.51; LSD (p 0.1%) – 10.10.													
Evapo-transpiration at the foliar level (Evap - mmolm^{-2}s^{-1})	2.05	4.00	2.24	1.37	2.30	2.07	1.36	1.23	1.40	2.49	2.44	2.91	0.96
Significance	Ctr	***	***	000	***	-	000	000	000	***	***	***	000
LSD (p 5%) - 0.10; LSD (p 1%) – 0.13; LSD (p 0.1%) – 0.17.													
Water deficit (VPD – kPa)	2.63	2.70	2.39	2.72	2.58	2.73	2.66	2.53	2.63	2.64	2.65	2.61	2.80
Significance	Ctr	-	000	*	-	*	-	00	-	-	-	-	***
LSD (p 5%) - 0.08; LSD (p 1%) – 0.10; LSD (p 0.1%) – 0.15.													

Following the study conducted in the pedoclimatic conditions from Dej it was found that the number of tubers larger than 40 mm was between 5.10 (Red Fantasy) and 10.10 (Alonso). Compared with the average number of tubers throughout the experiment, significant differences in the number of tubers larger than 40 mm were obtained only in the Alonso variety. Interpreting the results obtained with the Duncan test, we find that there are no significant differences in the number of tubers larger than 40 mm between the varieties Catana, Martina, Galata, Valeria, Bosco, Marizza, Fabiola and Red Fantasy (Table 8).

Table 8. Number of tubers per potato plant larger than 40 mm (Dej, Cluj County. 2017)

Variety	Control	Catana	Meierska	Bojana	Martina	Sokrates	Galata	Valeria	Bosco	Marizza	Alonso	Fabiola	Red Fantasy
No. of tubers / plant	6.89	6.15	8.45	8.05	6.15	8.95	6.95	5.95	5.75	5.6	10.1	5.45	5.1
Significance	Ctr	-	-	-	-	-	-	-	-	-	*	-	-
LSD (p 5%) – 2.30; LSD (p 1%) – 3.25; LSD (p 0.1%) – 4.64.													
Duncan test	-	abc	cde	bcde	abc	de	abcd	abc	ab	ab	e	a	a
DS (p5%) 2.30-2.60													

The average mass of a tuber larger than 40 mm was over 100 g in all the twelve varieties studied, in six of them registering even over 150 g (Catana, Meierskana, Galata, Valeria, Bosco and Fabiola). Regarding the average mass differences of a commercial tuber in the experimented varieties, we have identified close values, not statistically assured by the method of analysis of variance.

The Duncantest shows that there are no significant differences between the experimental varieties Catana, Meierskana, Bojana, Sokrates, Galata, Valeria, Marizza, Alonso and Fabiola either by this evaluation (Table 9). Between the number and the average mass of a tuber of commercial size, there was an inverse (negative) correlation, ie with the increase of the number of tubers/plant the average mass decreases.

The commercial production obtained in the pedoclimatic conditions from Dej, Cluj county was over 45t/ha in the varieties Meierska and Alonso.

Table 9. Average mass of a potato tuber larger than 40 mm (Dej, Cluj County, 2017)

Variety	Control	Catana	Meierska	Bojana	Martina	Sokrates	Galata	Valeria	Bosco	Marizza	Alonso	Fabiola	Red Fantasy
Average mass of tubers	141,5	152	153	149,5	107	132,5	155	163,5	168	134,5	121,5	150	111,5
Significance	Ctr	-	-	-	-	-	-	-	-	-	-	-	-
LSD (p 5%) – 3.66; LSD (p 1%) – 48.99; LSD (p 0.1%) – 69.94.													
Duncan test	-	bc	bc	bc	a	abc	bc	c	c	abc	ab	bc	a
DS (p5%) 34.64-39.10													

Comparing the productions obtained with the average of the varieties taken as a control we obtained significantly positive production differences in the Meierskana variety, significantly negative differences in the Martina variety and distinctly significantly negative differences in the Red Fantasy variety. Between the productions obtained in the Catana variety and the productions obtained in the Bojana, Sokrates, Galata, Valeria, Bosco, Marizza, Alonso and Fabiola varieties, there were small differences that are not statistically ensured either by the Duncan test (Table 10).

It is noticed a high share of commercial production from total tuber production (Fig. 1)

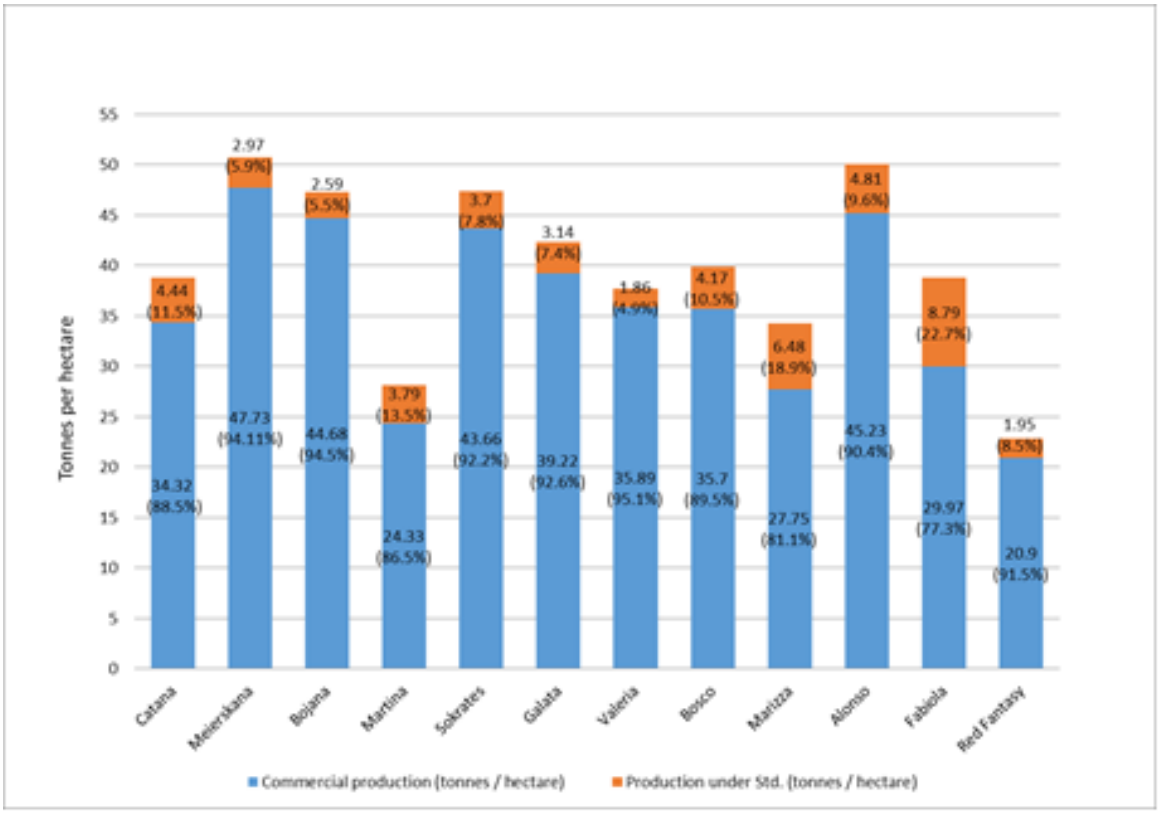

Figure 1. The share of the commercial production from the total production

Table 10. Results obtained on commercial production (Dej, Cluj County, 2017)

Variety	Control	Catana	Meierska	Bojana	Martina	Sokrates	Galata	Valeria	Bosco	Marizza	Alonso	Fabiola	Red Fantasy
Commercial production (tha^{-1})	35.78	34.32	47.73	44.68	24.33	43.66	39.22	35.89	35.7	27.75	45.23	29.97	20.9
Significance	Ctr	-	*	-	0	-	-	-	-	-	-	-	00
DL (p 5%) – 10.50; DL (p 1%) – 14.85; DL (p 0.1%) – 21.20													
Duncan test	-	bcd	e	de	ab	de	cde	bcd	bcd	abc	de	abc	a
DS (p5%) 10.50-11.85													

In the pedoclimatic conditions from Dej, total productions between 22.85 t/ha (Red Fantasy) and 50.70 t/ha (Meierskana) were obtained. Compared to the average of the varieties taken as a control, there were obtained significantly positive differences in production in the variety Meierskana and Alonso and distinct differences significantly negative in he variety Red Fantasy(Table 11).

Table 11. Results obtained regarding total production (Dej, Cluj County, 2017)

Variety	Control	Catana	Meierska	Bojana	Martina	Sokrates	Galata	Valeria	Bosco	Marizza	Alonso	Fabiola	Red Fantasy
Total yield (tha-1)	39.84	38.76	50.7	47.27	28.12	47.36	42.36	37.75	39.87	34.23	50.04	38.76	22.85
Significance	Ctr	-	*	-	0	-	-	-	-	-	*	-	**00**
DL (p 5%) – 9.45; DL (p 1%) – 13.36; DL (p 0.1%) – 19.07													
Test Duncan		cd	f	def	ab	def	cdef	bcd	cde	bc	ef	cd	a
DS (p5%) 9.44-10.66													

Interpreting the results obtained by the duncan test, it is found that there are no significant differences in production between the varieties meierskana, bojana, sokrates, galata and alonso, varieties with production of more than 40t/ha (Table 11).

Conclusions

The Martina, Marizza, Alonso, Fabiola and Bosco varieties are characterized by a high photosynthetic activity in all three floors of the potato plant analyzed, as well as by a lower evapotranspiration which denotes a drought tolerance, which hypothetically could be considered as an adaptation to new climate change.

The test being non-invasive and practical and fast enough, it is recommended to be applied in the potato breeding field in order to identify potential genotypes worthy of being considered as tolerant to new climate changes.

The climatic changes observed in the last decades, characterized by moderate temperatures and high rainfall in May and June and frequently in the first part of July, favor the early and semi-early varieties and which can assimilate a reasonable and quality production (30-40 t/ha) without being exposed to the extreme climatic conditions of high temperatures and drought from the second part of July or from August and September, which can have serious consequences on removal from vegetative rest, of sprouting in the nestor accented dehydration.

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