INFLUENCE OF HYDROTHERMAL CONDITIONS ON THE PRODUCTIVITY OF WINTER WHEAT VARIETIES IN DRY-STEPPE ZONE OF THE URAL PIEDMONT

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ABSTRACT

In the West Kazakhstan region, the proper selection of adaptive, high-yielding varieties with high technological qualities is of great importance in increasing the grain yield of winter wheat. The paper presents the study of biology and potential capacities of new regional and perspective varieties of winter wheat. The specific features of growth and development, the formation of productivity, the variability of quantitative characteristics characterizing the feedback of winter wheat varieties to the environmental conditions are presented. The varieties adapted to the local conditions by productivity and a set of economically valuable features that are of practical value were identified.

Keywords: Winter wheat; vegetation period; hydrothermal conditions; harvest structure

INTRODUCTION

Republic of Kazakhstan is one of the largest exporters of grain in the neighbourhood and far abroad countries. The level of grain production has always been one of the major characteristics of economic viability and prosperity of any country. In order to stabilize the yields in the ever-changing weather conditions, as well as increase gross yield, the grain production needs of new high-productive varieties that best meet the needs of farmers (Urazaliev, 2006a; Shaimerdenova 2007).

A huge role in increasing of crop yields belongs to a variety of the crop. In this regard, the study of biological characteristics of promising varieties in conditions of dry-steppe zone in Western Kazakhstan and identifying the high-quality and productive varieties in breeding work is actual. The main adverse weather factors of the studied area include the shortage of moisture in the soil during planting, which causes difficulty in simultaneous sprouting of wheat and the low temperatures at long absence of snow (Urazaliev, 2006b; Urazaliev, 2008; Zhuchenko 1988).

The purpose of the study is to examine different varieties of winter wheat of different origin for their economic and valuable characteristics and identification the features of the basic elements of productivity in the conditions of the dry-steppe zone of the Western Kazakhstan.

MATERIALS AND METHODS

In the West Kazakhstan Agro-Technical University the study of the collection material of winter wheat developed in various regions of the world and in Russian Federation for basic economic and biological characteristics has been conducting.

Sowing of the wheat crops were performed after field fallowing on 20-25 August, at a depth of 6-7 cm. The beginning of vegetation of any culture was determined by the period of sowing-germination.

To understand the biology of the local agro-ecotype, the varieties allowed for use in a production were taken, as well as 20 promising varieties of winter wheat that are under the varietal test (Table 5).

The phenological observations, recording and analysis of the yield indices were carried out according to the method of the state variety testing (Methodic of State Variety Testing of Agricultural Crops, 1971; 1989). The experimental data were processed by mathematical statistics, the calculation of the correlation coefficient, and the variance analysis were carried out according to the Dospechov (1979).

RESULTS AND DISCUSSION

The number of germinated plants is highly influenced by precipitation that fell before sowing, which refill the productive moisture in plough layer of upper soil horizons.

Influence of conditions of pre-sowing period is confirmed by the significant correlation. A strong degree of dependencies between the yield and rainfall fell in the pre-sowing period ($r = 0.67$), as well as the hydrothermal coefficient of pre-sowing period ($r = 0.70$) was found. On average, for the studied years the duration of this period was 9 -11 days. The total duration of the period of sowing-beginning of tillering of winter wheat varieties was 26-27 days.

Beginning of the tillering period-end of autumn vegetation depended on temperature and amounted 35-47 days.

The total duration of the autumn vegetation period of studied winter wheat varieties over the studied years ranged from 61 to 72 days and depended on the sum of active temperatures

for the autumn vegetation period, which has a positive role in the formation of the vegetative plant capacity.

Importance of the duration of the tillering in autumn is confirmed by the significant correlation dependence with yields over the years of research (r = 0.59).

There has been a moderate correlation dependence between the total duration of autumn vegetation and the grain yield during the years of studies (r = 0.43) (Table 1).

Table 1. Correlation coefficients between the grain yield of winter wheat and the duration of vegetation

Period	Correlation coefficients, r
Germination-beginning of tillering	- 0.28
Beginning of tillering – end of autumn vegetation	0.59
Duration of autumn vegetation	0.43
Duration of spring tillering	0.47

Study of the formation of vegetative organs of winter wheat plants at the end of the autumn vegetation revealed that before wintering the plants of various varieties have in average from 5.1 to 5.4 shoots; 4.0-4.4 embryonic and 4.5-6.0 nodal roots. By the number of embryonic roots, an average for one plant, the notable varietal differences were not observed. The number of embryonic roots for one plant have amounted: 4.3 for “Mironovskaya 808”; 4.4 for “Saratovskaya 90” and 4.0 for “Ljutescens 72”. The average number of nodal roots, which is crucial to this culture, ranged from 4.5 to 5.1 pieces.

The spring tillering period depended on the prevailing hydrothermal growth conditions. For the studied area zone, it was 34-38 days. Early resumption of spring vegetation is biologically preferable because of the better conditions for the tillering, than later, when there is rapid temperature rise (Krasnova, 2003).

A positive correlation between the yield and the duration of spring tillering was r = 0.47. An important economic and biological characteristic of a variety is matching of the duration of vegetation period to the zone of its cultivation. Duration of vegetation period for “Saratovskaya 90” variety amounted 304-305 days (Table 2)

Table 2. **Duration of interphase and vegetation periods of Saratovskaya 90 winter wheat varieties in the West-Kazakhstan region (average for 4 years)**

Duration of the period, days			
Germination – End of autumn vegetation	Beginning of spring vegetation – Earing	Earing – Wax ripeness	Germination - Wax ripeness
66.2+2.5	59.7+2.6	39.7+0.37	304.7+0.36

Productivity is a complex feature that is composed of many specific constituents. In this connection, a set of winter wheat varieties was examined on the elements of yield structure (Table 3). Crop structure shows the advantages of the “Saratovskaya 90” variety on the productivity elements. Based on the results of our research, the distinctive feature of the “Saratovskaya 90” variety, compared to the “Mironovskaya 808” is a high performance of field germination rate and preservation of plants as well as some increase in productive tillering and in the average grain weight per plant.

Table 3. Structure of the yield of studied winter wheat varieties (average for 4 years)

Variety	Number of plants by shoots, pcs/m^2	Preserved plant numbers		Number of productive stalks, pcs/m^2	Grain weight per plants, g	Weight of 1000 grains, g
		Number of plants before harvest per m^2	%			
Saratovskaya 90	370	322	87.1	478	0.71	37.8
Mironovskaya 808	361	303	83.3	444	0.62	34.3

Identification of quantitative trait variability that characterizes the reaction of the variety to the environmental conditions and selection of signs with the smallest variability in local conditions, allows selection of productive forms (Table 4).

There was recorded a high stability of the manifestations of the number of the spikelet in the ear, as evidenced by the low coefficient of variation (CV 5.8%).

The data show that low values of the coefficient of variation for mass of 1000 grains (CV 7.3) indicates the stability of this sign and the selection effectiveness in the studied climatic conditions.

Table 4. The variability of plant height and elements of yield structure of winter wheat varieties (average for4 years)

Sign	Index							
	Plant height, cm	Number of plants before harvest per m^2	Ear length, cm	Number of ears, piece.	The number of grains in an ear, piece.	Weight of 1000 grains, g	Grain weight per plants, g	Yield, t/ha
Average (x)	0.9 ± 2.0	308± 8,8	7,1 ± 0.34	7,3 ± 0.22	18,9 ± 0.82	36.1 ± 0.02	0.64 ± 0.67	2.04 ± 0.89
Limit (Lim)	58 - 79	243 - 362	5.4 – 8.7	16.4 - 18	3.2 – 24.3	33.9 – 37.6	0.49 – 0.8	1.08 – 3.50
Sweep (R)	21	119	3.3	1.6	11.1	3.7	0.31	24.2
CV, %	17.9	21	12.1	5.8	17.2	7.3	11.6	28.5

The number of grains and grain weight per plant are characterized by high variability in years of research, and their coefficients of variation were respectively 17 and 11.6%. Variation of grain weight by varieties, on average, for the studied years ranged from 0.49 to 0.80 g. The high variability in the number of plants before harvesting (CV 21%) was recorded. The most variable for the studied years was an indicator of yield with high coefficient of variation (CV 28.5%).

Depending on the environmental conditions, the yield and related indices are characterized by varying degrees of variability. Study of biological characteristics of winter wheat in dry-steppe conditions showed that studied varieties have high productive potentials.

The most productive, adapted to the local conditions, were the varieties: “Saratovskaya 90”, “Mironovskaya 808”, as well as promising new varieties “Zhemchuzina Povolzhia”, “Levoberezhnaya 2” and “Atkara” (Table 5). The yield of grain of “Mironovskaya 808” and “Saratovskaya 90” varieties in moisture favourable years amounted to 2.70 and 3.06 t/ha, correspondingly, and in dry years decreased to 0.8 and 1.84 t/ha.

The maximum grain yield for all the years of research was recorded for the variety “Zhemchuzina Povolzhia”.

Table 5. The yield of winter wheat varieties, t/ha (average for 4 years)

Variety	Yield, t/ha	Standard of variation, t/ha
Saratovskaya 90	2.41	
Mironovskaya 808	1.77	- 6,4
Lyutescens 72	1.99	- 4,2
Kuybyshevka	2.19	- 2,2
Saratovskaya awned	1.39	- 10,2
Guberniya	1.74	- 6,7
Victoria 95	1.76	- 6,5
Atkara	2.42	+0,1
Ershovskaya 10	1.65	- 7,6
Ershovskaya 11	2.18	- 2,3
Levoberezhnaya 1	1.78	-6,3
Levoberezhnaya 2	2.53	+1,2
Levoberezhnaya 3	2.03	- 3,8
Smuglyanka	1.80	- 6,1
Zhemchuzhuna Povolzhia	2.86	+4,5
Almaly	1.76	- 6,5
Naz	1.21	-12.0
Sapaly	1.14	- 12,7
Steklovidnaya 24	0.98	- 14,3
Yubilenaya 60	0.76	- 16,5
Average X±Sx	1.82±0,46	

In favourable years, the maximum yield was recorded for the variety “Zhemchuzhuna Povolzhia”, which amounted to 3.69 t/ha. Average grain yield for this variety for the studied years was to 2.85 tonne/hectare, which is for 0.44 t/ha higher than for the standard variety “Saratovskaya 90”.

CONCLUSIONS

The biological features of winter wheat varieties of the local ecotype were revealed:

- The duration of the growing season of winter wheat is 308-309 days, which creates certain prerequisites for the dependence of yields on weather conditions. As the hydrothermal coefficient increases, the yield also increases, as evidenced by the high correlation of yields with the hydrothermal coefficient over the vegetation period ($r = 0.86 \pm 0.26$).
- The pre- sowing period affects the completeness and speed of the seeds emergence, what is confirmed by the significant correlation between the yield and precipitation in the pre-sowing period ($r = 0.67$), as well as the hydrothermal coefficient of the pre-sowing period ($r = 0.70$).
- The duration of autumn tillering plays an important role in increasing the productivity of winter wheat that is emphasized by its significant dependence from the average yield for the years of research ($r = 0.59$), with the elements of plant productivity: the mass of grain in plant ($r = 0.09$), with the number of grains ($r = 0.13$). There is an average correlation between the total duration of autumn vegetation and the average grain yield for the years of study ($r = 0.43$).
- Determination of the degree of variability of quantitative signs that characterize the feedback of the varieties to environmental conditions, and the choice of signs with the least variability in the local conditions, allows selection of productive forms.
- The number of spikelets in the ear with the coefficient of variation 5.8%, and the mass of 1000 grains (CV = 7.3) showed a high consistence, which indicates the stability of this sign and efficient using of this sign in selection in the local conditions.
- High variability was noted for the weight of the grain per plant (V = 11.6%), the number of grains (V = 17%) and the number of plants before harvesting (V-21%), and yield (V-28.5%).
- the studied varieties of winter wheat showed a good potential for high yield.

The maximum grain yield average for the studied years was observed for the variety “Zhemchuzhuna Povolzhia” region (2.85 t/ha), which is for 0.44 t/ha higher than the yield of the “Saratov 90” variety.

REFERENCES

Krasnova LI. 2003: Biology, breeding, seed production of winter wheat in South Ural, Orenburg. P.54.

Urazaliev RA. 2006a: Breading and gene fond of wheat in Kazakhstan. (Ed.) R.A. Urazaliev, Alma-Ata, 18 p.

Urazaliev RA. 2006b: Biological principles of breading of wheat varieties of different ecotypes. (Ed.) RA Urazaliev, Almaty, 56 p.

Shaimerdenova DA, Tastanbekov ST and Medvedkov EB. 2007: Qualitative characteristics of Kazakh grain. Bulletin of the Science of Science of Kazakhstan, No. 5:9-12

Urazaliyev RA and Dzhatkanbaeva AE. 2008: Yield of the intensive type varieties of winter wheat of in the conditions of Kazakhstan and Kirghizia. Herald of the s.X. Sciences of Kazakhstan. Almaty, no. 4:4-5

Zhuchenko AA. 1988: Adaptive potential of cultivated plants (ecological and genetic basis). (Ed.) AA Zhuchenko. Shtitsa.

Methodic of the State Variety Testing of Agricultural Cultures. 1971: Moscow, Kolos, Issue 1, 248 p.

Methodics of the State Variety Testing of Agricultural Cultures.1989: Mkoscow, Kolos, Issue 2, 194 p.

Dospechov BA. 1979: Methodology of field experiment. (Ed.) BA Dospechov. 4th ed., Moscow, 416 p.