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ECOLOGICAL PLASTICITY AND STABILITY OF SOYBEAN VARIETIES UNDER GROWING CONDITIONS IN DIFFERENT ECOGRADIENTS

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In world agriculture diseases lead to a shortage of grain of approximately 135 million tons annually. It has been determined that the use of only one resistant variety corresponds, equally, to an increase in sown areas by 15-20 %, and their introduction reduces the need in using about 14-15 thousand tons of pesticides. Thus, the introduction of ecologically adaptive varieties will reduce the anthropogenic load on agrocenoses due to the higher resistance of genotypes to pathogens. The research results on the assessment of soybean varieties by adaptability (ecological plasticity and stability) in different soil and climatic conditions by resistance to diseases (downy mildew, viral mosaic) have been presented. The ranking of soybean varieties according to environmental plasticity and stability in accordance with their response to environmental conditions has been conducted. Our researches have shown that the intensity of the development of downy mildew and viral mosaic depends not only on the genetic *characteristics of genotypes, but also on factors that are associated* with *the growing zone, especially with the hydrothermal and edaphic conditions* of the region. *The highest value for cultivation in different ecogradients under contrasting edaphic* and *hydrothermal conditions are the varieties that have disclosed the maximum indicators of downy mildew and viral mosaic resistance. Oriana – 84.1 and 82.8 %, Hoverla – 83.3 and 83.0 %, Amethyst – 80.1 and 80.7 %, Vezha – 79.5 and 80.6 % – with increased resistance during the research period in different ecogradients. At the same time, the varieties Oriana and Hoverla reacted little to changes in environmental conditions environment (hydrothermal and edaphic conditions), providing high stable stability indicators, and the Vezha and Amethyst varieties – to plastic and highly plastic, with a high response to changes in growing conditions.*

Key words: *ecological plasticity, adaptability, ecogradient, stability, environmental conditions, hydrothermal regime, soybeans.*
Table 2. Fig. 3. Lit. 14.

Introduction. Taking into consideration the fact that in recent decades global climatic changes and fluctuations of different environmental factors have been quite noticeably traced, the creation of stress-tolerant varieties and hybrids of F1 agricultural plant species is considered as one of the priority national tasks, which is now being solved even by those countries that have relatively favourable soil and climatic conditions [1]. At the same time, as the author notes, one of the main tasks in ecological plant breeding is the combination of high potential productivity and resistance to environmental stress factors in a variety or hybrid. The requirement for the above-mentioned combination is not accidental. It has been experimentally proven that at present only 30-40% of the potential productivity of varieties is realized in mass production, and at best 50-60% of the potential productivity of varieties. The main reason for this is their lack of environmental sustainability. Therefore, it is obvious that under unstable growing conditions, the resistance of lines, varieties and hybrids to abiotic and biotic stresses becomes the main factor in the biologisation and ecologisation of intensification processes in crop production [2].

Creation of resistant varieties is the most effective tool of combating plant diseases, including soybeans. Their introduction into production eliminates the need for plant protection measures, which require significant funds, and most importantly, ensures the cultivation of environmentally friendly products and environmental protection [3].

Analysis of recent research and publications. Under constant influences of adverse environmental factors: temperature fluctuations, droughts, excessive moisture, soil salinisation, etc., each plant organism is able to adapt to these conditions only within the limits determined by the norm of the reaction of its genotype. The higher the ability of a species to change its metabolism according to the ranges of changing conditions is, the wider its response rate and the higher its ecological adaptive capacity is [4].

The current conditions of anthropogenic pressure on the biosphere and global climate change cause the primary problem of theoretical and experimental ecology related to understanding the mechanisms of functional relationships of plants with the environment, which ensure their growth, development, reproduction and distribution in various regions of the world. Climate change has a significant impact on the living conditions of biotopes, to which plants leading a predominantly sedentary lifestyle must quickly adapt. The emergence of new stable phenotypes through epigenetic modifications, phenotypic plasticity, is viewed as the basis for the survival and conservation of populations, as well as one of the key elements in the evolution and ecological relationships of species in biotopes [5].

Ecological plasticity is understood as the ability of a variety to form high yields under diverse soil and climatic conditions in different years of cultivation. If we look at the degree of its reaction to changing conditions as the ecological plasticity of a variety, then a variety is considered highly plastic, which quickly increases this trait with the improvement of conditions and quickly decreases it with their deterioration. Highly plastic varieties are often suitable for growing in favourable conditions and soil fertility. At the same time, low-plastic varieties are less responsive to changes in the environment and are most suitable for growing in harsh conditions, where they do not reduce productivity and quality [6, 7].

Determination of the optimal plant varieties that can stably realise their potential and at the same time adequately respond to changes in growing conditions constantly attracts the attention of scientists. According to S.A. Eberhart and W.A. Russell, medium-plastic varieties with a high average trait value and high stability in different growing conditions are preferable [8]. G. Wricke considers the most adapted genotypes to be those which have minimal interaction with the environment, or a high stable implementation of the characteristic response of the genotype trait (relatively stable) [9]. According to K.W. Finley and J.N. Wilkinson, the optimal variety is characterized by high overall adaptive capacity and the highest yield in favourable environments, providing maximum stability in unfavourable environments [10].

The main source of phenotypic plasticity is assumed to be the wide distribution of epigenetic mechanisms of developmental regulation in plants, that is, high plasticity of the epigenome compared to the genome and, at the same time, sufficient stability of the epigenome to transmit adaptive changes in generations. A sharp increase in epigenetic diversity in plant populations under conditions of adverse environmental changes is observed in case of an almost unchanged genetic background. Numerous spontaneous natural and experimental epimutations are observed. They have visible phenotypic manifestations and are stably inherited in generations of plants. The fundamental difference between epimutations and classical mutations is their reversibility. Such variability is supposed to allow plants in adapting to changing environmental conditions in a time too short for adaptive mutations to occur [11].

Phenotypic plasticity, namely, the ability of the genotype to change its expression and realise itself in different phenotypes in response to various external influences, determines the adaptation of organisms to temporal and spatial variations of the external environment [10].

The modular concept of phenotypic plasticity has been proposed. According to this concept, changes in the expression of traits occurring while growth and development, as well as under the influence of the external environment, appear at the level of modules [12].

The plasticity of the whole organism is a manifestation of all the responses of the individual modules and the interaction between them. Extensive theoretical and experimental researches of phenotypic plasticity in populations, at the interpopulation and interspecific levels are currently being carried out in order to clarify its significance in evolution, specialisation, population dynamics and survival in a heterogeneous environment [13].

The concept of plasticity has been emphasized as a general biological phenomenon that requires special attention to its environmental aspects, since a significant impact of the plasticity of organisms on the stability and local diversity of populations and communities is assumed by influencing energy transport, carbon cycles, the number of trophic levels, nutrient cycling and primary productivity. The prospect of plasticity research in the ecological aspect for further understanding of both the mechanisms of responses of organisms to the action of the abiotic and biotic environmental factors, and the influence of these responses on the relationship of organisms with each other and the environment has been highlighted [7].

Stable in yield and suitable for growing in different climatic conditions of the region varieties are of great importance for agriculture. In favourable conditions, greater preference is given to varieties with high potential productivity, in unfavourable and extreme conditions, the latter should be combined with sufficiently high environmental stability [8].

Phenotypic plasticity is believed to be realised within the normal response on the basis of metabolic and hormonal regulation of gene expression and provides two directions of the adaptation process: rapid acclimatisation in response to daily and seasonal fluctuations in environmental factors and long-term adaptation to moderate chronic exposure to adverse changes in environmental factors. As we have already noted, it has recently been pointed out that the key to the plasticity of plant responses to environmental signals must be the epigenetic system as a part of the transmission of the perceived external signal to changes in gene expression, which has the potential to maintain a stable memory across multiple cell generations [1].

The adaptability of the variety to various weather, soil and economic conditions has been called ecological plasticity [3]. Plasticity has been proposed as a term referring to an adaptive mechanism due to environmental conditions. A high plasticity index characterises plants that respond optimally to the heterogeneity of the environment [5].

As a result, the analysis of ecological plasticity and stability, enables finding out not only the diverse rate of response of growing conditions, but also identifying genotypes that can realise productivity with significant changes in environmental factors and ensure the most effective use and distribution of them [3].

Most researchers [14] believe that in order to obtain a reliable assessment of the adaptive potential of varieties, it is advisable to conduct their ecological testing in various environments using different static assessment methods.

The purpose of the research is to protect soybean crops from diseases is one of the key problems in the regions where soybeans are sown. The introduction into production of varieties with high field resistance to pathogens is the main reserve for increasing the productivity of this crop. In this regard, there is a need to research changes in the structure of phytopathogen populations and assess resistance to them.

Research methods. The researches were conducted during 2010-2021, which were contrasting in terms of hydrothermal regime and at variety testing points located in different edapho-climatic provinces of Ukraine. This ensured the study of the reaction of varieties according to the gradient of variability of environmental factors. Soil differences were represented by grey forest soils in Vinnytsia region, podzolic black soils in Poltava region, and typical black soils in Kyiv region

The object of the research is such soybean varieties: Amethyst, Hoverla, Artemida, Femida, Zolotysta, Vezha and Oriana, which are included in the State Register of varieties suitable for distribution in Ukraine. The research has been conducted according to the standard methodology [1].

Assessment of the indicators’ ecological plasticity and stability in terms of resistance to diseases (downy mildew and mosaic virus) was carried out in accordance with the method of Eberhart and Russell [8]. It is based on the calculation of two parameters: the coefficient of ecological plasticity or linear regression (bi) and the dispersion or stability variance (Si^2). The first indicates the response of the genotype under changes in growing conditions, and the second characterises the stability of the variety in various environmental conditions [8].

Due to the calculation results of the plasticity (bi) and stability parameters (Si2), the following grouping ranks have been distinguished for varieties: 1) indicators bi < 1, $Si^2 > 0$ − have better results in unfavourable conditions, unstable; 2) indicators bi < 1, $Si^2 = 0$ − have better results in unfavourable conditions, stable; 3) indicators bi = 1, $Si^2 = 0$ − respond well to improved conditions, stable; 4) indicators bi = 1, $Si^2 > 0$ − respond well to improving conditions, unstable; 5) indicators bi > 1, $Si^2 = 0$ − have the best results in favourable conditions, stable; 6) indicators bi > 1, $Si^2 > 0$ − have better results in favourable conditions, unstable.

Accurate assessment of the genotype by ecological plasticity and stability (adaptability) involves research of the peculiarities of resistant indicators to harmful objects (diseases) under changes in abiotic factors during the growing season. In our research, this chief requirement has been confirmed, and a significant difference in the hydrothermal coefficient has been determined (Fig. 1).

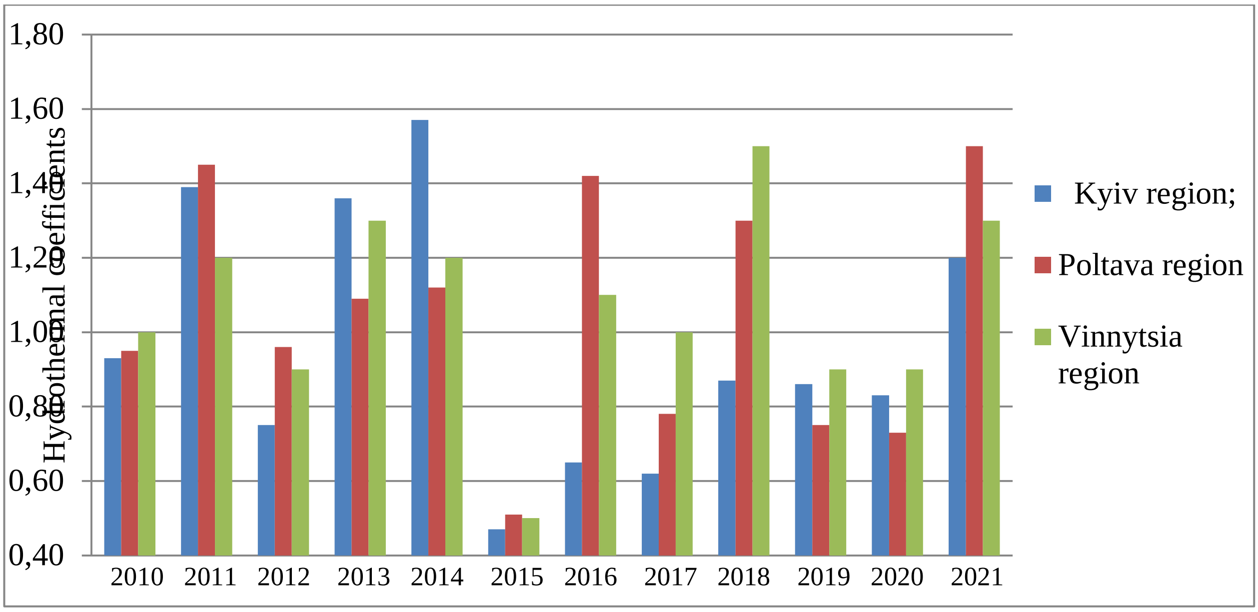

Fig. 1. Hydrothermal coefficients during the growing season (BBCH-10-99) (May-September) 2010–2021

Our research has shown that the intensity of development of downy mildew and mosaic virus depends not only on the genetic characteristics of soybean varieties, but also on factors related to the growing zone, especially the hydrothermal conditions of the region. The highest values of the hydrothermal coefficient were observed in 2011, 2013, 2014, 2021, where GTC = 1.39, 1.45, 1.2; 1,36, 1,09, 1,3; 1,57, 1,12, 1,2; 1,2, 1,5, 1,3. This affected the degree of damage by downy mildew, which was higher in years with significant moisture supply, namely in the specified growing seasons, while in dry years, in 2015, 2019, 2020, the development of the causative agent of this disease was minimal. However, under dry conditions, there was a higher level of mosaic virus damage due to the activation of viromorphic insects – aphids.

Research results. The results of the analysis of hydrothermal conditions, which developed during the research, were reflected in forming significant indicators of the influence of the genotype’s mean squares (according to the Fisher criterion) – 904.8, the conditions of the year – 261.2 and their interaction – 13.2, in the variance of the two-factor analysis of the dispersion analysis of the results of the varieties' resistance to downy mildew. The above mentioned factors enable evaluating soybean varieties using different approaches and methods for assessing their environmental plasticity and stability (Table 1).

Table 1

Ecological plasticity and stability of soybean varieties due to downy mildew resistance, % (2010-2021)

Variety	Downy mildew resistance, %	Coefficient			Stability variance (Si^2)	Hom-Homeo-staticity	Components	
	Year, trial sites	ecological plasticity (bi)	agronomic stability (As), %	Variances (V), %		Hom	a_i	λ_i
Amethyst	80.1	1.2	96.4	3.6	0.26	22.5	0,1	0.11
Hoverla	83.3	0.9	97.0	3.0	0.87	28.2	-0.005	0.23
Artemida	77.3	1.0	96.8	3.2	0.17	23.8	0.03	0.07
Femida	74.6	1.1	96.3	3.7	0.56	20.1	0.07	0.16
Zolotysta	78.5	1.0	96.8	3.2	0.21	24.5	0.03	0.08
Vezha	79.5	1.0	96.8	3.2	0.26	24.9	0.03	0.1
Oriana	84.1	0.8	97.5	2.5	1.04	33.2	-0.09	0.29
Factor	F ф	F т						
Variety	904.8	2,19						
Conditions	261.2	1,54						
Interaction variety – conditions	13.2	1,39						

source: formed on the basis of own research

In terms of downy mildew resistance in the conditions of a contrasting eco-gradient, the varieties Oriana – 84.1% and Hoverla – 83.3% stood out, which were distinguished by a conservative reaction to changes in the hydrothermal mode of cultivation, the coefficient of ecological plasticity (bi) < 1. Namely, soybean varieties Oriana and Hoverla provided high rates of downy mildew resistance, despite the improvement or deterioration of the hydrothermal regime in different eco-gradients of researches. These varieties showed the highest indicators of agronomic stability (As) – 97.5 and 97.0 % and the lowest coefficient of ecological variation (V, %) in our studies among the presented varieties – 2.5 and 3.0%. The ecological coefficient of variation characterises the degree of variability of the arithmetic mean (up to 10% − low, 11-20% − medium, and > 21% − high).

Homeostaticity is an important indicator of resistance to adverse environmental factors, that shows the ability of genotypes to reduce the effects of harmful biotic and abiotic environmental factors. High homeostatic (Hom) revealed itself in the soybean varieties Hoverla and Oriana – 28.2 and 33.2.

The Vezha variety was distinguished by the highest response to the improvement of environmental conditions, in which the coefficient of ecological plasticity (bi) = 1. Downy mildew resistance – 79.5%, relatively high values of stability variance (Si^2), which characterises the stability of its characteristics in a certain range of environmental situations or deviation from the direction of the coefficient of ecological plasticity is maximum close to 0. The coefficient of agronomic stability (A s) makes up 96.8%, and the coefficient of variation (V%) – 3.2%. The Amethyst variety was characterized by the highest environmental plasticity (bi) – 1.2, that is, the variety responds well to the improvement of the agricultural background of cultivation. Variana stability (Si^2) is maximum close to 0, the ecological coefficient of variation (V, %) – 3.6%, and the agronomic stability (A s) – 96.4%.

A thorough analysis of the assessment of soybean genotypes' ecological plasticity and stability [8] (Figure 2) showed that the varieties of the first (I) zone belong to genotypes with a high response to changes in growing conditions.

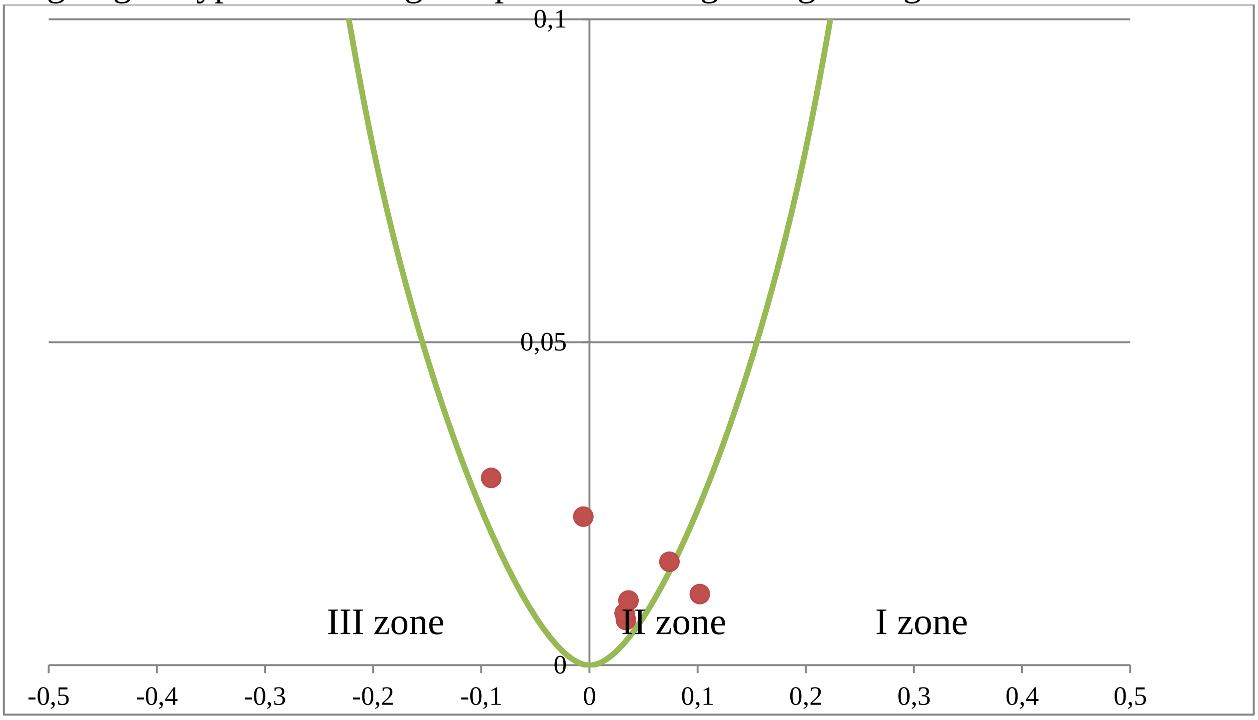

Fig. 2. Division of soybean varieties into classes due to plasticity (ai) and stability (λ) of downy mildew resistance

source: formed on the basis of own research

Namely, the varieties Amethyst and Femida should be recommended for cultivation in conditions of Intensive agriculture. However, in case of a low agricultural background, the indicators of downy mildew resistance of such genotypes are sharply reduced. The ecological plasticity of the varieties located coordinately in the second (II) zone remains at the level of medium plasticity, these varieties include the Artemida, Zolotysta and Vezha. In their turn, the varieties whose coordinates are located in the third (III) zone, primarily Oriana and, to a lesser degree, Hoverla, are more conservative in their response to changes in environmental conditions. According to this grouping, the first rank includes the varieties Hoverla and Oriana, the third rank – Artemida, Zolotysta and Vezha, the fifth rank – the Amethyst variety and the sixth rank – Femids.

The conducted two-factor variance analysis has made it possible to testify the significance (according to the Fisher criterion) of the influence of the genotype's mean squares − 2359.3 and edapho-climatic conditions − 213.8 and their interaction − 1.73 in a separate variance of statistical processing of mosaic virus resistance (Table 2).

In its turn, this has allowed us to assess genotypes in different ecogradients in terms of environmental plasticity and stability. Due to mosaic virus resistance, the following varieties stood out: Hoverla – 83.0%, Oriana – 82.8%, Amethyst – 80.7% and Vezha – 80.6%. It should be noted that according to the parameters of

Table 2

Ecological plasticity and stability of soybean varieties due to mosaic virus resistance, % (2010-2021)

Variety	Mosaic virus resistance, %	Coefficient			Stability variance (Si^2)	Homeo-staticity	Components	
	Year, trial sites	ecological plasticity (bi)	agronomic stability (As), %	Variances (V), %		Hom	a_i	λ_i
Amethyst	80.7	1.0	94,7	5.3	0.05	15.3	0.023	0.15
Hoverla	83.0	0.8	95,5	4.5	0.16	18.4	-0.16	0.14
Artemida	79.5	1.2	93,4	6.6	0.15	12.1	0.38	0.04
Femida	73.0	1.2	93.1	6.9	0.66	10.5	0.31	0.18
Zolotysta	79.6	1.0	94.7	5.3	0.04	14.9	0.02	0.15
Vezha	80.6	0.9	94.8	5.2	0.05	15.4	0.02	0.16
Oriana	82.8	0.9	95.3	4.7	0,42	17.7	-0.13	0.18
Factor	F ф	F т						
Variety	2359.3	2,19						
Conditions	213.8	1,54						
Interaction variety – conditions	1.73	1,39						

source: formed on the basis of own research ecological plasticity and stability (adaptability), the listed varieties belong both to genotypes with a good response to changes in growing conditions, the coefficient of ecological plasticity (bi) = 1 − Amethyst, and to the coefficient of ecological plasticity (bi), which are conservative in response to changes in the agricultural background of cultivation < 1 – Hoverla, Oriana and Vezha. These varieties provided the highest indicators of agronomic stability (As) from 94.7 to 95.5% and the lowest ecological coefficients of variation (V%) from 5.3 to 4.5%. Moreover, these varieties have the highest indicators of homeostaticity (Hom) from 15.3 to 18.4%, and according to the indicators of variance stability (Si^2), the listed genotypes are stable, since the stability variance is maximum close to 0.

A thorough analysis of the assessment of soybean genotypes' resistance to mosaic virus, presented graphically in Figure 3, testified that the varieties of the first (I) zone belong to the genotypes with a high response to changes in growing conditions, namely the Artemida and Femida varieties. Thus, such varieties should be recommended for cultivation in conditions of intensive agriculture.

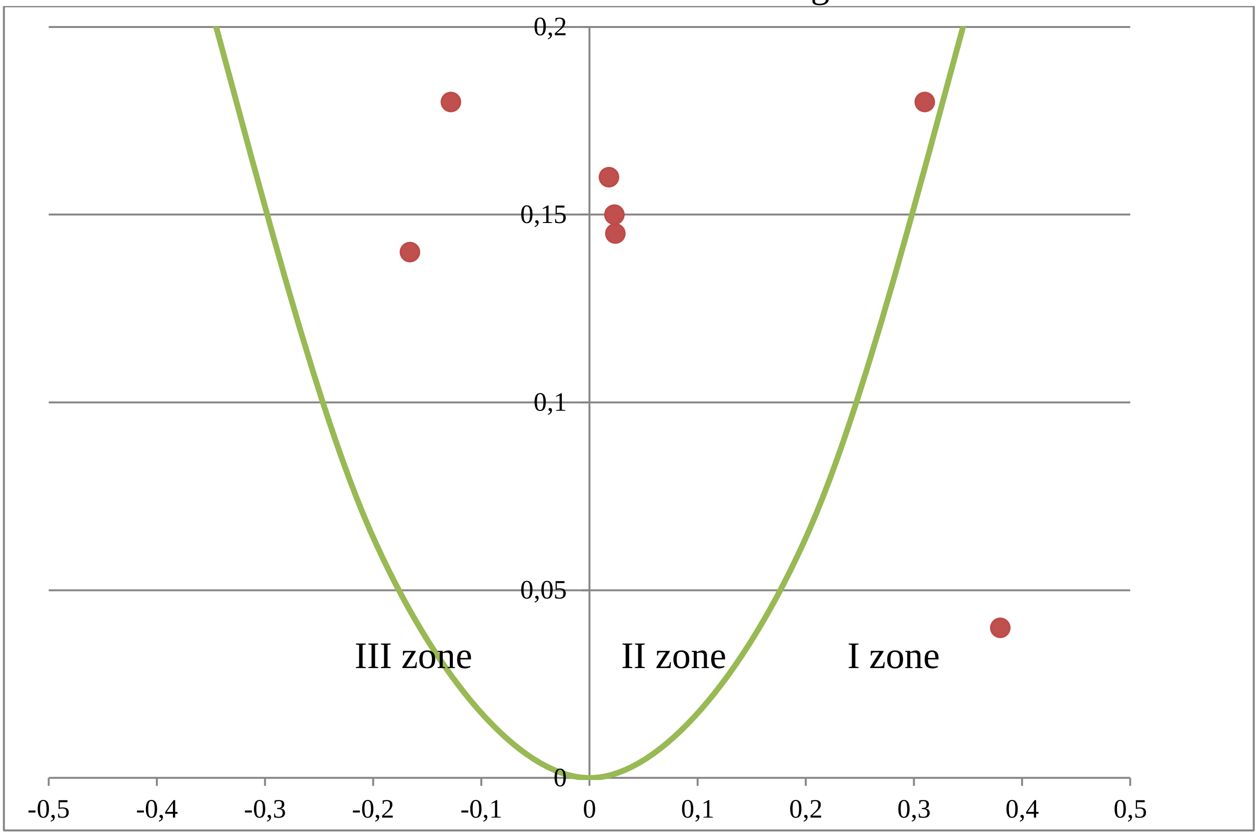

Fig. 3. Division of soybean varieties into classes due to plasticity (ai) and stability (λ) of mosaic virus resistance

source: formed on the basis of own research

However, on a low agricultural background, they are strongly affected by mosaic virus. The ecological plasticity of varieties located in the second (II) zone is at the level of average plasticity, typical for the Zolotysta and Amethyst soybean varieties. However, the varieties with coordinates located in the third (III) zone are more conservative in their response to changes in environmental conditions. They include the Hoverla, Oriana and Vezha varieties.

Consequently, in accordance with the above grouping, the Oriana and Hoverla varieties belong to the first rank, the Vezha variety – the second rank, the Amethyst and Zolotysta varieties – the third rank, the Artemida and Femida – the sixth rank.

Conclusions. Thus, the highest value for cultivation in different ecogradients under contrasting edaphic and hydrothermal conditions are varieties that have shown maximum indicators of resistance to downy mildew and viral mosaic. During the research period, the following varieties were noted with increased resistance in different ecogradients: Oriana – 84.1 and 82.8%, Hoverla – 83.3 and 83.0%, Amethyst – 80.1 and 80.7%, Vezha – 79.5 and 80.6%. At the same time, the Oriana and Hoverla varieties reacted little to changes in environmental conditions (hydrothermal and edaphic conditions), providing high stable resistance indicators, and the Vezha and Amethyst varieties were plastic and highly plastic, with a high response to changes in growing conditions. However, according to the comprehensive assessment of ecological plasticity and stability (adaptability), the varieties Oriana, Hoverla, Vezha and Amethyst showed the highest rates of resistance to downy mildew and viral mosaic during the period of research in the contrasting ecogradient and have the maximum correspondence of the genotype due to the conditions of existence that have developed for the implementation of resistant indicators due to the mentioned harmful objects.

Список використаної літератури у транслітерації / References

1. Mazur O., Kupchuk I., Biliavska L., Biliavskyi Yu., Voloshyna O., Mazur O., Razanov S. (2023). Ecological plasticity and stability of soybean varieties under climate change in Ukraine. *Acta fytotechnica et zootechnica*. Vol. 26 (4). P. 398-411. DOI: https://doi.org/ 10.15414/afz.2023.26.04.398-411. [in English].

2. Samovol O.P., Kondratenko S.I., Shtepa L.Yu., Uryupina L.M. (2020). Adaptive potential of lines of spicy-aromatic species of vegetable plants according to the content of vitamin C and quantitative traits that are structural components of productivity [Adaptyvnyi potentsial linii priano-aromatychnykh vydiv ovochevykh roslyn za vmistom vitaminu S ta kilkisnymy oznakamy, yaki ye strukturnymy komponentamy urozhainosti]. Ovochivnytstvo i bashtannytstvo − *Vegetable and melon growing*. Issue 68. P. 22-35. DOI: https://doi.org/10.32717/0131-0062-2020-68-22-35. [in Ukrainian].

3. Ivanyuk C.B., Shkatula Yu.M. (2013). Fitopatolohichna otsinka sortozrazkiv soi v umovakh Pravoberezhnoho Lisostepu Ukrainy [Phytopathological evaluation of soybean varieties in the conditions of the Right Bank Forest Steppe of Ukraine]. *Selektsiia i nasinnytstvo − Breeding and seed production*. Issue 103. 255-260. [in Ukrainian].

4. 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].

5. Peng H., Zhang J. (2009). Plant genomic DNA methylation in response to stresses: potential applications and challenges in plant breeding. *Progress in Natural Science*. Vol. 19. P. 1037–1045. URL: https://doi.org/10.1016/j.pnsc.2008.10.014. [in English].

6. Tétard-Jones C., Leifert C. (2011). Plasticity of yield components of winter wheat in response to cereal aphids. *NJAS: wageningen journal of life sciences*. Vol. 58. Issue 3–4. P. 139–143. URL: https://doi.org/10.1016/j.njas.2011.01.003. [in English].

7. Grogan S.M., Baenziger P.S., Anderson J., Byrne P.F. (2016). Phenotypic Plasticity of Winter Wheat Heading Date and Grain Yield across the US Great Plains. *Crop science.*Vol. 56. Issue 5. P. 21–35. URL: https://doi.org/10.2135/cropsci2015. 06.0357. [in English].

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

9. Wricke G. (1962). Uber eine Methode zur Erfassung der Okologischen Streubreite in Feldversuchen. Z. *Pflanzenzuchtuung*. Vol. 47. № 1. P. 92. [in English].

10. Finley K.W., Wilkinson G.N. (1963). The analysis of adaptation in a plant breeding programme. Austr. J. *Agric*. Vol. 6. P. 742–754. URL:http://dx.doi.org/ 10.1071/AR9630742 [in English].

11. Lachmann M., Jablonka E. (1996). The inheritance of phenotypes: an adaptation to fluctuating environments. *Journal of Theoretical Biology*. Vol. 181. Issue 1. P. 1–9. [in English].

12. Kroon de H., Huber H., Stuefer J.F., Groenendael van J.M. (2005). A modular concept of phenotypic plasticity in plants. *New Phytologist*. Vol. 166. № 1. P. 73–82. URL : https://doi. org/10.1111/j.1469-8137.2004.01310.x. [in English].

13. Schneider R.F., Meyer A. (2017). How plasticity, genetic assimilation and cryptic genetic variation may contribute to adaptive radiations. *Molecular Ecology*, Vol. 26. Issue 1. P. 330–350. URL :https://doi.org/10.1111/mec.13880 [in English].

14. Schrey A.W., Alvarez M., Foust C.M., Kilvitis H.J., Lee J.D.,Liebl A.L., Martin L.B., Richards C.L., Robertson M. (2013). Ecological epigenetics: beyond MS-AFLP. *Integrative and Comparative Biology*. Vol. 53. Issue 2. P. 340–350. URL: https://doi. org/10.1093/icb/ict012 [in English].

АНОТАЦІЯ

ЕКОЛОГІЧНА ПЛАСТИЧНІСТЬ І СТАБІЛЬНІСТЬ СОРТІВ СОЇ ЗА УМОВ ВИРОЩУВАННЯ У РІЗНОМУ ЕКОГРАДІЄНТІ

У світовому землеробстві хвороби призводять до недобору зерна біля 135 млн т щорічно. Встановлено, що використання лише одних стійких сортів відповідає рівною мірою збільшенню посівних площ на 15–20 %, а їхнє впровадження знизило б необхідність у застосуванні приблизно до 14-15 тис. т пестицидів. Так, впровадження еколого-адаптивних сортів дозволить зменшити антропогенне навантаження на агроценози завдяки вищій стійкості генотипів до патогенів.

Наведено результати досліджень оцінки сортів сої за адаптивністю (екологічною пластичністю і стабільністю) у різних ґрунтово-кліматичних умовах, а також за *стійкістю до хвороб (пероноспороз, вірусна мозаїка). Проведено ранжування сортів сої за екологічною пластичністю і стабільністю відповідно до їхніх реакції на умови навколишнього середовища. Наші дослідження показали, що інтенсивність розвитку пероноспорозу й вірусної мозаїки залежать не тільки від генетичних особливостей генотипів, а й від чинників, які пов'язані із зоною вирощування, особливо з гідротермічними й едафічними умовами регіону. Найвищою цінністю для вирощування у різному екоградієнті за контрасних едафічних і гідротермічних умов є сорти, які проявили максимальні показники стійкісних характеристик до пероноспорозу і вірусної мозаїки. З підвищеною стійкістю упродовж періоду досліджень у різному екоградієнті відзначилися такі сорти: Оріана – 84,1 і 82,8 %, Говерла – 83,3 і 83,0 %, Аметист – 80,1 і 80,7 %, Вежа – 79,5 і 80,6%. Водночас сорти Оріана і Говерла мало реагували на зміну умов навколишнього середовища (гідротермічні й едафічні умови), забезпечуючи високі сталі показники стійкості, а сорти Вежа та Аметист − до пластичних і високопластичних, з високим відкликом на зміну умов вирощування.*

Ключові слова: *екологічна пластичність, адаптивність, екоградієнт, стабільність, умови середовища, гідротермічний режим, соя.*

Табл. 2. Рис. 3. Літ. 14.

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