UDC 635.65:631.527 (477.4)(043)
DOI: 10.37128/2707-5826-2023-3-7

PLASTICITY AND STABILITY OF THE ELEMENTS OF THE YIELD STRUCTURE OF COMMON BEAN VARIETIES

O.V. MAZUR, *PhD in Agricultural Sciences, associate professor*
O.V. MAZUR*, PhD in Agricultural Sciences, associate professor*
Vinnytsia National Agrarian University
O.V. DMYTRENKO, *PhD in Agricultural Sciences, Senior researcher of the State institution of Grunthorona*

The article presents the results of long-term studies of the influence of hydrothermal conditions on the elements of the yield structure of common bean forms. It was found that along with genotypic features, the hydrothermal conditions of the years of research have a significant influence on the level of trait manifestation. the most favorable conditions were noted in 2021, 2018 and 2016, it was during the research period of these years that the highest grain productivity of common bean forms was obtained.

The lowest grain productivity was observed in the conditions of the least favorable hydrothermal regime, which were in 2015, 2017 and 2020. However, despite the general biological dependence, the research made it possible to rank common bean forms according to their response to changes in the hydrothermal regime of their cultivation. This made it possible to identify forms that respond well to improved growing conditions and those with a lower response to changes in the hydrothermal regime. The highest number of productive nodes during the research period was observed in varieties Great Northern 1140, haricot - 4.55 pcs, Mestnaya 82 - 5.32 pcs, Jamunada, haricot - 5.05 pcs, Mestnaya - 4.95 pcs. mainly these varieties were characterized by an increased response to the improvement of hydrothermal conditions, the coefficient of plasticity (bi>1). In particular, in the varieties Mestnaya 82 - 1.49, Jamunada, haricot - 1.34, Mestnaya - 1.15, except for the variety Great Northern 1140, haricot, which was characterized by a conservative response to changes in the hydrothermal regime (bi<1). The number of beans per plant is determined by the number of productive nodes, beans per node, and growing conditions. Therefore, as well as by the number of productive nodes, the following varieties stood out: Great Northern 1140, haricot - 18.3 pcs, Mestnaya 82 - 21.5 pcs, Jamunada, haricot - 20.0 pcs, Mestnaya - 19.8 pcs. The highest indices of the number of beans per plant were observed in varieties characterized by a high response to the improvement of hydrothermal conditions. The number of seeds per plant is a derivative of the number of beans. Thus, the best varieties in terms of the number of seeds per plant, as well as the previous trait, were Great Northern 1140, haricot - 55 pcs, Mestnaya 82 - 63.9 pcs, Jamunada, haricot - 60 pcs, Karamtsa - 64 pcs, Mestnaya - 58 pcs. All these varieties, except Great Northern 1140, haricot, belong to highly plastic, the regression coefficient of which was above one.

In terms of weight of 1000 grains, the varieties with the national catalog number UD0300658 were distinguished by 330 g, Kharkivs'kii - 256 g, and only Great Northern 1140, haricot, which had slightly higher average values of the number of productive nodes, number of beans per plant and number of seeds per plant, also showed slightly higher average values of weight of 1000 grains - 254 g. Thus, the grain productivity of common bean is determined by the average and above average values of the elements of the crop structure, and not by the maximum complementary combination of each structural element.

The highest grain productivity was observed in common bean forms: Karamtsa - 12.2 g, Mistseva 82 - 11.5 g, Great Northern 1140, haricot - 11.3 g. It should be noted that these forms of common bean respond well to the improvement of hydrothermal growing conditions, the plasticity coefficient of these varieties was more than one. In addition, the variant stability of these varieties was as close to zero as possible.

Key words: *common bean, varieties, productive nodes, number of beans, number of seeds, weight of 1000 grains, grain productivity, plasticity, stability.*

Table 5. Lit. 15.

Statement of the problem. Due to the sharp climate change in recent years, the inconsistency of the current level of standard elements of plant growing technology, insufficient adaptive parameters of valuable plant properties, existing varieties included in the State Register of Plant Varieties Suitable for Distribution in Ukraine are losing their potential [1].

It is known that as the intensity of varieties increases, there is a natural decrease in their adaptive potential. The potential of plants of new varieties, even under optimal biotic and abiotic factors, is realized only by 50-60% [2], so the search for the most optimal conditions for growing plants of certain genotypes, under which they could fully realize their genetic potential, remains relevant. The solution to the problem of increasing the adaptability of cultivated plants lies in the involvement of adaptive forms with enhanced recombination processes of gene interaction. In the gene pool of a population, under the influence of a limiting factor (or several of them), in the process of recombination, mutual adaptation of different genes occurs, which in a number of genotypes forms more pronounced traits and properties compared to parental forms [3]**.**

Analysis of the latest research results. The success of breeding work with any crop depends more on properly selected source material. The availability of donors and sources of valuable economic traits allows the breeder to purposefully construct new genotypes by using certain genes and their blocks in hybridization programs. At the same time, it is very important to involve more distant forms - carriers of valuable genes - when creating new source material, which makes it possible to significantly expand the genetic base of breeding material. Numerous data indicate that hybrid populations based on crosses of varieties created in different natural and environmental conditions are the most valuable for selecting forms that can combine high productivity and adaptability. This is due to the fact that in different natural zones certain gene complexes are formed that provide the highest productivity due to the rather efficient use of environmental factors (solar energy, moisture, soil nutrients).

According to the results of studies by Sichkar V.I. [4, 5], Biliavska L. et al. [6], the negative weather trend (increased air temperature, long inter-rain periods, frequent dry spells and heavy rains), which has intensified in recent years, requires the creation of fundamentally new varieties, the main characteristic of which is increased adaptability, which is expressed in the stability of the yield over the years. We believe that this is the main feature of modern plant breeding. In this regard, we give top priority to the field assessment of drought tolerance. Only determining the productivity of plants over a long period of time under different conditions makes it possible to objectively assess the genotype in terms of adaptability. At present, the amount of precipitation in most of our country is the main limiting factor of yield [4, 5].

Based on the experimental data obtained, we can state that it is usually not possible to achieve significant breeding results by strengthening one element of productivity. A plant is a biological system whose individual components are closely interconnected, so a change in one factor has a major impact on the state of another. Therefore, in breeding work, the combination of productivity elements should be approached with caution, avoiding their level that would cause negative changes in others. As a rule, these are the average values of the traits or slightly higher. Breeding progress is achieved by a gradual movement due to positive changes in individual plant indicators that affect the level of productivity [4, 5].

Most often, the adaptation of cultivated and wild plants to insufficient moisture is a xeromorphic structure characterized by small leaf size and poor development of the mesophyll layer of cells in them, increased sensitivity of stomata, the presence of protected covers on leaves and stems, good development of the root system, and other indicators. As a rule, the above characteristics are possessed by separate genotypes and the breeder's task is to combine them in one variety. Such physiological and biochemical traits as water-holding capacity of leaves, ability to tolerate significant cytoplasmic dehydration, accumulation of specific compounds in cells (free amino acids, secondary metabolic products), and the ability to quickly restore vital functions after severe tissue dehydration are of great importance for enhancing protection against insufficient soil and air moisture and high temperatures. It is important to remember that these traits are under genetic control, so they can be managed, although these are rather complex genetic and breeding tasks. The adaptive potential of a variety is an integral system whose individual components interact with each other [4, 5].

In recent years, high air temperatures (over +30°C) and lack of precipitation for a long time in the summer have been observed more and more often in the Forest-Steppe of Ukraine. Such conditions cause significant yield fluctuations, which often exceed varietal differences by two or more times. The creation of intensive varieties adapted to the changing conditions of the Ukrainian Forest-Steppe is possible with the use of specific approaches to the development of breeding methods for this crop. Currently, breeding technologies for many crops (peas, soybeans, fodder beans, chickpeas, winter wheat) are increasingly using breeding indices that provide a reliable assessment of productivity compared to direct plant evaluation and allow for a real unloading of the breeding process. The issue of improving the prediction of progeny yields by secondary traits (indices) in beans has not been studied. Moreover, modification differences in a number of cases significantly exceeded varietal differences, which indicates low adaptive properties of the majority of the collection. Due to climate change in recent years, it is advisable to direct the selection of bean varieties in the Forest-Steppe to the creation of varieties with a powerful root system and reduced transpiration intensity. Regarding the interrelationships of index traits, the harvesting index showed a close or medium intervarietal phenotypic correlation in groups of in- and determinant forms with the indices of microdistribution and attraction, indicating their main contribution to productivity. Plants with more beans and more intensive outflow of plastic substances from the assimilating part to the forming seeds will ultimately provide higher productivity [13].

Increasing production volumes is possible with the creation of high-performance varieties with improved taste, resistant to bio- and abiotic environmental factors, and high-tech varieties. The main method of obtaining such forms is currently hybridization, the effectiveness of which is determined by the availability of promising source material. In this regard, a comprehensive study of the best domestic and foreign varieties in certain soil and climatic conditions, identification of sources of economically valuable traits with determination of their degree of variability and establishment of existing relationships between them is quite relevant.

The yield of legumes, in particular common beans, significantly depends on the peculiarities of the formation of generative organs - the number of flowers and beans that have formed and remained on the plant until the phase of full ripeness. The generative organs of plants, in turn, are affected by hydrothermal conditions and cultivation techniques. Plant density contributes to changes in the formation of generative organs. A larger number of flowers and beans are formed at a lower plant density per 1 ha, respectively, with a higher percentage of beans preserved. The fall of flowers and beans is observed in both dry and wet years, but a certain minimum of beans is preserved under any conditions, which ensures a fairly high yield. Under the influence of high temperatures and excessive moisture during the growing season, plants form significantly fewer flowers and beans. Flowering and bean formation in bush varieties is quite intense. Plants can have up to 70 flowers and beans at a time, and about 36 of them normally develop at the same time. The process of formation of generative organs depends on the biological characteristics of the variety, hydrothermal conditions, as well as on the factors under study [14].

Plant productivity is determined by the presence of these factors, and the more they correspond to the biological characteristics of the crop, the more fully the potential of the bean is realized [15].

The photosynthetic apparatus of common bean is continuously changing from germination to harvesting, reaching a maximum during the budding-flowering period of this crop. The larger the area of the leaf apparatus at the optimal density of common bean, the greater the photosynthetic potential per unit area [14-16].

The productivity of bean plants is a complex quantitative trait caused by the interaction of a whole range of indicators, of which the most important are such elements of the yield structure as the number of seeds per bean, the number of beans per plant, and individual plant productivity. High productivity of beans is the result of the most optimal combination of elements of the crop structure, so when breeding for bean productivity, attention should be paid to these traits [14-16].

Yield is a complex trait that correlates with plant productivity and survival.

Plant survival mostly depends on resistance to drought, heat, diseases and pests. That is, samples with high yields are sources of disease tolerance, have above-average resistance to drought and heat, and an optimal ratio of productivity components [14-16].

The aim of the research is to conduct a comparative assessment of common bean varieties by elements of the yield structure, indicators of adaptability (plasticity and stability), to identify the best forms for their targeted inclusion in hybridization to create highly productive and adaptive varieties.

Material and methods of the research. The research was conducted during 2014-2021 in the experimental field of VNAU. The object of research was common bean accessions provided by the National Center for Plant Genetic Resources of Ukraine [7].

The calculation of indicators of ecological plasticity and stability of the elements of the crop structure was carried out in accordance with the methodology of Eberhart and Russell [8]. It is based on the calculation of two parameters: the coefficient of environmental plasticity or linear regression (bi) and variance or stability variance (Si2). The former indicates the response of the genotype to changes in growing conditions, and the latter characterizes the stability of the variety under various environmental conditions [9].

According to the results of calculations of the parameters of plasticity (bi) and stability (Si2), the following grouping ranks are distinguished for varieties: 1) bi < 1, Si2 > 0 - has better results in unfavorable conditions, unstable; 2) bi < 1, Si2 = 0 - has better results in unfavorable conditions, stable; 3) bi = 1, Si2 = 0 - responds well to improved conditions, stable; 4) bi = 1, Si2> 0 - responds well to improved conditions, unstable; 5) bi > 1, Si2 = 0 - has better results in favorable conditions, stable; 6) bi > 1, Si2 > 0 - has better results in favorable conditions, unstable.

The coefficient of variation (V e %) was determined by the ratio of the mean trait to its standard deviation. The ecological coefficient of variation characterizes the degree of variability of the arithmetic mean (up to 10 % - low, 11-20 % - medium and > 21 % - high) [10].

The homeostaticity and agronomic stability coefficient (As) were calculated according to the method [10]. The coefficient of agronomic stability, which characterizes the stability of the trait (As), was determined: Ve = S/x : 100 and As = 100 - Ve, where Ve is the environmental coefficient of variation; x is the average value of the varietal trait, S is the standard deviation [10].

Results of experimental studies. The number of productive nodes per plant is one of the indicators that determines the number of beans per plant and the overall productivity of common bean (Table 1).

It should be noted that these varieties were mainly characterized by an increased response to the improvement of the hydrothermal regime, the plasticity coefficient (bi>1). In particular, in the varieties Mestnaya 82 - 1.49, Jamunada, haricot - 1.34,

Mestnaya - 1.15, except for the variety Great Northern 1140, haricot, which was characterized by a conservative response to changes in the hydrothermal regime (bi<1).

In addition, it should be noted that the most favorable years of research were 2021, 2018 and 2016 in terms of hydrothermal regime. The years 2015, 2017, and

Table 1

Plasticity and stability parameters by the number of productive nodes of common bean, pcs.

Name of the variety (National catalog number)	Year									Coefficient			Homeostaticity	Variants stability (Si^2)
	2014 year	2015 year	2016 year	2017 year	2018 year	2019 year	2020 year	2021 year	Average	ecological plasticity of bi	agronomic stability of As	variations (V), %.		
Kharkivs'kii (UD0300232)	3,5	3,25	3,75	3,25	4,25	3,76	3,35	4,34	3,68	0,56	90,2	9,8	0,37	0,01
Great Northern 1140, haricot (UD0300565)	4,5	3,75	4,75	4,0	5,25	4,54	4,21	5,41	4,55	0,78	89,1	10,9	0,42	0,01
- (UD0300658)	3,25	2,5	3,5	2,75	4,0	3,11	2,87	4,38	3,3	0,86	84,7	15,3	0,22	0,01
(Gama) UD0300856	4,25	3,5	4,5	3,75	5,0	4,34	3,86	5,59	4,35	0,93	88,3	11,7	0,37	0,01
Perlyna (UD0301899 ст.)	3,75	3,0	4,0	3,25	4,5	3,95	3,34	4,84	3,83	0,86	86,5	13,5	0,28	0,01
- UD0302256	4,5	3,25	5,0	3,5	5,5	4,87	3,8	5,82	4,53	1,27	81,4	18,6	0,24	0,02
Mistseva 82 (UD0302642)	5,5	3,75	6,0	4,25	6,5	5,45	4,36	6,78	5,32	1,49	80,9	19,1	0,28	0,04
Jamunada, haricot (UD0302683)	5,25	3,5	5,5	4,0	6,0	5,3	4,45	6,43	5,05	1,34	82,3	17,7	0,29	0,03
Karamtsa (UD0302746)	4,25	3,75	4,5	4,0	5,0	4,4	4,34	5,65	4,49	0,77	91,2	8,8	0,51	0,04
Local (UD0303533)	5,0	3,5	5,25	4,25	5,75	5,1	4,56	6,23	4,95	1,15	85,1	14,9	0,33	0,02
HIP0.05	0,16	0,15	0,15	0,19	0,23	0,21	0,20	0,25	4,4	Options			Ff	Ft
Average, xj	4,4	3,4	4,7	3,7	5,2	4,5	3,9	5,5						
Index of conditions, lj	0,0	-1,0	0,3	-0,7	0,8	0,1	-0,5	1,1		Conditions of the year			1146	2,8
										Variety			1149	2,6
										Variety x year			18,0	1,7

Source: compiled on the basis of own research

2020 were less favorable in terms of hydrothermal conditions. The individual stages of ontogeny in promising source material should be consistent with the dynamics of environmental factors in a particular region.

Valuable breeding material has its own adaptive mechanisms that provide buffering against unfavorable environmental conditions [4, 5].

Maintaining the relative dynamic constancy of the parameters of physiological processes in the body during individual development and resistance to sudden environmental changes is the essence of developmental homeostasis. At the same time, the degree of homeostasis of individual signs and reactions in varying environmental conditions is recognized. The arithmetic mean of the yield and the coefficient of variation are used as an indicator of relative homeostasis (RH) of varieties. Homeostasis is also used as the main indicator of the breeding value of a genotype [10].

The highest homeostaticity indices were observed in varieties that were characterized by a conservative response to changes in the hydrothermal regime of cultivation. That is, common bean varieties with plasticity coefficients less than 1 provided the highest resistance to sudden environmental changes, Karamtsa - 0.51, Great Northern 1140, haricot - 0.42. The number of productive nodes in these varieties was higher than the population average and amounted to 4.49 in Karamtsa, 4.55 in Great Northern 1140, and 4.55 in Haricot.

The coefficients of agronomic stability were quite high in all common bean varieties and ranged from 80.9 to 90.2%. The stability variance, which indicates deviation from the direction of the plasticity coefficient, was as close to zero as possible in all common bean varieties.

The number of beans per plant is determined by the number of productive nodes, beans per node, and growing conditions. Therefore, as well as by the number of productive nodes, the following varieties stood out: Great Northern 1140, haricot - 18.3 pcs, Mestnaya 82 - 21.5 pcs, Jamunada, haricot - 20.0 pcs, Mestnaya - 19.8 pcs. The highest number of beans per plant was observed in varieties that were characterized by a high response to the improvement of the hydrothermal regime. That is, common bean varieties Mestnaya 82, Jamunada, haricot and Mestnaya responded well to the improvement of the hydrothermal regime of cultivation, providing the highest quantitative values of beans per plant. The variance of stability was as close to zero as possible for all varieties. That is, the direction of the regression coefficient on the value of the stability variance was subject to minimal deviations. The coefficients of agronomic stability of the number of beans per plant in common bean varieties were high and ranged from 81.1 to 91.0%.

The highest homeostatic indices were observed in Karamtsa - 1.96 and Great Northern 1140, haricot - 1.69. The bean varieties that provided the highest number of beans were characterized by quite high homeostaticity. Mestnaya 82 - 1.14, Jamunada, haricot - 1.1, Mestnaya - 1.29.

Table 2

Parameters of plasticity and stability by the number of beans per plant common bean, pcs.

Name of the variety (National catalog number)	Year									Coefficient			Homeostaticity	Variants stability (Si^2)
	2014 year	2015 year	2016 year	2017 year	2018 year	2019 year	2020 year	2021 year	Average	ecological plasticity of bi	agronomic stability of As	variations (V), %.		
Kharkivs'kii (UD0300232)	14	13	15	13	17	15	13	18	14,8	0,64	89,9	10,1	1,45	0,37
Great Northern 1140, haricot (UD0300565)	18	15	19	16	21	18	17	22	18,3	0,83	89,2	10,8	1,69	0,15
- (UD0300658)	13	10	14	11	16	14	12	17	13,4	0,84	84,8	15,2	0,88	0,05
(Gama) UD0300856	17	14	18	15	20	17	16	21	17,3	0,83	88,5	11,5	1,51	0,15
Perlyna (UD0301899 ст.)	15	12	16	13	18	16	14	19	15,4	0,84	86,8	13,2	1,16	0,05
- UD0302256	18	13	20	14	22	19	15	23	18	1,29	81,4	18,6	0,97	0,17
(Mistseva 82) UD0302642	22	15	24	17	26	23	18	27	21,5	1,53	81,1	18,9	1,14	0,42
Jamunada, haricot (UD0302683)	21	14	22	16	24	21	17	25	20	1,37	81,8	18,2	1,1	0,39
Karamtsa (UD0302746)	17	15	18	16	20	18	17	21	17,8	0,68	91,0	9,0	1,96	0,22
Local (UD0303533)	20	14	21	17	23	21	18	24	19,8	1,14	84,7	15,3	1,29	0,37
НІР0.05	1,23	1,09	1,21	0,7	0,78	0,83	0,8	0,92		Options			Ff	Ft
Average, xj	17,5	13,5	18,7	14,8	20,7	18,2	15,7	21,7	17,6					
Index of conditions, lj	-0,1	-4,1	1,1	-2,8	3,1	0,6	-1,9	4,1		Conditions of the year			216	2,8
										Variety			206	2,6
										Variety x year			3,3	1,7

Source: based on own research

The number of seeds per plant is a derivative of the number of beans (Table 3). Thus, the best varieties in terms of the number of seeds per plant, as well as the previous trait, were Great Northern 1140, haricot - 55 pcs, Mestnaya 82 - 63.9 pcs, Jamunada, haricot - 60 pcs, Karamtsa - 64 pcs, Mestnaya - 58 pcs. All these varieties, except Great Northern 1140, haricot, are highly plastic, with regression coefficient above one.

Table 3

Plasticity and stability parameters by the number of seeds per common bean plant, pcs.

Name of the variety (National Catalog number)	Year									Coefficient			Homeostaticity	Variants stability (Si^2)
	2014 year	2015 year	2016 year	2017 year	2018 year	2019 year	2020 year	2021 year	Average	ecological plasticity of bi	agronomic stability of As	variations (V), %.		
Kharkivs'kii (UD0300232)	42	26	45	29	50	44	30	51	39,6	1,07	76,2	23,8	1,7	1,9
Great Northern 1140, haricot (UD0300565)	54	45	57	50	63	55	51	65	55	0,7	89,6	10,4	5,3	2,7
- (UD0300658)	39	30	42	34	47	41	36	49	39,8	0,69	85,9	14,1	2,8	1,2
Gama (UD0300856)	51	42	54	48	59	52	49	62	52,1	0,66	89,9	10,1	5,1	3,4
Perlyna (UD0301899 ст.)	45	36	48	39	54	46	41	56	45,6	0,75	86,8	13,2	3,4	2,0
- UD0302256	54	39	60	45	67	58	47	69	54,9	1,16	82,3	17,7	3,1	1,0
Mistseva 82 (UD0302642)	66	45	72	51	76	70	53	78	63,9	1,36	81,2	18,8	3,4	2,3
Jamunada, haricot (UD0302683)	63	42	66	49	69	65	51	71	60,0	1,15	82,6	17,4	3,4	3,2
Karamtsa (UD0302746)	68	45	72	50	76	71	52	78	64	1,39	80,4	19,6	3,3	5,2
Local (UD0303533)	60	42	63	49	68	61	51	70	58	1,06	84,2	15,8	3,7	0,4
HIP0.05	1,58	1,23	1,65	1,7	1,81	1,63	1,82	1,74		Options			Ff	Ft
Average, xj	54,2	39,2	57,9	44,4	62,9	56,3	46,1	64,9	53,2					
Index of conditions, lj	1,0	-14,0	4,7	-8,8	9,7	3,1	-7,1	11,7		Conditions of the year			2276	2,8
										Variety			1794	2,6
										Variety x year			23,9	1,7

Source: based on own research

It should be noted that, in general, the trait was characterized by higher variability compared to the number of productive nodes and the number of beans per plant. This is due to the higher quantitative values of the trait and the polygenic nature of its inheritance of both the number of beans per plant and the number of seeds per bean. Thus, the coefficients of variation in the number of seeds per plant varied from 10.1 to 23.8%, and the coefficients of agronomic stability ranged from 76.2 to 89.9%, respectively. The best maintenance of the relative dynamic stability of the parameters of physiological processes in the body during individual development and resistance to sudden changes in the environment was observed in the varieties Great Northern 1140, haricot - 5.3, Gama - 5.1, Mistseva 82 - 3.4, Jamunada, haricot - 3.4 and Mestnaya - 3.7. All varieties of common beans had a stability index above zero. The lowest value was observed in Mestnaya variety - 0.4 and was as close to zero as possible.

The breeding work is aimed at creating early maturing high-yielding bean varieties with high processability and nutritional value, resistant to the most common diseases and suitable for intensive cultivation technologies for the Forest-Steppe and Polissya zones of Ukraine, which correspond to the developed model: compact standing bush shape, high attachment of the lower tier of beans, large weight of 1000 seeds, high yield, growing season duration up to 110 days, simultaneous ripening, and stability. Today, producers need large-seeded varieties suitable for mechanized cultivation. Knowledge of the mechanisms of inheritance of traits and properties, primarily productivity, quality and disease resistance, will make it more efficient to work on the creation of highly productive varieties [11].

The most integral indicator of drought tolerance is the high productivity of varieties, which is determined not by a single trait or quality, but by the entire genetic system of plants. Under arid conditions, the highest yield is formed with the optimal combination of individual productivity elements and economically valuable traits, among which the most important are the aboveground mass of plants, the number of beans and seeds per plant, and a slight decrease in the weight of 1000 grains [12].

It should be noted that common bean varieties that excelled in the number of productive nodes, number of beans per plant, and number of seeds per plant did not excel in the weight of 1000 grains. However, other common bean varieties with lower number of productive nodes, number of beans and seeds per plant were distinguished by the weight of 1000 grains. Our research results are confirmed by previous scientific studies by a number of authors [4, 5].

On the one hand, production requires stable varieties that would minimize productivity under adverse conditions, but at the same time would be able to realize high potential under intensive environmental factors, which is one of the most important tasks of breeding. In addition, it is necessary to have highly specialized varieties for specific ecological zones [12].

Thus, in terms of weight of 1000 grains, the varieties with the national catalog number UD0300658 were distinguished by 330 g, Kharkivs'kii - 256 g, and only Great Northern 1140, haricot, which had slightly higher average values of the number of productive nodes, the number of beans per plant and the number of seeds per plant, also showed slightly higher average values of weight of 1000 grains - 254 g. Thus, the grain productivity of common bean is determined by the maximum complementary combination of each structural element. In addition,

Table 4

Parameters of plasticity and stability by weight of 1000 grains on a common bean plant, g

Name of the variety (National catalog number)	Year									Coefficient			Homeostaticity	Variants stability (Si2)
	2014 year	2015 year	2016 year	2017 year	2018 year	2019 year	2020 year	2021 year	Average	ecological plasticity of bi	agronomic stability of As	variations (V), %.		
Kharkivs'kii (UD0300232)	251	213	273	234	285	270	236	289	256	1,16	90	10	25,6	13,7
Great Northern 1140, haricot (UD0300565)	267	196	284	205	295	281	208	297	254	1,83	83,1	16,9	15,0	107
- (UD0300658)	334	273	352	298	367	348	301	369	330	1,53	89,6	10,4	31,7	6,9
Gama (UD0300856)	245	187	263	201	276	259	204	281	240	1,58	85,2	14,8	16,2	23,9
Perlyna (UD0301899 ст.)	236	195	245	208	253	243	212	256	231	0,98	90,4	9,6	24,1	5,8
- UD0302256	243	217	256	234	263	252	237	266	246	0,70	93,7	6,3	39,0	9,6
(Mistseva 82) UD0302642	216	195	223	205	239	219	209	243	219	0,68	93,6	6,4	33,9	20,2
Jamunada, haricot (UD0302683)	205	184	201	197	213	198	202	216	202	0,37	95,6	4,4	46,2	30,7
Karamtsa (UD0302746)	234	212	236	223	248	231	226	252	233	0,54	95,1	4,9	47,9	15,6
Local (UD0303533)	198	173	204	187	215	198	192	218	198	0,62	93,3	6,7	29,6	14,5
HIP0.05	8,52	6,42	8,06	6,3	1,67	7,94	7,56	1,72		Options			Ff	Ft
Average, xj	242,9	204,5	253,7	219,2	265,4	249,9	222,7	268,7	240,9					
Index of conditions, lj	2,0	-36,4	12,8	-21,7	24,5	9,0	-18,2	27,8		Conditions of the year			12600	2,8
										Variety			3698	2,6
										Variety x year			141,5	1,7

Source: based on own research

the weight of 1000 grains in the context of the years of research depended on the soil and climatic conditions that developed during the research period. the highest weight of 1000 grains was noted in 2016 - 253.7 g, 2018 - 265.4 g, 2021 - 268.7 g, and the lowest weight of 1000 grains was noted in 2015 - 204.5 g, 2017 - 219.2 g and in 2020 - 222.7 g.

Highly plastic varieties included common bean varieties Kharkivs'kii - 1.16; Great Northern 1140, haricot - 1.83, variety sample UD0300658 - 1.53, variety Gama - 1.58. These bean varieties were distinguished by the absolute value of the weight of 1000 grains. However, the highest indicators of homeostasis were observed in common bean varieties that did not have a high weight of 1000 grains, in particular Karamtsa - 47.9, and the weight of 1000 grains - 233 g, Jamunada, haricot - 46.2, and the weight of 1000 grains - 202 g. According to the indicator of agronomic stability, all varieties were classified as stable, the coefficient of agronomic stability varied from 83.1 to 95.6%, and the coefficient of variation from 4.4 to 16.9%. The variant stability of all varieties was above zero.

It should be noted that the most drought-resistant were common bean varieties, which reacted less to changes in the hydrothermal regime, ensuring a stable realization of the quantitative value of the mass of 1000 grains. Such varieties included Jamunada, haricot, coefficient of variation was 4.4%, agronomic stability - 95.6%, Karamtsa, coefficient of variation - 4.9%, agronomic stability - 95.1%, Mistseva 82, coefficient of variation - 6.4%, agronomic stability - 93.6% and UD0302256, coefficient of variation - 6.3%, agronomic stability - 93.7%. Thus, it can be argued that lower variability was characterized by common bean forms that did not have the maximum quantitative expression of the trait, i.e. the weight of 1000 grains in such forms is lower. The highest variability of the variety was observed in the forms of beans that were characterized by higher quantitative values of the mass of 1000 grains: UD0300658 - 330 g, Kharkivs'kii - 256 g, only the form UD0302256, which combined a relatively higher weight of 1000 grains and rather low variability, providing high stability of the quantitative trait under changing hydrothermal conditions of the years of research. The most important polygenic trait of the elements of the crop structure is the grain productivity of common bean. This indicator reflects the influence of abiotic and biotic factors (drought and heat resistance, cold resistance, resistance to diseases and pests) in its quantitative value. In addition to these traits, the formation of grain productivity is also influenced by the manufacturability of common bean varieties, i.e., their suitability for mechanized harvesting, which is determined by the shape of the bush, resistance to lodging, the height of the lower beans, and resistance to shattering, i.e., non-cracking of the beans after ripening.

The highest grain productivity was observed in common bean forms: Karamtsa - 12.2 g, Mistseva 82 - 11.5 g, Great Northern 1140, haricot - 11.3 g. It should be noted that these forms of common bean respond well to the improvement of hydrothermal growing conditions, the plasticity coefficient of these varieties was more than one. In addition, the variant stability of these varieties was as close to zero as possible. That is, the deviation from the direction of the regression line was minimal. Also, these common bean varieties provided high agronomic stability indices of 84.2-85.1% and coefficients of variation of 14.9-15.8%. In addition, these forms provided the highest rates of homeostasis, i.e. the ability to maintain relative dynamic stability parameters of physiological processes in the body during individual development and

Table 5

Parameters of plasticity and stability of grain productivity of common bean plants, pcs.

Name of the variety (National catalog number	Year									Coefficient			Homeostaticity	Variants stability (Si^2)
	2014 year	2015 year	2016 year	2017 year	2018 year	2019 year	2020 year	2021 year	Average	ecological plasticity of bi	agronomic stability of As	variations (V), %.		
Kharkivs'kii (UD0300232)	8,0	5,3	9,1	6,4	10,8	8,8	7,1	11,0	8,3	1,15	77,9	22,1	0,38	0,07
Great Northern 1140, haricot (UD0300565)	10,9	8,5	12,8	9,7	13,0	12,1	9,9	13,5	11,3	1,03	84,8	15,2	0,75	0,11
- (UD0300658)	9,8	7,9	11,1	9,5	13,0	11,0	10,1	13,7	10,8	1,06	85,3	14,7	0,73	0,19
(Gama) UD0300856	9,4	7,6	11,2	9,1	12,3	9,5	9,0	12,5	10,1	0,96	84,6	15,4	0,66	0,26
Perlyna (UD0301899 ст.)	8,0	6,8	9,3	7,6	10,3	11,0	7,8	10,9	9,0	0,85	82,8	17,2	0,52	0,51
- UD0302256	9,9	8,2	12,1	9,9	13,3	11,2	8,9	13,6	10,9	1,12	83,5	16,5	0,66	0,19
Mistseva 82 (UD0302642)	10,8	8,5	12,7	9,8	13,7	12,1	10,2	14,1	11,5	1,13	84,2	15,8	0,73	0,01
Jamunada, haricot (UD0302683)	9,8	7,5	10,5	9,1	11,1	9,7	9,2	11,8	9,8	0,74	88,3	11,7	0,84	0,12
Karamtsa (UD0302746)	12,0	9,2	13,4	10,5	14,2	13,1	10,6	14,5	12,2	1,1	85,1	14,9	0,82	0,1
Local (UD0303533)	9,0	7,0	10,2	8,6	11,1	10,4	8,9	11,7	9,6	0,86	85,7	14,3	0,67	0,06
HIP0.05	0,28	0,17	0,28	0,17	0,46	0,32	0,21	0,45		Options			Ff	Ft
Average, xj	9,8	7,7	11,2	9,0	12,3	10,9	9,2	12,7	10,3					
Index of conditions, lj	-0,5	-2,6	0,9	-1,3	1,9	0,5	-1,2	2,4		Conditions of the year			27007	2,8
										Variety			14753	2,6
										Variety x year			20346	1,7

Source: based on own research

resistance to sudden changes in the environment, which is expressed by the homeostatic index, was the highest in these forms: Karamtsa – 0,82 г, Great Northern 1140, haricot – 0,75, Mistseva 82 – 0,73. And only the Jamunada, haricot variety provided higher homeostatic parameters, which amounted to 0.84, but a rather low level of grain productivity of 9.8 g. It should be noted that the varieties with a conservative reaction to changes in the hydrothermal regime were not characterized by high grain productivity: Pearl - 9.0 g, Jamunada, Haricot - 9.8 g and Mestnaya – 9.6 g. Grain productivity significantly depended on the hydrothermal conditions that prevailed during the research period. Thus, the highest grain productivity was observed in 2021 - 12.7 g, in 2018 - 12.3 g, and in 2016 - 11.2 g. The lowest grain productivity was noted in 2015 - 7.7 g, 2017 - 9.0 g and 2020 - 9.2 g. In general, all forms of common bean that were studied were characterized by high agronomic stability from 77.9 to 88.3%. According to the coefficient of variation, common bean varieties were mostly of medium variability, the coefficient of variation ranged from 11.7 to 17.2%, except for Kharkivs'kii, which had a high coefficient of variation and amounted to 22.1%.

Conclusions and prospects for further research. The highest number of productive nodes during the study period was observed in varieties Great Northern 1140, haricot - 4.55 pcs, Mestnaya 82 - 5.32 pcs, Jamunada, haricot - 5.05 pcs, Mestnaya - 4.95 pcs. mainly these varieties were characterized by an increased response to the improvement of hydrothermal conditions, the plasticity coefficient (bi>1). In particular, in varieties Mestnaya 82 - 1.49, Jamunada, haricot - 1.34, Mestnaya - 1.15, except for the variety Great Northern 1140, haricot, which was characterized by a conservative response to changes in hydrothermal conditions (bi<1).

The number of beans per plant is determined by the number of productive nodes, beans per node, and growing conditions. Therefore, as well as by the number of productive nodes, the following varieties stood out: Great Northern 1140, haricot - 18.3 pcs, Mestnaya 82 - 21.5 pcs, Jamunada, haricot - 20.0 pcs, Mestnaya - 19.8 pcs. The highest indices of the number of beans per plant were observed in varieties characterized by a high response to the improvement of hydrothermal conditions. The number of seeds per plant is a derivative of the number of beans. Thus, the best varieties in terms of the number of seeds per plant, as well as the previous trait, were Great Northern 1140, haricot - 55 pcs, Mestnaya 82 - 63.9 pcs, Jamunada, haricot - 60 pcs, Karamtsa - 64 pcs, Mestnaya - 58 pcs. All these varieties, except Great Northern 1140, haricot, belong to highly plastic, the regression coefficient of which was above one. According to the weight of 1000 grains, the varieties with the national catalog number UD0300658 were distinguished by 330 g, Kharkivs'kii - 256 g, and only Great Northern 1140, haricot, which had slightly higher average values of the number of productive nodes, the number of beans per plant and the number of seeds per plant, also showed slightly higher average values of the weight of 1000 grains - 254 g. Thus, the grain productivity of common bean is determined by the average and above average values of the elements of the crop structure, and not by the maximum complementary combination of each structural element. The highest grain productivity was observed in common bean forms: Karamtsa - 12.2 g, Mistseva 82 - 11.5 g, Great Northern 1140, haricot - 11.3 g. It should be noted that these forms of common bean respond well to the improvement of hydrothermal growing conditions, the plasticity coefficient of these varieties was more than one. In addition, the variant stability of these varieties was as close to zero as possible.

Список використаної літератури

1. Сайко О.Ю. Джерела для селекції квасолі овочевої, придатні до механізованого збирання. *Овочівництво і баштанництво.* 2012. Вип. 58. С. 269-273.

2. Попов С.І., Ермантраут Е.Р. Адаптивність сортів пшениці м'якої озимої залежно від умов вирощування. *Вісник ЦНЗ АПВ Харків. обл.* 2013. Вип. 15. С. 93-95.

3. Jones S., Murray T., Allan R. Use of alien genes for the development of disease resistance in wheat. *Phytopathol.* 1995. № 33. P. 429-443.

4.Січкар В.І., Лаврова Г.Д., Ганжело О.І. Урожайність і якість насіння широкоадаптованих сортів сої: *зб. наук. пр. Селекційно-генетичного ін.* 2014. Вип. 23. С. 72-87.

5. Січкар В.І. Ефективніше використовувати сортовий потенціал сої – потреба сьогодення. *Посібник українського хлібороба.* 2013. Т. 2. С. 146-150.

6. Biliavska L., Biliavskiy Y., Mazur O., Mazur O. Adaptability and breeding value of soybean varieties of Poltava breeding. *Bulgarian Journal of Agricultural Science*. 2021. Vol. 27. № 2. P. 312-322.

7.Безугла О.М., Кобизєва Л.Н. Генетичні ресурси рослин у вирішенні проблем селекції квасолі в Україні. *Збірник наукових праць Селекційно-генетичного інституту.* 2015. Вип. 26. С.74-83**.**

8. Eberhart S.A., Russell W.A. Stability parameters for comparing varieties. *Crop Sci*. 1966. Vol. 6, №1. P. 36-40. DOI.:10.2135/cropsci1966.0011183X000600010011x.

9. George C.C. Tai, 1971. Genotypic stability analysis and its applikcation to potato regional trials. *Crop. Sci.* 11(2): 184-185. DOI.10.2135/cropsci1971.0011183X001100020006x.

10. Корнієнко С.І., Горова Т.К., Штепа Л.Ю. та ін. Науково-практичні підходи селекції і насінництва петрушки та пастернаку. Теорія і практика. За ред. доктора с.-г. наук С.І. Корнієнка. Вінниця : ТОВ «Нілан-ЛТД», 2015. 152 с.

11. Михайлов В.Г., Романюк Л.С., Щербина О. З. Успадкування кількісних ознак у гібридів квасолі F 1. *Селекція та насінництво.* 2016. №3-4. С. 197-205.

12. Січкар В.І. Зернобобові культури в Україні: що вирощувати? *Агробізнес сьогодні*. 2016. № 21. С. 26-30.

13. Дупляк О. Т., Бовгира В. А. Використання непрямих ознак та індексів у селекції квасолі звичайної на стабільну продуктивність. *Селекція і насінництво.* 2012. Вип. 102. С. 106-111.

14. Воронецька І.С., Мовчан К.І. Особливості формування генеративних органів квасолі звичайної від способу сівби та густоти рослин в умовах правобережного Лісостепу України. *Вісник аграрної науки.* 2014. № 4 (734). С. 14-19.

15. Іванюк С. В., Глявин А. В. Оцінка сортозразків квасолі звичайної на основі кореляції кількісних ознак та індексів. *Селекція і насінництво*. 2012. Вип. 101. С. 192-197.

Список використаної літератури у транслітерації / References

1. Sajko O.Yu. (2012). Dzherela dlya selekciyi kvasoli ovochevoyi, pry`datni do mexanizovanogo zby`rannya [*Sources for selection of vegetable beans, suitable for mechanized harvesting*]. *Ovochivny`cztvo i bashtanny`cztvo − Vegetable and melon growing.* Issue. 58. 269-273. [in Ukrainian].

2. Popov S.I., Ermantraut E.R. (2013). Adapty`vnist` sortiv psheny`ci m'yakoyi ozy`moyi zalezhno vid umov vy`roshhuvannya [*Adaptability of soft winter wheat varieties depending on growing conditions*]. *Visny`k CzNZ APV Xarkiv. Obl − Bulletin of the Center for APV Kharkiv. region.* Issue. 15. 93-95. [in Ukrainian].

3. Jones S., Murray T., Allan R. (1995). Use of alien genes for the development of disease resistance in wheat. *Phytopathol.* № 33. P. 429-443. [in English].

4.Sichkar V.I., Lavrova G.D., Ganzhelo O.I. (2014). Urozhajnist` i yakist` nasinnya shy`rokoadaptovany`x sortiv soyi: zb. nauk. Pr [*Yield and seed quality of widely adapted soybean varieties: coll. of science pr.*]. *Selekcijno-genety`chnogo in − Breeding-genetic other.* Issue. 23. 72-87. [in Ukrainian].

5. Sichkar V.I. (2013). Efekty`vnishe vy`kory`stovuvaty` sortovy`j potencial soyi – potreba s`ogodennya [*More effective use of the varietal potential of soybeans is today's need*]. *Posibny`k ukrayins`kogo xliboroba − Guide to the Ukrainian farmer.* Vol. 2. 146-150. [in Ukrainian].

6. Biliavska L., Biliavskiy Y., Mazur O., Mazur O. (2021). Adaptability and breeding value of soybean varieties of Poltava breeding. *Bulgarian Journal of Agricultural Science.* Vol. 27. № 2. P. 312-322. [in English].

7.Bezugla O.M., Koby`zyeva L.N. (2015). Genety`chni resursy` rosly`n u vy`rishenni problem selekciyi kvasoli v Ukrayini [*Genetic resources of plants in solving the problems of bean breeding in Ukraine*]. *Zbirny`k naukovy`x pracz` Selekcijno-genety`chnogo insty`tutu − Collection of scientific works of the Breeding and Genetics Institute*. Issue. 26. 74-83. [in Ukrainian].

8. Eberhart S.A., Russell W.A. (1966). Stability parameters for comparing varieties. Crop Sci. 1966. Vols. 6. №1. P. 36-40. DOI.:10.2135/cropsci 1966.0011183 X000600010011x [in English].

9. George C.C. Tai, (1971). Genotypic stability analysis and its applikcation to potato regional trials. *Crop. Sci.* 11(2): 184-185. DOI.10.2135/ cropsci 1971. 0011183X 001100020006x [in English].

10. Korniyenko S.I., Gorova T.K., Shtepa L.Yu. ta in. (2015). Naukovo-prakty`chni pidxody` selekciyi i nasinny`cztva petrushky` ta pasternaku [*Scientific and practical approaches to breeding and seed production of parsley and parsnip*]. *Teoriya i prakty`ka − Theory and practice.* Za red. doktora s.-g. nauk S.I. Korniyenka. Vinny`cya : TOV «Nilan-LTD»,152. [in Ukrainian].

11. My`xajlov V.G., Romanyuk L.S., Shherby`na O.Z. (2016). Uspadkuvannya kil`kisny`x oznak u gibry`div kvasoli F 1 [*Inheritance of quantitative traits in bean hybrids F 1*]. *Selekciya ta nasinny`cztvo − Breeding and seed production.* №3-4. 197-205. [in Ukrainian].

12. Sichkar V.I. (2016). Zernobobovi kul`tury` v Ukrayini: shho vy`roshhuvaty`? [*Legume crops in Ukraine: what to grow?*]. *Agrobiznes s`ogodni − Agribusiness today*. № 21. 26-30. [in Ukrainian].

13. Duplyak O.T., Bovgy`ra V.A. (2012). Vy`kory`stannya nepryamy`x oznak ta indeksiv u selekciyi kvasoli zvy`chajnoyi na stabil`nu produkty`vnist`[*The use of indirect traits and indices in the breeding of common beans for stable productivity*]. *Selekciya i nasinny`cztvo−Breeding and seed production.* Issue 102. 106-111. [in Ukrainian].

14. Voronecz`ka I.S., Movchan K.I. (2014). Osobly`vosti formuvannya generaty`vny`x organiv kvasoli zvy`chajnoyi vid sposobu sivby` ta gustoty` rosly`n v umovax pravoberezhnogo Lisostepu Ukrayiny` [*Peculiarities of the formation of generative organs of common bean depending on the method of sowing and the density of plants in the conditions of the right-bank forest-steppe of Ukraine*]. *Visny`k agrarnoyi nauky` − Herald of Agrarian Science*. № 4 (734). [in Ukrainian].

15. Ivanyuk S.V., Glyavy`n A.V. (2012). Ocinka sortozrazkiv kvasoli zvy`chajnoyi na osnovi korelyaciyi kil`kisny`x oznak ta indeksiv [*Assessment of variety samples of common beans based on the correlation of quantitative traits and indices*]. *Selekciya i nasinny`cztvo − Breeding and seed production.* Issue. 101. 192-197 [in Ukrainian].

АНОТАЦІЯ
ПЛАСТИЧНІСТЬ І СТАБІЛЬНІСТЬ ЕЛЕМЕНТІВ СТРУКТУРИ ВРОЖАЮ СОРТІВ КВАСОЛІ ЗВИЧАЙНОЇ

У статті представлені результати багаторічних досліджень впливу гідротермічних умов на елементи структури врожаю форм квасолі звичайної. Встановлено, що поряд із генотипними особливостями на рівень прояву ознак значний вплив мають гідротермічні умови років досліджень. Найбільш сприятливі умови відмічено в умовах 2021, 2018 та 2016 років, саме у період досліджень цих років отримано найвищу зернову продуктивність форм квасолі звичайної. Найнижчу зернову продуктивність відмічено в умовах наймени сприятливих за гідротермічним режимом, які складалися у 2015, 2017 та 2020 роках. Проте, незважаючи на загальну біологічну залежність у результаті досліджень вдалося провести ранжування форм квасолі звичайної за реакцією на зміну гідротермічного режиму їх вирощування. Це дозволило виділити форми, які добре реагують на покращення умов вирощування, так і з меншою реакцією на зміну гідротермічного режиму.

Найвища кількість продуктивних вузлів впродовж періоду досліджень відмічено у сортів Great Northern 1140, haricot – 4,55 шт., Місцева 82 – 5,32 шт., Jamunada, haricot – 5,05 шт., Місцева – 4,95 шт. Переважно вказані сорти характеризувалися підвищеною реакцією на покращення гідротермічного режиму, коефіцієнт пластичності (bi>1). Зокрема, у сортів Місцева 82 – 1,49, Jamunada, haricot – 1,34, Місцева – 1,15, окрім сорту Great Northern 1140, haricot, який відзначився консервативною реакцією на зміну гідротермічного режиму (bi<1).

Кількість бобів на рослині визначається кількістю продуктивних вузлів, бобів у вузлі, а також умовами вирощування. Тому, як і за кількістю продуктивних вузлів виділилися сорти Great Northern 1140, haricot – 18,3 шт., Місцева 82 – 21,5 шт., Jamunada, haricot – 20,0 шт., Місцева – 19,8 шт. Найвищі показники кількості бобів на рослині відмічено у сортів, які характеризувалися високою реакцією на покращення гідротермічного режиму. Кількість *насінин на рослині є похідною ознакою від кількості бобів. Отже, кращими за кількістю насінин на рослині, як і за попередньою ознакою виділилися сорти Great Northern 1140, haricot – 55 шт., Місцева 82 – 63,9 шт., Jamunada, haricot – 60 шт., Karamtsa – 64 шт., Місцева – 58 шт. Всі вказані сорти, окрім Great Northern 1140, haricot належать до високопластичних, коефіцієнт регресії яких був вище одиниці.*

За масою 1000 зерен відзначилися сорти, за номером національного каталога UD0300658 – 330 г, сорт Kharkivs'kii – 256 г і лише Great Northern 1140, haricot, який займав дещо вищі середні показники кількості продуктивних вузлів, кількості бобів на рослині та кількості насінин на рослині також продемонстрував дещо вищі середні значення маси 1000 зерен – 254 г. Таким чином, зернова продуктивність квасолі звичайної визначається середніми і вище середнього значеннями елементів структури врожаю, а не максимальним взаємодоповнюючим поєднанням кожного структурного елемента.

Найвищу зернову продуктивність відмічено у форм квасолі звичайної: Karamtsa – 12,2 г, Mistseva 82 – 11,5 г, Great Northern 1140, haricot – 11,3 г. Слід відмітити, що вказані форми квасолі звичайної відмінно реагують на покращення гідротермічного режиму вирощування, коефіцієнт пластичності у цих сортів склав більше одиниці. Крім того, варіанса стабільності у цих сортів була максимально наближеною до нуля.

***Ключові слова**: квасоля звичайна, сорти, продуктивні вузли, кількість бобів, кількість насінин, маса 1000 зерен, зернова продуктивність, пластичність, стабільність.*

Табл. 5. Літ. 15.

Інформація про авторів

Мазур Олександр Васильович – кандидат сільськогосподарських наук, доцент кафедри рослинництва та садівництва Вінницького національного аграрного університету (21008, м. Вінниця, вул. Сонячна, 3).

Мазур Олена Василівна – кандидат сільськогосподарських наук, доцент кафедри ботаніки, генетики та захисту рослин Вінницького національного аграрного університету (21008, м. Вінниця, вул. Сонячна, 3).

Дмитренко Ольга Василівна – кандидат сільськогосподарських наук, старш. наук. співроб., завідувач лабораторії екологічної безпеки земель, якості продукції та довкілля ДУ «Держгрунтохорона».

Mazur Oleksandr Vasyliovych – Candidate of Agricultural Sciences, Associate Professor of the Department of Plant Production and horticulture, Vinnytsia National Agrarian University (21008, Vinnytsia, Soniachna Str., 3 e-mail: selection@vsau.vin.ua).

Mazur Olena Vasylivna – Candidate of Agricultural Sciences, Associate Professor of the Department of botany, genetics and plant protection, Vinnytsia National Agrarian University (21008, Vinnytsia, Soniachna Str. 3).

Dmytrenko Olha Vasylivna – Candidate of Agricultural Sciences, Senior researcher, head of the laboratory of ecological safety of land, product quality and the environment of the State institution of Grunthorona.