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Evaluation of parsnip varieties (*Pastinaca sativa* L.) on productivity and adaptability in the conditions of the Right-Bank Forest-Steppe Of Ukraine

Abstract. Commercial products of parsnip were formed in the conditions of the Right-Bank Forest-Steppe of Ukraine within the sum of effective temperatures of 1356 1495°C, precipitation amounts of 171 318 mm, and relative humidity of 57 64%. The yield value had an inverse relationship with the sum of temperatures and a direct relationship with the amount of precipitation, relative humidity, and hydrothermal coefficient. The highest yield in the conditions of the Right-Bank Forest-Steppe of Ukraine is provided by Stymul and Pul's varieties with a total yield of 46.2 and 44.8 t/ha, and a marketability of root crops of 89 and 88%, respectively. Pul's and Stymul varieties had the highest breeding value of genotype in terms of yield (BVGi = 46.2 and 44.8, respectively), high ecological

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stability (Sgi = 3.43 and 1.96, respectively), and plasticity (bi = 1.47 and 0.89%, respectively). The highest indicator of general adaptive ability for plant productivity was observed in the Stymul (GAA= 3.12) and Pul's (GAA= 1.76) varieties. According to the indicator of specific adaptive ability, the Stymul variety (SAA = 2.52) and Pul's (SAA = 0.78) were highlighted. According to the biochemical composition of root crops, the varieties under study did not exceed the control. However, in the Borys variety, the content of dry matter – 25.1%, dry solute – 15.8%, and sugar content – 6.4% was at the control level. All varieties were identified to have a high content of vitamin C – 8.9 10.1 mg/100 g. The varieties did not tend to accumulate nitrates and their content ranged from 67 to 80 mg/kg and was below the maximum allowable level (MAL 250 mg/kg). The highest tasting score of 5.6 points was given by the Pul's variety. It is recommended to grow highly productive varieties of parsnip – Stymul and Pul's to obtain a consistently high yield of root crops (44.8 46.2 t/ha) and their marketability at the level of 88 89% with a high content of basic biochemical components in the conditions of the Right-Bank Forest-Steppe of Ukraine on medium-podzolic coarse-pollinated light loamy turf soil

Keywords: yield, quality indicators, stability, plasticity, breeding value of the genotype

RELEVANCE

Providing the population with high-quality and environmentally safe products is one of the main socio-economic problems of modern times (Engalycheva, I.A. *et al.*, 2021). Parsnip seed is a valuable vegetable crop (Aćimović, M.G., 2017). The chemical composition of parsnip is quite multifaceted and includes a substantial number of biologically active compounds that determine a wide range of its biological properties, which can effectively affect various organs and systems of the body and maintain their health (Shimorova, J.E. *et al.*, 2017)

The problem of selecting and using environmentally plastic variety samples is an important element of adaptive vegetable growing. Its correct solution enables the efficient using material and natural resources and reduces production costs (Gaplaev, M.Sh., 2016).

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

Since each variety, depending on the growing conditions, realises its genetic potential differently, it is advisable to choose ones of intensive type that differ in biological characteristics within the same soil and climate zone to reduce the risks associated with weather instability (Gaplaev, M.Sh., 2014; Potapskyi, Y.V., 2015; Khareba, V.V. & Komar, O.O., 2017). Breeding is equally important for product quality. The concept of quality includes various properties, starting from the biochemical composition, which determines the nutritional value, taste properties, and transportability, suitability for storage (Cherkasova, V.K. & Shabetya, O.N., 2014).

Parsnip, as an object of breeding, are characterised by narrow genetic diversity and lower genetic variation in comparison with other root crops (Fedorova, M.I. *et al.*, 2017) Varietal populations and hybrids F_1 of parsnip must have a number of mandatory characteristics, such as high and stable yield of root crops and seeds, improved product quality, good suitability for storage, cold resistance, suitability for mechanised harvesting, high resistance to adverse environmental conditions (Fedorova, M.I. & Stepanov, V.A., 2017; Sokolova, D.V., 2018).

Thus, the most effective and profitable is the widespread introduction of varieties and hybrids with a genetically determined level of adaptation to soilclimatic zones of their cultivation (Komar, O.O. *et al.*, 2020)

The purpose of the study is the selection of the most adapted, high-yielding varieties of parsnip with a high content of basic biochemical components.

MATERIALS AND METHODS

Experimental studies were conducted during 2015-2019 in the field experiment of the Department of Vegetable Crops in the EL "Fruit and vegetable garden" of the National University of Life and Environmental Sciences of Ukraine in the conditions of the Right-Bank Forest-Steppe of Ukraine. The soil of the experimental site is turf-medium-podzolic, coarse-dusty, light loamy. Humus content – 1.8%, total absorbed bases – 6.43 mgEq/100 g of soil, content of easily hydrolysed nitrogen – 42.1 mg/kg, mobile phosphorus – 52 mg/kg, and potassium – 41 mg/kg. The reaction of the soil medium is close to neutral (pH of the salt extract is 6.1).

The following varieties were studied: Petryk (control), Stymul, Borys, and Pul's. The size of the accounting experimental plot was 11.3 m^2, the repetition is fourfold. Variants in the experiment were placed systematically. The predecessor for parsnip was cucumber. Sowing was carried out in the second decade of April according to the 45x10 cm scheme to a depth of 1.52 cm with a seeding rate of 3 kg/ha. In the phase of two true leaves, the final density of plants was formed.

RESULTS

It was established that commercial products of parsnip were formed in the conditions of the Right-Bank Forest-Steppe of Ukraine during the growth period of shootstechnical ripeness during 2015-2019 within the sum of effective temperatures of 13561495°C, precipitation amounts of 171318 mm, and relative humidity of 5764%. The yield value had an inverse relationship with the sum of temperatures and a direct relationship with the amount of precipitation, relative humidity, and hydrothermal coefficient. An increase in the sum of effective temperatures by 1°C provided a decrease in yield in the Borys variety by 6.0 kg, Stymul – 6.3 kg, Pul's – 7.2 kg with a control indicator of 10.5 kg. An increase in the amount of precipitation by 1 mm contributed to an increase in yields in the Stymul variety by 12.2 kg, Borys – 9.1 kg, and Pul's – 8.5 kg with a control indicator of 11.8 kg. An increase in relative humidity by 1% provided an increase in yield in the Stymul variety by 244 kg, Borys – 171 kg, and Pul's – 130 kg with a control indicator of 199 kg. An increase in the hydrothermal coefficient by 0.1 contributed to an increase in yield in the Stymul variety by 327 kg, Borys – 251 kg, and Pul's – 231 kg with a control indicator of 317 kg.

Varietal characteristics affected biometric indicators in parsnip plants (Table 1). In terms of technical ripeness, the largest number of leaves on the plant (9.6 pcs.) were identified in the Petryk variety (control), and the smallest amount – (8.0 pcs.) in the Borys variety, which is 1.6 pcs. less than the control. In the Stymul and Pul's variety, this indicator was 8.7 and 8.3 pcs., which is 0.9 and 1.3 pcs. less than the control, respectively. The height of the plant in the studied varieties ranged from 53.0 cm to 62.7 cm. However, the plant was higher in the Stymul variety, and lower in the Petryk variety (control).

The largest mass of leaves to the total mass of plants was determined in the Stymul (32.6%) and Pul's (30.5%) varieties, which is 3.9% and 1.8% more than the control, respectively. In the Petryk (control) and Borys varieties, this indicator was 28.7% and 29.1%. The largest length of root crops (28.2 cm) was characteristic of the

Petryk variety (control), while the diameter of root crops was 7.6 cm, and the shape index was 3.72. The smallest length of root crops (23.2 cm) was identified in the Borys variety, while the diameter of root crops was 6.8 cm, and the shape index was 3.42.

Table 1. Biometric indicators of parsnip plants in the technical ripeness phase (average for 2015-2019)

Indicator	Variety			
	Petryk (c)*	Stymul	Borys	Pul's
Number of leaves, pcs.	9.6	8.7	8.0	8.3
Plant height, cm	53.0	62.7	55.4	57.6
Leaf weight, g	73	102	78	90
Leaf weight (% of total plant weight)	28.7	32.6	29.1	30.5
Root crop length, cm	28.2	26.5	23.2	24.7
Diameter of root vegetables, cm	7.6	8.5	6.8	9.4
Form index	3.72	3.10	3.42	2.63
Marketability of root vegetables, %	81	89	86	88
Weight of root vegetables, g	181	210	190	205

Note: (c)* – control

Stymul and Pul's varieties were characterised by the highest weight and marketability of root crops, which is 29 g and 24 g, respectively, and 8.0% and 7.0% more than the control.

A substantial amount of dry matter was accumulated in the varieties under study – 24.725.4% (Table 2). Root crops of the Petryk variety (control) accumulated the most dry matter – 25.4%. Borys root crops were characterised by a high dry matter content (25.1%), which is within the control range. The content of dry solute in the varieties under study ranged from 14.4% to 16.5%. The highest sugar content (6.7%) was observed in the Petryk variety (control), and the lowest in the Stymul variety (6.0%). The content of vitamin C in root vegetables was highest in the Petryk variety (control) – 10.1 mg/100 g. Thus, in the Borys, Stymul, and Pul's varieties, the vitamin C content was 8.9 mg/100 g, 9.2 mg/100 g, and 9.6 mg/100 g, respectively, which is substantially less than the control.

Table 2. Main biochemical parameters and tasting assessment of parsnip root crops (average for 2015-2019)

Variety	Content					Tasting score, units
	dry matter, %		sugars (sum), %	vitamin C, mg/100 g	nitrates, mg/kg	
	general	soluble				
Petryk (c)*	25.4	16.5	6.7	10.1	75	4.7
Stymul	24.7	14.4	6.0	9.2	60	5.1
Borys	25.1	15.8	6.4	8.9	80	5.4
Pul's	24.9	15.0	6.1	9.6	67	5.6
HIP_{05}	*0.43*	*0.13*	*0.39*	*0.37*	*2.31*	

Note: (c)* – control

Among the safety indicators of fresh vegetable products, special attention is paid to the content of nitrates in them. At the same time, the presence of nitrates in the plant and their accumulation in food organs is a biological necessity for the nutrition and photosynthetic activity of plants.

Parsnip roots of the Stymul variety were characterised by the lowest nitrate content – 60 mg/kg, the Borys variety had the highest (80 mg/kg). The nitrate content in the varieties under study was below the maximum allowable level (MAL 250 mg/kg). According to organoleptic parameters, the best among the studied assortment was the Pul's variety, which received the highest score of 5.6 points during the tasting. The Petryk (control), Stymul, and Borys varieties also scored a high tasting score of 4.7, 5.1, and 5.4 points, respectively.

A substantial variation in the yield of parsnip by year (2015-2019) was identified in the Stymul and Petryk varieties. Over the years of research, it was 8.6% or 4.2 t/ha and 6.3% or 2.6 t/ha, respectively. In the Pul's and Borys varieties, this indicator reached 5.6% or 2.6 t/ha and 5.3% or 2.3 t/ha, respectively (Table 3).

Table 3. Parameters of adaptive capacity, ecological stability, and plasticity of parsnip varieties by yield (average for 2015-2019)

Variety	Yield, t/ha			Variation range (v), t/ha	Adaptive ability		Stability (Sgi)	Plasticity (bi), %	Breeding value (BVGi)
	min	max	$\bar{X}$		GAA (Vi)	SAA (CACi)			
Petryk (c)*	38.4	41.0	39.6	2.6	-3.42	0.65	2.03	0.81	22.6
Stymul	44.7	48.9	46.2	4.2	3.12	2.52	3.43	1.47	46.2
Borys	40.8	43.1	41.6	2.3	-1.45	0.71	2.03	0.83	41.6
Pul's	43.9	46.5	44.8	2.6	1.76	0.78	1.96	0.89	44.8
HIP_{05}			2.62						

Note: (c)* – control

During 2015-2019, a substantial difference in yield was identified in Stymul (46.2 t/ha) and Pul's (44.8 t/ha) varieties, which is 6.6 t/ha or 16.7% and 5.2 t/ha or 13.1% more than the control, respectively. The yield of the Borys variety was at the control level and amounted to 41.6 t/ha.

The Stymul (GAA = 3.12) and Pul's (GAA = 1.76) varieties were characterised by the highest general adaptive ability (GAA), reflecting the preservation of genotype traits under various environmental conditions. The lowest GAA is noted in the varieties Borys (GAA = 1.45) and Petryk (control) (GAA = 3.42).

According to the indicator of specific adaptive ability (SAA), which indicates the plasticity of the variety, i.e. adaptability to individual conditions, the Stymul (SAA = 2.52) and Pul's (SAA = 0.78) varieties had better stability. The worst varieties in this parameter were Borys (SAA = 0.71) and Petryk (control) (SAA = 0.65).

The relative stability index ranged from 1.96 to 3.43. Thus, all the varieties of parsnip under

study can be attributed to a highly stable group. It was identified that the Petryk (control) and Borys varieties had the lowest sensitivity to growing conditions. Thus, with an increase in the average yield level by 1 t/ha, the increase in root crops was 0.81 and 0.83 t/ha, respectively. The changes in the growing conditions affected the Stymul and Pul's varieties the most (with an increase in the average yield level by 1 t/ha, the increase in root crops was 1.47 and 0.89 t/ha, respectively).

By BVG_i indicator, the best in descending order were parsnip varieties of seed Stymul, Pul's, Borys, and Petryk (control).

CONCLUSIONS

It is recommended to grow highly productive varieties of parsnip – Stymul and Pul's to obtain a consistently high yield of root crops (44.846.2 t/ha) and their marketability at the level of 8889% with a high content of basic biochemical components in the conditions of the Right-Bank Forest-Steppe of Ukraine on medium-podzolic coarse-pollinated light loamy turf soil. In connection with the forecast of experts on climate aridification, it is promising to create varieties that are comprehensively resistant to drought, extreme temperatures, acidity, salinity, and other environmental stress factors.

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Оцінка сортів пастернаку (*Pastinaca sativa* L.) за продуктивністю та адаптивністю в умовах Правобережного Лісостепу України

Анотація. Товарна продукція пастернаку формувалася в умовах Правобережного Лісостепу України в межах суми ефективних температур 1356 1495 °С, кількості опадів 171 318 мм та відносної вологості повітря 57 64%. Величина врожайності мала обернену залежність від суми температур і пряму залежність від кількості опадів, відносної вологості повітря та гідротермічного коефіцієнта. Найвищу врожайність в умовах Правобережного Лісостепу України забезпечили сорти Стимул і Пульс із загальною врожайністю 46,2 і 44,8 т/га та товарністю коренеплодів 89 і 88% відповідно. Сорти Пульс і Стимул мали найвищу селекційну цінність генотипу за врожайністю (BVGi = 46,2 і 44,8 відповідно), високу екологічну стабільність (Sgi = 3,43 і 1,96 відповідно) та пластичність (bi = 1,47 і 0,89% відповідно). Найвищий показник загальної адаптивної здатності за продуктивністю рослин спостерігався у сортів Стимул (GAA = 3,12) та Пульс (GAA = 1,76). За показником специфічної адаптивної здатності виділилися сорти Стимул (SAA = 2,52) та Пульс (SAA = 0,78). За біохімічним складом коренеплодів досліджувані сорти не перевищували контроль. Проте у сорту Борис вміст сухої речовини – 25,1%, сухих розчинних речовин – 15,8% та цукрів – 6,4% був на рівні контролю. Всі сорти характеризувалися високим вмістом вітаміну С – 8,9 10,1 мг/100 г. Сорти не були схильні до накопичення нітратів, їх вміст коливався від 67 до 80 мг/кг і був нижчим за максимально допустимий рівень (МДР 250 мг/кг). Найвищу дегустаційну оцінку 5,6 бала отримав сорт Пульс. Рекомендовано вирощувати високопродуктивні сорти пастернаку – Стимул і Пульс для отримання стабільно високої врожайності коренеплодів (44,8 46,2 т/га) та їх товарності на рівні 88 89% з високим вмістом основних біохімічних компонентів в умовах Правобережного Лісостепу України на середньопідзолистому крупнопилуватому легкосуглинковому дерновому ґрунті

Ключові слова: урожайність, показники якості, стабільність, пластичність, селекційна цінність генотипу