UDC 635.656:631.527 https://doi.org/10.21498/2518-1017.18.1.2022.257584

Characteristics of introduced varieties of pea (*Pisum sativum* L.) in the zone of the Southern Forest-Steppe of Ukraine

S. M. Kholod[1*], N. V. Kuzmyshyna[2], V. M. Kirian[1], O. V. Tryhub[1]

*[1]Ustymivka Experimental Station of Plant Production of Plant Production Institute nd. a. V. Ya. Yuriev, NAAS of Ukraine, 15 Akademika Vavilova St., Ustymivka, Hlobyno district, Poltava region, 39074, Ukraine, *e-mail: svitlanakholod77@ukr.net*
[2]Plant Production Institute nd. a. V. Ya. Yuriev, NAAS of Ukraine, National Center for Plant Genetic Resources of Ukraine, 142 Moskovskyi Ave., Kharkiv, 61060, Ukraine, e-mail: ncpgru@gmail.com

Aim. To assess new introduced varieties of pea (*Pisum sativum* L.) of different ecological and geographical origin in conditions of the Southern part of the Forest-Steppe of Ukraine according to a set of productivity and adaptability indicators. **Methods.** During 2018–2020 in the conditions of Ustymivka Experimental Station of Plant Production of the Plant Production Institute named after V. Ya. Yuriev of NAAS of Ukraine (Poltava region, 49°18′21″N, 33°13′56″E) 30 new pea samples originating from Belarus, Azerbaijan, Canada, Poland and the Netherlands were studied. In the ripening phase of pods and seeds (BBCH 86–90) in field and laboratory conditions yields, productivity, 1000 beans weight, early-ripening, plant height and height of attachment of the lower pods above the soil level, number of nodes to the first pod and their total number per plant, number of pods and seeds per plant, number of seeds per pod, pod parameters were studied. **Results.** As a result of studying new samples of pea, the range of variation of their yield from 200.5 to 300.0 g/m^2 was established, while the varieties 'Aleks', 'Atlant', 'Minskiy ovoschnoy' (Belarus), 'Fidan' (Azerbaijan), 'Dacota' (Canada), 'Angela' (Netherlands) were more productive, in which the mass of grain from the plant exceeded 10.0 g. The productivity of the plant was high due to both the increased number of seeds and the weight of 1000 grains. Almost all the studied samples were medium-ripe (71–80 days) and are optimal for the Southern Forest-Steppe zone of Ukraine. The most early maturing (64–69 days) were the Belarusian varieties 'Yan', 'Gontso', 'Gorynets', 'Alfa', 'Pryvabny', 'Malyish' and the Dutch 'Angela' variety. The lowest varieties were Belarusian varieties – 'Gorynets', 'Vlad', 'Alfa', 'Atlant' and others (31.0–60.0 cm), which can be used as sources on this basis. Special attention should be paid to varieties that combine several valuable features: 'Aleks', 'Atlant', 'Minskiy ovoschnoy', 'Korelicheskiy ovoschnoy', 'Slodyich', 'Malyish', 'Kosmay', 'Kelvidon' (Belarus), 'Fidan' (Azerbaijan), 'Jof' (Poland), 'CDC Limerick' (Canada), 'Orix' (Spain). **Conclusions.** The above varieties can be recommended as sources of valuable traits for practical use in breeding, and they are suitable for cultivation in the Southern Forest-Steppe, subject to inclusion in the State Register of plant varieties suitable for distribution in Ukraine.

Keywords: *pea; samples; valuable economic characters; productivity*.

Introduction

One of the priority components of breeding programs is the use of source material of both domestic and foreign origin, which genetic diversity is of practical value in creating new varieties. Therefore, plant breeding should be developed in the direction of increasing productivity, improving product quality, increasing the adaptive properties of varieties and hybrids to environmental conditions, their stability and plasticity, as well as resistance to diseases, pests and other stress factors [1, 2]. Successful breeding of leguminous crops is based on the use of original material with a wide genetic diversity of sources of economic and biological traits and properties. But without an introduction, it is impossible to create a high-grade collection of specimens. Foreign samples are often characterized by a difference in the genetic determination of valuable traits, which is the basis for the formation of transgressive forms when used as parental forms in hybridization with domestic ones [3, 4]. That is why it is necessary to purposefully carry out the introduction from other countries [5, 6].

Pea (*Pisum sativum* L.) is one of the most important leguminous crops in the world and has a variety of uses [7]. In Ukraine, pea is the most productive leguminous crop, an important source of vegetable protein [8], contains a number of macro- and microelements, as well as vitamins, such as ascorbic acid, PP, A, choline (B4), inositol (B8) and others [9]. It has a balanced amino acid composition, high palatability and digestibility, and is a valuable dietary product [10–12]. Due to its ability to sym-

Svitlana Kholod
http://orcid.org/0000-0002-2443-0879
Nataliia Kuzmyshyna
http://orcid.org/0000-0001-8046-1760
Viktor Kirian
http://orcid.org/0000-0001-8730-8507
Oleg Tryhub
http://orcid.org/0000-0003-3346-9828

biotic nitrogen fixation with the help of rhizobia, pea is one of the best predecessors for cereals and other crops [13, 14].

The main task of pea breeding at the present stage is to create a stable pipeline of varieties with different ripening periods (from ultra-early to late conveyor), with high yields and product quality, resistance to pests, diseases and environmental plasticity. Therefore, in order to enrich the diversity of pea collection of genetic resources, the introduction of the varieties that are carriers of valuable sources is carried out.

The aim of the research is to evaluate new varieties of pea of different ecological and geographical origin in the conditions of the southern part of the Forest-Steppe of Ukraine according to a set of indicators of productivity and adaptability.

Materials and methods

Field and laboratory studies were carried out in the introduction-quarantine nursery of Ustymivka Experimental Station of Plant Production (UESPP) of the Plant Production Institute named after V. Ya. Yuriev NAAS of Ukraine during 2018–2020 (Ustymivka village, Kremenchuk district, Poltava region – location 49°18′21″N, 33°13′56″E, 94 m above sea level).

The research material was 30 varieties of peas (*Pisum sativum* L.) originating from six countries: Belarus, Azerbaijan, Canada, Poland, Spain and the Netherlands. Sowing was carried out manually in two repetitions at the optimal time for peas (I–II decade of April). Five-row plots with a row spacing of 0.20 m, an area of 1.0 m^2. The standard was placed through 20 numbers. The predecessor was a fellow land. Crop care was manual weeding.

During the growing season, the samples were observed and described. During the vegetation of plants, the following phenological phases of pea development were recorded: seedlings (BBCH 09), beginning of flowering (BBCH 61), full flowering (BBCH 65), fruiting (BBCH 71), and full ripeness (BBCH 89). In the phase of mass flowering, the color of the flowers was noted, and disease damage of the plant was scored by a 9-point scale. In the phase of full ripeness (BBCH 97) under field conditions, the resistance of plants to lodging was determined, the height of plants and the height of attachment of the lower bean above the soil were measured. A crop was harvested by hand. After structural analysis, the sheaves were threshed. Under laboratory conditions, a structural analysis was carried out according to the following quantitative characteristics: the number of nodes up to the first pod and their total number on the plant, the number of pods per plant, the number of seeds per plant and seeds per pod, based on the gradations of the wide unified classifier of CMEA and the international CMEA classifier of the genus *Pisum* L. [15], methods for conducting an examination of plant varieties of the group of legumes and cereals for distinctness, uniformity and stability [16] and a training manual Identification of signs of leguminous crops (peas, soybeans) [17]. Mathematical processing of the obtained results was performed using the analysis of variance of a single-factor field experiment. For statistical processing of research results and determination of the reliability of the obtained experimental data, a package of standard programs (Microsoft Excel) was used.

The meteorological conditions prevailing during the growing season at the period of material investigation allowed us to analyze the introduced variety samples for adaptability to the conditions of the Southern Forest-Steppe and evaluate them according to economically valuable indicators.

Spring-summer (April-July) pea growing season 2018–2020 was characterized by contrasting hydrothermal parameters, especially the amount and distribution of precipitation during the growing season of pea plants. The average daily temperature during pea growing season was 20.1 °C (2018), 19.8 °C (2019), 18.7 °C (2020), multi-year indicator was 16.3 °C, the amount of precipitation – 69.9 mm; 208.8 mm and 136.2 mm respectively. The weather conditions of 2019 during the growing season were the most favorable for the growth and development of pea plants. In the period of sowing-seedling 2018–2020 the average daily temperature was at the level of 11.7 °C. The amount of precipitation in 2018 was 9.4 mm, in 2019 – 26.0, in 2020 – 3.3 mm. In the seedling-flowering phase, the average daily temperature in 2018 was 19.3 °C, in 2019 – 16.6 °C, in 2020 – 14.2 °C at a norm of 15.9 °C, the amount of precipitation – 31.3 mm; 159.6 and 110.5 mm respectively. This allowed pea plants to form a good vegetative mass and a full-fledged ovary. During the grainfilling period, the average temperature in 2018 was 22.8 °C, in 2019 – 23.5 °C, in 2020 – 24.8 °C. The amount of precipitation during this period in 2018 was less than the norm by 10.8 mm, in 2019 it was 68.3 mm, in 2020 – 43.1 mm (according to the UESPP meteorological post).

Results and discussion

Based on the results of the study, approbation and morphological features of each pea variety were revealed (Table 1).

The duration of the growing season is an important biological property of plants, determined by both genetic characteristics and environmental factors. According to scientific data, the duration of the growing season is

Table 1

Assessment of introduced samples of pea varieties by morphological features

Name of the variety sample	Country of origin	Seed		Leaf type	Flower color
		coloring	shape		
'Adagumskiy', St	Russia	yellow-green	wrinkled	with tendril	white
'Gorynets'	Belarus	yellow	wrinkled	with tendril	white
'Aleks'	Belarus	green	wrinkled	with tendril	white
'Yan'	Belarus	yellow-green	wrinkled	common	white
'Vlad'	Belarus	yellow-green	wrinkled	common	white
'Malysh'	Belarus	green	wrinkled	common	white
'Alfa'	Belarus	green	wrinkled	common	white
'Atlant'	Belarus	green	wrinkled	common	white
'Gontso'	Belarus	light yellow	wrinkled	with tendril	white
'Zazerskiy ovoshchnoy'	Belarus	yellow	wrinkled	common	white
'Kelvidon'	Belarus	yellow-green	wrinkled	common	white
'Kosmay'	Belarus	yellow-green	wrinkled	common	white
'Slodych'	Belarus	green	wrinkled	common	white
'Nemiga'	Belarus	green	wrinkled	common	white
'Korelicheskiy ovoshchnoy'	Belarus	yellow	wrinkled	common	white
'Syabruk'	Belarus	yellow-green	wrinkled	common	white
'Pryvabny'	Belarus	light yellow	wrinkled	with tendril	white
'Minskiy ovoshchnoy'	Belarus	emerald	wrinkled	common	white
'Kuyavyak'	Belarus	green	wrinkled	common	white
'ROS-1'	Belarus	gray-green	wrinkled	common	white
'Fidan'	Azerbaijan	yellow-green	wrinkled	common	white
'Jof'	Poland	emerald	wrinkled	common	white
'CDC Dacota'	Canada	green	wrinkled	common	white
'CDC Striker'	Canada	emerald	wrinkled	with tendril	white
'CDC Raezer'	Canada	yellow	wrinkled	with tendril	white
'CDC Limerick'	Canada	yellow-green	wrinkled	with tendril	white
'Angela'	Netherlands	yellow	wrinkled	with tendril	white
'Orix'	Spain	yellow-green	wrinkled	common	white
'Lay'	Spain	yellow-green	wrinkled	common	white
'Mitra'	Spain	yellow-green	wrinkled	common	white
'Gerion'	Spain	yellow-green	wrinkled	common	white

70% determined by the hereditary characteristics of the variety, and only 30% by external factors [18]. The length of the growing season and the duration of the origin of individual phenological phases is very important when selecting pairs for crossing and in the process of working with hybrid and breeding material, since early maturing varieties ensure timely collection, obtaining full-fledged, high-quality seed material [19]. The flowering time was determined in the phase of the beginning of flowering, when 25% of pea plants have at least one flower. For the studied pea varieties, the duration of the growing season ranged from 64 to 84 days (Table 2). Almost all studied samples turned out to be mid-ripening (71–80 days) and optimal for the Southern Forest-Steppe zone of Ukraine. The most early maturing (64–69 days) were the Belarusian varieties 'Jan', 'Gontso', 'Gorynets', 'Alfa', 'Pryvabny', 'Malysh' and Dutch variety 'Angela'. In the structure of the growing season, an average of 13 days falls on the period of sowing-seedling, 41 days – seedling-flowering and 31 days – for the period of flowering-ripening. The variation in the duration of interphase periods was weak or medium. In particular, the coefficient of variation for the duration of the flowering-ripening period was 6.5%, for the duration of sowing-seedling and seedling-flowering – 13.7–14.7%. The shortest sowing-sprouting period (10 days) was revealed in eight varieties 'Yan', 'Alfa', 'Korelicheskiy ovoshchnoy', 'Syabruk', 'Kuyavyak', 'ROS-1' (Belarus), 'Fidan' (Azerbaijan), 'Jof' (Poland). For 18 studied varieties, the appearance of total number of seedlings was recorded on the 13–14th day. The shortest sprouting-flowering

period (32–35 days) was recorded in the Belarusian varieties 'Yan', 'Malysh', 'Alpha', 'Gontso', 'Kosmay', 'Nemiga', 'Kuyavyak', Polish variety 'Jof' and Dutch variety 'Angela'.

Table 2

Assessment of samples of pea varieties by duration and structure of the growing season (mean for 2018–2020)

Name of the variety sample	Duration of interphase periods, days			Duration of vegetation period, days
	sowing-seedlings	seedlings-flowering	flowering-ripening*	
'Adagumskiy', St	13	40	33	75
'Gorynets'	14	39	30	68
'Aleks'	14	41	30	76
'Yan'	10	32	33	65
'Vlad'	14	40	30	78
'Malysh'	14	33	30	64
'Alfa'	10	33	33	65
'Atlant'	14	41	30	84
'Gontso'	14	35	31	65
'Zazerskiy ovoshchnoy'	14	38	33	73
'Kelvidon'	14	37	33	72
'Kosmay'	14	35	30	74
'Slodych'	14	39	29	75
'Nemiga'	14	34	32	72
'Korelicheskiy ovoshchnoy'	10	49	29	75
'Syabruk'	10	41	29	77
'Pryvabny'	14	38	31	69
'Minskiy ovoshchnoy'	14	39	31	75
'Kuyavyak'	10	33	30	71
'ROS-1'	10	36	30	84
'Fidan'	10	41	37	78
'Jof'	10	34	32	81
'CDC Dacota'	14	45	31	75
'CDC Striker'	12	40	29	76
'CDC Raezer'	12	41	30	77
'CDC Limerick'	12	49	30	84
'Angela'	12	30	35	69
'Orix'	13	49	27	79
'Lay'	13	49	29	78
'Mitra'	13	48	30	75
'Gerion'	13	48	30	82
X	12.5	39.4	30.6	74.3
min	10	29.5	27	64
max	14	49.0	37	84
R (max–min)	4.0	19.5	10	20
V, %	13.7	14.7	6.5	7.6

*maturation of at least 70% of the pods on the plant.

Note. X, min, max – average, minimum and maximum values, respectively; R (max–min) – range of variation; V – the coefficient of variation.

Samples of pea varieties were studied in terms of plant height, the height of attachment of the lower pods above the soil level, the number of nodes to the first bean and their total number on the plant. Table 3 shows that pea varieties differ in plant height, which averaged from 37.7 ('Mitra', Spain) to 122.5 cm ('Fidan', Azerbaijan). Variety 'Fidan' (Azerbaijan) – (101.0–160.0 cm) was tall, Belarusian varieties – 'Gorynets', 'Vlad', 'Alpha', 'Atlant', 'Gontso', 'Kelvidon', 'Kosmay', 'Slodych', 'Korelicheskiy ovoshchnoy', 'Syabruk', 'Pryvabny', 'Kuyavyak' – 31.0–60.0 cm were undersized. The remaining 14 varieties are medium-sized (61.0–100.0 cm). Low-growing varieties can be used as sources of lodging resistance [19]. The coefficient of variation in plant height was 23.1%, the range of variation was 84.8 cm.

An important feature that determines the suitability of a variety for mechanized harvesting is the height of attachment of the lower pod. Yield losses in varieties with low pod attachment at harvest can range from 3 to 20%. They can be reduced by using varieties suitable for mechanized harvesting, that is, with a high attachment of lower pods [20]. The forma-

Table 3

Assessment of samples of pea varieties by plant height and number of nodes (mean for 2018–2020)

Name of the variety sample	Plant height, cm	Height of attachment of the lower bean above the ground, cm	Number of nodes, pcs.	
			to the first production node	total
'Adagumskiy', St	75.0	49.0	13.0	21.0
'Gorynets'	53.7	39.6	12.8	17.8
'Aleks'	66.7	42.3	12.9	22.0
'Yan'	66.5	42.9	12.9	20.0
'Vlad'	54.9	33.1	13.4	18.2
'Malysh'	73.0	36.8	12.5	19.4
'Alfa'	51.3	33.1	10.0	17.7
'Atlant'	58.8	44.0	10.9	23.7
'Gontso'	59.2	33.6	11.2	16.7
'Zazerskiy ovoshchnoy'	67.6	34.1	11.1	18.0
'Kelvidon'	48.2	22.6	8.6	15.2
'Kosmay'	54.7	35.5	11.3	17.8
'Slodych'	53.1	27.1	13.4	23.6
'Nemiga'	66.4	43.5	14.1	19.2
'Korelicheskiy ovoshchnoy'	59.7	45.1	14.1	22.0
'Syabruk'	48.9	30.5	12.9	17.1
'Pryvabny'	56.6	38.7	12.3	18.1
'Minskiy ovoshchnoy'	61.4	39.3	8.7	17.2
'Kuyavyak'	53.5	36.2	7.6	17.2
'ROS-1'	66.8	35.9	8.1	23.1
'Fidan'	122.5	61.0	25.0	30.0
'Jof'	78.4	23.1	10.9	19.7
'CDC Dacota'	69.1	42.4	9.1	19.5
'CDC Striker'	58.2	44.9	13.8	14.8
'CDC Raezer'	60.7	35.3	11.2	20.9
'CDC Limerick'	68.2	51.3	10.1	20.7
'Angela'	60.6	29.5	9.6	14.7
'Orix'	61.5	38.0	8.3	10.4
'Lay'	65.1	50.4	6.8	10.9
'Mitra'	37.7	22.8	6.5	15.6
'Gerion'	47.6	32.7	11.5	16.5
X	61.7	37.5	11.3	18.4
min	37.7	22.6	6.5	10.3
max	122.5	61	25	30
R (max–min)	84.8	38.4	18.5	19.6
V, %	23.1	23.0	29.8	22.3

tion of this sign depends on weather conditions. It is clear that in dry years, the attachment of beans is higher, in wet years, on the contrary, lower. With late sowing periods or with an increase in the area of plant nutrition, the height of attachment of the lower pod significantly decreases [21]. The height of attachment of the lower pod on average over the years of study ranged from 22.6 cm ('Kelvidon', Belarus) to 61.0 cm ('Fidan', Azerbaijan), a high variability of the trait was observed (coefficient of variation – 23.0%).

The number of unproductive nodes to the first productive node and the total number of nodes per plant averaged 11.3 and 18.3 pcs. respectively. Varieties with the least number of unproductive nodes were stunted and had a shorter growing season. The least number of unproductive nodes up to the first productive one (9.0–11.0 pieces) had ten pea varieties – 'Kosmay', 'Kuyavyak', 'ROS-1', 'Minskiy ovoshchnoy', 'Alfa' (Belarus), 'CDC Dacota' (Canada), 'Angela' (Netherlands), 'Orix', 'Lay', 'Mitra' (Spain). The largest number of unproductive nodes to the first productive one (20–30 psc.) was noted in 'Atlant', 'Slodych', 'Aleks', 'Korelicheskiy ovoshchnoy' (Belarus), 'Fidan' (Azerbaijan), 'CDC Raezer', 'CDC Limerick' (Canada). The coefficient of variation by the number of unproductive nodes to the first productive one was 29.8%, by the total number of nodes per plant – 22.3%.

Productivity is one of the most important characteristics that determines the economic value of a variety. We analyzed such elements of the structure of the pea yield as the number of pods and seeds per plant, the number of seeds per pod, the parameters of a pod, the weight of seeds from the plant, and the weight of 1000 seeds (Table 4).

Table 4

Assessment of samples of pea varieties by elements of productivity structure (mean for 2018–2020)

Name of the variety sample	Number of pods per plant, pcs.	Number of seeds, pcs.		Bean size, cm		Weight of seeds per plant, g	Weight of 1000 seeds, g
		per plant	per pod	length	width		
'Adagumskiy', St	8.5	40.0	7.0	6.5	1.5	8.32	227
'Gorynets'	7.2	42.5	6.4	7.1	1.6	6.42	209
'Aleks'	10.6	48.1	6.4	7.1	1.6	10.74	202
'Yan'	9.7	41.2	7.2	8.3	1.6	7.46	194
'Vlad'	8.5	36.3	6.0	7.8	1.5	7.30	169
'Malysh'	12.3	56.6	6.7	5.4	1.0	5.21	102
'Alfa'	8.2	36.2	6.6	7.7	1.4	6.31	177
'Atlant'	9.6	61.3	7.6	7.2	1.5	10.43	166
'Gontso'	7.8	57.8	7.3	7.2	1.4	4.87	132
'Zazerskiy ovoshchnoy'	9.0	35.1	7.0	8.1	1.4	7.91	181
'Kelvidon'	9.8	51.6	7.1	7.3	1.4	6.19	155
'Kosmay'	9.7	53.0	7.2	8.4	1.3	7.88	158
'Slodych'	9.6	56.7	7.9	7.2	1.5	8.08	195
'Nemiga'	8.2	42.0	7.7	7.2	1.5	6.70	201
'Korelicheskiy ovoshchnoy'	12.4	60.4	6.0	6.4	1.3	8.10	184
'Syabruk'	8.2	50.8	6.3	6.3	1.4	6.75	170
'Pryvabny'	8.4	38.1	7.3	7.4	1.5	6.23	168
'Minskiy ovoshchnoy'	13.3	69.5	6.3	8.0	1.5	10.55	191
'Kuyavyak'	9.8	24.6	7.0	6.7	1.5	5.46	197
'ROS-1'	8.8	27.4	7.5	6.9	1.5	4.56	195
'Fidan'	14.7	75.5	7.4	9.0	1.5	12.35	224
'Jof'	11.3	74.5	5.6	7.7	1.5	7.65	169
'CDC Dacota'	8.6	33.8	5.8	6.0	1.3	11.34	161
'CDC Striker'	7.3	29.4	5.5	6.4	1.3	3.90	174
'CDC Raezer'	8.0	61.2	6.0	7.5	1.5	8.04	173
'CDC Limerick'	10.4	51.8	6.6	7.4	1.5	6.85	174
'Angela'	9.5	44.5	6.0	7.0	1.5	9.45	176
'Orix'	10.0	48.5	6.9	6.9	1.0	6.89	145
'Lay'	5.4	24.9	4.8	5.5	1.5	3.56	215
'Mitra'	9.3	25.6	6.0	5.5	1.0	4.19	169
'Gerion'	9.2	47.8	7.1	6.1	1.0	4.95	158
X	9.5	46.9	6.6	7.1	1.4	7.2	176
min	5.4	24.6	4.8	5.4	1.0	3.6	102
max	14.7	75.5	7.9	9.0	1.6	12.3	224
R (max–min)	9.3	50.9	3.1	3.7	0.6	8.8	121.1
V, %	20.0	31.2	11.2	12.6	13.0	31.4	14.1

The number of pods per plant is a trait that is largely influenced by environmental factors and is determined by varietal characteristics only by 45% [22]. Over the years of study, under the influence of various conditions, the number of pods per plant in introduced pea varieties ranged from 5.4 ('Lay', Spain) to 14.7 pieces 'Fidan', Azerbaijan), the range of variation was 9.3 pcs., the variability of the indicator is average (the coefficient of variation is 20.0%). According to this indicator, 20 samples (66.7%) had an average number of pods per plant – 8.0–10.0 pcs. A significant number of pods per plant (more than 10.1 pieces) had seven varieties of pea or 23.3% of their total number. Some samples were characterized by a rather high number of pods per plant – more than 12.0 pcs. Varieties: 'Malysh', 'Korelicheskiy ovoshchnoy', 'Minskiy ovoshchnoy' (Belarus), 'Fidan' (Azerbaijan) are among them.

The number of seeds per plant is the most important indicator of variety evaluation; it depends on genetic characteristics, external factors, and other factors and is determined by the number of productive nodes, pods per productive node, and seeds per pod. The number of seeds per plant is the most variable trait. The reproductive ability of a plant, determined by the number of seeds per plant, is the main trait that provides the selective advantage of the genotype. The number of seeds per plant is derived from the number of pods per plant and the number of seeds per pod [23]. The number of seeds per plant on average over the years of study ranged from 24.6 ('Kuyavyak', Belarus) to 75.5 pcs. ('Fidan', Azerbaijan), the range of variation was 50.9 psc., a high variability of the indicator was observed (variation coefficient – 31.2%). The largest number of seeds per plant was produced by varieties 'Fidan' – 75.5 pcs. (Azerbaijan), 'Jof' – 74.5 (Poland),

'Minskiy ovoshchnoy' – 69.5, 'Atlant' – 61.3, 'Korelicheskiy ovoshchnoy' – 60.4, 'Gontso' – 57.8, 'Slodych' – 56.7, 'Malysh' – 56.6, 'Kosmai' – 53.0 (Belarus), 'CDC Raezer' – 61.2, 'CDC Limerick' – 51.8 pcs. (Canada).

In the formation of pea productivity the number of seeds per pod is of great importance, which, in turn, depends on the number of seed buds laid in the ovary. It was revealed that from 4 to 12 seeds are laid in the seed germ [23]. The number of seeds in a pod in introduced pea cultivars varied from 4.8 ('Lay', Spain) to 7.9 pcs. ('Slodych', Belarus); an average of 6.6 pcs. per pod. The highest number of seeds (more than 7.0 pieces) was noted in the varieties 'Fidan' (Azerbaijan), 'Yan', 'Atlant', 'Gontso', 'Kelvidon', 'Kosmay', 'Slodych', 'Nemiga', 'Pryvabny', 'ROS-1' (Belarus), 'Gerion' (Spain), and the smallest (4.8–5.8 pcs.) – in varieties 'Lay' (Spain), 'CDC Dacota', 'CDC Striker' (Canada). The range of variation was 3.1 psc., a weak coefficient of variation was 11.2%.

The average pod length over the years of study ranged from 5.4 ('Malysh', Belarus) to 9.0 cm ('Fidan', Azerbaijan), the range of variation was 3.7 cm, there was a slight variability (coefficient of variation – 12.6%). The longest pods were recorded in Belarusian varieties 'Kosmay' (8.4 cm), 'Yan' (8.3 cm), 'Zazerskiy ovoshchnoy' (8.1 cm), 'Minskiy ovoshchnoy' (8.0 cm), 'Vlad' (7.8 cm), 'Alpha' (7.7 cm), Azerbaijani variety 'Fidan' (9.0 cm) and Polish 'Jof' (7.7 cm). The pod width of the new pea varieties averaged 1.4 cm. Fourteen varieties (46.7%) which had a bean width of 1.5 cm were identified. The widest pods were in varieties 'Gorynets', 'Aleks', 'Yan' (Belarus) – 1.6 cm.

Seed productivity of pea plants is one of the most complex traits, due to the interaction of many genes and the influence of soil, climatic and agrotechnical conditions. The productivity of pea plants consists of the following elements of the yield structure: the number of productive nodes per plant, the number of pods per productive node, the number of seeds per pod, and the weight of 1000 seeds [24]. The mass of seed per plant in pea varieties varied from 3.6 ('Lay', Spain) to 12.3 g ('Fidan', Azerbaijan), on average 7.2 g. A big mass of seeds per plant was determined in varieties 'Aleks' – 10.7 g, 'Atlant' – 10.4, 'Minskiy ovoshchnoy' – 10.5 (Belarus), 'Fidan' – 12.3 (Azerbaijan), 'CDC Dacota' – 11.3 (Canada), 'Angela' – 9.4 g (Netherlands), which have a fairly high plant productivity due to a larger number of pods per plant and a weight of 1000 seeds.

The weight of 1000 seeds is one of the most variable elements of pea seed productivity [24]. The average weight of 1000 seeds was 176.0 g, the range of variation was 121.1 g. When studying the material, 24 samples (80%), which had an average weight of 1000 grains (161–260 g) were identified. Varieties 'Fidan' – 224 g (Azerbaijan), 'Lay' – 215 g (Spain), 'Gorynets' – 209 g, 'Aleks' – 202 g, 'Nemiga' – 201 g (Belarus) produced the most by seed weight, and least of all 'Malysh' – 102 g (Belarus).

The potential yield of seeds was determined, that is, the yield that can be obtained with an average productivity and a certain number of plants saved before harvesting. This does not take into account the degree of seed damage by pests. The actual yield was obtained by weighing the mass of seeds obtained from the plot, but at the same time, the seeds affected by diseases and damaged by the pea moth were previously removed from the total mass, that is, the actual yield is the yield of pea seeds after processing [25]. The best results on this indicator were obtained in varieties 'Aleks', 'Atlant', 'Slodych', 'Nemiga', 'Korelicheskiy ovoshchnoy', 'Minskiy ovoshchnoy' (Belarus), 'CDC Dacota' (Canada), 'Fidan' (Azerbaijan), 'Jof' (Poland), 'Angela' (Netherlands), which averaged 200.5–300.0 g/m^2.

Varieties that combine several valuable traits deserve special attention. So, as a result of studying the new introduced material of pea, samples with a high and optimal level of manifestation of signs were identified:

– yield (> 200 g/m^2) (for the standard variety 'Adagumskiy' – 190 g/m^2), the number of beans per plant (> 10.0 pcs.), the number of seeds per plant (> 45.0 pcs.) and plant productivity (> 10.0 g) – 'Aleks', 'Atlant', 'Minskiy ovoshchnoy' (Belarus), 'Fidan' (Azerbaijan);

– yield (> 200 g/m^2) (for the standard variety 'Adagumskiy' – 190 g/m^2), the number of beans per plant (> 10.0 pcs.), the number of seeds per plant (> 45.0 pcs.) – 'Korelicheskiy ovoshchnoy' (Belarus), 'Jof' (Poland);

– number of seeds per plant (> 45.0 pcs.) and number of seeds per pod (> 7.5 pcs.) – 'Slodych' (Belarus);

– the number of pods per plant (> 10.0 pcs.) and the number of seeds per plant (> 45.0 pcs.) – 'Malysh' (Belarus), 'CDC Limerick' (Canada), 'Orix' (Spain);

– number of pods per plant (> 10.0 pcs.), number of seeds per plant (> 45.0 pcs.), number of seeds per pod (> 7.0 pcs.) and pod length (> 8.0 cm) – 'Kosmay', 'Kelvidon' (Belarus).

Conclusions

In the conditions of the southern part of the Forest-Steppe of Ukraine, the studied varieties of pea produced a grain yield from 200.5 to 300.0 g/m^2. An analysis of the average yield

over the years of research shows that the most productive varieties include: 'Aleks', 'Atlant', 'Minskiy ovoshchnoy' (Belarus), 'Fidan' (Azerbaijan), 'Dacota' (Canada), 'Angela' (Netherlands), in which the mass of seed per plant exceeded 10.0 g. Plant productivity indicators were high due to the increased number of seeds and the weight of 1000 seeds. On the basis of a set of characteristics, varieties 'Aleks', 'Atlant', 'Minskiy ovoshchnoy', 'Korelicheskiy ovoshchnoy', 'Slodych', 'Malysh', 'Kosmay', 'Kelvidon' (Belarus), 'Fidan' (Azerbaijan), 'Jof' (Poland), 'CDC Limerick' (Canada), 'Orix' (Spain) were distinguished. The above varieties can be recommended as sources of valuable traits for practical use in breeding, and they are also suitable for cultivation in the Southern Forest-Steppe zone, subject to the inclusion in the State Register of Plant Varieties suitable for distribution in Ukraine.

References

1. Sechniak, V. Yu., & Fait, V. I. (2012). The role of genetic resources and plant introduction in breeding. *Bulletin of Agricultural Science*, *Spec. Iss*., 127–128. [In Ukrainian]
2. Keller, E. R. J., Senula, A., Leunufna, S., & Grübe, M. (2006). Slow growth storage and cryopreservation – tools to facilitate germplasm maintenance of vegetatively propagated crops in living plant collections. *International Journal of Refrigeration*, *29*(3), 411–417. doi: 10.1016/j.ijrefrig.2005.07.0122
3. Kyrychenko, V. V., Riabchun, V. K., & Bohuslavskyi, R. L. (2008). Importance of plant genetic resources for state programs realization. *Plant Genetic Resources*, *5*, 7–13. [In Ukrainian]
4. Kobyzieva, L. N., Bezuhla, O. M., & Bohuslavskyi, R. L. (2010). Enrichment of the National Plant Gene Bank of Ukraine by specimens of the gene pool of legumes of domestic and foreign origin. *Plant Genetic Resources*, *8*, 9–20. [In Ukrainian]
5. Klysha, A. I., Kulinich, O. O., & Khoroshun, I. V. (2010). Results and directions in the selection of leguminous cultures. *Bulletin of the Institute of Grain Farming*, *39*, 27–32. [In Ukrainian]
6. Fernie, A. R., Tadmor, Y., & Zamir, D. (2006). Natural genetic variation for improving crop quality. *Current Opinion in Plant Biology*, *9*(2), 196–202. doi: 10.1016/j.pbi.2006.01.010
7. Voitovska, V. I., Storozhyk, L. I., Liubych, V. V., & Romanov, S. M. (2021). Amino acid content in grain of different winter pea varieties and products of its processing. *Plant Varieties Studying and Protection*, *17*(4), 312–318. doi: 10.21498/2518-1017.17.4.2021.249013 [In Ukrainian]
8. Bezruchko, O. I., & Svynarchuk, O. V. (2012). Replenishment of the market of plant varieties of Ukraine: vegetable peas (*Pisum sativum* L. partim). *Plant Varieties Studying and Protection*, *1*, 48–57. doi: 10.21498/2518-1017.1(15).2012.60208 [In Ukrainian]
9. Sachyvka, T. V., & Bosak, V. N. (2020). Evaluation of varieties of vegetable peas on the main economically valuable sings. *News of Federal Scientific Vegetable Center*, *3–4*, 85–91. doi: 10.18619/2658-4832-2020-3-4-85-91 [In Russian]
10. Kobyzieva, L. N., & Honcharova, O. O. (2013). Collection of the pea varieties – source for the creation of green conveyor. *Bulletin of the Center for Science Provision of Agribusiness in the Kharkiv Region*, *14*, 60–67. [In Ukrainian]
11. Rasskazova, L., & Kirse-Ozolina, A. (2020). Field pea *Pisum sativum* L. as a perspective ingredient for vegan foods: a review. *Research for Rural Development*, *35*, 125–131. doi: 10.22616/rrd.26.2020.019
12. Mardilovich, M. I. (2014). Evaluaton of green pea collection. *Agriculture and Breeding in Belarus*, *50*, 361–375. [In Russian]
13. Didur, I. M., & Mostovenko, V. V. (2019). The influence of technological methods of cultivation on the formation of structural elements of the crop of vegetable peas in the conditions of the right-bank Forest-Steppe. *Agriculture and Forestry*, *15*, 21–29. doi: 10.37128/2476626-2019-4-2 [In Ukrainian]
14. Bosak, V. N., & Sachivko, T. V. (2019). Productivity and features of nitrogen fixation in leguminous vegetable crops. *Agriculture and Plant Protection*, *1*, 21–23. [In Russian]
15. Makasheva, R., Belekhova, K., Korneychuk, V., Lemann, H., & Pavelkova, A. (1981). *Shirokiy unifitsirovannyy klassifikator SEV i mezhdunarodnyy klassifikator SEV roda Pisum L*. [Wide unified classifier of the CMEA and the international classifier of the CMEA of the genus *Pisum* L.]. Leningrad: VIR. [In Russian]
16. Tkachyk, S. O. (Ed.). (2016). *Metodyka provedennia ekspertyzy sortiv roslyn hrupy zernobobovykh ta krupianykh na vidminnist, odnoridnist i stabilnist* [Methods of examination of plant varieties of leguminous plants and cereals for difference, uniformity and stability]. (2rd ed., rev). Vinnytsia: FOP Korzun D. Yu. [In Ukrainian]
17. Kyrychenko, V. V., Kobyzieva, L. N., Petrenkova, V. P., Riabchun, V. K., Bezuhla, O. M., Markova, T. Yu., … Riabukha, S. S. (2009). *Identyfikatsiia oznak zernobobovykh kultur (horokh, soia)* [Identification of characters of leguminous crops (peas, soybean)]. V. V. Kyrychenko (Ed.). Kharkiv: Vydavnytstvo "Kharkiv". [In Ukrainian]
18. Leshchenko, A. K., & Mykhailov, V. K. (1978). Soybean. In *Selektsiya tekhnicheskikh i kormovykh kul'tur* [Breeding of industrial and fodder crops]. Kyiv: Urozhai. [In Ukrainian]
19. Vitko, G. I. (2017). Research into initial material of vegetable peas according to a complex of economically valuable traits. *Bulletin of the Belarussian State Agricultural Academy*, *3*, 57–62. [In Russian]
20. Turin, E. N., & Sichkar, V. I. (2007). High-yielding, plastic. Soybean varieties of the Breeding and Genetics Institute. *Seed Production*, *3*, 19–22. [In Russian]
21. Vozhehova, R. A., Borovyk, V. O., Klubuk, V. V., & Marchenko, T. Yu. (2018). Influence of some quantitative structural characteristics of introduced soybean (*Glycine max* (L.) Merr.) accessions on seed productivity in irrigated conditions in the South of Ukraine. *Plant Genetic Resources*, *22*, 11–18. doi: 10.36814/pgr.2018.22.01 [In Ukrainian]
22. Vozhehova, R. A., Borovyk, V. O., Klubuk, V. V., & Rubtsov, D. K. (2018). Selection value of sources of valuable attributes of introduced soybean samples (*Glycine max* L.) for new varieties creation under irrigated conditions of the South of Ukraine. *Plant Varieties Studying and Protection*, *14*(2), 176–182. doi: 10.21498/2518-1017.14.2.2018.124765 [In Ukrainian]
23. Semenova, E. V., & Sobolev, D. V. (2009). Productivity of pea (*Pisum sativum* L.) accessions from the VIR collection in the Leningrad Region. *Proceedings on Applied Botany, Genetics and Breeding*, *166*, 242–249. [In Russian]
24. Allard, R. W., & Hansche, P. E. (1964). Some parameters of population variability and their implications in plant breeding. *Advances in Agronomy*, *16*, 281–325. doi: 10.1016/S0065-2113(08)60027-9
25. Kholod, S. M. (2019). Characteristics of different varieties of the pea (*Pisum sativum* L.) in the zone of the Southern Forest-Steppe of Ukraine. *Plant Varieties Studying and Protection*, *15*(2), 109–117. doi: 10.21498/2518-1017.15.2.2019.173552 [In Ukrainian]

Використана література

1. Сечняк В. Ю., Файт В. І. Роль генетичних ресурсів та інтродукції рослин у селекції. *Вісник аграрної науки*. 2012. Спец. вип. С. 127–128.
2. Keller E. R. J., Senula A., Leunufna S., Grübe M. Slow growth storage and cryopreservation – tools to facilitate germplasm maintenance of vegetatively propagated crops in living plant

collections. *International Journal of Refrigeration*. 2006. Vol. 29, Iss. 3. P. 411–417. doi: 10.1016/j.ijrefrig.2005.07.0122
3. Кириченко В. В., Рябчун В. К., Богуславський Р. Л. Роль генетичних ресурсів рослин у виконанні державних програм. *Генетичні ресурси рослин*. 2008. № 5. С. 7–13.
4. Кобизєва Л. Н., Безугла О. М., Богуславський Р. Л. Збагачення національного генбанку рослин України зразками генофонду зернобобових культур вітчизняного та зарубіжного походження. *Генетичні ресурси рослин*. 2010. № 8. С. 9–20.
5. Клиша А. І., Кулініч О. О., Хорошун І. В. Результати і напрями селекції зернобобових культур. *Бюлетень Інституту зернового господарства*. 2010. Вип. 39. С. 27–32.
6. Fernie A. R., Tadmor Y., Zamir D. Natural genetic variation for improving crop quality. *Current Opinion in Plant Biology* 2006. Vol. 9, Iss. 2. P. 196–202. doi: 10.1016/j.pbi.2006.01.010
7. Войтовська В. І., Сторожик Л. І., Любич В. В., Романов С. М. Уміст амінокислот у зерні різних сортів гороху озимого та продуктах його перероблення. *Plant Varieties Studying and Protection*. 2021. Т. 17, № 4. С. 312–318. doi: 10.21498/2518-1017.17.4.2021.249013
8. Безручко О. І., Свинарчук О. В. Поповнення ринку сортів рослин України: горох овочевий (*Pisum sativum* L. partim). *Сортовивчення та охорона прав на сорти рослин*. 2012. № 1. С. 48–57. doi: 10.21498/2518-1017.1(15).2012.60208
9. Сачивка Т. В., Босак В. Н. Оценка хозяйственно полезных признаков различных сортов овощного гороха. *Известия ФНЦО*. 2020. № 3–4. С. 85–91. doi: 10.18619/2658-4832-2020-3-4-85-91
10. Кобизєва Л. Н., Гончарова О. О. Колекція сортів гороху овочевого – джерело для створення зеленого конвеєру. *Вісник ЦНЗ АПВ Харківської області*. 2013. Вип. 14. С. 60–67.
11. Rasskazova L., Kirse-Ozolina A. Field pea *Pisum sativum* L. As a perspective ingredient for vegan foods: a review. *Research for Rural Development*. 2020. Vol. 35. P. 125–131. doi: 10.22616/rrd.26.2020.019
12. Мардилович М. И. Оценка коллекции овощного гороха. *Земледелие и селекция в Беларуси*. 2014. Вып. 50. С. 361–375.
13. Дідур І. М., Мостовенко В. В. Вплив технологічних прийомів вирощування на формування елементів структури врожаю гороху овочевого в умовах лісостепу правобережного. *Сільське господарство та лісівництво*. 2019. № 15. С. 21–29. doi: 10.37128/2476626-2019-4-2
14. Босак В. Н., Сачивко Т. В. Продуктивность и особенности азотфиксации в посевах бобовых овощных культур. *Земледелие и защита растений*. 2019. № 1. С. 21–23.
15. Широкий унифицированный классификатор СЭВ и международный классификатор СЭВ рода *Pisum* L. / сост. : Р. Макашева, К. Белехова, В. Корнейчук и др. Ленинград : ВИР, 1981. 46 с.
16. Методика проведення експертизи сортів рослин групи зернобобових та круп'яних на відмінність, однорідність і стабільність / за ред. С. О. Ткачик. 2-ге вид., випр. і доп. Вінниця : ФОП Крзун Д. Ю., 2016. 216 с.
17. Кириченко В. В., Кобизєва Л. Н., Петренкова В. П. та ін. Ідентифікація ознак зернобобових культур (горох, соя) / за ред. В. В. Кириченка. Харків : Вид-во «Харків», 2009. 172 с.
18. Лещенко А. К., Михайлов В. К. Соя. *Селекция технических и кормовых культур*. Киев : Урожай, 1978. С. 70–86.
19. Витко Г. И. Изучение исходного материала овощного гороха по комплексу хозяйственно полезных признаков. *Вестник Белорусской государственной сельскохозяйственной академии*. 2017. № 3. С. 57–62.
20. Турин Е. Н., Сичкарь В. И. Высокоурожайные, пластичные. Сорта сои Селекционно-генетического института. *Насінництво*. 2007. № 3. С. 19–22.
21. Вожегова Р. А., Боровик В. О., Клубук В. В., Марченко Т. Ю. Зв'язок структурних елементів інтродукованих зразків сої (*Glycine max* (L) Merr.) з продуктивністю насіння в умовах зрошення Півдня України. *Генетичні ресурси рослин*. 2018. № 22. С. 11–18. doi: 10.36814/pgr.2018.22.01
22. Вожегова Р. А., Боровик В. О., Клубук В. В., Рубцов Д. К. Селекційне значення джерел цінних ознак інтродукованих зразків сої (*Glycine max* L) для створення нових сортів в умовах зрошення Півдня України. *Plant Varieties Studying and Protection*. 2018. Т. 14, № 2. С. 176–182. doi: 10.21498/2518-1017.14.2.2018.124765
23. Семенова Е. В., Соболев Д. В. Продуктивность образцов гороха (*Pisum sativum* L.) из коллекции ВИР в условиях Ленинградской области. *Труды по прикладной ботанике, генетике и селекции*. 2009. Т. 166. С. 242–249.
24. Allard R. W., Hansche P. E. Some parameters of population variability and their implications in plant breeding. *Advances in Agronomy*. 1964. Vol. 16. P. 281–325. doi: 10.1016/S0065-2113(08)60027-9
25. Холод С. М. Характеристика різних сортозразків гороху посівного (*Pisum sativum* L.) у зоні Південного Лісостепу України. *Plant Varieties Studying and Protection*. 2019. Т. 15, № 2. С. 109–117. doi: 10.21498/2518-1017.15.2.2019.173552

УДК 635.656:631.527

Холод С. М.[1*], Кузьмишина Н. В.[2], Кір'ян В. М.[1], Тригуб О. В.[1] Характеристика інтродукованих сортозразків гороху овочевого (*Pisum sativum* L.) у зоні Південного Лісостепу України. *Plant Varieties Studying and Protection*. 2022. Т. 18, № 1. С. 24–33. https://doi.org/10.21498/2518-1017.18.1.2022.257584

*[1]Устимівська дослідна станція рослинництва Інституту рослинництва імені В. Я. Юр'єва НААН України, вул. Академіка Вавилова, 15, с. Устимівка, Глобинський р-н, Полтавська обл., 39074, Україна, *e-mail: svitlanakholod77@ukr.net*

[2]Інститут рослинництва імені В. Я. Юр'єва НААН України, Національний центр генетичних ресурсів рослин України, Московський пр-т, 142, м. Харків, 61060, Україна, e-mail: ncpgru@gmail.com

Мета. Оцінити нові інтродуковані сорти гороху овочевого (*Pisum sativum* L.) різного еколого-географічного походження в умовах південної частини Лісостепу України за комплексом показників продуктивності та адаптивності. **Методи.** Протягом 2018–2020 рр. в умовах Устимівської дослідної станції рослинництва Інституту рослинництва імені В. Я. Юр'єва НААН (Полтавська обл., 49°18'21"N, 33°13'56"E) досліджували 30 нових зразків гороху походженням із Білорусі, Азербайджану, Канади, Польщі та Нідерландів. У фазі достигання стручків та насіння (ВВСН 86–90) у польових та лабораторних умовах визначали показники врожайності, продуктивності, маси 1000 насінин, скоростиглості, висоти рослин та висоти прикріплення нижніх бобів над рівнем ґрунту, кількості вузлів до першого бобу та загальну кількість їх на рослині, кількості бобів та насіння на рослині, кількості насіння в бобі, параметри бобу. **Результати.** У процесі вивчення нових зразків гороху овочевого встановлено розмах рівня варіювання їх урожайності від 200,5 до 300,0 г/м^2, при цьому найурожайнішими були сорти 'Алекс', 'Атлант', 'Минский овощной' (Білорусь), 'Fidan' (Азербайджан), 'Dacota' (Канада), 'Angela' (Нідерланди), у яких маса насіння з рослини перевищувала 10,0 г. Показники продуктивності рослини були високими завдяки як підвищеній кількості насінин, так і масі 1000 зерен. Майже всі досліджені зразки виявилися середньостиглими (71–80 діб) і є оптимальними для

зони Південного Лісостепу України. Найбільш скоростиглими (64–69 діб) були білоруські сорти 'Ян', 'Гонцо', 'Горынец', 'Альфа', 'Прывабны', 'Малыш' та нідерландський сорт 'Angela'. Найбільш низькорослими виявилися білоруські сорти – 'Горынец', 'Влад', 'Альфа', 'Атлант' та ін. (31,0–60,0 см), які можна використати як джерела за цією ознакою. Особливої уваги заслуговують сорти, які поєднують у собі кілька цінних ознак: 'Алекс', 'Атлант', 'Минский овощной', 'Корелический овощной', 'Слодыч', 'Малыш', 'Космай', 'Кельвидон' (Білорусь), 'Fidan' (Азербайджан), 'Jof' (Польща), 'CDC Limerick' (Канада), 'Orix' (Іспанія). **Висновки.** Вищезазначені сорти можна рекомендувати як джерела цінних ознак для практичного використання в селекції, а також вони є придатними для вирощування в зоні Південного Лісостепу, за умови включення до Державного реєстру сортів рослин, придатних для поширення в Україні.

Ключові слова: *горох овочевий; сортозразки; цінні господарські ознаки; продуктивність.*

Надійшла / Received 25.03.2022
Погоджено до друку / Accepted 17.04.2022