RESEARCH ON THE FERTILIZATION OF SWEET POTATOES ACCORDING TO THE NUTRITIONAL SPACE, IN THE SANDY SOIL CONDITIONS FROM ROMANIA

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ABSTRACT

Research conducted during 2015-2017, in the climatic conditions of sandy soils in Romania, highlights the role of fertilization and plant density on the growth and development of sweet potato plants (Ipomoea batatas). The obtained results, show the positive implications of chemical and foliar fertilization on the physiological processes in the plant and on the quantity and quality of the obtained production. The fertilization of the sweet potato culture with $N_{150}P_{80}K_{80}$, prior to planting and the use of a density of 50000 plants / ha led to a maximum yield of 27907 kg / ha. From the point of view of the quality of the production, the application of two foliar fertilizations with the product Timasol in a concentration of 1%, having $N_{15}P_{15}K_{30}$ + 13 microelements, determined the increase of the biochemical components from the sweet potato tubers, compared to the only radicular fertilized.

INTRODUCTION

Sweet potato (Ipomoea batatas), is one of the most important plants cultivated widely in over 110 countries for an annual starch production estimated at about 114 million tonnes (2010 United Nations Food and Agriculture Organization). In developed countries, sweet potato is primarily intended for fresh or preserved consumption, but most of the time in the market is in the form of processed food products with added value and biological industrial products (Nicholas A. George, et al. 2011). Thus, research conducted by Ziska et al., 2009 highlights the high yield of biomass, which can be transformed into industrial products. For example, starch can be converted into simple sugars and then used to produce plastics or fuels such as ethanol and butanol (Klass, 1998). For growing and maturing tubers, sweet potato plants need large amounts of potassium (Pathleen Titus, 2008). It recommends the application of 12: 8: 16 fertilizers at a dose of 250 - 500 kg / ha, applied in two phases (at soil preparation for planting and to 5 - 6 weeks after planting. Research on sweet potato culture by I.Kareem, 2013 at the University of Ibadan highlights the role of organic fertilizer in the quality and productivity of sweet potato culture as compared to inorganic and organo-mineral fertilizers. The results obtained in Cameroon by J. T. Ambe, 1995, showed that sweet potatoes can produce two crops per year, and the yield obtained depends on variety and density. The highest yields of 29.6 t / ha (season I) and 18.7 t / ha (Season II) were obtained by planting 20000 plants / ha. Considering the suitability of sweet potatoes for sandy soils (Draghici Reta et al., 2013, Iamandei Maria et al., 2014, Aurelia Diaconu et al., 2016) and taking into account by the deficient physical and chemical properties of sandy soil and the consumption in plant (Sipoş Gh. et al., 1981, Marinică Gh. et al., 2003), the purpose of this experiment is to optimize nutrient consumption, depending on the size of the plant nutrition space.

MATERIALS AND METHODS

The research was carried out during the period 2015-2017, at the Research and Development Center for Agricultural Plants on Sands, Dabuleni, by ADER Project 2.2.2., within the Sectoral Program 2015-2018, financed by the Ministry of Agriculture and Rural Development of Romania. The eperimental device was placed on a sandy soil, with a reduced natural fertility (extractable phosphorus between 75 ppm and 115 ppm, exchangeable potassium between 57 ppm and 97 ppm, organic carbon with values of 0.18% - 0.51% , and the pH of the soil oscillated between 5.64 and 6.98). The study aimed to establish the fertilization system for sweet potato culture according to the plant nutrition space. The experience was placed in according to the subdivision parcel method, studied four fertilization levels ($N_0P_0K_0$; $N_{80}P_{80}K_{80}$; $N_{80}P_{80}K_{80}$; $N_{150}P_{80}K_{80}$ + 2 foliar fertilization with Timasol product, in 1% concentration (having the composition in $N_{15}P_{15}K_{30}$ + 13 microelements), and three planting densities (30000 plants / ha, 40000 plants / ha, 50000 plants / ha) in the KSP 1 variety. Culture was established in the field by seedling obtained by planting sweet potato tubers in a double solar protection during 20 to 25 March. At 35-40 days of vegetation (10-15 May), the shoots were cut, kept for 24 hours at room temperature and then the next day after 17 o'clock, were planted in the field on billy ground and mullioned with foil PE and drip irrigation. During the vegetation period, in the root tuberization phase, was determined photosynthesis rate and plant perfusion rate at leaf level with the LCpro + Portable Photosynthesis System, in 3 moments of the day (9 o'clock, 12 o'clock, 15 o'clock). The sweet potato was harvested about 120 days after the shoots were planted in the field and the production was analyzed qualitatively as follows: water content and total dry substance (%) by gravimetric method; soluble dry matter content (%) by refractometric method; total carbohydrate content (%) by Fehling Soxhlet method; C vitamin content (mg / 100g of fresh substance) by iodometric method; starch content (%) by gravimetric method. The obtained results were statistically interpreted by variance analysis and mathematical function.

RESEARCH RESULTS

Analyzing the evolution of climatic conditions during the period 2015-2017, during the growing season of sweet potatoes, there is an increase of average air temperature in all years of study compared to the multiannual average (Table 1). There were temperature increases of 1.53-2 ^{0}C, relative to the multiannual average, which were favorable for the growth and development of sweet potato plants. From the point of view of the precipitation regime, these were not sufficient for the consumption of sweet potato plants, being supplemented by the irrigation work, in order to ensure 80% of the active humidity range on a 50 cm depth. Of the three experimental years, 2017 was marked by higher air temperature values, with peaks above 40 ^{0}C and very low air humidity (25-30%) during root tuberization, which affected the accumulation of the dry substance.

Table 1

Climate conditions recorded at the weather station from R&DCAPS Dabuleni during the potato growing season

Period / Climate parameters		May	June	July	August	September	Average (^{0}C)	∑ ^{0}C /mm
2015	Monthly average temperature (^{0}C)	19.2	20.5	24.9	24.3	20.1	21.8	3335.4
	Maximum monthly temperature (^{0}C)	30.2	36.1	39.2	37.6	37.3		
	Rainfall (mm)	52.4	134.2	11	47.4	84.8		329.8

2016	Monthly average temperature (^{0}C)	16.8	23.6	24.8	23.5	20.4	21.82	3338.5
	Maximum monthly temperature (^{0}C)	32.9	37.3	38.0	38.0	34.1		
	Rainfall (mm)	104.4	53.2	31.6	1	37.6		227.8
2017	Monthly average temperature (^{0}C)	17.8	24	24.8	24.8	20.2	22.32	3415
	Maximum monthly temperature (^{0}C)	29.0	41.2	40.8	40.4	36.9		
	Rainfall (mm)	78.6	17.4	120.8	28.8	18.2		263.8
Multiannual period (1956-2017)	Monthly average temperature (^{0}C)	16.8	21.6	23.1	22.4	17.8	20.32	3109
	Rainfall (mm)	62.12	69.30	53.15	37.28	41.81		263.66

The climatic conditions in the sandy soils area, with high temperatures in the air up to 40 °C, with soil surface temperatures of 65 °C, minimum air humidity at 25% act as stressful factors on the plants, which they dehydrate through the very pronounced foliar sweating. By directing agro-technical factors (irrigation, fertilization, treatment and herbicide of plants) their metabolism can be guided. Plant density influences physiological processes through competition on nutrition space, vegetative shading, and water and mineral consumption. The rate of plant photosynthesis in sweet potato (Figure 1) recorded a daily variation with different values depending on density and fertilization dose. The increase of atmospheric and pedological drought at 12 o'clock and 15 o'clock reduces the absorption of mineral elements due to the increase in the soil solution concentration. Sweet potato has used the most of the nutrition space created by planting 40000 plants / ha and $N_{150}P_{80}K_{80}$ fertilization + 2 foliar fertilization with Timasol product, in 1% concentration, recording a maximum rate of photosynthesis in plant (26.7 µmol CO_2 / m^2 / s) at 12 o'clock at an active photoisynthesis radiation of 1431-1958 µmol / m^2/s. Increasing plant density per hectare causes increased mineral consumption, due to competition on the nutrition space. Stressing factors in the sandy soil area, especially the hydro and thermal regime, have influenced the sweat of the sweet potato plant, depending on the number of plants per hectare and the fertilization regime (Figure 2). The analysis of the results obtained, highlights the increase in the rate of perspiration, as well as increased fertilization doses and planting density. The increase in air temperature also correlates positively with the perspiration rate, with the minimum perspiration values at 9 o'clock (1.34-3.71 mmol H_2O / m^2 / s), when at the leaf level, in the LCpro + air chamber, was recorded 27.5-29.9 ° C, and the maximum of perspiration rate at 15 o'clock (3.71-6.83 mmol H_2O / m^2 / s), when the temperature was 33-38.6 °C. The climatic conditions in the area of sandy soils are favorable for the growth and development of the sweet potato plant, revealing a significant positive correlation between the foliar surface of a leaf and the rate of photosynthesis (Figure 3).

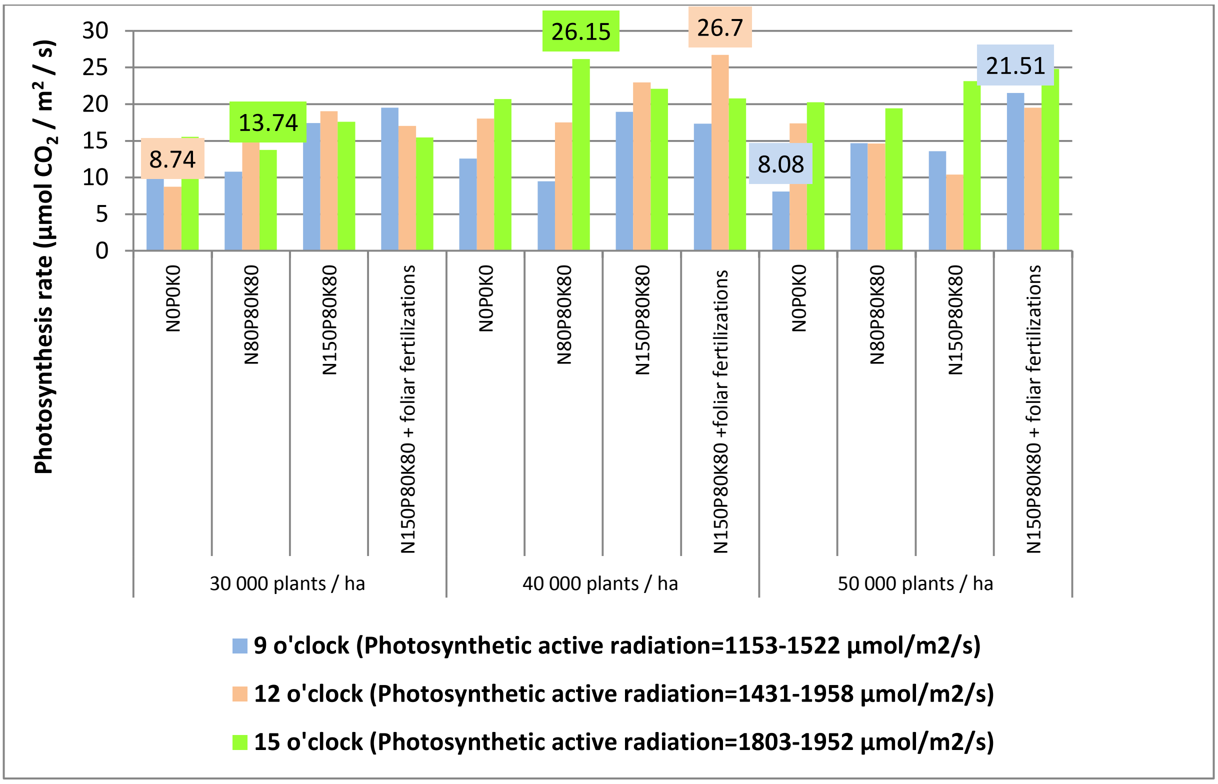

Figure 1. Daily variation of plant photosynthesis according to fertilization and planting density

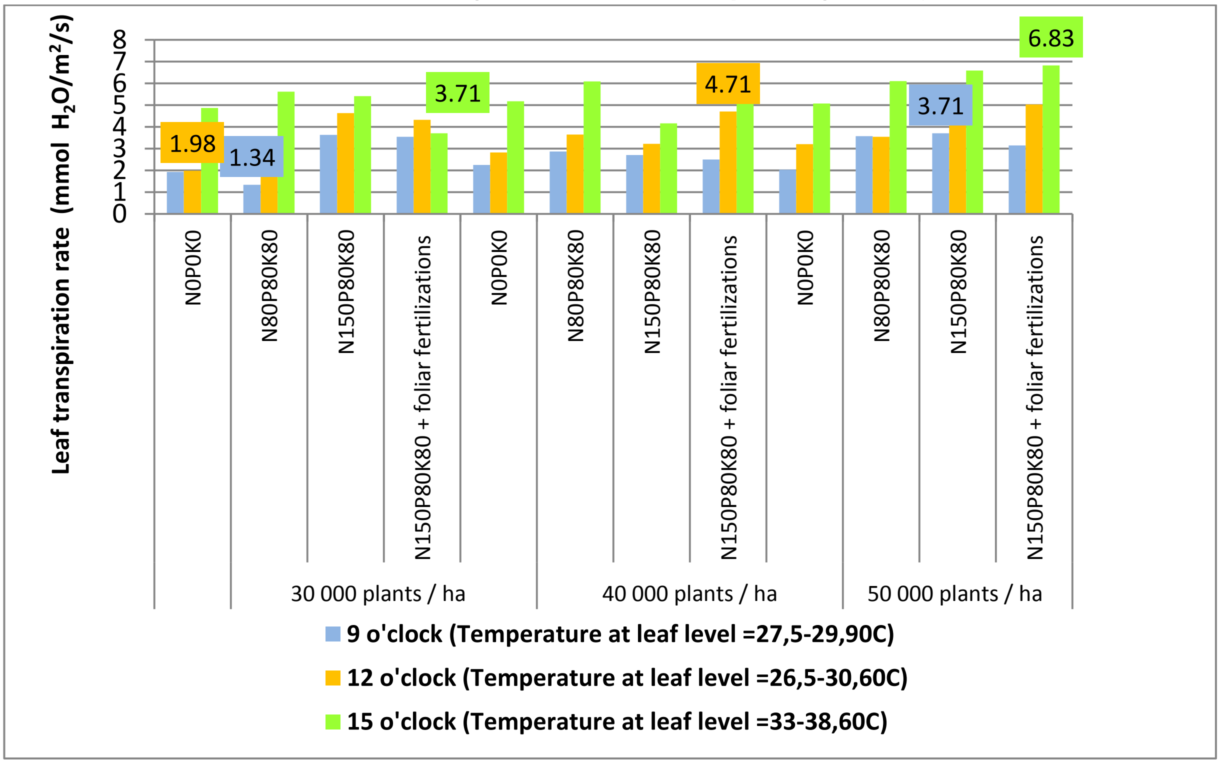

Figure 2. Diurnal variation of the plant sweating process, according to the density of planting and fertilization

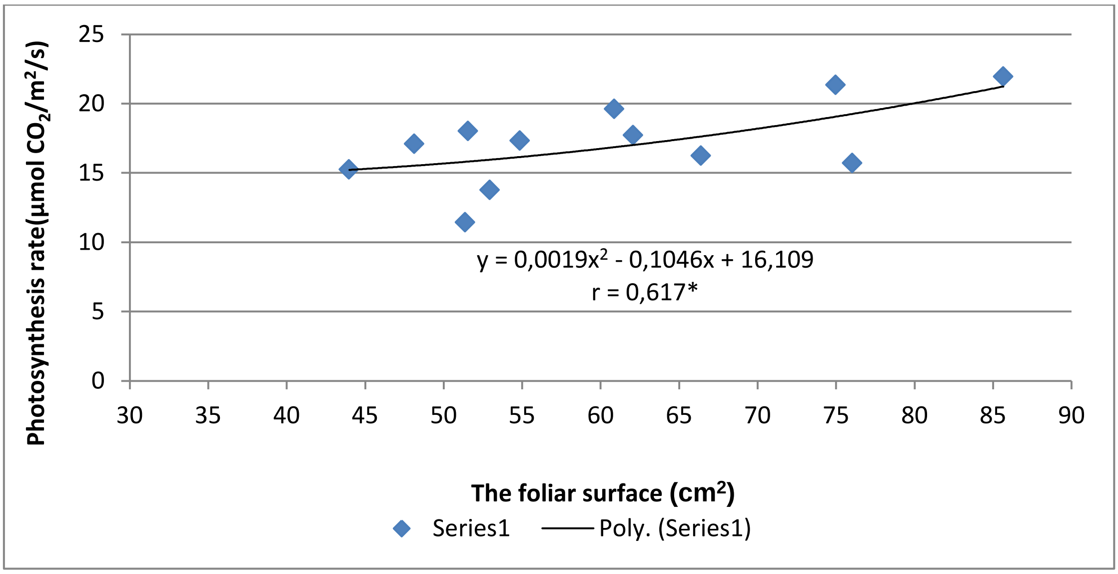

Figure 3. Correlation between the foliar surface and the photosynthesis process in sweet potatoes in the sandy soils conditions

The production of tubers (tuberous roots) in sweet potatoes was influenced both by the climatic conditions and by the technological factors studied (Figure 4). Sweet potato produced the largest production in 2016, significantly correlated with fertilization and planting density (r = 0.796 **). The same distinct positive correlation between production and experimental technological factors was recorded in 2015. The extreme drought conditions of 2017, during the period of tuber rooting, have negatively influenced the effect of applying radicular + foliar fertilization on the accumulation process. This year, a significantly negative correlation was established between production and increased fertilization doses. The variance analysis on the production of tuberous roots with a diameter of more than 3.5 cm, (average 2015-2017) highlights fertilization with $N_{150}P_{80}K_{80}$ and fertilization with $N_{150}P_{80}K_{80}$ + the application of two foliar fertilizations with the product Timasol in a concentration of 1%, having $N_{15}P_{15}K_{30}$ + 13 microelements, through statistically insured differentiations, of 5309-9300 kg / ha, against the control (planting 30000 plants / ha in non-fertilized system). The maximum yield (27907 kg / ha) was recorded in the fertilized variant with $N_{150}P_{80}K_{80}$, when 50000 shoots / ha were planted (Table 2).

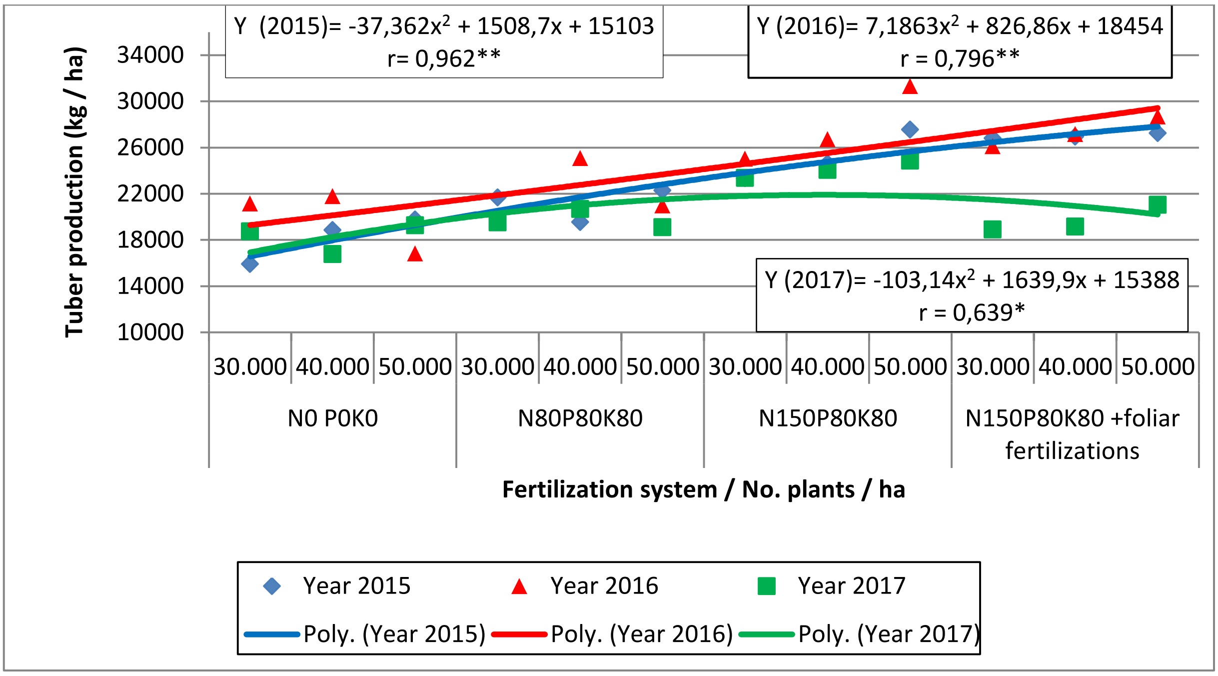

Figure 4. Correlations between plant nutrition and tuber production obtained from sweet potatoes, depending on the climatic year

Table 2

Significance of tuber production obtained from sweet potatoes, depending on fertilization and nutrition space (Average 2015-2017)

Fertilization dose	No. plants/ha	Production of tubers Kg/ha	% din control variant	Difference	
				Kg/ha	Significance
$N_0 P_0 K_0$	30000	18607	100.0	control variant	
	40000	19144	102.9	537	-
	50000	18626	100.1	19	-
$N_{80}P_{80}K_{80}$	30000	20287	109.0	1680	-
	40000	21778	117.0	3171	-
	50000	20806	111.8	2199	-
$N_{150}P_{80}K_{80}$	30000	23916	128.5	5309	*
	40000	25140	135.1	6533	**
	50000	27907	150.0	9300	***
$N_{150}P_{80}K_{80}$ + two foliar fertilizations with 1% Timasol product	30000	23942	128.7	5335	*
	40000	24426	131.3	5819	*
	50000	25673	138.0	7066	**

LSD 5%=4213kg/ha
LSD 1% = 6051 kg/ha
LSD 0.1%= 8908 kg/ha

The results obtained with regard to the quality of sweet potato tubers, depending on the fertilization system and the planting density, are presented in Table 3. The biochemical components of the sweet potato tubers were influenced by the plant nutrition regime, with the best results evidenced by the fertilized variant with $N_{150}P_{80}K_{80}$ + the application of two foliar fertilizations with the product Timasol in a concentration of 1%, having $N_{15}P_{15}K_{30}$ + 13 microelements, which resulted in increases in the total dry substance content by 1, 92%, of the soluble carbohydrate content by 1.61%, the starch content by 4.57% and the C vitamin content by 0.5 mg / 100 g of fresh substance, compared to the unfertilized variant. From the point of view of the nutrition space, the most balanced content of total dry substance, starch, soluble carbohydrates and C vitamin was achieved when 40000 shoots / ha were planted.

Table 3

Biochemical composition of sweet potato fruits according to planting density and fertilization system

Fertilization variant	Density (No. plants / ha)	Total dry substance %	Water %	Soluble dry substance %	Simple soluble glucosides %	Starch %	C vitamin mg/100g s.p
$N_0 P_0K_0$	30000	34.82	65.18	9.50	7.90	12.03	9.68
	40000	34.43	65.57	9.4	7.85	11.73	11.44
	50000	30.24	69.76	9.1	7.60	12.94	10.56
	Average	33.16	66.84	9.33	7.78	12.23	10.56
$N_{80}P_{80}K_{80}$	30000	33.78	66.22	10.20	8.50	13.82	9.68
	40000	32.48	67.52	9.80	8.15	10.78	8.80
	50000	34.75	65.28	9.90	8.30	11.04	9.94
	Average	33.67	66.34	9.96	8.32	11.88	9.47
$N_{150}P_{80}K_{80}$	30000	33.75	66.25	11.20	9.32	17.11	9.50
	40000	34.61	65.39	11.00	9.00	15.43	9.68
	50000	31.60	68.40	11.00	9.15	16.56	10.34
	Average	33,32	66.68	11.067	9.16	16.37	9.84
$N_{150}P_{80}K_{80}$ + two foliar fertilizations with 1% Timasol product	30000	34.14	65.86	10.40	8.65	16.40	10.82
	40000	38.28	61.72	11.40	9.50	17.37	11.62
	50000	32.81	67.19	12.00	10.00	16.63	10.74
	Average	35.08	64.92	11.28	9.39	16.8	11.06

CONCLUSIONS

The climatic conditions in the southern Oltenia soils are favorable for the growth and development of sweet potato plants.

The fertilization of the sweet potato, before planting, with $N_{150}P_{80}K_{80}$ and the use of a density of 50000 plants / ha resulted in a maximum yield of 27907 kg / ha.

The application of two foliar fertilizations with the 1% Timasol product, which has N15P15K30 + 13 microelements, led to increase the biochemical components of sweet potato tubers compared to the only radicular fertilized variant.

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