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Research Article

The sweet potatoes new genotypes introduction in Ukraine

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Abstract

Aim: Conduct research on the collection of new genotypes of sweet potatoes introduced under growing conditions in the Kharkiv district of Ukraine.

Results and discussion: In the conditions in the Kharkiv district of Ukraine, an assessment was made of 13 genotypes of sweet potato a domestic and foreign selection. The genotypes were very different in length of the growing season, biometric parameters of plants, and productivity. The studied genotypes were divided into three ripeness groups. Samples that characterized the three groups - early ripening: V-1, V-6, A-7, B-4; medium ripening: Or-3, D-2, M-8; late-ripening: B-9, P-11, B-10, J-12, E-5, Ok-14. A wide range of shapes was obtained along the length of the stem. All genotypes that entered the mid-ripening group formed long, climbing stems. So, plants of the genotype Or-3 formed long stems similar to vines, 214 cm long. The genotypes of the early ripening group were characterized by lengths from 144 cm (V-6) up to 153 cm (A-7). According to the "Quantity of additional shoots" attribute, the variability range was 4–8 cm, and the coefficient of variation was 17%. Significant variation was observed along the length of the internodes (V = 30%). The variability range was 4.39–9.97 cm. According to the "Quantity of leaves" characteristic, the variability range was 40–77 pcs. And the coefficient of variation was 20%. The genotypes of the middle ripening group that had the largest "Quantity of leaves" were 77 pcs./plant (Or-3) and 71 pcs./plant (D-2). The smallest was 40 pcs./plant (B-10), 42 pcs./plant (B-9), 44 pcs./plant (P-11). The root tubers in genotype V-6 had an oval shape, smooth peel, and pink color. The flesh was a creamy solid color; it was a sample of sweet potato. The shoots were long, climbing, leaves of a dark green color without anthocyanin color, kidney-shaped. The genotype of sweet potato D-2 of Ukrainian selection was a dessert variety. The tubers of the genotype were elliptical, orange with a smooth peel; the flesh was firm and bright orange. The shoots of the plants were very long, very climbing, and light green. The shoots of the leaves were kidney-shaped, light green. The results showed that table genotypes are of greater value for dietary nutrition. Dessert genotypes are conducive to a variety of diets for people with diabetes. A list of genotypes that can be used by people who follow a diet has been provided.

Conclusion: In the conditions in the Kharkiv district of Ukraine, 13 introduced genotypes of sweet potato domestic and foreign breeding were evaluated. They already discovered that the genotypes were different in the growing season by biometric parameters of plants and yields. By using clonal selection in vitro culture, two completely new promising genotypes of domestic selection of sweet potatoes V-6 and D-2 were obtained. Tubers of genotype V-6 were oval, skin smooth, and pink. The average weight of one was 351 g. The raw flesh was cream-colored. Long shoots were woven, their length was 144 cm; the leaves were dark green, and kidney-shaped. Another example of a domestic selection of sweet potato D-2 was a dessert type. The root tubers were elliptical and had an orange color with smooth skin. The average weight of the tubers was 410 g. The raw flesh was a solid bright orange color. Shoots were extremely long -198 cm, very creeping, and had a light green color. The leaves were kidney-shaped and light green.

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Introduction

Sweet potatoes are a perennial herbaceous plant [1]. Varietal characteristics are plant-dependent and can be fully used by humans for food [2]. This is especially true in developing countries, the diet includes leaves, young shoots, seeds, and root tubers [3]. However, in Ukraine, sweet potatoes are grown as an annual plant to then obtain root tubers.

According to biochemical studies, root tubers have antioxidant properties [4]; they contain substances useful for human health. These are vitamins C and B, glucose, calcium, magnesium, β-carotene, folic acid, and trace elements [5].

Scholars believe that the center of origin of sweet potatoes lies between the Yucatan Peninsula in Mexico and the Orinoco River in Venezuela. Thanks to Christopher Columbus, the first root tubers were brought to Europe about a century earlier than traditional Ukrainian potatoes - *Solanum tuberosum* L. [7].

As reported by FAOSTAT [8], the total cultivation of sweet potatoes in the world in different years ranged between 100 million tons. The main producers were Asia (75.3%), the USA (20.2%) and Oceania (0.8%). Sweet potato cultivation in Europe has the lowest percentage in the world (3.7%), which is about 56,200 tons.

The productive part of sweet potato plants - root tubers are very diverse in shape and color. They are round, elongated, oval, or spindle-shaped. The skin can be white, cream, yellow, orange, pink, or purple; smooth or rough. The pulp of the root tubers also varies from white, pink, orange, and cream to purples [9-20].

Characteristically, sweet potatoes are also widely used in the food industry and for animal feed [21]. Root tubers are processed into sugar, alcoholic beverages, and starch; made fried in bars, chips, candied fruits and pastilles, and purees for baby food [22,23].

Flower pollination occurs crosswise, but mostly plants reproduce vegetatively [24]. Sweet potato is a hexaploid (2n = 6x = 90) with the main number of chromosomes x = 15 [25]. Various marker systems such as RAPD, AFLP, SSR, and ISSR are used worldwide to assess the genetic diversity of sweet potato varieties [26,27]. Most SSR markers are used in genetic research [28]. This is because SSR markers are more polymorphic and reproduce accurate sequences of results [29]. Some of them have been successfully used for the genetic differentiation of sweet potato varieties from Brazil. They were also involved in assessing the genetic origin of sweet potatoes from New Guinea, which is considered a secondary center of cultural origin [30].

Sweet potatoes have great potential for agriculture and human nutrition in the Central European area. Culture is becoming increasingly popular in Ukraine [31]. The climatic conditions of our country are quite suitable for growing sweet potatoes. Since the culture originates from a warm subtropical climate, where there are appropriate thermal conditions and humidity, in the Kharkiv region, especially in May, when there is a high risk of spring frosts, it will be necessary to create the additional cover. One of the advantages of growing sweet potatoes is that in Ukraine there are no pests and diseases specialized for sweet potato culture. Thus, the evaluation of sweet potato samples in the Kharkiv region is of considerable selection value for obtaining new commercial domestic varieties [32].

Therefore, the study of samples of sweet potatoes of foreign selection in the Kharkiv region of Ukraine is urgent task research.

The aim

Conduct research on the collection of new genotypes of sweet potatoes introduced under growing conditions in the Kharkiv district of Ukraine.

Materials, methods and conditions of research

The research was conducted from 2019 to 2021 in the Laboratory of Genetics, Genetic Resources, and Biotechnology of the Institute of Vegetable and Melon Growing of NAAS. They were conducted in laboratory and soil conditions according to methodological recommendations [33,34]. Mathematical processing of the obtained data was performed [35].

The materials of the study were 13 samples of sweet potatoes of domestic and foreign selection. The choice of genotypes was determined by those who were able to collect from different countries. And then conducted a detailed description of them after they were grown in soil conditions. Then already divided into groups of maturity. To obtain planting material, root tubers were germinated in boxes with sand. The obtained cuttings were planted in late May-early June in the open ground in the ridges mulched with black film, height 30 cm, width - 40 cm. The soil was chernoz typical low humus medium loam. Humus content - 3.9%, mobile phosphorus - 113–269 mg/kg; exchangeable potassium - 90–163; alkaline-hydrolyzed nitrogen - 126–146 mg/kg of soil). Planting scheme - (20 + 80 cm) x 40 cm, planting density - 50 ths./ha . Irrigation was carried out by drip irrigation. During the growing season, according to the descriptor [36], phenological observations of plant development were made. At least 20 plants in the variant were measured for accounting. The number of shoots and leaves was described as average.

Sweet potatoes are harvested before frost in autumn in September. To characterize the structure of the crop from each site dug an average sample of bushes, which were 8-12 pieces. For further use in breeding studies, tubers were selected from the best in terms of productivity and marketability of plants, which had a yield of 40-80 t / ha and marketability of tubers at the level of 80–90%. The most promising sweet potato clones for selection work were manually selected. Boxes with sweet potatoes were marked according to the fractions and a "treatment period" was carried out. Warmed root tubers at a temperature of + 28 + 30°C for 5 days, humidity 80-90%. As a result, the skin of the root tubers was rough, the mechanical damage dried up. This method prevents the possibility of

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additional infection and contributes to the full preservation of the crop.

Results and discussion

According to the results of the research, a description of 13 introduced genotypes of sweet potato was performed. The studied genotypes were divided into three ripeness groups. There are: early ripening: V-1, V-6, A-7, B-4; medium ripening: Or-3, D-2, M-8; late-ripening: B-9, P-11, B-10, J-12, E-5, Ok-14 (Table 1).

The length of the stem received a wide range of forms. The range of variability based on the "length of the stem" was 110 - 214 cm, and the coefficient of variation was 21%, which indicated significant variation. All specimens included in the group of medium-ripe formed long stems. Thus, plants of the Or-3 variety formed the longest stems, similar to vines, 214 cm long. Samples of the early ripening group were characterized by a length of 144 cm (V-6) to 153 cm (A-7). Samples of the late-ripening group did not form long stems, they had a length of 110 cm (B-10) to 137 cm (Ok-14).

Based on the "Quantity of additional shoots" the range of variability was 4 - 8 cm, and the coefficient of variation - was 17%. Samples from different maturity groups had the largest number of additional shoots: 8 pcs. (Ok-14), 8 pcs. (V-6), and 6 pcs. (D-2), 4 pcs. (B-10), 5 pcs. (M-8) had the smallest number of shoots.

Significant variation was observed in the length of the internode (V = 30%). The range of variability was 4.39 - 9.97 cm. Samples Or-3, D-2, and M-8 had the longest internode length - 10 cm, 8 cm, and 7 cm, respectively.

Based on "Quantity of leaves" the range of variability was 40 - 77 pcs., and the coefficient of variation - was 20%. The largest number of leaves had genotypes of the middle group of maturity: 77 pcs. and 71 pcs. (Or-3 and D-2, respectively), 40 pcs. (B-10), 42 pcs. (B-9), 44 pcs. (P-11) had the smallest.

Over the years of research, according to the descriptor, collectible samples of sweet potatoes have been described. The results are presented in Table 2. The characteristics of the morphological features of the samples were described by the shape, color of the skin and pulp of root tubers, and the shape of the leaves. Samples with a light color of the pulp are considered for table use, and with color - for dessert.

Table 1: Biometric indicators of sweet potato plants (average 2019 - 2021).

Maturity group	Genotype	Country of origin	Length, cm		Quantity, pcs.	
			stems	internode	additional shoots	leaves
Early ripening	V-1	USA	151	4	6	54
	V-6	UKR	144	4	8	52
	A-7	USA	153	5	5	55
	B-4	USA	133	5	6	48
Medium ripening	Or-3	USA	214	10	6	77
	D-2	UKR	198	8	6	71
	M-8	USA	161	7	5	58
Late ripening	B-9	USA	115	6	5	42
	P-11	USA	120	6	6	44
	B-10	ESP	110	6	4	40
	J-12	JPN	124	5	6	45
	E-5	USA	136	4	6	49
	Ok-14	CHN	137	6	8	50
$SSD_{0.05}$			12	2	2	13
min			110	4	4	40
max			214	8	8	77
V%			21	17	17	20

Table 2: Characteristics of sweet potato's new genotypes (average 2019-2021).

Genotype	Country of Origin	Characteristics of root tubers			The shape of the leaves
		the shape	color of the peel	the pulp color	
V-1	USA	oval	pink	cream	heart-shaped
V-6	UKR	oval	pink	cream	heart-shaped
A-7	USA	elongated-elliptical	light pink	cream	spear-shaped
B-4	USA	elongated-elliptical	cream	cream	kidney-shaped
Or-3	USA	elliptical	orange	orange	kidney-shaped
D-2	UKR	elliptical	orange	orange	kidney-shaped
M-8	USA	oval	orange	orange	heart-shaped
B-9	USA	rounded	orange	orange	spear-shaped
P-11	USA	elliptical	purple	purple	spear-shaped
B-10	JRN	elliptical	orange	orange	heart-shaped
J-12	JPN	elliptical	cream	white	spear-shaped
E-5	USA	elliptical	orange	orange	heart-shaped
Ok-14	CHN	elliptical	cream	white with purple	spear-shaped

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A promising example of domestic selection V-6 is a table variety of sweet potatoes. Root tubers had an oval shape and smooth pink skin. The flesh is a creamy solid color. Shoots are long, creeping, dark green leaves without anthocyanin color, kidney-shaped. Another interesting example of sweet potato domestic selection is D-2 refers to dessert varieties. Root tubers are elliptical, orange in color with smooth skin. The flesh is a solid bright orange color. Shoots are extremely long, very creeping, and light green. The leaves are kidney-shaped, and light green without anthocyanin color.

Sweet potato root tubers were dug up in mid-September. The optimal time was chosen before the first frosts. The root tubers were immediately weighed. Thus, the average weight of root tubers of early-maturing samples was 342 g (V-1), 351 g (V-6), 255 g (A-7), and 189 g (B-4). In the samples of the middle-ripe group, the average weight of root tubers was much higher: 390 g (Or-3), 410 g (D-2), and 315 g (M-8). In the samples of the late-ripening group, the average weight of root tubers was the smallest and was: 238 g (B-9), 230 g (P-11), 233 g (B-10), 160 g (J-12), 185 g (E-5), 115 g (Ok-14). This fact was explained by the insufficient growing season for these samples in the Kharkiv district of Ukraine.

The highest yield of sweet potato root tubers was obtained in the dessert sample D-2 (112 t/ha), with marketability of 88%. The table sample V-6 also had a high yield (87 t/ha), and the marketability of root tubers was at the level of 81 %.

It should be noted that the varieties E-5, Ok-14, and P-11 did not form a high yield of root tubers, as they were late ripening.

The comparative study of sweet potato genotypes revealed the peculiarities of the biochemical composition of root crops (Table 3). Thus, table genotypes had a high percentage of dry matter in the root tubers. Its highest content was determined in genotypes B-4 (27.3%) and A-7 (26.6%). This also affected the high content of Starch - 20.08 and 16.2, respectively. The content of Total sugar in these genotypes is 10.27% and 11.47%, respectively. The content of Ascorbic acid was among the highest - 10.81 mg% and 15.71 mg%. Among the dessert species, the Be-9 genotype was noted; the percentage of dry matter was 25.3%, total sugar 12.26%, and ascorbic acid 12 mg%. Genotype D-2 had (Dry matter - 17.8%, Total sugar - 9.12%, the most was ß-carotene 6.43 mg%, ascorbic acid - 12.03 mg%). Genotypes Av-7 (15.71 mg%), and Pu-13 (17.7 mg%) also had a high content of ascorbic acid.

Table 3: Biochemical composition of root tubers of sweet potato genotypes.

№ on biotechnology catalog	Dry matter, %	Total sugar, %	ß- carotene, mg %	Starch	Ascorbic acid, mg %
V-6	17.7	7.74	-	14.0	7.01
V-1	17.6	7.71	-	14.2	7.00
B-4	27.3	10.27	-	20.08	10.81
M-8	15.88	10.34	-	12.18	6.76
Or-3	17.3	8.86	6.33	14.00	11.84
D-2	17.8	9.12	6.43	14.12	12.03
E-5	12.62	11.4	-	-	11.5
A-7	26.6	11.47	-	16.2	15.71
Be-9	25.3	12.26	3.52	16.78	12.0
Ok-14	17.3	7.46	6.7	17.03	9.24
Pu-11	-	7.02	-	9.6	17.7
B-10	-	7.61	-	10.1	9.6
J-12	-	6.24	-	11.74	20.1
$SSD_{0.05}$	8,3	3,2	0,8	4,1	5,3
V%	11,2	8,1	0,3	6,4	3,1

Conclusion

In the conditions in the Kharkiv district of Ukraine, 13 introduced genotypes of sweet potato domestic and foreign breeding were evaluated. They already discovered that the genotypes were different in the growing season by biometric parameters of plants and yields. By using clonal selection *in vitro* culture, two completely new promising genotypes of domestic selection of sweet potatoes V-6 and D-2 were obtained. Tubers of genotype V-6 were oval, skin smooth, and pink. The average weight of one was 351 g. The raw flesh was cream-colored. Long shoots were woven, their length was 144 cm; the leaves were dark green, and kidney-shaped. Another example of a domestic selection of sweet potato D-2 was a dessert type. The root tubers were elliptical and had an orange color with smooth skin. The average weight of the tubers was 410 g. The raw flesh was a solid bright orange color. Shoots were extremely long -198 cm, very creeping, and had a light green color. The leaves were kidney-shaped and light green.

The obtained data showed that genotypes of table purpose are of greater value for dietary nutrition. Dessert genotypes are conducive to a variety of diets for people with diabetes. As such patients are quite limited in their attire for healthy eating.

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