Title of the project: IRN AP14870923 «Development of techniques for increasing productivity, drought tolerance of wheat in arid conditions of Central, Northern Kazakhstan using mathematical modeling»

Relevance: Currently, applied dynamic models of the production process of agricultural plants are an important instruments for the introduction of modern high-tech technologies into the traditional practice of crop production.

The development of adaptive techniques to increase the drought resistance of spring soft wheat in arid conditions of Northern Kazakhstan using mathematical modeling allows to significantly simplify the analysis of a variety of alternative solutions and the choice of optimal agricultural technologies compared with the traditional approach.

In this regard, the application of a complex of agrotechnical measures to increase the drought resistance of spring soft wheat in arid conditions of Northern Kazakhstan using mathematical modeling is an urgent problem and has great theoretical and practical significance.

Goal of the project: Application of mathematical modeling in the development of a set of agronomic measures to improve productivity and drought resistance of spring wheat in severe continental arid soil-climatic conditions of central and North Kazakhstan

Expected and achieved results: The influence of studied factors on drought resistance of spring wheat varieties based on molecular genetic evaluation will be established and recommendations for their use will be given.

The optimal technological parameters of pre-sowing treatment of spring wheat seeds with micronutrients contributing to increased drought tolerance and productivity will be established, taking into account the soil and climatic conditions of Northern and Central Kazakhstan.

With the help of mathematical modeling the optimal elements of agrotechnological methods of surface tillage on the productivity of spring soft wheat in the arid conditions of Northern Kazakhstan will be established.

Based on mathematical modeling for different soil and climatic zones of Northern and Central Kazakhstan will be created a model of drought-resistant variety of spring wheat.

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Research results:

To conduct research, field testing grounds were laid in two farms in Northern and Central Kazakhstan:

1. LLP "Scientific and Production center of grain farming named after A.I.Barayev" (field No. 10, on an area of 40 hectares) - dry steppe zone, southern chernozem, small-scale plain, Akmola region;

2. "Naydorovskoye" LLP (field No. 11, on an area of 40 hectares) - dry steppe zone, chestnut soil on a small mound, Karaganda region.

The technology of soil preparation corresponded to the generally accepted one for the respective zones.

Amplifluor-like SNP primer KATU-W62SNP2, KATU -X1-F1, KATU_X1-F2, KATU_X1-R was used for molecular screening of samples for wheat drought resistance. Molecular studies were carried out on varieties of various ecological and geographical origin, namely domestic breeding: Fantasia, Lamis, Aina, Karabalykskaya 90 (Karabalykskaya ShOS), Celina 50, Akmola 2, Assyl Sapa, Taimas, Shortandinskaya 2014 (SPC ZH named after A.I. Baraev), as well as foreign breeding: Liskam (France), Granny (Australia).

As a result of the studies, the studied spring wheat varieties clearly differed from each other by the KATU-W62-SNP2 primer and corresponded to one of the allele distribution variants: coinciding with the 18-4 genotype ‘bb’, or with the high-yielding in drought conditions, the carrier of polymorphism genotype 18-5 ‘aa'. Of the 11 varieties studied, a positive homozygous result (aa) was shown by the varieties of spring soft wheat of domestic selection: Taimas and Shortandinskaya 2014, along with the carrier of polymorphism associated with drought resistance, the Opata 85 variety. The varieties Granni and Celina 50 have been identified by the Dreb1 gene as heterozygotes or are a mixture of ’ab' genotypes.

When determining the morphophysiological signs of spring soft wheat seedlings with the best germination rates (92.67-97.67%), batches of seeds of the varieties Taimas, Lamis, Liskam, Aina, Fantasia, Asyl Sapa, Granni, Virgin 50 distinguished themselves. According to GOST 12047-85, the batch of seeds of the above varieties belongs to the 1st and 2nd class in terms of sowing qualities.

The seedlings of the Liskam and Asyl Sapa varieties differed in large indicators in the length of the shoot, the mass of the shoot, the area of the shoot and the weight of the roots for 10 days. On the basis of the appearance of roots, Aina and Facets are a more drought-resistant variety, the roots are located at an angle of 28.3-30.67 about kpobegu.

According to the results of the study, it was found that medium-ripened varieties of soft spring wheat have a wide range of genotypic diversity in response to water deficiency in the initial phases of development.

Most of the studied soft wheat varieties showed a high degree of resistance to early drought. The degree of drought stability of the varieties Shortandinskaya 2014, Taimas, Karabalykskaya 90, Lamis, Liskam, Aina, Granni, Akmola 2, Virgin 50 was 76.81-89.78%. Ana (87.23%), Facets (89.78%) and Taimas (88.24%) stood out with the highest drought resistance. Fantasy and Asyl Sapa varieties were identified with increased drought resistance (more than 76%).

According to the results of mathematical analyses, a strong correlation was revealed between the mass of shoots and the laboratory germination of seeds of soft wheat varieties. At the same time, the correlation coefficient was g = 0.71, the regression coefficient y = 4.08 and the criterion of the significance of the correlation coefficient p = 0.091. The results of mathematical processing of the data obtained showed that the germination level was not affected by the length of seedlings and the shoot area.

For agrochemical studies of the soils of experimental plots, the sampling was carried out with a 3-hectare grid to assess the initial state for the content of humus, mobile forms of nitrogen, phosphorus, potassium, sulfur, trace elements, pH and degree, type of salinity.As the results of agrochemical analyses have shown, different types of soils differ in the content of macro and micro elements. The humus content in the horizon of 0-100 cm of soils is in the chernozems in the range of 3.57-4.46% and in the dark chestnut soils of Naydorovskoye LLP - 2.73-3.78%. The reaction of the soils of dark chestnut and southern chernozems is medium-alkaline and highly alkaline, the acidity of the soil is within the pH range of 8.16-8.87.

The conducted studies on the content of easily hydrolyzable nitrogen in the soil of the experimental plots showed that the content of easily hydrolyzable nitrogen on dark chestnut (25.56%) soils was higher by 10.15 mg/kg compared to the soils of the southern chernozem.

The content of mobile phosphorus in the soil at both sites is very low, in field No. 10 (southern chernozem) its content is on average -18.59 mg/kg in the field, in field No. 11 (dark chestnut soil) on average -13.53 mg/kg in the field. The provision of soils with exchangeable potassium in both experimental plots is mainly very high, its content is in the range of 611-1044 mg/kg

. When analyzing the soils of two farms in Northern and Central Kazakhstan for the content of mobile sulfur (sulfur sulfates), it was found that only traces of it are noted in the soil.

Based on the results of laboratory work to determine the yield and sowing properties of seeds, genotyping based on SNP markers of wheat varieties, agrochemical soil analyses of experimental plots, a recommendation is made to make adjustments to agrotechnologies of the following elements;

For the conditions of the A.I. Barayev Scientific and Production Center of Grain Farming LLP:

1. fertilization - Ammophos + Ammonium sulfate with a norm of 45+60 kg d.v./ha;

2. seed treatment before sowing with complex micronutrients with the norm - Zn - 75g, Co- 75g, Si- 75g, Cd-40 g d.v / t.;

3. to carry out leaf feeding during the tillering of spring soft wheat with chelated forms of micronutrients with the norm - Zn - 45g, Co- 35g, Si- 40g, Cd-20 g d.v / t.;

4. Carrying out the rolling of the soil after sowing and harrowing of the soil during the tillering of spring soft wheat.

For the soil and climatic conditions of Naydorovskoye LLP:

1. fertilization of ammonium sulfate with a norm of 50 kg d.v./ ha before sowing spring soft wheat;

2. processing of seed material before sowing with complex micro-fertilization with the calculation of Zn - 80g, Co - 70g, Si- 77g, Cd-38 g d.v/t.;

3. carrying out leaf feeding during the tillering of spring soft wheat chelated form of micro-fertilization with the norm - Zn - 50g, Co- 42g, Si- 37g, Cd - 22g d.v / t.;

4. rolling of the soil after sowing and harrowing of the soil during the tillering of spring soft wheat.