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THE BEHAVIOR OF SWEET POTATO *(IPOMOEA BATATAS)* IN TERMS PSAMOSOILS IN SOUTHERN ROMANIA

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Abstract

Variability of climate, especially lack of rain and low fertility psamosoils determines that surfaces quite stretched in most crop yields to be much reduced. In this context, the choice assortment of plants and varieties with high adaptability to the harsh conditions of climate and soil is a necessity for obtaining high yields, stable and reliable, that provide increased energy needs of the population food. Research conducted during 2013-2015 at the Research - Development Center for Agricultural Plants on Sands, Dabuleni, highlights a favorable microclimate for plant growth and development of sweet potato (Ipomoea batatas). The values recorded physiological indices sweet potato grown in climatic conditions in the sandy soils of southern Oltenia showed that it easily adapts to the conditions of excess heat here is a plant heat-loving and light. Productions made from sweet potato varieties Pumpkin (KSP1) and Chestnut (KSC 1), sandy soil conditions studied ranged 17428kg / ha and 35467 kg / ha depending on the crop and cultivated variety. We showed correlations between tuber production and the amount of degrees of temperature recorded in air (r = 0.904; r = 0.992). Also between rainfall and production carried out by two varieties of sweet potato is negative correlations (r = -0.642; r = - 0.848). These correlations highlight the specificity of the plant to dry climate. Nutritional quality presented values differentiated to the two varieties studied, according to the year of culture.

Key words*: sweet potato, tolerant, drought, physiology, quality*

INTRODUCTION

Sweet potato (*Ipomoea batatas*) belongs to the family *Convolvulaceae* and is native to Central America and the north-west of South America. Globally, is among the food crops the most important in the world after wheat, rice, corn, potato Irish and barley, being adaptable to climate tropical and subtropical zones, drought-tolerant and grows in conditions of fertility and soil pH decreased (Kareem I., 2013). It is a plant well adapted to tropical and subtropical climates, but can grow successfully in a wide range of climatic conditions in the cold season average to not more than 5 months. Research by James A. Duke 1983 plant underlines the sensitivity at low temperatures, frost tolerating plant (www.ncsweetpotatoes.com). It grows best at an average temperature of 24°C, with abundant sunshine and warm nights. Annual rainfall of 750-1000 mm are considered most appropriate, with a minimum of 500 mm in the growing season. Culture is sensitive to drought tuber initiation stage, 50-60 days after planting and is not tolerant to water stagnation, it can cause tuber rots and reduce root growth due to poor aeration. Abundant in nutrients and fiber (of which 40% soluble fibre that helps lower the blood sugar and cholesterol), sweet potato is the ideal food for diabetics, children and pregnant women (Betty J. Burri, 2011 Mihaela Cioloca et al., 2013). Through its qualities, a sweet potato variety with yellow and orange pulp is a valuable source of vitamin A and vitamin B6. Also, sweet potato provides a significant amount of vitamin C and vitamin D, essential in the formation of bones and teeth, for good digestion, wound healing and immune system. Sweet potato also contains iron, which helps metabolize protein, and magnesium, a mineral stress. Concerns for sweet potato cultivation in Romania took place in USAMV Bucharest (Ciofu R., 2005, Musat C., 2010) and were resulting in the creation of two varieties (Crux V., 1991, 1997). The variety of sweet potato varieties grown in Romania is quite limited and they are cultivated more experimental. Orange and yellow varieties have

a high content of beta-carotene, the precursor of vitamin A (Kareem I., 2013). Therefore encourages the cultivation of these species in places like Africa where vitamin deficiency is causing severe health problems (Wariboko C. et al., 2014, Ladokum OA, et al., 2007). All species of sweet potatoes are rich in antioxidants. Sweet potato, although it has a sweetish taste, the presence of complex carbohydrates, which help regulate carbohydrate and reduced insulin resistance, is beneficial for people with diabetes. Based on these considerations nutrients, Center for Science in the Public Interest of America awarded the highest score compared to other vegetables. They also have a low glycemic index, which means that hunger will appear later. Research - Development Center for Agricultural Plants on Sands, Dabuleni began in 2013 a collaboration with the Institute for Agricultural Technology and Science Kyungpook National University, based in Daegu, represented by Prof. dr. Jong - and Dr. Sang KIM Gi Cho Eun-, South Korea, under "Technical and Scientific Cooperation Memorandum between Kyungpook National University ASAS Bucharest and the Institute for Agricultural Science and Technology. Within this collaboration was initiated research on the behavior of two varieties of sweet potato (Ipomoea batatas): Pumpkin (KSP1) and Chestnut (KSC1) in terms of climate and soil from RDCAPS Dabuleni, Dolj County.

MATERIALS AND METHODS

Research at the culture of sweet potato (Ipomoea batatas), were conducted in 2013-2015 at RDCAPS Dabuleni on sandy soil with low natural fertility (0.42 to 0.82% humus) and pH (H_2O) = 5.9 to 6.9 in the Bilateral Cooperation Protocol between Kyungpook National University (KNU) in South Korea and the Academy of Agricultural and Forestry Sciences "Gheorghe Ionescu sisesti" Bucharest. It studied the behavior of two varieties Korean: Pumpkin (KSP1) and Chestnut (KSC1) in terms of climate and soil in the sandy soils of southern Oltenia. Seedling product to the protected system type solar greenhouses as follows:
-between 20 to 25 March were planted sweet potatoes from seed in the greenhouse (Figure 1)

Figure 1. Planting sweet potato tubers in greenhouse

-between March and April are maintained in the greenhouse through irrigation and ventilation
After cutting the shoots, fertilize the solar N50 and watered with water necessary to obtain another generation of shoots (Figure 2)

Figure 2. Cutting the shoots in solar

-from May 5 to 10 they were cut shoots produced in solar and were planted in the field billon covered with polyethylene mulch. (Figure 3).

Figure 3. Planting the sweet potao shoots in field

In field was fertilized with $N_{80}P_{80}K_{80}$, to prepare the ground and in the vegetation was fertilized with N_{70}.Sweet potato tubers grown in two varieties were received from the Republic of Korea in accordance with the cooperation agreement. During the growing season, in root tubers stage was determined the photosynthesis and transpiration rate of plant to

leaf level with + Portable Photosynthesis System LCpro device in three times of the day. At harvest the production of tubers has been determined and the quality of production as follows: total dry substance and water (%) - gravimetric method; simple soluble carbohydrates (%) - Soxleth Reagent method; the starch (%) - colorimetric method; C vitamin (mg/100 g f.s.) - iodometric method.

RESULTS AND DISCUSSIONS

Climatic conditions during the period 2013-2015 reveals an increase in atmospheric drought, revealing the sweet potato vegetation period mean monthly temperature higher by approx. 0.15 to 1.45℃, compared to the annual average (Table 1). Although the average amount of rainfall recorded during the study period was 372.3 mm, with 102.92 mm above the annual average, they were unevenly distributed and water to meet the needs of the work was drip irrigation necessary to ensure the ceiling of 80% of active moisture range. In terms of ensuring the thermal requirements for growing sweet potato, 2015 it was the most favorable, followed by 2013 and then 2014. The average air temperature during the growing season (May to September) was between 20.48 -21.78 ℃ and rainfall were within 269.2 to 516.9 mm. 2014 was unfavorable for sweet potato and due to heavy rainfall that occurred in September, which coincided with the maturation period tubers, preventing dry substance accumulation and weight gain formed tubers per plant. Also, the average temperature in 2014 was lower by 1.02- 1.30 ℃, the values recorded in the other two years, which led to unevenness maturing tubers and finally to production results low, sweet potato is a heat-loving plant. To mature, sweet potato varieties needed about 3133.44 to 3332.34 ℃, built up during the growing season.

Table 1. Climate characterization of sweet potato vegetation period (2013-2015 Dabuleni)

Month	Climatic element	2013 Year	2014 Year	2015 Year	Multiannual average
May	Air temperature average ^{0}C	20	16.6	19.2	16.8
	Rainfall average (mm)	61	117.4	52.4	61.6
	Relative humidity %	71	76.5	73	
June	Air temperature average ^{0}C	22.1	20.7	20.5	21.6
	Rainfall average (mm)	105.2	92	134.2	68.5
	Relative humidity %	76.8	76.9	73.8	
July	Air temperature average ^{0}C	23.5	23.1	24.9	23.1
	Rainfall average (mm)	36.2	125.6	11.0	54.2
	Relative humidity %	73.7	77.9	62.9	
August	Air temperature average ^{0}C	24.1	23.7	24.3	22.4
	Rainfall average (mm)	30.8	16	48.4	37.7
	Relative humidity %	68	72	68.2	
September	Air temperature average ^{0}C	17.8	18.3	20.1	17.75
	Rainfall average (mm)	36	165.9	84.8	47.38
	Relative humidity %	72.5	82,3	77.3	
Air temperature average during the growing sweet potato 01.05– 30.09 (^{0}C)		21.5	20.48	21.78	20.33
Rainfall average during the growing sweet potato 01.05– 30.09 (mm)		269.2	516.9	330.8	269.38
Relative humidity average during the growing sweet potato 01.05– 30.09 (%)		72.4	77.12	71,04	-
$\sum$ ^{0}C in air during the growing sweet potato 01.05– 30.09		3292.6	3133.44	3332.34	3110.49
Rainfall (mm) during the growing sweet potato 01.05– 30.09		269.2	516.9	330.8	269.38
Production of sweet potato tubers (kg/ha)	Sweet potato variety / Year	2013	2014	2015	Average
	Pumpkin (KSP1)	23864	17428	33300	24864
	Chestnut (KSC1)	30176	18857	35467	28166

Results on physiological reactions to sweet potato depending on climatic factors:

During the growing season, in root tubers stage was determined the photosynthesis and transpiration rate of plant to leaf level with + Portable Photosynthesis System LCpro device in three times of the day (Figure 4). Figure 5 shows the diurnal variation of photosynthesis (micromoles CO_2 / m^2 / s) - determined the two varieties of sweet potatoes planted Pumpkin (KSP1) and Chesnut (KSC1) depending on the climatic conditions in the crop year 2014 -2015.

In 2014 the variety Pumpkin (KSP1) when determining the 15 o'clock when the daytime temperature reaches the highest values (38 -40 ℃), photosynthesis rate recorded 12,555 micromoles CO_2 / m^2 / s and the variety Chestnut (KSC1) at the same time of day photosynthesis rate was 18,975 micromoles CO_2 / m^2 / s. 2015 variety pumpkin (KSP1) when determining the 15 o'clock rate of photosynthesis recorded 21 715 micromoles CO_2 / m^2 / s and the variety Chestnut (KSC1) at the same time of day rate of photosynthesis was 27 175 micromoles CO_2 / m^2 / s. Every year the production was positively correlated with the amount of diurnal variation of photosynthesis.

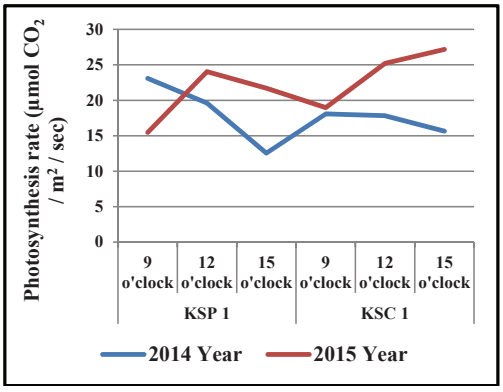

Figure 4. Diurnal variation of photosynthesis sweet potato plant, depending on the variety and the crop year

Figure no. 6 shows the diurnal variation of photosynthesis in the two sweet potato varieties in the 3 times of day in 2014 and 2015. In 2014 when the amount of degrees the temperature was lower than the annual average and exceeded the annual average rainfall amount, variety Pumpkin (KSP1) recorded higher values of photosynthesis diurnal variation in measurements performed at 9:12 and at 15, the variety Chestnut (KSC1) achieved the highest value of diurnal variation of photosynthesis. Climatic conditions during the vegetation period of 2015 influenced the different speed and pacing of physiological processes to sweet potato grown in the sands. In July, air temperature varied between 26.7 to 41.5 ℃ determinations when air humidity fell below 25% and photosynthetic active radiation varies between 1200 to 1700 mol / m2 / s. In 2015 when the amount of degrees the temperature was higher than the annual average, and the amount of rainfall was lower than the annual average, the variety Chestnut (KSC1) recorded higher values of diurnal variation of photosynthesis in tests carried out in all 3 points of the day. This indicates that the variety Chestnut (KSC1) has the capacity to behave better in drought conditions than the variety Pumpkin (KSP1).

Diurnal variation of the sweet potato leaf transpiration depending on the variety and the crop

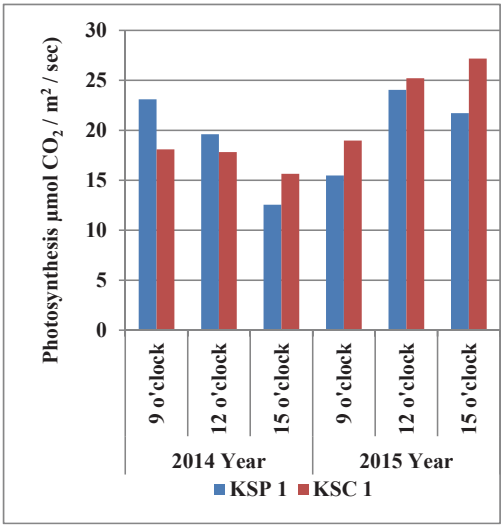

Figure 5. Diurnal variation of photosynthesis sweet potato plant, depending on the crop year and variety

Figure no. 7 presents diurnal variation of leaf transpiration (mmol H_2O / m^2 / s) - determined the two sweet potato varieties planted, Pumpkin (KSP1) and Chesnut (KSC1) depending on the climatic conditions

in culture in 2014 -2015. In 2014 the variety Pumpkin (KSP1), diurnal variation of leaf transpiration (mmol H_2O / m^2 / s) when determining from 9 was 3.32 mmol H_2O / m^2 / s at 12 was 3.44 mmol H_2O / m^2 / s and at 15, when daytime temperatures reach the highest values, diurnal variation of leaf transpiration recorded 2.3 mmol H_2O / m2 / s. Variety Chestnut (KSC1) diurnal variation of transpiration leaf (mmol H_2O / m^2 / s) when determining from 9 was 2.795 mmol H2O / m2 / s at 12 was 2.975 mmol H_2O / m^2 / s and at 15 pm, when daytime temperatures reach the highest values, diurnal variation of leaf transpiration of 4.46 mmol H_2O / m^2 / s.

In 2015 Year, Pumpkin variety (KSP1), diurnal variation of leaf transpiration (mmol H_2O / m^2 / s) when determining from 9 was 1.97 mmol H_2O / m^2 / s at 12 was 7.01 mmol H_2O / m^2 / s, and at 15, when daytime temperatures reach the highest values, diurnal variation of transpiration foliar registered 9.705 mmol H_2O / m^2 / s the variety Chestnut (KSC1) diurnal variation of transpiration leaf (mmol H_2O / m^2 / s) when determining from 9 was 2.58 mmol H_2O / m^2 / s at 12 was 7.11 mmol H_2O / m^2 / s and at 15, when daytime temperatures reach the highest values, diurnal variation of leaf transpiration recorded 9.93 (mmol H_2O / m^2 / s).

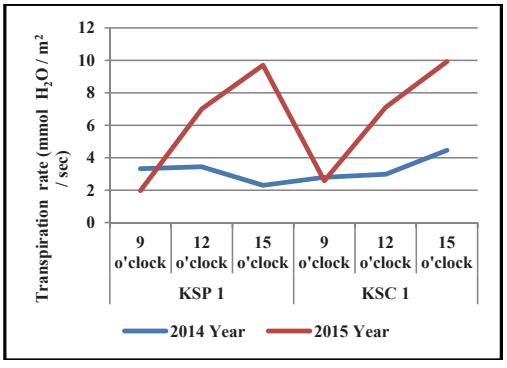

Figure 6. Diurnal variation of transpiration sweet potato plant, depending on the variety and the crop year

In 2014 when the amount of degrees the temperature was lower than the annual average and the amount of rainfall exceeded the annual average, the variety Pumpkin (KSP1) recorded higher values of diurnal variation of leaf transpiration tests carried out at 9:12 and at 15, variety Chestnut (KSC1) achieved the highest value of diurnal variation of leaf tanspiration. In 2015 when the amount of degrees the temperature was higher than the annual average and the amount of rainfall was lower than the annual average, the variety Chestnut (KSC1) recorded higher values of diurnal variation of leaf transpiration tests carried out in all 3 points of the day. This indicates that the variety Chestnut (KSC1) has the capacity to behave better in drought conditions than the variety Pumpkin (KSP1). Climatic factors have intensified leaf transpiration which recorded high values ranging from 1.97 to 9.7 mmol H_2O / m^2 / s variety Pumpkin (KSP1) and values between 2.58 to 9.93 mmol H_2O / m^2 / s variety Chestnut (KSC1). Both varieties to leaf transpiration maximum intensity registered between 12 to 15 hours and action when stress factors (drought atmospheric and pedological drought) was maximum.

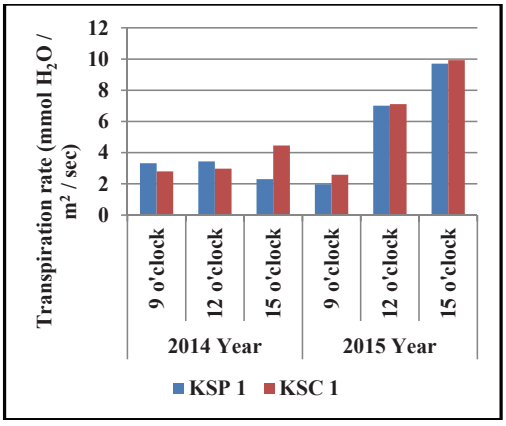

Figure 7. Diurnal variation of transpiration sweet potato plant, depending on the crop year and variety

The climatic conditions of the three years of study have influenced both the production of sweet potato and their nutritional quality (Table 2). The best production results were obtained in terms of 2015, the variety Chestnut (KSC 1) 35467kg / ha). The lowest production was obtained in the climatic conditions of 2014 (high rainfall and temperature below the annual average) (17428kg / ha variety Pumpkin (KSP1) and 18857kg / ha variety Chestnut (KSC 1).

Nutritional quality presented values differentiated the two varieties studied climate conditions of the three years.

The content of total solids of higher values under the years 2014 and 2015 (38.50% variety Pumpkin and 39.93% for the variety Chestnut), when rainfall was higher than 2013.

If the soil temperature is high dry substance can be lost through excessive breathing. In a warm season but soil moisture, dry substance will remain high due to the reduction in the intensity of process breathing.

The amount of soluble carbohydrates and vitamin C to higher values also in terms of 2014 (10.12% carbohydrate variety Pumpkin and 16.72 mg / 100g fresh substance, vitamin C variety Chestnut).

The starch content presented similar values in the years 2014 and 2015.

Figure 8. Determinations of plant physiology sweet potato

Table 2. Results on production of sweet potato tubers and their biochemical composition, depending on the variety and the crop year

Variety	Year	Tuber production (Kg/ha)	Total dry matter (%)	Water (%)	Soluble carbohydrates (%)	Starch (%)	C vitamin (mg / 100g fresh substance)
Pumpkin (KSP 1)	2013	23864	37.44	62.56	8.38	-	10.56
	2014	17428	38.50	61.50	10.12	12.70	11.44
	2015	33300	38.41	61.59	8.33	12.55	7.99
Chestnut (KSC 1)	2013	30176	35.44	64.56	7.97	-	13.20
	2014	18857	36.55	66.95	10.04	12.60	16.72
	2015	35467	38.93	61.07	8.09	12.69	10.56

The results obtained in the production of sweet potato tubers during 2013-2015, highlights a positive correlation with the amount of degrees of temperature recorded during the growing season (May-September) (Figure 9). This function connexion is more closely to KSC1, which is delayed compared to the variety Pumpkin 5-7 days, production is greatly influenced by climatic conditions during baking.

Production recorded in both varieties was negatively correlated with the amount of rainfall recorded during the growing of the plant (Figure 10). The climatic conditions in 2014, particularly abundant rainfall, were unfavorable to plant productivity, due to the growth of lush foliage at the expense of root tubers process;

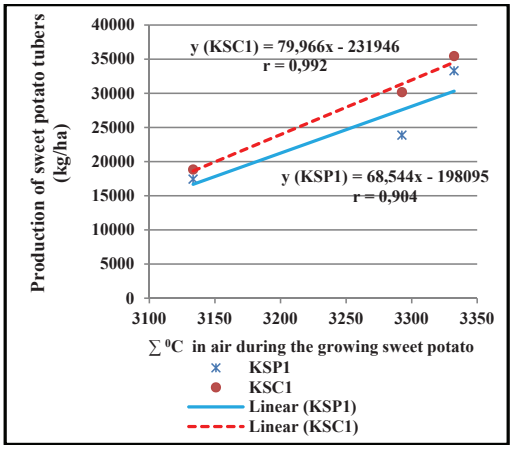

Figure 9. Relationship between production of tubers and the amount of degrees of temperature recorded during the growing season of sweet potato

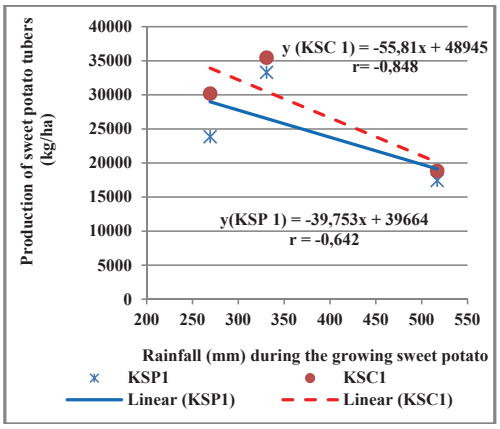

Figure 10. The relationship between production of tubers and rainfall recorded during the growing sweet potato

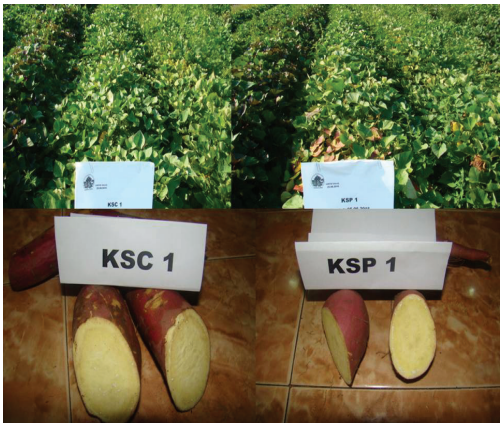

Figure 11. Sweet potato in the vegetation phase of and phase of tubers

CONCLUSIONS

Research conducted during 2013-2015 at the Research - Development Center for Agricultural Plants on Sands, Dabuleni, highlights a favorable microclimate for plant growth and development of sweet potato (*Ipomoea batatas*).

The values recorded physiological indices sweet potato grown in climatic conditions in the sandy soils of southern Oltenia showed that it easily adapts to the conditions of excess heat here is a plant heat-loving and light. Noting that the rate of photosynthesis in this species remains high throughout the day compared to other species (watermelons, peppers, eggplant), where the rate of photosynthesis decreases sharply from 12 to 15 hours under direct stress factors.

Production made sweet potato varieties Pumpkin (KSP 1) and Chestnut (KSC 1), studied under sandy soils ranged 17428kg / ha and 35467 kg / ha depending on the crop and cultivated variety.

Production of sweet potato tubers obtained from the period 2013-2015, is positively correlated with the amount of degrees of temperature and negatively with rainfall recorded during the growing season (May-September).

Nutritional quality presented values differentiated to the two varieties studied, according to the year of culture.

Given the level of production that was achieved in sweet potato grown in the period 2013 - 2015 is necessary to continue research on introduction in culture in the sandy soils of Romania sweet potato (Ipomoea batatas).

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