International Journal of Biology and Chemistry 7, №2, 53 (2014)

UDC 633/635:631.527 https://doi.org/10.26577/2218-7979-2014-7-2-53-56

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Physiological indicators in screening of winter wheat gene fund for breeding on yielding and adaptability

Abstract. The perspective high yielding of winter bread wheat germplasm is differentiated by genetic systems of adaptability, attraction and plasticity micro-distributions of the traits «mass of kernel per ear» and «mass of chaff per ear». The donors of the specified traits limiting yielding of winter bread wheat are selected.
Key words: physiological indicators, wheat breeding

Introduction

The target setting of typical breeding program is the selection of the trait with maximum expression of the characteristics that underlie the productivity, quality and resistance to abiotic and biotic stresses. The main way to improve the majority of breeding programs is to find good sources among a large number of tested germplasm. Approach is often successful in the absence of knowledge about limiting factor. The knowledge of important limits does not automatically lead to a more effective selection, but it helps to determine the level of genetic variation in responsiveness to such deterrence in a defined population. Understanding the biological factors limiting the potential opportunities genotypes under certain conditions is the most important to improve breeding programs [1]. The successful application of genetics knowledge in the breeding process is determined by the degree of rapid tests use, which aimed the accelerating of genotypes productivity evaluation. The test progenies are the traditional principle of the individual genotype identification by its phenotype. But the frequency of occurrence of unique genotypes in natural populations is so low and the population is so abundant, that in the early stages of breeding, the breeder, must to reject from 80-90% of the material. Long term test progeny is not very reliable-it is distorted by genotype environment relationship [2, 3]. It was proposed principle for rapid identifycation of the genotype by phenotype, excluding progeny tests. It can be possible on background which helps to get quick information as to whether the controlled phenotypic characteristic value by genetic systems or it is only modification, that is the result of the influence of micro-ecological niche of habitats [3, 4, 5].

Material and methods

52 accessions of winter wheat East – European variety trials (WWEERYT) nursery, formed and coordinated by the International winter wheat breeding program (CIMMYT/ICARDA/Turkey).

Statistical analysis of the genetic – physiological systems adaptability, attractions and micro distribution plastic of traits «mass of grain per spike» and «mass of chaff per spike» conducted using the mathematical formalism of orthogonal regression [5].

$$tg2\varphi = \frac{2\mu_{11}}{\mu_{20} - \mu_{02}}$$

$$\mu_{20} = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2$$

$$\mu_{02} = \frac{1}{n-1}\sum_{i=1}^{n}(y_i - \bar{y})^2$$

$$\mu_{11} = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})$$

where x_i – is an individual (or mean) value of the character x, $\bar{x}$ – is a mean value of all the individuals within the variety (or the mean of the average values of the varieties when calculating the genotypical regression).

The parameters of axis of the orthogonal regression are given by:

$$y-\bar{y}=\frac{2\mu_{11}}{(\mu_{20}-\mu_{02})\pm\sqrt{(\mu_{20}-\mu_{02})^2+\mu_{11}}}(x-\bar{x})$$

where the sign «–» corresponds to the longer axis of the ellipse of dispersion.

Evaluation was performed in 2 versions – on the main stem and on plants 1 m².

Results and their discussion

Within the framework of the international project ICAR/WSU/CIMMYT «The yield potential of winter wheat modern varieties of local and foreign breeding and evaluation of the mineral nutrition and irrigation effect on the yield» were identified traits, limiting of productivity.

Among such traits was attributed the spike productivity «mass of grain per spike» that highly correlated (r = 0, 65 -0, 74) to yield [7]. In this regard, the genetic system adaptability + attractions and plastics micro distribution were evaluated through the analysis of two-dimensional orthogonal coordinate system of the trait «mass of grain per spike», limiting productivity and the main feature «mass of chaff per spike».

The productive accessions of «WWEERYT» nursery was divided into 4 groups with different combinations of positive and negative shifts of studied genetic systems. The varieties: Zhetisu (Kazakhstan), PTZ Niska/UT1556-170, Stephens (USA), GK Kalasz, MV Madrigal, MV Palma (Hungary), Kharkivskay 106 (Ukraine) have been incorporated in the first group, which had a positive changes in all three genetic systems. In the second group, where the positive shifts micro-distribution plastics combined with negative for attraction + adaptation were included accessions: AGRI / BJY // VEE (Mexico), GK Othalon (Hungary), N95L158 (USA), Nikoniy (Ukraine). The third group was characterized by negative changes in all three genetic systems: Kinaci 97, Zander-12 (Mexico), MV 05-96 (Hungary), Belchanka 7 (Moldova), Erythrospermum 350 (Kazakhstan), Madsen, (TX71A562.6 * 4/AMI) * 4/LARGO, (TX71A562.6 * 4/AMI) * 4/LARGO (USA), TAM 200 (USA, Mexico). For the fourth group, it was noted the combination of positive developments on adaptability + attractions and negative for micro-distribution plastics. Two varieties Erythrospermum 26210 (Ukraine), Vorona (Mexico) were assigned to the fourth group, figure 1.

The analysis of shifts «measures of the genes work» was made it possible to identify the varieties – donors for each of the studied genetic systems. According to the genetic system micro distribution plastics in the spike marked the varieties and lines: Seri, AGRI / BJY // VEE, GK Othalon, Yunak, Bononia, N95L158, Ukrainka, Nikoniy, Luzanovka; for genetic system adaptive + attractions: Aisi, Sarka, NE93554, Soratniza, Erythrospermum 26210, MNCH, Vorona. The list of varieties selected by complex genetic systems adaptability + attractions and micro- distribution plastics is shown in Table 1.

Table 1 – Accessions of «WWEERYT» nursery, selected by complex genetic systems adaptability + attractions (a) and micro distribution plastics (b).

Accessions	Origin	Genetic system	The main stem	Plants/m^2	The number of definitions with a positive shift
Zhetisu	Kazakhstan	a	+	+	2
		б	+	+	2
Ptz Niska/ Lut1556-170	USA	a	+	+	2
		б	+	+	2
Gk Kalasz	Hungary	a	+	+	2
		б	+	+	2
Mv Madrigal	Hungary	a	+	+	2
		б	+	+	2
Mv Dalma	Hungary	a	+	+	2
		б	+	+	2
Harkovskaya106	Ukraine	a	+	+	2
		б	+	+	2
Stephens	USA	a	+	+	2
		б	+	+	2

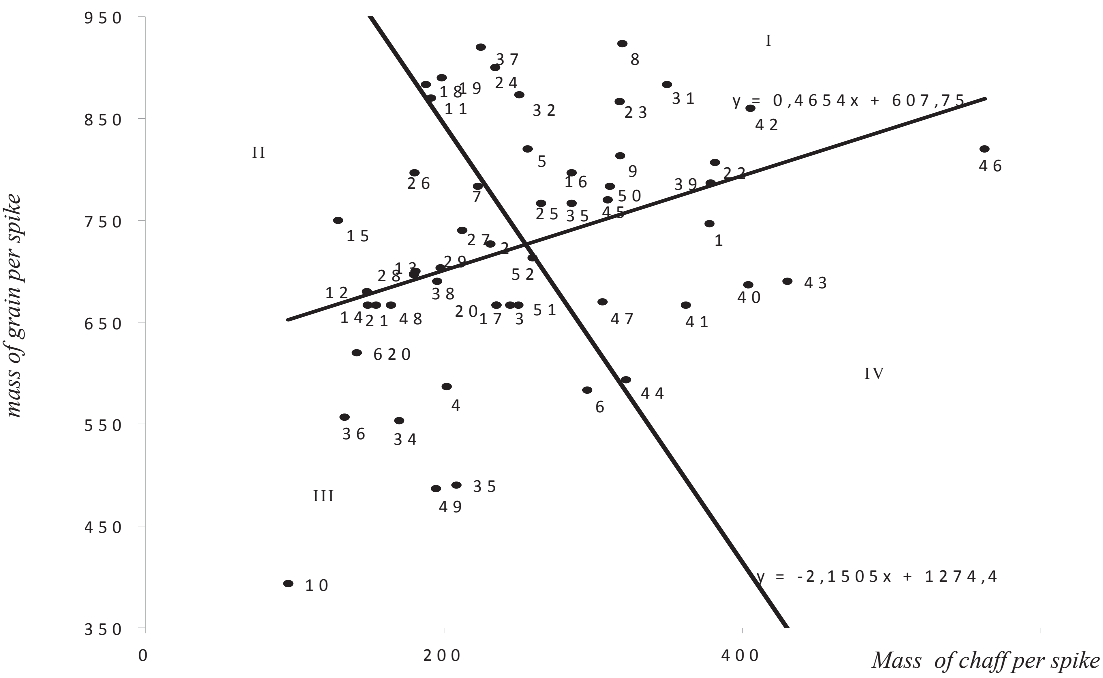

Figure 1 – Graphical analysis of the genetic systems adaptability + attractions and plastic micro distributions of winter wheat varieties and lines (analysis of plants, 1 m^2)
I-IV – numbers of groups with different combinations of genetic systems
1 – Bez; 2 – Seri; 3 – Kinaci97; 4 – Sultan95; 5 – Zhetysu; 6 – Zander-12; 7 – Agri/Bjy//Vee; 8 – Pyn/Bau; 9 – Ptz Niska/Ut1556-170; 10 – Gk Pinka; 11 – Gk Kalasz; 12 – Gk Othalon; 13 – Yunak; 14 – Prelom; 15 – Bononia; 16 – Aisi; 17 – Kartuli21; 18 – Mv Madrigal; 19 – Mv Palma; 20 – Mv 05-96; 21 – Boka; 22 – Sarka; 23 – Saskia; 24 – Ne94482; 25 – Ne93554; 26 – N95l158; 27 – Ukrainka; 28 – Nikonia; 29 – Lusanovka; 30 – Harkovskay 99; 31 – Karlygach; 32 – Harkovskay 106; 33 – Stephens; 34 – Gene; 35 – Madsen; 36 – Mac Vicar; 37 – Spartanka; 38 – Yna; 39 – Soratniza; 40 – Skifynka; 41 – Eryt 26210; 42 – Eryt 26221; 43 – Mnch; 44 – Vorona; 45 – Dana; 46 – Belchanka; 47 – Egemen; 48 – (Tx71a562.6*4/Ami)*4/-Largo; 49 – Erit. 350; 50 – (Tx71a562.6*4/Ami)*4/Largo; 51 – (Tx71a562.6*4/Ami)*4/-Largo; 52 – Tam200

Conclusion

The frequency of positive changes in the genetic system is a relatively weak criterion to identify donors. Quantitative criterion deviation of the genetic system is a measure of "work" the genes of adaptability + attractions. About the additive genes work can be judged by the equation shifts in the best and worst conditions of growth.

Optimal performance shifts on genetic systems in our experiments were 0.40 and above (in the study of stem), 100 and above (in the study of plants from 1 m2). When selected the donors take into account the direction of the shift, its magnitude.

Comparison of the varieties shifts magnitude showed that the most powerful effects of genes adaptability + attractions have varieties – Belchanka 7, Stephens, Karla, and genes micro-distribution – varieties GK Kalasz, MV Madrigal, MV Palma, Spartanka, PRELOM. The advantage of these genotypes was confirmed by the study in different versions (main stem, plants 1 m^2).

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