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ORIGINAL ARTICLE

Ecological plasticity and adaptibility of Chinese winter wheat varieties (*Triticum aestivum* L.) under the conditions of North-East forest steppe of Ukraine

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The results of research as for adaptive potential of Chinese winter wheat (*Triticum aestivum* L.) varieties are represented. 50 new varietis of Chinese origin were analyzed under the conditions of left-bank side of north-east forest steppe of Ukraine: ultra-early ripening-10%; early ripening-54%; mid-early ripening-12%; mid-ripening-24%. As for the level of winter resistance, all groups of introduced vatieties yielded to the standard (the cultivar Podolyanka) though they had a great index level (score 6.4-7.9). In general, Chinese varieties under the conditions of the research were characterized by relatively satisfactory winter resistance condition; 52%of analyzed samples overwintered at the level of standard with the score 8. Among them: ultra-early ripening-2%; early ripening-20%; mid-early ripening-8%; mid-ripening-22%. As for the plant height we identified a great range of fluctuations-from dwarf (30-50 cm) to growth medium (81-110 cm) forms. The analyzed genotypes were divided into growth medium forms-22%, semi-dwarf forms-64%and dwarf forms-14%. There was a direct relation between: a ripeness group → plant height (r=0.96) → resistance to overwintering (r=0.78) → ripeness group (r=0.92). The shorter the period of genotype vegetation is, the lower the plants and the score of plants overwintering are as the correlation coefficient is near +1, which indicates the close direct correlative connection between these indices. Among the analyzed samples a high resistance against a disease group had such varieties: early ripening genotypes-Lankao 906, DF529, DF581, Shi 4185, CA0175, Zhongmai 9, Shixin 733, Jimai 22 Shimai 12; middle-early ripening genotypes-Zhong mai 19, Shijra zhuang 8, Lun Zhou 10; mid-ripening genotypes-Lun Zhou 1, Lun Zhou 2, Longzhong 3, Longzhong 4, Longzhong 7, Longzhong 12. As for the crop productivity the following genotypes early ripening-DF529, Jimai 19; middle-early ripening-Jingdong 8, Shijiazhuang 8, Longzhong 10; middle-ripening-Longzhong 2, Longzhong 3, Longzhong 4, Longzhong 5, Longzhong 7, Longzhong 8, Longzhong 11, Longzhong 12, NSA 97-2082 were better than the cultivar standard. 16%of analyzed varieties distinguished by the complex of researched characteristics-Shijiazhuang 8, DF529 Longzhong 2, Longzhong 3, Longzhong 4, Longzhong 7, Longzhong 10, Longzhong 12. They were characterized by a high adaptibility and significant indices of homeostasis (54,5-868,4), plant breeding value (5.5-9.3), and stability (0.2). Having analyzed the received indices as for homeostasis and adaptibility we made sure that Chinese varieties realized its genetic potential-40-80% under the conditions of north-east forest steppe of Ukraine It was stipulated by the fact that the most new cultivars were introduced from the province of Gansu which is located on t the II terrain platform of China and is the closest one to the conditions of Ukraine as for the eco-gradient.

Keywords: Winter wheat (*Triticum aestivum* L.); variety; adaptibility; ripeness groups; plant height; winter resistance condition; resistance to diseases; crop productivity

Introduction

The creation and widespread use of breab wheat varieties that meet the requirements of production is an important place in solving the problems of modern agriculture (Morhun et al., 2014). It means that the plants of these varieties must withstand successfully the unfavorable effects of external factors, as well as the best possible use of favorable environmental conditions. According to the scientists' opinion, the contribution of plant breeding to increasing crop yields over the past decades is estimated at 30-70%, and the role of this factor is always increasing (Korchynskyi et al., 2010). The new high-yield and high-quality variety has a genetic potential of more than 10 t/ha, but its realization under the production conditions does not exceed 30-50% (Kolomiiets et al., 2018). This is because of the growing technology breach, insufficient supply of plants

with mineral nutrients during the growing season, as well as an insufficient level of new varieties adaptability to global climate change.
The diversity of soil and climatic conditions in different regions of winter wheat growing leads to significant variations in crop yields both in space and in time (Anderson, 2010). This problem arises because of unfavorable weather conditions for growing wheat in Europe, by reason of climate change. There is a need to make breeders' efforts to develop new cultivars, not only highly productive but also those that will ensure the crop stability under various agro-climatic conditions (Sadras, et al. 2011; Fanny et al., 2015; Buhaiov et al., 2010). Studies conducted by a number of scientists provide useful information for understanding of agronomic and physiological mechanisms responsible for yield stability (Fanny et al., 2015; Al-Otayk et al., 2010; Mohammadi et al., 2008). Hence, different varieties can demonstrate contrasting reactions to the environmental conditions as a result of their interaction.
The source material is, of course, the basic guarantee for the creation of modern high-yield and adaptive cultivars. Selection practice confirms the need for a purposeful quest for valuable parental forms from the world of plant diversity (Kirian et al., 2011; Bakumenko et al., 2015). The mobilization of world plant resources for the preservation of biodiversity on our planet and the active use of these resources as the source material for plant breeding work is a fundamental idea of M. I. Vavilov (Vavilov, 1931). The historical experience of mankind and modernity convincingly proved that the necessary condition for the effective development of agriculture and related branches of the economy, science and education in any country, is a wide involvement and testing of valuable samples of the foreign plant genepool (Kholod et al., 2012; Lytvynenko et al., 2015).
Particular attention for plant breeding provides an opportunity to use the genetic potential of wheat in China. M. I. Vavilov (Vavilov, 1931) noticed that China was a secondary center for wheat, and Chinese subspecies of *Triticum aestivum* L. is probably originated from India, as evidenced by some resemblance to the Indian type. Studying the peddigree of the best foreign wheat, M.I. Vavilov noted that the Italian cultivars, created at the beginning of the 20th century by the breeder Strampelli (in particular-Ardito) with the involvement of Chinese forms, have their obvious attributes-short growth, accelerated grain filling, inimmunity to a brown rust, multiflowered, peculiar yellowness under the ear and straw maturation.
Nowadays wheat is cultivated all over China. (Zhuang, 2003). Under the favorable conditions of wheat cultivation in the central (Henan, Sichuan) and adjoined provinces the new varieties obtain yields of 7-11 t/ha. The main direction of the breeding is the creation of "super wheat" (Men al., 2017; Wang et al., 2012; Zheng et al., 2003; Xiao et al., 2011), which main purpose is the high ear productivity (Luo et al., 2003). When creating such varieties, great attention is paid to introgressive breeding selection with the engagement in hybridization such species as Secale, Thinopyron, Haynaldia, Elymus (Lanqin et al., 2012; Li et al., 2003), creating 3-genetical hybrids T. durum-Dasypyrum villosum-Secale cereale (Fu et al., 1997), hybridization of wheat with triticale (Vlasenko et al., 2012), etc. The pedigree analysis of the modern Chinese wheat showed that their genoplasm was mainly a local selective material. At the same time, the majority of Chinese breeders in their work prioritize early maturity, as they have a production task-to get two grain crops for 1 year (mainly wheat and corn). Therefore, the foreign genoplasm was very rarely presented in the new gene pool created by them, although geographically distant cross-breeding were carried out, and European varieties were used very often, including those from the former USSR: Avrora, Kavkaz, Bezostya 1, Bezostya 4, Skorospelka 1, Skorospelka 2, Skorospelka 3, Erytrospermum 841, Lyutestsens 329. Besides, the genoplasm of Ukrainian cultivars was also used, namely Ukrainka 0246, Myronivska 808, Odeska 3, Odeska 16 (Vlasenko et al., 2012).
According to the results of researches in 1994-2005, scientists-breeders of the V.M. Remeslo Myronivka Institute of Wheat National Academy of Agrarian Sciences of Ukraine (Vlasenko et al., 2004; Vlasenko, 2008), introduced from China new samples of winter and spring T. aestivum L., it was found that the majority of the specimen uner field conditions had an unsatisfactory evaluation as for winter resistance and resistance to disease; many of them are among the representatives of the eastern and especially the central provinces of China. Although, the main limiting factors under the conditions of the right-bank central forest-steppe of Ukraine in the structure of adaptive potential of winter wheat varietiess are winter and frost resistance, length of the vegetation period, resistance to diseases, which determine the plant breeding direction (Kolomiiets, 2007).
As a result of the above, the aim of our work was ecohradiative study of the adaptive potential of the Chinese wheat assortment under the conditions of north-east forest steppe of left-bank Ukraine and the selection of long-term, ecological and plasticity samples with a group of selective and valuable features for crossing and obtaining the combined genetic potential of the best wheat varieties of Ukrainian and Chinese origin.

Materials and methods

Experimental researches had been carried out during 2012-2016 in the crop rotation of Sumy National Agrarian University (SNAU) of the Ministry of Education and Science of Ukraine. SNAU is located on the outskirts of the city of Sumy, which is part of the north-eastern part of the left-bank Forest-Steppe of Ukraine. Geographical coordinates are nothern latitude 50° 54'43", eastern longitude 34 ° 48'12". The city is located on the banks of the Psel River, with the River Sumka flowing into it. Sumy covers the part of the Middle Russian hills and the Prydneprovska lowland (about 138 m above sea level). The highest point of the region is 246.2 m above the sea level. The northern part of the region lies within the Novhorod-Siversky Polissya Woodlang , the southern part-belongs to the Forest-Steppe zone. The soils are represented on 70% by chernozem. The average content of humus in arable land is 4.1%. Arable lands have a high content of phosphorus 15.1-15.4 mg per 100 g soil and the average content of potassium 6.7-8.0 mg per 100 g soil. The acidity of the soil solution is close to neutral-5.9 pH (Masalitin, 2004).
Soils on the experimental field of SNAU-black soil typical deep, non-humusful medium-loam with high and medium provision with elements of mineral nutrition. The humus content varies about 3.9 %. The reaction of the soil solution is close to neutral

(5.8). Easy-to-reach nitrogen-87 mg, phosphorus-109 mg and exchangeable potassium-100 mg per 1 kg of soil (Masalitin, 2004). In order to provide the plants with physiologically necessary nutrients in autumn, the full rate of nitrogen, phosphoric and potassium fertilizers («Nitroamofoska»-N16P16K16) in the calculation of 60 kg of active substance per hectare was enriched in the rows. In permafrost, wheat crops were nurished with nitrate (N_{34}) in the calculation of 30 kg/ha of active substance.
In general, it can be affirmed that the soil conditions on the experimental field of SNAU are typical for the zone, that allows to realize the genetically determined productivity potential of winter wheat cultivars and determine their adaptive potential.
The analysis of the weather conditions of 2012-2016 researches (Table 1) was conducted on the basis of annual data provided by the meteorological station of the Institute of Agriculture of the North-East of the NAAS, located five kilometers from the experimental field of SNAU.
The SNAU soils are classified in the second agro-climatic region of the Sumy region, which according to a long-term data is characterized by temperate continental climate with warm summers and not very cold winters with thaws. There are no large water basins in the region that would affect the climate in general, or its single elements. According to the average long-term data, the coldest months are January and February, while the hottest months are July and August. Over the years the absolute minimum of air temperatures often occurs in January, and the maximum is August. Average daily (average annual) air temperature during 2012-2016 fluctuated from +7.9 to +9.5 ºC, and the legth of the frost-free period was close to 230 days. Long-term indicator, precipitation falls within 597-600 mm, with most of it-in the warm period (April-October).

Table 1. Characteristics of weather conditions for years of research (according to the Institute of Agriculture of the North East NAAS).

Vegetation years	**Autumn**		**Winter**		**Spring**		**Summer**		**HTC**
	deviation from the optimum air temperature (± °C)	**the amount of precipitation to the norm (%)**	**deviation from optimum air temperature (±°C)**	**the amount of precipitation to the norm (%)**	**deviation from the optimum air temperature (±°C)**	**the amount of precipitation to the norm (%)**	**deviation from the optimum air temperature (±°C)**	**the amount of precipitation to the norm (%)**	
2012/2013	2.8	119	1	99	1.3	126	2.2	72.4	0.95
2013/2014	1.6	148	1.5	44	3.2	77	2.2	96	1.55
2014/2015	0.4	73	2.3	106	1.4	168	2.3	74	1.56
2015/2016	1.9	92	2.5	122	1.8	189	2.1	125	1.4

Hydrothermal coefficient (HTC) was calculated according to the method of G. T. Selyaninov (1937), since it is an integral index, which reflects the general temperature and precipitation influence on the main characteristics of the cultivar adaptability. In Ukraine, spring regeneration of winter wheat vegetation occurs at +5 °C, therefore, according to the technique, the amount of active air temperatures above +5 °C was used. Accordingly, hydrothermal conditions at the level of HTC were divided into groups: from 0.5 to 1.0-arid or dry period; from 1.0 to 1.5-normal; over 1.5-wet or excessively wet. The optimal for wheat is the HTC index=1.2 (Suhovetskiy, 1976). Two years of research (2013/2014 and 2014/2015) were somewhat higher with a hydrothermal coeficient than the norm (HTC=1.55; 1.56) and the adaptation of the Chinese wheat assortment to the environmental conditions that developed in those years was due to excessive moisture. In 2015/2016 (HTC=1.40), the vegetation of plants occurred under the optimal hydrothermal conditions. The conditions of 2012/2013 were characterized as arid (HTC=0.95), so the vegetation of winter wheat plants was carried out at a slight excess of the optimal air temperature.
In general, the weather conditions during the winter wheat vegetation periods differed from the average annual parameters of the temperature regime, the amount of precipitation and their monthly distribution. It should be noted the excess of temperature to the average long-term index, as well as a slight precipitation increasing. In general, it facilitated to a comprehensive evaluation of the studied Chinese varieties as for an adaptive ability under condition of Ukraine.
The samples of Chinese winter wheat varietis which originated from the expeditionary gatherings conducted by V. A. Vlasenko in Gansu and Hebei provinces in (2000-2012) were the material for conducting researches. The cultivar Podolianka (the national standard) was used in the study for comparison. Sowing was carried out in optimal terms with a manual drill in 3-fold repetition. The seed planting rate was 5 million pieces/ha. The plot area was 1 m^2, the forecrop-buckwheat. Plants were harvested manually in a phase of full grain ripeness. The research was carried out using field, laboratory and mathematical-statistical methods (Dospehov, 1985). Phenological observations and records, evaluation and harvesting were conducted in

accordance with generally accepted methods (Volkodav, 2003; Rudenko et al., 1977). To determine the adaptability of the Chinese wheat assortment we calculated average yield, its maximal and minimal values, the scope of its variation. We determined to which groups of maturity the studied varieties were included, their winter resistance, resistance to diseases (Babayants et al., 1988; Babayants, 2011), and we also calculated indices of plant breeding value, homeostasis, plasticity and stability (Hangildin et al., 1981).

Results

In studies as for the length of the vegetation period from full shoot to full earing the samples were divided into four groups. At the same time, according to researches in the mid-ripening cultivar-standart Podolanka, the vegetation period lasted 229 days. The difference in vegetation period between the groups according to maturity was 4 days. Thus, the period of ultra early ripening varieties was 218 or less days (RS 526, DF 526, RS 6079, RS 6075, RS 412), early ripening varieties-219-222 days (Lankao 906, DF529, RS 718, DF581, CA0175, Zhongmai 9, Shixin 733 , Shi 4185, Jimai 22, Jing 411, Lunxuau 518, Jimai 19, Shimai 12, Pekin KMS-2012, DF549, DF425, Jinan 17 RS 6076, RS 6125, DF 401, Duto 1081, DF 549, RS 6049, DF412, RS 6024, RS 6052, RS 6102), mid-early ripening varieties-223-226 days (Jingdong 8, Zhongmai 19 Jingdong 8, Longzhong 9, Longzhong 10, RS 987), mid-ripening varieties-227-230 (Longzhong 1, Longzhong 2, Longzhong 3, Longzhong 4, Longzhong 5, Longzhong 6, Longzhong 7, Longzhong 8, Longzhong 11 Longzhong 12, RS6018, NSA 97-2082). According to the level as for winter resistance (Table 2), all groups of introduced varieties yield to the standard, although they had a significant index level (6.4-7.9 on a 9-score scale). Almost yield (<0.1 points) to the standard on the level of hibernation genotypes are classified as moderately advanced samples. The early-ripening cultivar LanKao 906 exceeded the standard as for an adaptability to winter conditions in the forest-steppe Ukraine and had the highest (9.0) score in the experiment. The lowest level to unfavourable winter conditions was found in ultra-early ripening cultivar RS 6075 (score 3.0). In general, the Chinese wheat assortment under the field conditions of SNAU was characterized by a relatively satisfactory winter resistance. 52% of the studied samples, of which: ultra early ripening-2%; early ripening-20%; mid-early ripening-8%; mid-ripening-22%, overwintered at the standard level with an assessment of 8 points.

Except winter resistance, the studied genotypes were characterized by a positive characteristic for selection important vegetation character. So, a large amplitude of oscillations was detected according to the height of plants: from dwarf (30-50 cm) to growth medium (81-110 cm) forms. 22% of the studied forms belong to the group of growth medium which were at the cultivar Podolanka level (see Table 2). Under the conditions of SNAU for the predominant majority of Chinese wheat assortment semi-dwarf plants are characteristic (64%) at plant height within 51-80 cm. 14% of the studied samples are included to the group of dwarf. The implementation of high genetic potential (more than 8-10 t/ha) can be provided only by varieties with strong and short stem. The optimum plant height, which provides the highest level of productivity and resistance to unfavourable environmental conditions can be the height of 91-100 cm (Lytvynenko, 2002). Our research confirms it. In the group of growth medium varieties, the score of winter resistance is higher (7.9-8.0), and with the resistance decreasing to the conditions of hibernation this score decreases. It is also because of the group of variety maturity, as there is a direct correlation dependence (index r) between: the ripeness group → the plant height (r=0.96) → the resistance hibertation (r=0.78) → the ripeness group (r=0.92). That is, the shorter the period of genotype vegetation the lower the plant height and the plant hibernation score. In our experiments, the correlation coefficient is close to +1, indicating a close normal or raw correlation (almost functional), between the ripeness group → plant height → winter resistance. The reliability of genotype and HTC that influenced the manifestation of signs was determined wth the variance analysis of resistance evaluation to disease and yield.

Table 2. The level of winter resistance and plant height of introduced wheat samples from China under the conditions of the north-eastern forest-steppe of Ukraine (SNAU), the average for 2012-2016.

Cultivar ripeness group	**Number of winter wheat samples (pcs.) according to the level of winter resistance (score)**					**$\bar{X}$ in group (score)**	**Plant height**					
							$\bar{X}$ according to groups (cm)	**Number of samples according to groups (pcs)**			**Limits, (cm)**	
	9-8	7-6	5-4	3-2	1			**D**	**SD**	**GM**	**min**	**max**
Podolianka St	-					8	92					
Ultra early ripening	1	3	-	1	-	6.4	53.2	1	4	-	42	63
Early ripening	11	16	-	-	-	7.4	55	6	21	-	46	68
Mid-early ripening	4	2	-	-	-	7.7	68.1	-	4	2	54	86
Mid-ripening	11	1	-	-	-	7.9	83.5	-	3	9	55	100

Note: -mid-arithmetic mean; min-minimum, max-maximum; D-dwarf; SD-semi-dwarf; GM-growth medium

We indentified the different rate of genotype reaction depending on the ripeness groups, yield and resistance against diseases under the influence of various ecogradients during the years of crop cultivation. The confidence interval was less than 0.02% the genotype and eco-gradient impact significance. It proves that both factors (genotype and eco-gradient) influenced the object with a probability close to 100%. That means that different genotypes and conditions of the year have a statistically significant effect on disease resistance and productivity (Table 3).

The analysis of four groups as for the ripeness shows that the highest score of resistance (more than 3) against mildew, compared with the cultivar-standard, was found in the genotypes of the mid-ealry and mid-ripening groups (score 6,5-7,1). Ultra-early and early ripening varieties yielded to the cultivar-standard 0.2-0.3 points and the average value of the experiment 0.5-0.6 points. The same results were detected as for septoria. Against brown rust the best varieties of the standard were samples of early-ripening (by score 0.2), mid-early ripening (0.8) and mid-ripening (0.3) groups. The standard Podolianka was characterized by high resistance to mildew. 61.5% of the studied varieties exceeded the standard. Among them: 5.8%-ultra-early ripening; 26.9%-early-ripening; 7.7%-mid-early ripening; 21.2-mid-ripening. 59% of the studied genotypes exceeded the cultivar-standard as for resistance to brown rust. Among them a group of varieties: 1.9%-ultra-early ripening; 32.7%-early-ripening; 9.6%-mid-early ripening; 15.4-mid-ripening. 46.2% of studied genotypes exceeded the cultivar Podolianka as for resistance to septoriosis; 19.2%-early-ripening; 7.7%-mid-early ripening; 19.2%-mid-ripening. So, early ripening does not cause a higher resistance to leaf diseases.

The genotypes with high resistance, or immunity to the complex of leaf diseases are more valuable for modern selection. Among the studied samples, the high resistance to the group of disease had such varieties: early-ripening-Lankao 906, DF529, DF581, Shi 4185, CA0175, Zhongmai 9, Shixin 733, Jimai 22, Shimai 12; mid-early ripening-Zhongmai 19, Shijiazhuang 8, Longzhong 10; mid-ripening-Longzhong 1, Longzhong 2, Longzhong 3, Longzhong 4, Longzhong 7, Longzhong 12. The above mentioned varieties can be recommended for the further selective work as a source of resistance to the complex leaf diseases.

Table 3. Resistance to leaf diseases and productivity of winter wheat varieties of Chinese origin under the conditions of SNAU, average 2012-2016.

Variety ripeness group	Number of cultivars in the group (pcs.)	Resistance to the diseases, (score)				Grain yield, t/ha			
		mildew	septoria	brown rust	$\overline{X}$	$\overline{X}$ according to groups	limits		R
							min	max	
Podolyanka (St)	St	6.1	5.5	6.1	5.9	5.9	5.5	6	0.5
ultra-early ripening	5	5.8	2.8	3.3	4	6.1	5.8	6.4	0.6
early ripening	27	5.9	4.9	6.3	5.7	5.7	5.2	6.3	1.1
mid-early ripening	6	6.5	5.6	6.9	6.3	6.4	5.9	6.9	1
mid-ripening	13	7.1	6.4	6.4	6.7	7.9	7.6	8.1	0.5
$\overline{X}_r$	-	6.4	4.9	5.7	5.8	6.4	6	6.7	0.7
LSD_{05}/p	Genotype influence	0.54/0.00	0.47/0.00	0.69/0.00		0.36/0.00			
	Eco-gradient influence	0.18/0.00	0.16/0.00	0.23/0.02		0.12/0.00			
	Interaction eco-gradient+genotype	0.93/0.94	0.82/0.77	1.19/0.99		0.63/0.36			

Note: mid-arithmetic-mean; r-mid-arithmetic mean in the research; R-rande of the sign variation; min-minimum, max-maximum; p-confidence interval (level).

Over the years yields varied from 5.2 (early-ripening) to 8.1 t/ha (mid-ripening) in the researched genotypes. The average population significance of sign was 6.4 t/ha. This index shows an adaptive optimum of crop yield, which is represented by varieties of Chinese origin under the condition of the right-bank north-east Forest Steppe of Ukraine. Exceeding of index shows a higher level of the genotype adaptability under the research conditions, as it is more closely related to the full realization of the genetic potential level. It should be noted that at the level of the average population mean the varieties of the mid-early ripening group were found, and the best ones-2 t/ha were med-ripening genotypes. At the same time, only ultra-early ripening varieties yeild significantly. It indicates that in spite of the inadequate adaptive potential, Chinese wheat assortment is characterized by a rather high level of potential yield.

The variation in yields over the years of research was 0.5-1.1 t/ha. The smallest index was observed in the varieties of the mid-ripening group with a yield of 7.9 t/ha. The largest scale of the investigated variation sign was recorded in the group of early-ripening varieties with a yield of 5,7 t/ha. Among the researched samples, the genotypes were found to be significantly higher than the culivar standard (LSD 05=1.01): early-ripening-DF529, Jimai 19; mid-early ripening-Jingdong 8, Shijiazhuang 8, Longzhong 10; mid-ripening-Longzhong 2, Longzhong 3, Longzhong 4, Longzhong 5, Longzhong 7, Longzhong 8, Longzhong 11, Longzhong 12, NSA 97-2082. Mentioned genotypes can be recommended for further plant breading work as a source of high productivity. Sources of high adaptability with a set of economically valuable and selection signs were identified as a result of the Chinese wheat assortment study (Table 4).

16% of the studied cultivars-Shijiazhuang 8, DF529, Longzhong 2, Longzhong 3, Longzhong 4, Longzhong 7, Longzhong 10 and Longzhong 12 showed a high resistance to hibernation, the group of diseases and yields. The plasticity coefficient according to the yield shows the cultivar reaction to the change of growing conditions. Genotypes with a bi value close to one are considered to be most suitable for growing in the given region, since the change in their yields fully corresponds to fluctuations of growing conditions. If bi is above one, then these cultivars relate to the intensive tipe. That is, they are intensely responding to the improvement of growing condition, but under unfavourable weather conditions, the productivity dramatically dicreases. When bi is much less than one, then such varieties are suitable only for growing under extensive technology. As a result of the conducted researches, the most plastic were cultivars Longzhong 7 and Longzhong 12. They showed themselves to be highly intensive in this region of cultivation (bi=0.9-1.4). Other selected varieties in which the value of bi was within 0.3-4.5 (with the «minus» sign) deviated from the group of extensive varieties that were not recommended to grow on the best forecrops and on a high agricultural background.

Table 4. Parameters of the selected sources adaptive ability according to the set of valuable signs (SNAU, average 2012-2016).

Cultivar	Ripeness Group	Plant height	Winter resostace (score)	Resistanse to (score)			Grain yield, t/ha				
				mildew	brown rust	septoria	t/ha	H_{om}	P_{BV}	b_i	S^2_{di}
Shijiazhuang 8	mid-early ripening	SD	8	6.3	8.5	6.55	7.4	868.4	7.27	-4.55	0.175
DF529	early ripening	SD	7	8.6	6.3	6.48	7.38	80.3	6.14	-0.45	0.185
Longzhong 2	mid-ripening	SD	8	7.1	8.43	6.47	7.06	83.66	5.96	-0.51	0.187
Longzhong 3	mid-ripening	GM	8	7.17	8.47	6.65	7.53	784.9	7.39	-4.36	0.186
Longzhong 4	mid-ripening	GM	8	8.53	7.3	7.57	9.18	79.04	7.27	-0.29	0.187
Longzhong 7	mid-ripening	GM	8	8.5	6.47	7	9.21	384.21	8.78	1.39	0.186
Longzhong 10	mid-ripening	GM	8	7.37	6.97	6.5	7.24	54.52	5.54	-0.32	0.186
Longzhong 12	mid-ripening	GM	8	8.7	8.47	6.5	10.37	193.43	9.31	0.88	0.115

Note: SD-semi-dwarf; GM-growth medium; Hom-homeostatic index; PBV-plant breeding value; bi-plasticity; S^2_{di}-stability.

The sign of variety is more stabilized when the mean-square departure deviation of the actual yield indeces from the expected theoretically (S^2_{di}) is smaller. Among them the varietiy Longzhong 12 was characterized the highest stability (S^2_{di}=0.1). The rest of the samplesalso showed high stability and had a positive index (S^2_{di}=0.2).

With the smallest variability of yield in a changable environment, the manifestation of high homeostaticity is associated. Then plants, where homeostasis is manifested, can develop normally despite the unfavorable environmental conditions. In our studies, high homeostatic index (Hom=54.5-868.4) is recorded in all selected genotypes. The maximum value is found in the varieties Shijiazhuang 8. Determination of homeostatic varieties allows not only to evaluate their average yield productivity, but also to determine their reaction rate to limiting environmental factors.

According to the plant breading value, a positive result (Pbv=8.9-9.3) was obtained in all selected varieties. The maximum of Pbv was recorded in the varieties Longzhong 12, which was characterized by the highest yield. The same dependence was observed in other samples.

Thus, on the basis of the conducted researches with Chinese assortment, eight genotypes of winter wheat, which possess high plant breading value, adaptability, homeostasis index and stability were selected. Most of them are varieties from Gansu province created for the conditions of the II terrain platform of China, which is at an altitude of 1000-3000 m above the sea level and it is closer to the conditions of Ukraine according to their eco-gradient than Hebei province conditions. These data show that the limiting factor of yield in the Chinese wheat assortment cultivation is not the potential yield, but the ability to adapt to a certain soil and climatic zone. The obtained results show the value of the genotypes introduced from China, and they are the basis for their use in the plant breading process and biotechnological research.

Conclusion

Under the conditions of SNAU (2012-2016), 50 new ultra-early ripening-10%, early ripening-54%, mid-early ripening-12%, mid-ripening-24% varieties of Chinese origin were investigated. By the level of winter resistance all groups of introduced varieties give te way to the standard, although they had a significant level of the index (6.4-7.9 points). At the standard level, with an evaluation of 8 points, 52% of the samples were detected, of which: ultra-early ripening-2%; early ripening-20%; mid-early ripening-8%; mid-ripening-22%. In the height of plants, a large amplitude of oscillations was detected; from dwarf plants (30-50 cm) to growth medium plants (81-110 cm) forms. The studied genotypes were distributed among the growth medium forms-22%, semi-dwarf-64% and dwarf-14%. There was a direct relationship between: the ripeness group → the plant height (r=0.96) → resistance to hibernation (r=0.78) → the ripeness group (r=0.92). The shorter the genotype vegetation period, the lower plant height and the plant overwintering mark. Early-ripening-Lankao 906, DF529, DF581, Shi 4185, CA0175, Zhongmai 9, Shixin 733, Jimai 22 and Shimai 12, mid-early ripening-Zhongmai 19, Shijia Zhuang 8 and Longzhong 10, mid-ripening-Longzhong 1, Longzhong 2, Longzhong 3, Longzhong 4, Longzhong 7 and Longzhong 12 had a high resistance to the group of disease. Genotypes of early-ripening-DF529 and Jimai 19, mid-early ripening-Jingdong 8 and Shijiazhuang 8, Longzhong 10, mid-ripening-Longzhong 2, Longzhong 3, Longzhong 4, Longzhong 5, Longzhong 7, Longzhong 8, Longzhong 11, Longzhong 12 and NSA 97-2082 were found to be the most reliable to yield standard.

16% of the studied cultivars-Shijiazhuang 8, DF 529, Longzhong 2, Longzhong 3, Longzhong 4, Longzhong 7, Longzhong 10, Longzhong 12 were distinguished according to the complex of investigated features. They are characterized by high index of adaptability and homeostasis (54.5-868.4), plant breading value (5.5-9.3), stability (0.2). Most of these genotypes originate from the Gansu province, created under the conditions of the II terrain platform of China, which is at 1000-3000 m above the sea level. The limiting factors of yield when cultivating the Chinese wheat assotrment are not a potential productivity, but the ability to adapt to the soil and climatic zone. The obtained results show the value of the genotypes introduced from China, and they are the basis for their use in the plant breading process and biotechnological research.

A perspetive continuation of the research is the evaluation of the plant bread winter wheat genotypes from China, which can provide a better adaptability and a higher level of implementation of the grain productivity genetic potential under the condition of Ukraine. It will meet the requirements of plant breading to the source material and the success of both the sources and donors of features which appear when combining the genoplasm by hybridization.

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