UDC 633.112.1:631.52

Productivity and homeostaticity of collection samples of spring wheat

Demydov O.[1], Khomenko S.[2], Chuhunkova T.[3], Fedorenko I.[4]

*V. M. Remeslo Myronivka Institute of Wheat of NAAS, 68 Tsentralna Str., Tsentralne village, Myronivka region, Kyiv oblast, 08853, Ukraine; e-mail: [1]mwheats@ukr.net, [2]*homenko.mip@ukr.net, [3]t.chugunko@gmail.com, [4]ira_mip@ukr.net*

The purpose. To determine long-term average level of statistical parameters of productivity, homeostaticity and selection worth of samples of collection spring soft and hard wheat for use as new sources of economic-useful attributes in selection programs. Methods. Field, analytical, mathematical statistics with use of basic and special statistics and criteria. Results. Results of 10-years researches of collection of spring wheat gained from National center of genetic resources of plants of Ukraine (V. Yuriev Institute of plant industry of NAAS, Kharkiv), international selection centers CIMMYT and ICARDA are presented. Analysis of statistical parameters of productivity of collection samples of spring soft wheat from record plots in 1 m2 has shown that for years of researches it was on average at the level of 340,3 g/m2, spring hard wheat — 309,6 g/m2. Factor of variation of this index was at average statistical level and made accordingly 17,1 and 16,8%. The maximum productivity for years of researches was observed in 2014, the lowest level of productivity was fixed in stressful on weather environment 2011 and 2013. Assessment of homeostaticity showed that among collection samples of spring soft wheat high elasticity was characteristic to grades Turbo, Aletch (DEU), Alikat, Norwel (CAN), Prohresyvna (UKR), spring hard wheat — Asanhali, Boshan (KAZ), Yazi 13 (MEX). Index homeostaticity of these and other selected grades essentially exceeded the control. Digital values of complex index of selection worth of these grades also were high. Conclusions. On the basis of long-term (2007 – 2016) researches of collection spring soft and hard wheat, which annually cultivate in Myronivky institute of wheat of NAAS, statistical parameters of productivity of samples are specified. It was shown that the factor of variation on average did not exceed 20%. Collection samples were selected with high level of homeostaticity and selection worth, which can be used as sources of economic-useful attributes at creation of high-yielding varieties of spring wheat.

Key words: *Triticum aestivum L., Triticum durum Desf., selection worth, sources of economic-valuable attributes.*

DOI: https://doi.org/20.31073/agrovisnyk201909-07

Plant genetic resources play an important role in ensuring the food, economic, environmental and social security of mankind in general and in each country in particular. Therefore, the effective use of global collections of plants, their preservation in a viable state and genetic authenticity, comprehensive study on economic and useful features is relevant and creates the basis for economic development of present and future generations in Ukraine [1]. As practice shows, purposeful introduction of new starting material with the required level of manifestation of hereditary traits, especially plant productivity, contributes to the increase of genotypic variability, creation of high yielding, well adapted to different natural zones of wheat varieties [2].

The V. M. Remeslo Myronivka Institute of Wheat of NAAS established cooperation and exchange of seed material with international breeding centers of Asia, America and scientific institutions of other countries that have their own collections of wheat [3]. Over the period from 1993 to 2017, more than 5,000 spring wheat numbers of different ecological and geographical origins were investigated, foremost, the varieties put on the State Register of Plant Varieties Suitable for Dissemination in Ukraine, as well as samples of foreign breeding [4]. This paper presents the results of experimental studying accessions of world collection of bread and durum spring wheat obtained from the National Center for Plant Genetic Resources (Plant Production Institute nd. a V. Ya. Yuriev of NAAS, Kharkiv), International Breeding Centers CIMMYT and ICARDA, which were implemented during 2007–2016.

The purpose of the research study is to determine, based on long-term studying bread and durum spring wheat collection, the total yield and the level of homeostaticity and breeding value of varieties from various countries worldwide in order to enrich the Ukrainian varieties with new germplasm and use them in breeding programs of MIW.

Materials and methods. As starting material there were used 535 spring wheat accessions (346 of bread and 189 of durum wheat), which were grown in the fields of the MIW breeding crop rotation. Soybean was the preceding crop. The sample area was 1 m^2. The agrotechnical measures for preparing soil for sowing complied with the recommendations as for spring wheat cultivation. Statistical indices were calculated: arithmetic mean ($\bar{x}$), minimum values (x_{min}), maximum values (x_{max}), range of variation ($R = x_{max}-x_{min}$), coefficient of variation (V, %) by B.A. Dospekhov [5]. The index of

homeostaticity (Hom) and breeding value (Sc) was determined by the formulas of V.V. Khangildin [6].

Results. Productivity is determined by genetic characteristics of plant and its ability to realize them in specific growing conditions [7, 8]. Yield per unit area is the final indicator characterizing economic and breeding value of plant material studied. Analysis of statistical parameters of yield of spring wheat accessions over 10 years of the study (Table 1) showed that during this period the coefficient of variation (less than 20 %) was not characterized by high variability, but was at an average level. This indicates a sufficiently high and stable genotypic component in the formation of plant productivity for all years of the research. At the same time, it was found that the yield, which actually characterizes the reaction of genotypes to external, weather conditions of cultivation, was the highest in 2014 (bread spring wheat – 463 g/m^2 with variation from 337 g/m^2 to 581 g/m^2, and durum spring wheat – 364 g/m^2 with variation from 304 g/m^2 to 426 g/m^2). Rather low level of yield was recorded in 2011 and 2013, which during the growing season were characterized by unfavourable weather conditions.

1. Statistical parameters of spring wheat yield, 2007–2016

Statistical parameter	Yield, g/m^2
Bread spring wheat	
$\bar{x}$	340.3
min	308.0
max	463.0
R	155.0
V, %	17.1
Durum spring wheat	
$\bar{x}$	309.6
min	245.0
max	364.0
R	119.0
V, %	16.8

Homeostaticity is the indicator that combines average yield and adaptive rate for response of varieties (genotypes) to limiting environmental factors. This statistical indicator is quite widely used in research of spring and winter wheat, spring barley and other crop varieties [9–12]. Adaptation of plants is associated with the specific influence of environmental factors, which is determined, on the one hand, by their variety, dose, duration of exposure and on the other hand, by biological features of the species, its functional state [13]. In addition, when performing breeding programs, as a rule, there is determined breeding value for the genotypes involved in crossing. It is shown that the higher the homeostaticity and breeding value levels, variety, accession or breeding line is the more stable in changing weather conditions of cropping season.

Spring wheat accessions were studied for their homeostaticity and breeding value, the best of which are presented in Table 2.

2. Homeostaticity and breeding value of spring wheat accessions, 2007–2016

Variety, accession	Country of Origin	Hom	Sc
Bread spring wheat			
Elehiia myronivska (St)	**UKR**	**5093.6**	**455.7**
Turbo	DEU	8105.9	552.3
Aletch	DEU	7109.3	533.9
Alikat	CAN	6036.5	526.7
Norwell	CAN	5801.4	484.6

Prohresyvna	UKR	5732.0	528.9
TW 21311	GBR	5701.0	494.4
AC Corinne	CAN	5601.2	501.3
Quattro	DEU	5509.0	534.9
Triso	DEU	5501.2	521.4
Zebra	POL	5266.2	527.7
Durum spring wheat			
Spadshchyna (St)	**UKR**	**4801.2**	**421.3**
Asangali	KAZ	5543.2	491.2
Boshak	KAZ	5385.2	485.3
Saratovskaya zolotistaya	RUS	5256.2	496.4
Yazi 13	MEX	5244.2	459.1
Plenty	CAN	5243.2	466.4
AC Melita	CAN	5234.2	447.7
Nashchadok	UKR	5167.2	500.8
Nakat	UKR	5156.2	487.6
Hordeiforme1734	UKR	5101.2	495.2
Omskaya stepnaya	RUS	5003.2	467.5

This assessment allows us to analyze the ability of genotypes to respond to adverse environmental conditions in different periods of plant growth and development, to determine the possibility of their use as sources of useful traits in the implementation of scientific programs for the creation of highly productive adapted varieties.

The accessions of bread spring wheat Turbo, Aletch (DEU), Alikat, Norwel (CAN), Prohresyvna (UKR), etc. and the accessions of durum wheat Asangali, Boshak (KAZ), Yazi 13 (MEX) were the most homeostatic. The breeding value of the samples selected also significantly exceeded the standard.

Conclusions

Comprehensive long-term studies of bread and durum spring wheat collection have made it possible to analyze statistical parameters of yield for 2007–2016 and to identify the accessions with high levels of homeostaticity and breeding value. In the process of breeding work, based on the results obtained, work trait collection of accessions by complex or individual positive traits has been formed, which is widely used to create high-yielding varieties with wide adaptive capacity. The bread spring wheat varieties Panianka, Oksamyt myronivskyi, Bozhena, MIP Oleksandra, as well as durum spring wheat variety MIP Raiduzhna which have been put on the State Register of Plant Varieties Suitable for Dissemination in Ukraine in 2015, 2017, 2018 are the examples of practical implementation of long-term research of accessions.

References

1. Riabchun, V.K., Kuzmyshyna, N.V, Bohuslavskyi, R.I., Bondarenko, V.M., Muzafarova, V.A., Kholod, S.M., & Kurdin, O.O. (2014). Shliakhy zbahachennia natsionalnoho henbanku roslyn Ukrainy. [Ways of enrichment of the National Plant Genebank of Ukraine]. *Plant Genetic Resources, 14*. 5–21 [In Ukrainian].

2. Riabchun, V.K., Kuzmyshyna, N.V, & Bohuslavskyi, R.I. (2012). Introduktsiia zrazkiv henofondu roslyn do natsionalnoho banku henetychnykh resursiv roslyn Ukrainy. [Introduction and useing efficiency of plant gene pool samples in National Bank of Plant Genetic Resources of Ukraine*]. Plant Genetic Resources, 10/11,* 17–24 [In Ukrainian].

3. Kharchenko, M.V., Khomenko, S.O., & Chepur, H.T. (2012). Kochmarskyi V.S. (Eds). Studying collection material of bread and durum spring wheat forafronomic traits. *Myronivskyi instytut pshenytsi imeni V.M. Pemesla Natsionalnoi akademii ahrarnykh nauk Ukrainy (1912–2012)*. [The V.M. Remeslo Myronivka Institute of Wheat of NAAS Ukraine]. Myronivka, 346–352 [In Ukrainian].

4. Kobyzeva, L.N., Bezuhla, O.M., & Bohuslavskyi, R.I. (2010). Zbahachennia natsionalnoho henbanku roslyn Ukrainy zrazkamy henofondu zernobobobykh kultur vitchyznianoho ta zarubizhnoho pokhodzhennia. [Enrichment of the the National Plant Genebank of Ukraine with the samples of gene pool of leguminous crops of domestic and foreign origin]. *Plant Genetic Resources, 8,* 9–20 [In Ukrainian].

5. Dospekhov, B.A. (1976). *Metodika polevogo opyta: (S osnovami statisticheskoy obrobotki rezultatov issledovaniy)* [Methodology of field experiments (with the basics of statistical processing of research results)]. Moscow: Kolos. [In Russian].

6. Rokitskiy, P.F. (1973). *Biologicheskaya statistika* [Biological statistics]. Minsk: Vysheyshaya shkola. [In Russian].

7. Bozhko, L.Yu. (2013). *Otsinka vplyvu ekstremalnykh yavyshch na produktyvnist silskohospodarskykh kultur* [Evaluation of the impact of extreme events on crop productivity]. Handbook Odesa: Ekolohiia. [In Ukrainian].

8. Khakhula, V.S., Ulich, L.I., & Ulich, O.L. (2013). Vplyv ekolohichnoho chynnyka na realizatsiiu selektsiinoho potentsialu novykh sortiv pshenytsi ozymoi miakoi. [The influence of environmental factors on the implementation of new varieties of soft winter wheat breeding potential]. *Agrobiology, 11*, 44–49. [In Ukrainian].

9. Potanin, V.G., Aleinikov, A.F., & Stepochkin, P.I. (2014). Novyy podkhod k otsenke ekologicheskoy plastichnosti sortov rasteniy [A new approach to estimation of the ecological plasticity of plant varieties]. *Vavilov Journal of Genetics and Breeding*, *18*, 3, 548–552. [In Russian].

10. Burdeniuk-Tarasevych, L.A., Dubova, O.A., & Khakhula, V.S. (2012). Otsinka adaptyvnoi zdatnosti sortiv pshenytsi ozymoi miakoi v umovach Lisostepu Ukrainy. [Evaluation of the adaptive capacity of bread winter wheat varieties under conditions of the Forest-Steppe of Ukraine]. *Plant Breeding and Seed Production, 101,* 3–12. [In Ukrainian].

11. Solonechnyy P.N., Kozachenko M.R., Vas'ko N.I., et al. (2014). Produktivnost sortov yachmenya yarovogo v ekologicheskom sortoispytanii. [Productivity of spring barley varieties under ecological testing]. *Journal Zernobobovye i krupianye kultury, 4* (12), 96–99. [In Russian].

12. Moskalets, V.V., Pisarenko, P.V., Moskalets, T.S., & Moskalets, V.I. (2014). Agroekologicheskaya kharakteristika gtnotipov zernovykh kolosovykh kultur Nosovskoy sekektsionno-opytnoy stantsii. [Agroecological characteristics of ear grain genotypes of the Nosovka selection experimental station]. *Bulletin of Kurgan State Agricultural Academy, 2,* 45–47. [In Russian].

13. Sharma, R.C., Morgounov, A.I., Braun, H.J., et al. (2012). Yield stability analysis of winter wheat genotypes targeted to semi-arid environments in the international winter wheat improvement program. *International Journal of Plant Breeding*, *6* (1), 7–13.