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IMPACT OF CLIMATE CHANGE ON WHEAT PRODUCTIVITY

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Summary

This research evaluates interaction of genetically diverse genotypes with environment. It was found that in the second (2017) year of the field trial wheat accessions were exposed to stress but productivity was decreased. In the third year, results revealed that productivity of accessions was increased and stabilized. Based on results, and according to ecological plasticity, wheat accessions the № 1251 and 1125 demonstrated high plasticity (bi> 0,9). Concerning stability of productivity, accessions number 1006, 1136, and 1251 demonstrated Si2 = 0.21, Si2 = 0.46 and Si2 = 0.5, respectively, indicating that yield was stable but variability was low.

Keywords: *bread wheat, productivity, stability, ecologic plasticity, adaptation.*

Introduction. Improving agricultural production to meet projected increasing demand of global food products by around 60% until 2050, due to growing population and economic development, represents a substantial challenge, particularly in the context of climate change [1]. Ensuring food food security, of cereal crops, including increase of bread wheat productivity and quality is considered as one of the most significant tasks of grain growing to date. The creation and widespread use of bread wheat varieties which meet the requirements of food industry is an important step in solving the problems of modern agriculture [2].

Wheat (triticum L) production is heavily affected by the temperature extremes due to climate change in many countries, and may reduce the crop yield by 6% for each °C rise of temperature [3]. Drought and high temperatures are key stress factors that have high impact on cereal yields [4] and Rubisco, the central enzyme of photosynthesis, is disrupted if the temperature increases from 35 °C, and stops the photosynthetic process [5].

Introduction of new high quality wheat varieties which at the same time possess such as stable productivity, adaptation to environmental factors, ecologic plasticity and improved technologic traits are required for agricultural production. In modern selection introduction of cost-effective, adaptive, disease-resistant and high grain quality high quality grain varieties provides an opportunity to improve the level of ecological and economic stability of agriculture, improve cereal productivity [6].

Currently, recommendations for variety choice to cultivation are created at regional [7] or country level [8]. These recommendations are based on the set of performance data including yield and yield stability, grain quality, lodging, pest and disease resistance and other specific criteria [7]. As a result of study of wheat adaptation to the environmental conditions, it was found that the harvest volume wheat susceptibility to stress factors

are independent components of general adaptation [9].

The creation of varieties that can make the most effective use of the bioclimatic resource of a particular region, express tolerance to stressful environmental conditions, and ensure a sufficiently high realization of the genetic potential of productivity is a strategic task of the modern breeding science [10]. One of the new methods for improving the efficiency of the selection process is adaptive selection [11].

The variety is the most cost-effective means of obtaining a high yield at minimal cost. Replacing old varieties with new ones that are more productive and have a high adaptation to the soil and climate conditions of a particular area is one of the most effective methods increasing the yields.

Evaluation of varieties in ecological variety testing on the plasticity and stability of the crop, resistance to adverse vegetation conditions makes it possible to select from a large number of newly created varieties with high yield potential varieties with the highest degree of adaptation to the conditions of a particular region.

The main goal of the present study is exploration of agrobiologic characteristics of wheat germplasm collection accessions of soft winter wheat, determination ecologic plasticity of the varieties, mutual influence of external environment and genotypes, having stable productivity level.

Materials and methods. Relative humidity in the location of conducted experiment was unstable (changeable) in March-June months, hydrothermal coefficient (HTC) was equal to 1.57 ha. Average temperature was 19.70C, observing temperature was 21.30C (average of March-June months) and on comparison with average was more on 1.740C. The soil of area where the experiments were conducted was irrigated pasture sierozem (grey soil), the quantity of humus in it made 0.8-1.2 %, ensuring by active phosphorus on average was 30-38 mg/kg. It was observed share difference in metrological condition in years of experiments carrying out. Average air temperature in 2016 March-June months was 19.70C, temperature was 21.50C, in resects of average temperature was higher for 1.80C. It was observed that ere citations on average was 38.4 mm, observed precipitation was 41.4 mm and in resects of average rainfall it was increased for 69.1%. In 2017-2018 observed temperature was 20.9-21.50C and in comparison with 2016 appreciable difference was not observed. Precipitations in 2017-2018 in comparison with 2016 decreased for 26.6-30.5%.

As source of the research CIMMYT from gene pool of international organization of the 46-th IBWSN (from selected nursery of international soft wheat), 200 samples were used as a source, specimens were planted on the plot with 1m2 area in three repetitions by randomization method during three years, yield stability, soil adaptation to climatic conditions and ecologic plasticity were studied. The adaptability of varieties to environmental factors was assessed as a rule; their yield is stable and flexible, as the main one productivity indicator. Indexes of ecologic plasticity (bi-regression coefficient) and stability (Si2- standard deviation) were conducted by E.A. Eberkhart and V.A. Russel [12] by using method of V.Z. Pakudina and L.M. Lopatina [13]. Indexes of valuable economically valuable traits ensuring productivity were statistically analyzed on the basis of “Ken Saera” formula, which was developed by the leading scientists of CIMMYT organization [14].

Results and discussion. In each region, it is necessary to select such varieties, which bioecological features fully correspond to the environmental conditions of these regions [15]. Modern varieties of winter wheat are characterized by high ecological plasticity, resistance to diseases and grain quality [16].

Adaptation and to the soil-climatic conditions and yield stability of collection wheat accessions, genotypes plasticity in unfavorable conditions were estimated during the experiment. Ten accessions, possessing high grain productivity, were selected from investigated samples and statistical analysis of their data were performed.

Adaptation of wheat variety to the environmental conditions initially passed experimental field tests and implemented into agricultural production, as the most significant characteristics of varieties, they were evaluated by their plasticity and yield stability. In estimating yield stability of investigated collection accessions and ecologic plasticity of the genotypes across years, regression coefficient (bi), based on estimation of linear regression coefficient and stability coefficient, was used.

Linear regression methods allow to predict the approximate level and effects of interaction in a given set of environments but require of variety field testing during at least three consecutive years or multifactorial experiment. The estimation of the effects of interaction of genotypes in convenient measurement units for selection, which, adjusted for it, enables more reliable judgement of varieties based on a one-year field trial.

First of all, for calculation of regression coefficient (bi), index of environmental condition is defined. Indicator of environmental condition can be positive and negative. Good development and increased productivity of varieties is expressed by positive value of ecologic index, or on the contrary by negative value (table-1). In 2016- and 2018-years conditions were optimal, crop yield was high, but in 2017 relatively low productivity was observed. According to the results of experiments in 2016 (ij=0.4, 2018 (ij=0.5) positive conditions, and in 2017 (ij=1.0) negative conditions were observed. Regression coefficient bi express influence on varieties and their productivity in changeable environmental conditions. With an increase of coefficient bi>1, productivity can be more susceptible to the environmental conditions, and ecologic plasticity property can be low, such varieties require high agricultural practices. If bi<1 lower, less sensitivity of productivity to the changes of environmental conditions, then it is considered that plasticity of the variety is high. In this case low level of agricultural practices can be used in such varieties.

In our research works in accessions with catalogue number 1125 and 1251 ecologic plasticity (bi>0.9) was on high level and close to them indexes were observed in samples with catalogue numbers 1289 (1.0); 1131 (1.0); 1088 (1.0); 1006 (1.0) and 1164 (1.0) (table-1). In the remaining samples 1296 (1.1); 1082 (1.1) and 1136 (1.1) regression coefficient suddenly became high, which indicates that these accessions belong to the varieties of intensive type and to obtain high yield from them, they can be adapted to environmental conditions by means of conducting very strong agricultural practices.

From theoretical point of view, the lower index of standard deviation (Si2), the more stable varieties adaptation to environmental conditions will be. An important aspect of selection work in the evolutionary plan and in the conditions of the modern transformed environment is the adaptive orientation in the implementation of a complex of specific features in genotypes. Parameters the plasticity of a selection trait can be accessed through the interaction "genotype-environment". Studies on the stability and plasticity of traits allow us to identify the effect of biotic and biotic factors of a certain environment on the genotype and determine the degree of their influence on the growth, development and productivity of varieties [17].

In our research work, when analyzing samples productivity index across years, all accessions stability on years was observed.

Table-1. Yield, ecologic plasticity, stability and changeability of yield indexes of accessions from germplasm collection nursery

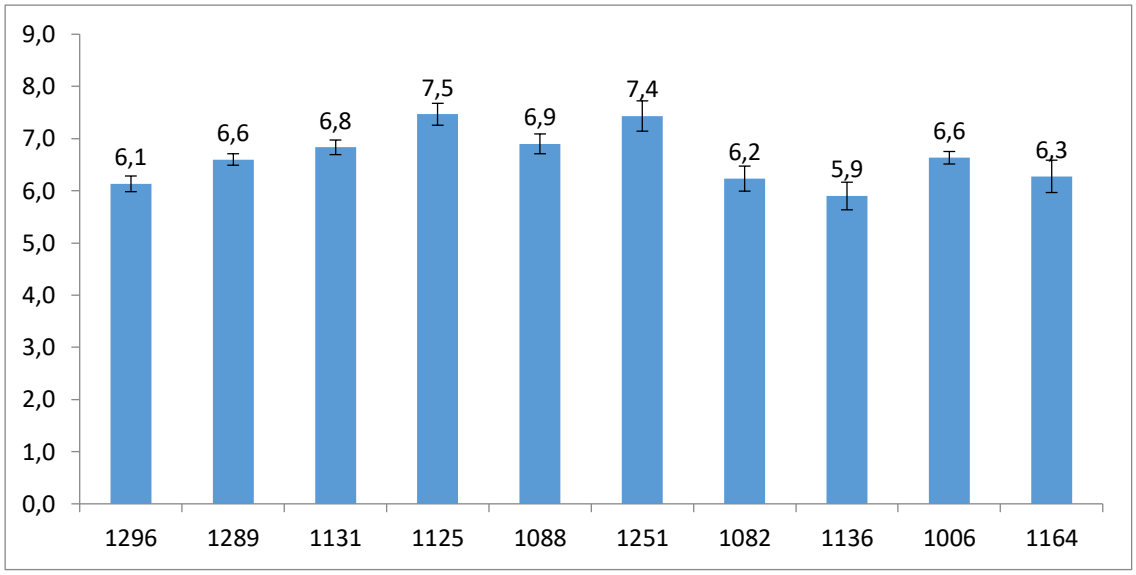
Catalogue number	Productivity t/ha			Σ Yi	Yi	Ecologic plasticity, bi	Stability, S_i^2	V%
	2016	2017	2018					
1296	6,9	5,3	6,2	18,4	6,13	1,1	0,80	13,08
1289	7,1	5,4	7,3	19,8	6,60	1,0	1,04	15,82
1131	7,3	6,03	7,2	20,53	6,80	1,0	0,71	10,32
1125	8,1	6,1	8,2	22,4	7,47	0,9	1,18	15,87
1088	8,1	5,5	7,06	20,66	6,88	1,0	1,31	19,0
1251	7,5	6,9	7,9	21,7	7,49	0,9	0,50	6,77
1082	6,2	5,2	7,3	18,7	6,23	1,1	1,05	16,85
1136	6,0	5,4	6,3	17,72	5,90	1,1	0,46	7,80
1006	6,8	6,4	6,7	19,9	6,63	1,0	0,21	3,14
1164	6,0	5,7	7,1	18,83	6,27	1,1	0,73	11,66
Mean Yj	7,0	5,8	7,1	19,7	6,6			
Σ Yi	70,05	57,93	71,26	199,2	66,0			
Ij	0,4	-1,0	0,5					
LCD 0,5	1,06 t/ha							

However, among specimens relatively the lowest index on relative stability observed in 1006 (0.21); 1164 (0.73); 1136 (0.46); 1251 (0.50); 1131 (0.71) and 1296 (0.80) accessions. It was found that these samples on relation to environmental conditions across years did not lose their stability trait. The of remaining accessions № 1289 (1.044); 1125 (1.18); 1088 (1.308) and 1082 (1.05) were estimated by relative intermediate calculations.

Variation coefficient (V %) is a relative unit of measurement of quantitative variation. If variation coefficient is till 10%, then changeability is insignificant, if on average 10-20%, or more than 20% it is considered as significant. In the research the lowest index in samples with catalogue number 1006 (3.14%); 1136 (7.8%) and 1251 (6.77%) in the rest accessions average variability was observed.

In the 1-diagram the average grain productivity of selected accessions across three-year field trials were shown. In optimal conditions the highest productivity was observed in the accession number 1125, in years with unfavorable conditions productivity decreases till 25%. It is observed, that in accession number 1251 even in the year with unfavorable conditions decrease of productivity was insignificant, in respect of three-year average productivity yield was on 7% less, this in its turn showed, that in comparison with other samples, it possesses stable productivity. Yield of genotypes across years varied from 8.1 t/ha till 5.62 t/ha.

Conclusions. The results of conducted experiments showed that the highest index of productivity across years was observed in accession with catalogue number 1251, followed by № 1125. It was revealed that these samples possessing high plasticity and stability characteristics from genetic point of view differ from other specimens by their adaptability to environmental conditions. These accessions were selected and recommended to be used in the selection and breeding process. In the selection and breeding process increasing attention must be paid to these traits.



1-diagram. Indexes of accession's yield from collection nursery across three-year field trials (t/ha)

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Климаттың өзгеруінің бидай шығымына әсері

Аңдатпа

Мақалада генетикалық әртүрлі генотиптердің қоршаған ортамен әрекеттесуі бағаланады. Далалық зерттеудің екінші (2017) жылының талдауында коллекция үлгілері стреске ұшырағыны және олардың өнімділігі күрт төмендегені анықталды. Ал далалық зерттеудің үшінші жылындағы (2018 ж.) талдау нәтижелерінде коллекциялық үлгілердің өнімділігі күрт өсіп, тұрақтанғанын көрсетті. Алынған нәтижелерге сәйкес, экологиялық пластикалық жағынан каталог нөмірлері 1251 және 1125 үлгілер жоғары пластикалық қасиеті bi> 0,9 деп бағаланды. Өнімділік тұрақтылығы бойынша №1006 (Si2 = 0,21), 1136 (Si2 = 0,46) және 1251 (Si2 = 0,50) үлгілері тұрақты өнімділікті көрсетті, ал өзгермелілігі төмен болды.

Негізгі сөздер: *жұмсақ бидай, өнімділік, тұрақтылық, экологиялық пластика, бейімделу.*

Влияние изменения климата на урожайность пшеницы

Аннотация

В статье оценивается взаимодействие генетически разнообразных генотипов с окружающей средой. Было отмечено, что при анализе второго (2017) года полевого исследования коллекционные образцы были подвержены стрессу, а их урожайность резко снизилась. На третий год (2018 г.) полевого исследования результаты анализа показали, что продуктивность коллекционных образцов резко возросла и стабилизировалась. Согласно полученным результатам, с точки зрения экологической пластичности, образцы с каталожным номером 1251 и 1125 были оценены как имеющие свойство

высокой пластичности bi> 0,9. Что касается стабильности урожайности, образцы №1006 (Si2 = 0,21), 1136 (Si2 = 0,46) и 1251 (Si2 = 0,50) показали стабильную урожайность, а изменчивость при этом оказалась низкой.

Ключевые слова: *мягкая пшеница, урожайность, стабильность, экологическая пластичность, адаптация.*

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