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Yielding capacity of spring triticale and its stability depending on genotype and environment conditions

V. K. Ryabchun (В. К. Рябчун), *Master of biological sciences*
V. S. Mel'nyk (В. С. Мельник), T. B. Kapustina (Т. Б. Капустіна), *Masters of agricultural sciences*
O. Ye. Shchechenko (О. Є. Щеченко)
Institute of Plant Growing named after V. Ya. Yur'ev (В. Я. Юр'єв) of National Academy of Agrarian Sciences (НААН)
melnikver@yandex.ru

Target - Assessment of stability when creating yielding capacity of integrated valuable grades and lines of spring triticale in conditions of different cultivation years. Selection of best genotypes according to their potential of yielding capacity, flexibility and stability

Methods – Ontogenetic statistically mathematic analysis

Results - Adaptive properties and selective value of grades and lines of spring triticale are defined. Methods of creation and pedigrees of best genotypes are analyzed. Comparison of yielding capacity in conditions of different cultivation years made possible selection of such genotypes with high potential of yielding capacity as *YATKH-38-14* (ЯТХ 38-14), *YATKH-61-14* (ЯТХ 61-14), and *YATKH-62-14* (ЯТХ 62-14), such ones with stable yielding capacity as *YATKH-17-14* (ЯТХ 17-14), *Boryviter Kharkivs'kyy* ("Боривітер харківський"), *YATKH-43-14* (ЯТХ 43-14), and *Gusar Kharkivs'kyy* („Гусар харківський"), such drought-resistant ones as *YATKH-37-14* (ЯТХ 37-14), *YATKH-43-14* (ЯТХ 43-14), and '*YATKH-64-1* (ЯТХ 64-1). More flexible grades are found be *Lebid' Kharkivs'kyy* („Лебідь харківський"), *YATKH-38-14* (ЯТХ 38-14), *YATKH-26-07* (ЯТХ 26-07), and *YATKH-62-14* (ЯТХ 62-14).

Conclusions – The most perspective genotypes fit for production and selection are such lines as *YATKH-17-14*, *YATKH-64-14*, *YATKH-37-14*, and *YATKH-43-14*

(for years yielding capacity amounts to 4.27–4.48 ton/hectare at average) and such grades as *Zlit Kharkivs'kyy* („Зліт харківський"), *Boryviter Kharkivs'kyy, Gusar Kharkivs'kyy*, and *Darkhliba Kharkivs'kyy* („Дархліба харківський") (yielding capacity amounts to 4.27–445 ton/hectare). They combine high adaptive and yielding capacity. They are valuable for using in the form of resulting material as more adaptive one in the case of selection.

Key words: spring triticale, yielding capacity, adaptability, stability, drought-resistance, grade, and line.

Introduction - Growing spring triticale offers opportunity to receive food-, feeding-, and industrial grain. Crops are used both as basic and insurance ones. The unique combination of best economical-and-biological indices of wheat and rye, high potential of grain yielding capacity, and high resistance against deceases is inherent to triticale culture.

At this time increase of adaptability of triticale grades is one of the most significant directions for triticale selection. Selection with a view of obtaining high adaptability is one of efficient methods for minimizing aftermaths of global climatic changes. Frequent drought seasons occurred in semi-savanna and in wood-and-semi-savanna zones of Ukraine, where the most part of seeds of spring grain crops are concentrated, result in permanent shortages of harvests. Introduction of new, more drought-resistant and widely adapted grades of spring triticale into production will give opportunity to stabilize grain output.

Any grade must combine drought-resistance with reliable response to moistening, be of the increased yielding capacity and quality, resistant to falling, pathogenic agents, and tolerant to vermin damages etc. A lot of researches are conducted with respect to this problem [1, 2]. New and more adapted grades of triticale, which are able to provide stable harvest in various ways, are introduced into production. Several years A. Goyal, B. Berez, H. Randhawa etc [3] explored the wide variety of triticale grown in different world countries and in several agrarian climatic zones of Canada. Genotypes, which are more stable for cropping in various cultivation conditions, were introduced into production or included into selection programs. Experience got by crop raisers of the International Center of maize- and wheat improvement (CIMMYT, Mexico), who tested their specimens in several zones with contrasting vegetation conditions owing to availability of the branched network of experimental stations and nursery gardens, deserves attention on the part of specialists. In the course of adaptability selection above-mentioned authors compared efficiency of full-complete and replacement triticale and proved that both schemes are efficient ones [4]. Examination of spring triticale, which was conducted in the laboratory of the adaptive-and-ecological selection as part of Vladimir Scientific-and-Research Institute of Agriculture, was based on using findings of CIMMYT and of the All-Russian Scientific-and-Research Institute of plant growing named after M. I. Valilov, as well as on findings of selection material testing in different nature-and-climate zones of the Russian Federation [5]. Specialists of the Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine are working with a view of developing the new, more adapted selective material using at that different hybridization schemes and drawing new valuable grades of wheat and triticale to their work. Expediency as regards drawing grades of soft wheat and spring triticale to hybridization is stressed [6].

The research target consists of assessment of stability when creating yielding capacity of integrated valuable grades and lines of spring triticale in various cultivation conditions and of selection of best genotypes according to their potential of yielding capacity, flexibility and stability.

Materials and research methods – In 2011–2015 researches were conducted in conditions of the eastern part of the wood-and-semi-savanna of Ukraine with using utilities of the experimental base belonging to the Institute of Plant Growing of the National Academy of Agrarian Sciences named after V. Ya. Yur'ev. Sowing of spring triticale was made with the aid of the *Klen-1.5* seeder manufactured in the Small Agricultural Scientific-and-Production Enterprise named as *Klen* according to soil dormancy in fields of selective crop rotation within the early-spring period. It planted ground with seeds into 4-6 cm deep and operated with seeding rate of 5 million similar seeds per hectare. Preliminary used culture was pea. Experimental plots with area of 10 m^2 were located with the aid of method of successive repetitions in the course of competitive progeny test. Repeating is quadruple. Such national standard as the grade named as Korovay *Kharkivs'kyy* („Коровай харківський") was sown out in every 20 numbers. 25 specimens of spring triticale, created in the Institute of Plant Growing of the National Academy of Agrarian Sciences named after V. Ya. Yur'ev, were researched. 11 prospective grades and 14 lines are among them.

Yielding capacity was defined as average one according to repeats with the aid of weight method. One-factor variance analysis according to B. A. Dospekhov (Б. А. Доспехов) [7] was used for defining substantiality and credibility of differences of yielding capacity of genotypes within the one-year period, and two-factor analysis [7] was used for defining influence of genotypes, environment and interaction between genotypes and environment on phenotype changeability of populations. The method proposed by A. V. Kil'chevs'kyy (А. В. Кильчевский) and P. V. Khotylyova (П. В. Хотылёва) [8, 9] was used for defining general adaptive ability (GAA), variance of specific adaptive ability (SAA), relative stability (Sgi), coefficient of compensation of interaction between genotypes and environment (Kgi), and selective value of genotypes (SVG). Method proposed by S. G. Eberhart & W. G. Russel [10] was used for defining the average response of grades, which shows their flexibility, to changing environment conditions according to regression coefficient (b_i). The agricultural meteorological information was put forward according to data presented by the Kharkiv regional hydro-meteorological center.

Non-uniform distributions of precipitations within the vegetation period together with high air temperatures often cause spring-and-summer droughts. Non-uniformity of precipitations and considerable temperature fluctuations compared with average indices for many years were observed during years of researches.

Within the vegetation period for 2011 weather conditions were insufficiently favorable for moisture provision. Within the said vegetation period over-moistening in the range from +2.9 to 131.3 mm was observed according to the average monthly rate, but precipitations were very non-uniform at that time. Temporary droughts, coincided with critical periods of spring triticale growth, alternated with intensive pouring rains. The major drought of the second part of May and of the first decade of June, which coincided with the period of trilling and ear formation, affected floating formation and thickness of haulm stand, as well as length and multiflorous of triticale ear, and as a result grain yield was reduced. Conditions of the vegetation period according to the temperature mode exceeded indices of many years by 2 °C at average.

Weather conditions for 2012 are characterized by high air temperature and periodic droughts of various durations. Within the vegetation period the average monthly air temperature exceeded that one of many years by 2.8-4.9 °C. Maximal temperature of different days amounted to 32 °C in May, 34 °C in June, and to 35 °C in July. Precipitations were not observed after sowing till the second decade of May. Sufficient precipitations (48 mm), amounted to the level of rate for many years, fell in the second and third decades of May. The said period coincided with phases of booting, ear formation, and meosis. Plants grew to optimal height and formed ears of long or medium length depending on their genotype. Long-lasted drought was characteristic for the period from the second decade of June to the second decade of July. It coincided with phases of grain filling and ripening. Precipitations of this period, coincided with phases of grain filling and formation of its quality, did not exceed 2 % of their standard rate. As a whole, weather conditions for 2012 were satisfactory for formation of yielding capacity.

Conditions for 2013 were extremely severe and unfavorable for growing and developing spring triticale. Drought lasted almost the entire vegetation period. The spring drought was in particular strong. It coincided with the shoots-and-booting period. Also summer droughts of different duration, which were alternated with short-lasted rain-pour precipitations, took place in June. It affected the state of crops, namely, productive tilling capacity, height of plants, and ear formation, and resulted in considerable reduction of yielding capacity. Within this period the amount of precipitations amounted to 8–27 mm (22–56 % of their proper rate). In April the average monthly air temperature was cool (8.9 °C, that is by 2.4 °C lower according to indices for many years), in May-July temperature exceeded that one of many years by 0.9-5.4 ° C. Weather conditions for 2013 affected the yielding capacity formation.

Weather conditions for 2014 were favorable for growing and developing plants during the vegetation period of spring triticale. Some phases of plant vegetation were optimal ones, and it provided the highest yielding capacity within the period of spring triticale selection. Within the vegetation period precipitations fell uniformly and compared with their standard rates amounted to 108–238 % in May-June and to 66 % in July. The June air temperature was close to average one for many years, but in May and July it exceeded the mentioned average one by 2–3 °C.

Conditions for 2015 were droughty ones, and it affected development of plants. In May precipitations amounted to 71 % of their standard rate. Beginning from the third decade of May to the second decade of June precipitations were not observed. The droughty period coincided with the critical phase of plant development, namely, with ear formation, and it affected the said plant development and yielding capacity formation.

In that way, weather conditions of research years were contrasting as regards air temperature and the amount of precipitations. It gave opportunity to assess stability of yielding capacity formation affected by environment conditions.

Results of researches - *methods of selective material creation -* Different methods of hybridization were used for creation of lines. The most part of lines was developed due to the complicated hybridization of spring triticale lines, including such grades as *Legin' Kharkivs'kyy* ("Легінь харківський"), *Khlibodar Kharkivs'kyy* ("Хлібодар харківський"), *Oberig Kharkivs'kyy* ("Оберіг харківський"), and *Kharkiv AVIAS* ("Харків АВІАС") (13 specimens or 52 % in total). 8 lines (32 %), including such grades as Solovey *Kharkivs'kyy* '("Соловей харківський") і *Korovay Kharkivs'kyy*, were developed with the aid of the paired interline hybridization method. Three grades of spring triticale (12 %) such as *Sontsedar Kharkivs'kyy* ("Сонцедар харківський"), *Lebid' Kharkivs'kyy* and *Legin' Kharkivs'kyy* were developed with the aid of inter-generic hybridization of spring triticale and soft spring wheat according to such scheme as "spring triticale-soft spring wheat-spring triticale". The grade named as *Aist Kharkivs'kyy* ("Аіст харківський") was developed with the aid of biological method according to such scheme of inter-generic hybridization as "soft spring wheat-spring rye-spring triticale". Best complicated valuable lines such as *ЖнГБ1, Х8InМС1, Х10ПГСвТ6б, Х10ГАС2, СЛ4-3+8р1, С46Х8РМ, С52ХГХ3, ЖЗРА11, Х2ПГАС29Пр* etc were drawn to hybridization process as sire components of spring triticale. In their turn they were developed with the aid of biological method. Developing resulting lines with the increased level of yielding capacity and showing a lot of other valuable economic characteristics in the course of inter-generic hybridization were achieved by force of drawing into such grades of spring soft wheat as *Kharkivs'ka 2* ("Харківська 2"), *Kharkivs'ka 8* ("Харківська 8"), *Kharkivs'ka 10* ("Харківська 10"), *Saratovs'ka 29* ("Саратовская 29"), *Saratovs'ka 46* ("Саратовская 46"), *Saratovs'ka 52* ("Саратовская 52"), *Zhnitsa* ("Жница"), *Zhemchuzhina Zavolzh'ya* ("Жемчужина Заволжья") etc. The grade named as *Zhayvoronok Kharkivs'kyy* ("Жайворонок харківський"), that is distinguished with its big, well-filled smooth grain, and stably shown donor properties as to these characteristics, was more often used (in nine lines) in pedigrees of specimens that were examined among sire components of spring triticale. The line named as *Х10ПГСвТ6б*. was used as the sire component in nine specimens. The line named as *Х8InСЛ23* was used as the resulting material in the case of creation of five specimens, and the line named as *СЛ4-3+8р1* in the case of creation of four specimens. Lines named as *Х10ГАС8, Х10ГАС21, С46ГХ8РМ18-15, С46Х8РМ18-15* and *СвТ2* were used in pedigrees of three specimens.

In that way, grades and selective lines of spring triticale have complicated pedigrees, which mainly include the hereditary material of several best wheat grades and intensively show valuable economic characteristics at the expense of crossover of resulting lines of triticale deprived of undesirable characteristics intrinsic to sire grades of wheat. The said elimination of undesirable characteristics was made with the aid of meticulous choices on the each research stage. All lines show resistance against floury dew and brand deceases, demonstrate leveled haulm stand, and increased or medium resistance against agents of septona blight and brown stripe rust.

Yielding capacity of grades and lines of spring triticale – The average yielding capacity according to genotype and depending on year varied from 226 ton/hectare under less favorable conditions in 2013 to 6.00 ton/hectare under more favorable conditions in 2014 (Table. 1).

In 2011 under conditions of the spring-and-summer drought of average intensity yielding capacity varied from 2.78 to 4.65 ton/hectare. Such grades as Boryviter *Kharkivs'kyy* (4.65 ton/hectare), *Darkhliba Kharkivs'kyy* (4.36 ton/hectare), and *Zlit Kharkivs'kyy* (4.28 ton/hectare) were best ones as to yielding capacity. Such grades as *Legin' Kharkivs'kyy* and *Korovay Kharkivs'kyy* (2.78–2.79 ton/hectare), which are earlier cultures, were less resistant to these conditions. Moreover drought occurred at the end of May-beginning of June coincided with critical development periods for plants of these grades.

In 2012 yielding capacity of specimens was average and varied from 3.90 to 5.78 ton/hectare depending on genotype. Conditions of this year turned out in such way that moisture was insufficient for growing of high harvest when using the most of genotypes. But such grades as *Gusar Kharkivs'kyy* and *Zlit Kharkivs'kyy* as well as the line named as YATKH *43-14* were distinguished with high level of yielding capacity (5.64–5.78 ton/hectare). It evidences about their ability of efficient consumption of even insufficient amount of moisture.

Table 1

Yielding capacity of grades and lines of spring triticale, ton/hectare (for 2011–2015)

Grade, line	Yielding capacity, ton/hectare					
	2011	2012	2013	2014	2015	роками
Legin' Kharkivs'kyy, standard	2.79	4.30	1.35	5.71	3.77	3.58
Aist Kharkivs'kyy	3.02	3.99	1.41	5.13	3.56	3.42
Khlibodar Kharkivs'kyy	2.95	3.97	2.26[1]	6.05[1]	3.68	3.78
Legin' Kharkivs'kyy	2.78	4.42	1.45	5.45	3.70	3.56
OberigKharkivs'kyy	3.03[1]	3.90	1.70[1]	5.83	3.66	3.62
Sontsedar Kharkivs'kyy	3.32[1]	4.74[1]	1.93[1]	6.02[1]	3.83	3.97[1]
Lebid'Kharkivs'kyy	3.07[1]	4.95[1]	1.73[1]	6.36[2]	3.88	4.00[1]
Darkhliba Kharkivs'kyy	4.36[2]	4.91[1]	2.21[1]	5.88	4.01[1]	4.27[1]
Boryviter Kharkivs'kyy	4.65[2]	5.44[2]	2.18[1]	5.99	4.00[1]	4.45[2]
Gusar Kharkivs'kyy	4.11[2]	5.78[2]	2.32[1]	5.98	3.82	4.40[2]
Zlit Kharkivs'kyy	4.28[2]	5.68[2]	2.45[1]	5.41	4.10[2]	4.38[2]
YATKH-17-14	4.00[2]	5.27[2]	2.59[1]	6.19[1]	4.33[2]	4.48[2]
YATKH-18-14	3.86[1]	5.22[1]	2.47[1]	5.71	3.72	4.20[1]
YATKH-23-14	3.67[1]	4.94[1]	2.41[1]	5.93	3.60	4.11[1]
YATKH-30-14	3.55[1]	5.07[1]	2.36[1]	6.32[2]	3.94	4.25[1]
YATKH-37-14	3.54[1]	4.96[1]	2.74[2]	5.88	4.22[2]	4.27[1]
'*YATKH-38-14*	2.90	4.85[1]	2.52[1]	6.93[2]	3.93	4.23[1]
YATKH-41-14	3.55[1]	4.93[1]	2.40[1]	5.97	3.87	4.14[1]
YATKH-43-14	3.56[1]	5.64[2]	2.80[2]	5.90	4.14[2]	4.41[2]
YATKH-46-14	3.55[1]	4.90[1]	2.72[2]	6.01[1]	3.71	4.18[1]
YATKH-51-14	3.93[1]	4.96[1]	2.23[1]	6.11[1]	3.89	4.22[1]
YATKH-60-14	3.38[1]	4.30	2.65[1]	5.86	3.85	4.01[1]
YATKH-61-14	3.81[1]	4.30	2.74[2]	6.40[2]	4.23[2]	4.30[1]
YATKH-62-14	3.79[1]	4.04	2.08[1]	6.83[2]	4.04[1]	4.16[1]
YATKH-64-14	3.93[1]	4.82[1]	2.83[2]	6.17[1]	3.88	4.33[1]
Average according to genotypes	3.58	4.81	2.26	6.00	3.89	4.11[1]
HIP_{05} in general	0.23	0.32	0.29	0.29	0.22	0.33
HIP_{05} according to genotype index						0.15
HIP_{05} according to index of year weather conditions						0.08

HIP_{05} according to interaction of indices for genotypes and year weather conditions	0.05

Note: 1) – Yielding capacity substantially exceeds the standard one of the grade named as *Korovay Kharkivs'kyy* on level of significance equal to 5 %; 2) – it is the higher yielding capacity among researched genotypes in this year.

In 2013 very droughty conditions gave opportunity to select genotypes fit for growing in such weather conditions. Under droughty conditions, which lasted during the entire vegetation period, yielding capacity varied from 1.35 to 2.83 ton/hectare. Best lines resulted in yielding capacity of 2.72–2.83 ton/hectare – *YATKH 64-14* (2.83 ton/hectare), *YATKH 43-14* (2.80 ton/hectare), *YATKH 37-14*, *YATKH 61-14* (2,74 ton/hectare), and *YATKH 46-14* (2.72 ton/hectare). The grade named as *Zhayvoronok Kharkivs'kyy* was among sire components of first fours of said lines. The line named as *Х10ПГСвТ66* (*YATKH 63-14*) was the sire component of three drought-resistant lines. Earlier grades named as *Aist Kharkivs'kyy, Legin' Kharkivs'kyy, and Korovay Kharkivs'kyy* (1.35–1.45 ton/hectare) were among specimens of lower yielding capacity (like before 2011).

In 2014 favorable conditions gave opportunity that genotypes largely realized their potential of yielding capacity. Lines named as *YATKH 38-14* (6.93 ton/hectare) and *YATKH 62-14* (6.83 ton/hectare) showed the better yielding capacity. Their values exceeded yielding capacity of the standard crop named as *Korovay Kharkivs'kyy* (5.71 ton/hectare) by 1.22 and 1.12 ton/hectare respectively. The grade named as *Lebid' Kharkivs'kyy* (6.36 ton/hectare) showed the higher yielding capacity, and grades named as *Aist Kharkivs'kyy* (5.13 ton/hectare) and YATKH *65-14* (5.17 ton/hectare) showed the lower yielding capacity among registered grades.

In 2015 yielding capacity of grades was lower compared with average one for many years due to the droughty period during phases of tillering and ear formation of plants. It amounted to 3.89 ton/hectare with respect to grades at average. Specimens named as *YATKH 17-14* (4.33 ton/hectare), *YATKH 61-14* (4.23 ton/hectare), and *YATKH 37-14* (4.22 ton/hectare) as well as grades named as *Darkhliba Kharkivs'kyy* (4.01 ton/hectare) and *Boryviter Kharkivs'kyy* (4.00 ton/hectare) showed the higher yielding capacity.

Within the five-year period yielding capacity of spring triticale varied from 3.21 ton/hectare to 4.27 ton/hectare at average. The yielding capacity of the standard grade named as *Korovay Kharkivs'kyy* amounted to 3.38 ton/hectare. In fact, 21 lines exceeded the standard yielding capacity. Lines and grades named as *YATKH 17-14* (4.48 ton/hectare), *Boryviter Kharkivs'kyy* (4.45 ton/hectare), '*YATKH 43-14* (4.41 ton/hectare), *Gusar Kharkivs'kyy* (4.40 ton/hectare), *YATKH 64-14*, and *Darkhliba Kharkivs'kyy* (4.11 ton/hectare) were best ones. The pedigree of specimens of the higher yielding capacity named as *YATKH 17-14* and *Boryviter Kharkivs'kyy* include the line named as Х10ПГСвТ6б used as maternal sire component in the first case and as sire component in the second case.

In that way, comparison of yielding capacities for different weather conditions made possible selecting such genotypes of high potential of yielding capacity as *YATKH 38-14*, *YATKH 61-14*, and *YATKH 62-14*, which demonstrated the highest yielding capacity under weather conditions in 2015. Such drought-resistant grades as *YATKH 37-14*, *YATKH 43-14*, and *YATKH 64-14* demonstrated the higher yielding under conditions of strong drought in 2013, and *YATKH 17-14*, *Boryviter Kharkivs'kyy*, *YATKH 43-14*, and *Gusar Kharkivs'kyy* were grades of the increased yielding capacity.

Adaptive ability, ecological flexibility and stability of grades and lines of spring triticale – Mainly such parameters as adaptive ability, flexibility and stability define grade adaptability to environment conditions.

General adaptive ability (GAA) makes possible selecting genotypes, which provide the maximal average harvest under other conditions [9]. Such grades of spring triticale as *Boryviter Kharkivs'kyy*, *Gusar Kharkivs'kyy*, *Darkhliba Kharkivs'kyy*, and *Zlit Kharkivs'kyy* as well as such their lines as *YATKH 17-14, YATKH 43-14, YATKH 61-14* and *YATKH 64-14* (Table 2) achieve highest GAA. But if genotypes of high GAA level demonstrate high variance of SAA, they cannot provide the guaranteed high harvest under any weather conditions. Index of specific adaptive ability, SAA, deviates from value of GAA in every individual environment. Therefore it becomes the genotype stability index.

Among specimens selected according to GAA value *Zlit Kharkivs'kyy* and *YATKH 64-14* demonstrated smaller values of SAA variance, and it is evidence of high stability of formation of the increased yielding capacity in various weather conditions.

Table 2

Parameters of adaptive ability of grades and lines of spring triticale as to yielding capacity (for 2011–2015)

Grade, line	Yielding capacity ton/hectare		Flexibility (b_i)	General adaptive ability (GAA)	Variance of specific adaptive ability (SAA)	Relative stability of genotypes (Sgi), %	SVG)Selective value of
	Average	Minimal-maximal					
Boryviter Kharkivs'kyy, standard grade	3.42	13.5–57.1	1.16	-5.25	16.3	45.4	13.0
Aist Kharkivs'kyy	4.45	14.1–51.3	0.96	-6.87	13.6	39.7	15.2
Khlibodar Kharkivs'kyy	3.78	22.6–60.5	0.98	-3.27	14.2	37.7	17.9
Legin' Kharkivs'kyy	3.56	14.5–54.5	1.08	-5.49	15.3	42.9	14.2
OberigKharkivs'kyy	3.62	17.0–58.3	1.05	-4.85	14.9	41.2	15.3
Sontsedar Kharkivs'kyy	3.97	19.3–60.2	1.10	-1.41	15.3	38.5	18.3
Lebid' Kharkivs'kyy	4.00	17.3–63.6	1.26	-1.11	17.6	44.1	15.3
Darkhliba Kharkivs'kyy	3.58	22.1–58.8	0.93	1.65	13.5	31.5	23.9
Boryviter Kharkivs'kyy	4.40	21.8–59.9	1.00	3.43	14.7	33.1	23.9
Gusar Kharkivs'kyy	4.27	23.2–59.8	1.03	2.93	15.1	34.2	22.9
Zlit Kharkivs'kyy	4.38	24.5–56.8	0.84	2.75	12.7	29.0	26.0
YATKH-17-14	4.48	25.9–61.9	0.97	3.67	13.5	30.2	25.9
YATKH-18-14	4.20	24.7–57.1	0.90	0.87	12.8	30.6	24.0
YATKH-23-14	4.11	24.1–59.3	0.96	0.01	13.5	32.8	22.2
YATKH-30-14	4.25	23.6–63.2	1.08	1.39	15.0	35.4	21.4
YATKH-37-14	4.27	27.4–58.8	0.86	1.59	12.1	28.4	25.7
'*YATKH-38-14*	4.23	25.2–69.3	1.21	1.17	17.6	41.6	17.6
YATKH-41-14	4.14	24.0–59.7	0.97	0.35	13.5	32.7	22.5
YATKH-43-14	4.41	28.0–59.0	0.92	2.99	13.3	30.1	25.5
YATKH-46-14	4.18	27.2–60.1	0.91	0.69	12.8	30.6	23.9
YATKH-51-14	4.22	22.3–61.1	1.02	1.15	14.3	33.9	22.2
YATKH-60-14	4.01	26.5–58.6	0.84	-1.01	11.9	29.8	23.4

YATKH-61-14	4.30	27.4–64.0	0.91	1.87	13.2	30.8	24.4
YATKH-62-14	4.16	20.8–68.3	1.16	0.47	17.0	40.9	17.8
YATKH-64-14	4.33	28.3–61.7	0.88	2.17	12.4	28.7	25.9

Such grades are exigent with respect to the high level of agrarian engineering and as regards favorable weather conditions. Only in this case they realize their potential to the maximum. If $b_i < 1$ then the said grade responds weaker to changing weather conditions compared with all set of researched genotypes at average. Better use such grades against extensive background, where they provide maximal return with minimal costs.

Calculation of regression coefficient for grades and lines of spring triticale made possible finding out response of genotypes to improvement of environment conditions. Such grades as *Lebid' Kharkivs'kyy* (b_i = 1.26), and *Korovay Kharkivs'kyy* (b_i = 1.16) as well as such lines *YATKH 38-14* (b_i = 1.21) and *YATKH 62-14* (*bi* = 1.16) are most flexible ($b_i > 1$), that is to say, able to increase considerably yielding capacity under favorable weather conditions. They demonstrate the high potential of yielding capacity and able realizing it in favorable weather conditions to the maximum. These specimens can be used in hybridization for increase of yielding capacity. Low relative stability of these genotypes shows their inability to gain advantage over other genotypes used during some years. Therefore it is reasonably that grades named as *Lebid' Kharkivs'kyy* and *Korovay Kharkivs'kyy* should be grown in natural conditions with the smaller value of drought risk, that is to say, in zones of the central and western wood-and-semi-savanna and of Woodlands against high and average agrarian background for gaining stable yielding capacity. Such grade as *Sontsedar Kharkivs'kyy* demonstrated the higher stability of yielding capacity among registered grades in the case of the increased flexibility ($b_i > 1$). It can be grown over all territory of Ukraine. At that this grade provides the high yielding capacity under favorable conditions and medium one under unfavorable conditions of environment.

Selective value of genotypes (SVG) was estimated with a view of searching genotypes of high adaptability and of optimal combination of productivity and ecological stability. This index varied from 13.0 to 26.0 among all researched genotypes. Most prospective genotypes are the grade named as Zlit *Kharkivs'kyy* (SVG= 26.0) and lines named as *YATKH 17-14, YATKH 64-14* (25.9), *YATKH 37-14* (25.7), and *YATKH 43-14* (25.5). They combine the considerable adaptive ability and the high yielding capacity. The line named as *YATKH 17-14* demonstrated the highest average yielding capacity in the amount of 4.48 ton/hectare (varied from 2.59 to 6.99 ton/hectare) among all genotypes. *Zlit Kharkivs'kyy,* which demonstrated yielding capacity of 4.38 *ton*/hectare (varied from 2.45 to 5.68 ton/hectare) at average within the five-year period, *Boryviter Kharkivs'kyy, Darkhliba Kharkivs'kyy* (2.39 ton/hectare) and *Gusar Kharkivs'kyy* (2.29 ton/hectare) showed high value of SVG among mentioned grades.

The pedigree of such grade as *Boryviter Kharkivs'kyy* and of such lines as *YATKH 17-14*, *YATKH 37-14*, and *YATKH 64-14* includes the line named as *Х10ПГСвТ6б*, which is used as one of sire components and characterized by its increased drought-resistance and combinative ability. *Zhayvoronok Kharkivs'kyy, Khlibodar Kharkivs'kyy, Х10ГАС7, ЖЗРА11, Х8СЛ4-3,* and *С29ГП* are used as other sire components for these specimens. Grades named as *Darkhliba Kharkivs'kyy* and *ZlitKharkivs'kyy* include the line named as *СЛ 4-3+8 р1*, which is used as sire component. Such grade as *Gusar Kharkivs'kyy* was created by the method of inter-genetic hybridization of triticale named as *Х10ГА21/С46ГХ8* with soft wheat named as *Prokhorovka* ("Прохоровка") and with such grade of triticale as *Zhayvoronok Kharkivs'kyy.*

Conclusions – Grades and selective lines of spring triticale have complicated pedigrees, which mainly include hereditary material of several best grades of wheat; they intensively show valuable economic characteristics at the expense of crossover of resulting lines of triticale. With a view of combining potential of yielding capacity, flexibility and stability in one genotype it should be expedient to make inter-generic hybridization with participation of wheat grades of high yielding capacity developed in local or droughty conditions as well as drawing high-adaptive lines of triticale to the said hybridization.

Comparison of yielding capacities characteristic for years of different weather conditions made possible selecting such genotypes with high potential of yielding capacity as *YATKH 38-14*, *YATKH 61-14*, and *YATKH 62-14*, which gained the highest yielding capacity under best weather conditions in 2015; such drought-resistant genotypes as *YATKH 37-14*, *YATKH 43-14*, and *YATKH 64-14*, which demonstrated the most yielding capacity under conditions of strong drought in 2013; and such genotypes of stable yielding capacity as *YATKH 17-14*, *Boryviter Kharkivs'kyy*,, *YATKH 43-14*, and *Gusar Kharkivs'kyy*, which outmatched all researched genotypes at average for passed years.

Grades named as *Lebid' Kharkivs'kyy* (b_i = 1.26) and *Korovay Kharkivs'kyy* (b_i = 1.16) as well as lines named as *YATKH 38-14* (b_i = 1.21) and *YATKH 62-14* (b_i = 1.16) were more flexible ones. They demonstrate high potential of yielding capacity and able realizing it under favorable weather conditions to the maximum.

Most prospective genotypes for production and selection are such lines as YATKH *36-13* (SVG = 26.0), *YATKH 17-14*, *YATKH 64-14* (SVG = 25.9), *YATKH 37-14* (SVG = 25.7), and *YATKH 43-14* (SVG = 25.5), which combine high adaptive ability with yielding capacity.

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V. K. Riabchun, V. S. Melnyk, T. B. Kapustina, O. Ye. Schechenko. Spring triticale yield and its stability depending on the genotype and environmental conditions

Purpose. Stability Assessment of formation of complex-valued varieties and lines of spring triticale in different growing conditions. Selecting the best genotypes for yield potential, stability and plasticity. **Methods.** Ontogenetic, statistical and mathematical analysis. **Results.** Adaptive capacity and breeding value of of spring triticale varieties and lines was established. The methods of creating and pedigree of best samples was analised. Comparison of yields in different environments possible to identify genotypes with high yield potential – 'ЯТХ 38-14', 'ЯТХ 61-14', 'ЯТХ 62-14', with stable yields – 'ЯТХ 17-14', 'Boryviter kharkivskyi', 'ЯТХ 43-14', 'Gusar kharkivskyi', drought resistance – 'ЯТХ 37-14', 'ЯТХ 43-14', 'ЯТХ-64-14'. The genotipes who is more plastic – 'Lebid kharkivskyi', 'ЯТХ 38-14', 'ЯТХ 62-14'. These samples may be used of hybridization to improve yield. **Conclusions.** The most promising to production and breeding are lines 'ЯТХ 17-14', 'ЯТХ 64-14', 'ЯТХ 37-14', 'ЯТХ 43-14' (their average yield 4,27–4,48 t/ha) and varieties 'Zlit kharkivskyi', 'Boryviter kharkivskyi', 'Gusar kharkivskyi', 'Darkhliba kharkivskyi', which have adaptive capacity combined with high productivity. They are valuable for use as a starting material in breeding for adaptability.

Key words: spring triticale, yield, adaptability, stability, drought resistance, variety, line.