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Evaluation of Winter Triticale Collection on the Stability of the Manifestation of the Grain Yield Trait

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Abstract: The aim of the study was to establish correlations between the main traits of grain productivity and quality, as well as evaluate collection samples of winter triticale for plasticity and yield stability. Material and methods. The research was conducted during 2017–2019 at the NSC "Institute of Agriculture of NAAS" (Ukraine, Kyiv region). The objects of the study were collection samples of winter triticale. During the study were used field, laboratory, measuring-weight and mathematical-statistical research methods. Main results. Correlation analysis showed a strong positive relationship between the weight of grain from the plant with the weight of grain from the ear (r = 0.78), the average - with the number of grains from the plant and ear and the weight of 1000 grains (r = 0.47; 0.63 and 0.37) and weak - with starch content (r = 0.14). A negative correlation of the average strength was found with the protein content in the grain (r = −0.37). It was found that there is a weak positive correlation between the starch content and the weight and number of grains, which proves the possibility of creating forms with high grain productivity and high starch content. The most favorable conditions for the formation of high grain yields (average collection 4.97 t/ha) was in 2017, and the worst - in 2019 (4.09 t/ha). The studied varieties and samples were different in the level of plasticity and stability.

Keywords: Weight and Number of Grains, Weight of 1000 Grains, Protein and Starch Content, Regression Coefficient, Standard Deviation, Index of Year Conditions

1. Introduction

In modern agriculture, the variety is an independent factor in increasing yields and is crucial for obtaining high and stable yields. The contribution of breeding in increasing crop yields over the last decade reaches 25-60% [1-3]. New varieties of cereals must meet all the requirements of modern production and, above all, have a high level of yield. The amount of grain productivity in triticale, as in other crops, depends on the degree of development of each of the structural elements [4-7]. The use in the breeding work of the identified features of the manifestation of the elements of the structure of productivity allows improving the effectiveness of breeding according to the specified parameters and thus the efficiency of creating new varieties.

The value of each variety is determined by its plasticity and stability, or the ability to form a certain level of yield in different environmental conditions [8-14]. It is important to take into account the different reaction of varieties on changes in conditions when choosing the place and cultivation technologies, which allows to best realize their genetic potential. Plasticity is characterized by a regression coefficient (b_i), which reflects the reaction of the variety on changes in environmental conditions and allows predicting the manifestation of the studied characteristics of different varieties in the appropriate conditions. Stability (standard deviation - S_i^2) characterizes how reliably the variety corresponds to the plasticity indicated by the regression coefficient [15-19].

The purpose of the study: to establish the strength and direction of the links between the main traits of productivity and quality of grain and to evaluate the collection samples of winter triticale for plasticity and stability of yield.

2. Material and Methods

The research was conducted during 2017–2019 at the National Scientific Center "Institute of Agriculture of NAAS" (Ukraine, Kyiv region). The experimental plots were placed on the fields of breeding crop rotation located in the Kyiv region, the soils of the fields belong to sod-medium-podzolic sandy loams. The years of research on the temperature regime generally exceeded the value of the average long-term norm, and the amount of precipitation was characterized as arid. Cultivation was carried out on a single agrotechnical background according to the generally accepted technology for winter triticale. The collection of winter triticale was represented by breeding numbers and varieties of breeding NSC "Institute of Agriculture NAAS" (Ukraine) and foreign varieties (Poland, Russian). Field, measuring, weighing and laboratory research methods were used to evaluate the collection material. Analysis of protein and starch content in grain was performed by infrared spectrometry on the Infratec 1241 device. To confirm the statistical reliability of the obtained data used correlation analysis using the computer program StatSoft STATISTICA 8. The calculation of plasticity and stability was performed by method of Eberhart S. A. and Russel W. A. [20].

3. Results and Discussions

Determining the strength and direction of the links between valuable economic characteristics helps to optimize the processes of breeding and analysis of source material and thus improve the effectiveness of work in the initial stages of the breeding process. Using correlation analysis, the relationships between traits that determine grain productivity and grain quality in winter triticale collection samples were investigated. In the weight of grain from the plant, the strongest positive correlation was established with the weight of grain from an ear (r = 0.78), medium strength - with the number of grains from a plant and ear and the weight of 1000 grains (r = 0.47; 0.63 and 0.37, respectively) and weak - with starch content (r = 0.14). The average negative correlation was found with the grain content of protein (r = −0.37). The strength and direction of the correlations between the grain weight from the ear and other traits were similar to the correlation of grain productivity with the same traits.

Table 1. *Matrix of paired correlation coefficients (r) between traits of grain productivity and quality in collection samples of winter triticale, 2017–2019.*

Traits		Grain weight		Number of grains		Weight of 1000 grains	Protein content
		From a plant	From an ear	From a plant	From an ear		
Grain weight from an ear		0.78*	–	–	–	–	–
Number of grains	from a plant	0.47*	0.34*	–	–	–	–
	from an ear	0.63*	0.87*	0.69*	–	–	–
Weight of 1000 grains		0.37*	0.26	−0.59*	−0.21	–	–
Protein content		−0.37*	−0.27	−0.29	−0.29	−0.01	–
Starch content		0.14	0.10	0.23	0.20	−0.10	−0.64*

*significant at $P_{0.05}$

Table 2. *Plasticityand stability of varieties and collection samples of winter triticale by grain yield.*

Collection sample	Yield, t / ha				Plasticity, b_i	Stability, S_i^2
	2017	2018	2019	average		
Molfar - Standart	4.78	4.21	3.77	4.25	1.82	0.12
181	5.72	4.82	4.98	5.17	2.39	0.21
101	5.33	5.23	4.81	5.12	1.50	0.08
185	5.52	5.16	4.66	5.11	1.81	0.12
219	5.61	5.11	4.54	5.09	1.97	0.14
Arystokrat	5.39	5.03	4.60	5.01	1.77	0.12
87	5.23	5.15	4.54	4.97	1.45	0.08
Maetok Polissia	5.04	5.08	4.44	4.85	1.29	0.06
123	4.99	4.64	4.72	4.78	1.66	0.10
Soloduk	5.53	4.51	4.21	4.75	2.46	0.22
141	5.44	4.52	4.27	4.74	2.34	0.20
217	5.39	4.48	4.30	4.72	2.32	0.20
Petrol	5.10	4.62	4.44	4.72	1.81	0.12
Lubomyr	5.38	4.47	4.22	4.69	2.31	0.20
Average for the collection	4.97	4.38	4.09	4.48	–	–
I_i	0.49	-0.10	-0.39	–	–	–

The correlation of the number of grains per plant was established: with the number of grains per ear - positive of medium strength (r = 0.69), with the weight of 1000 grains - negative average (r = −0.59), with protein content in grain - from capacitive weak (r = −0.29), with starch content - positive weak (r = 0.23). The number of grains from an ear has a weak positive correlation with the starch content (r = 0.20), and with the weight of 1000 grains and the protein content - a weak negative (r = −0.21 and −0.29). No significant correlations were found between the weight of 1000 grains and the protein and starch content. A negative relationship of medium strength between protein and starch content was determined (r = −0.64). It is important that there is a weak positive correlation between the starch content and the weight and number of grains. This

proves the possibility of creating forms with high grain productivity and high starch content.

In order to assess the level of plasticity and stability of the grain yield, the winter triticale collection was analyzed. Table 2 shows the indicators of the best yields of varieties and collection samples, which on average for three years exceeded the standard variety Molfar by 0.44-0.92 t / ha.

The conditions of the research years were differed in air temperature, rainfall and their distribution during the winter triticale growing season, as well as in soil fertility, which affected the yield of varieties and breeding numbers and allowed to determine their plasticity and stability. The most favorable year for the formation of high grain yield (average collection 4.97 t / ha) was 2017, which is confirmed by the value of the index of conditions of the year (I_j = 0.49). In 2018, the value of the index of environmental conditions decreased to -0.10, respectively, the yield was also lower and averaged 4.38 t / ha. The most unfavorable for the growth and development of winter triticale in weather conditions was 2019 with an index of environmental conditions -0.39, so the lowest yield for all years was obtained, which averaged 4.09 t / ha in the collection.

High variability of grain yield over the years of research was found in samples 217, Lubomyr, 141 and Soloduk, in which the difference between the maximum and minimum value ranged from 1.09 to 1.32 t / ha. The lowest variability was observed in samples 123, 101 and Maetok Polissia with a difference in years of 0.35, 0.52 and 0.60 t / ha, respectively. Of particular value among high-yielding are varieties with high regression and low standard deviation, which are characterized by a strong response to improved growing conditions and yield stability. Such genotypes include samples 185, 219, Petrol and Arystokrat with yields up to 5.11 t / ha, which had values of bi from 1.77 to 1.97, and S_i^2 - from 0.12 to 0.14. Higher values of both b_i (from 2.31 to 2.46) and S_i^2 (from 0.20 to 0.22) were determined in samples 181, 141, 217, Soloduk and Lubomyr with yields up to 5.17 t / ha, which shows their high ductility, but relatively less stability. Samples 101, 87, 123 and Maetok Polissia, which had a yield level from 4.78 to 5, were characterized by lower plasticity in terms of the regression coefficient (1.29–1.66) and at the same time high stability (0.06-0.10). These samples are less responsive to improved growing conditions, but in adverse weather conditions are better able to realize their genetic potential than more highly plasticity.

The reaction of collection samples, characterized by different parameters of plasticity and stability, to changes in growing conditions is clearly demonstrated by yield regression lines (Figure 1). The greater the value of b_i, i.e. the higher the plasticity of the sample, the steeper the slope of the regression line.

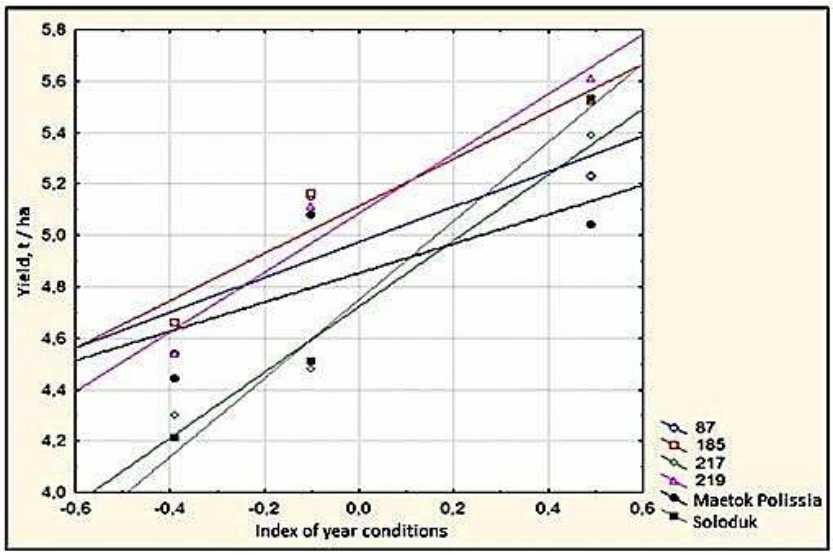

Figure 1. *Yield regression lines of triticale varieties and collection samples.*

Collection samples 185 and 219 have a fairly strong response to environmental conditions. However, sample 219 reacts more strongly to changes in growing conditions: when the conditions worsen, the grain yield of this sample decreases more, and with improvement - increases more than in sample 185. Samples Soloduk and 217 with high values of regression coefficients (2.46 and 2.32), are characterized by the greatest plasticity and have, accordingly, a very steep slope of the regression line. However, compared to other samples, they are less stable. Of these two samples, the Soloduk variety is more sensitive to changes in the conditions of the year. Samples 87 and Maetok Polissia are characterized by relatively low plasticity and high yield stability and have the most sloping regression line. These samples are weakly responsive to improved growing conditions. Thus, in samples 87 and 185 for the value of the index of conditions of the year -0.6 grain yield is the same, but when the index increases to 0.6, the sample 185 in terms of yield significantly exceeds sample 87.

4. Conclusions

Grain productivity of winter triticale plants has a strong positive correlation with the weight of grain from an ear (r =

0.78), medium strength - with the number of grains from a plant and ear and the weight of 1000 grains (r = 0.47; 0.63 and 0.37, respectively), weak - with starch content (r = 0.14) and medium negative - with protein content in grain (r = −0.37).

A negative relationship of medium strength between protein and starch content was determined (r = −0.64). The correlation between all other studied traits and starch content is weak, which allows us to conclude that it is possible to create forms of triticale with a high content of starch in the grain, regardless of the level of manifestation of other traits.

It was found that samples 185, 219 and varieties Petrol and Arystokrat are characterized by a strong response to improved growing conditions and yield stability, which is confirmed by high values of the regression coefficient (b_i - from 1.77 to 1.97) and low standard deviation (S_i^2 - from 0.12 to 0.14).

Samples 181, 141, 217 and varieties Soloduk and Lubomyr have higher values of both b_i (from 2.31 to 2.46) and S_i^2 (from 0.20 to 0.22), which shows their high ductility, but relatively less stability. Samples 101, 87, 123 and Maetok Polissia were characterized by lower plasticity (1.29–1.66) and at the same time high stability (0.06–0.10), which are less responsive to the improvement of growing conditions.

References

[1] Marenych M. M. (2012). Regularities of formation of winter wheat yield in conditions of unstable moisture. Bulletin of Kharkiv National Agrarian University. Series "Crop production, breeding and seed production, fruit and vegetable growing and storage", 2, 125-132.

[2] Antonaitus S. S., Mikhieiev V. H. (2018). Yield of winter wheat varieties. Bulletin of Kharkiv National Agrarian University. Series "Crop production, selection and seed production, fruit and vegetable growing and storage", 2, 155-161.

[3] Petrova I. F. (2013). The introduction of new varieties as the main factor in the intensification of grain production. Collection of sciences works. Tavriya State Agrotechnological University, 2 (3), 277-285.

[4] Shchypak H. V., Sviatchenko S. I., Nepochatov M. I. (2014). Evaluation of winter triticale cultivars by ecological plasticity and stability of the main characteristics of productivity. Bulletin of the Central Executive Committee of the APV of the Kharkiv region, 16, 247-254.

[5] Samofalov A. P., Podgornyi S. V., Skripka O. V. (2018). Optimal parameters of productivity elements of a model cultivar of soft winter wheat of intensive type for the conditions of the south of the Rostov region. Grain farming in Russia, 6 (60), 64-68.

[6] Bahan A. V. (2017). Variability of quantitative characteristics of spring wheat depending on varietal properties. The latest agricultural technologies: theory and practice: abstracts of international reports. scientific practice. conference dedicated. 175-176.

[7] Delchev G. (2018). Changes in the productivity and the yield structural elements in some spring crops sown on damaged by frost crops of winter oilseed canola. Production systems, 7 (3). URL: https://agriscitech.eu/changes-in-the-productivity-and-the-yield-structural-elements-in-some-spring-crops-sown-on-damaged-by-frost-crops-of-winter-oilseed-canola/

[8] Diordiieva, I. & Riabovol, Ia & Riabovol, L. & Kotsiuba, S.. (2018). Ecological plasticity and stability of new spelt wheat samples on yield capacity. Science and education a new dimension, VI (172), 7-9. DOI: 10.31174/SEND-NT2018-172VI20-01.

[9] Grogan S., Anderson J., Baenziger P., Frels K., Guttieri M., et al. (2016). Phenotypic plasticity of winter wheat heading date and grain yield across the us great plains. Crop science, 56. DOI 10.2135/cropsci2015.06.0357.

[10] Peltonen-Sainio P., Jauhiainen L., Sadras V. (2011). Phenotypic plasticity of yield and agronomic traits in cereals and rapeseed at high latitudes. Field Crops Research, 124, 261-269. DOI 10.1016/j.fcr.2011.06.016.

[11] Rolando O., Torres A. (2018). Yield stability of selected rice breeding lines and donors across conditions of mild to moderately severe drought stress. Field crops research, 220, 37-45. https://doi.org/10.1016/j.fcr.2016.09.011

[12] Sapega V. A. (2017). Productivity and parameters of intensity and stability of spring barley varieties. Grain farming in Russia, 3, 36-39.

[13] Vasilenko A. A., Solonechnyj P. N., Ponurenko S. G. (2019). Evaluation of breeding material for peas (Pisum sativum L.) in various calculation systems (regression, biplot models). Bulletin of the Belarusian State Agricultural Academy, 2, 12-16.

[14] Prysiazhniuk L. M., Topchii O. V., Dymytrov S. H., Kyienko Z. B.,. Chernii S. O. (2020). Estimation of adaptive potential of varieties of spring rape (Brassica napus L.) in different soil-climatic zones of Ukraine. Plant Varieties Studying and Protection, 16 (2), 144-153. DOI: https://doi.org/10.21498/2518-1017.16.2.2020.209354

[15] Kirchev H., Georgieva R. (2017). Genotypic plasticity and stability of yield components in triticale (x Triticosecale Wittm.). Scientific Papers. Series A. Agronomy, 285-288.

[16] Kakar K., Zainullah K., Shawani, M. (2003). Varietal dynamics of yield stability in wheat. journal of biological sciences. DOI: 10.3923/jbs.2003.137.140.

[17] Shcherbyna O. Z., Tkachyk S. O., Tymoshenko O. O.,. Shostak N. O. (2020). Evaluation of cultivars of cultivated soybean [Glycine max (L.) merrill] on the stability of the manifestation of economically valuable traits. Plant Varieties Studying and Protection, 16, 1, 90-96. DOI: https://doi.org/10.21498/2518-1017.16.1.2020.201331

[18] Detsyna A. A., Illarionova I. V., Shherbinina V. O. (2019). Evaluation of ecological plasticity and stability of large-fruited sunflower varieties. Oilseeds, 3 (179), 35-39.

[19] Mameev V. V. (2017). Evaluation of the plasticity parameters of winter wheat varieties depending on weather conditions in the southwestern part of the center of Russia. Collection of scientific works: fruit growing and berry growing in Russia, 48, 165-169.

[20] Eberhart S. A., Russel W. A. (1966). Stability parameters for comparing varieties. Crop Sci., 6, 36-40.