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Induced mutagenesis in obtaining donors of resistance to leaf rust in wheat

Abstract. The Concept of Kazakhstan entrance into one of the 30 most developed countries of the world long-term priorities are designated, one of which is translated into the path of innovation of agricultural industry, development of sustainable and highly productive agriculture. In countries, which are the major producers of marketable grain in the world, the main strategy advocates creation and introduction of wheat varieties resistant to abiotic and biotic environmental factors, namely, creation of productive drought-tolerant, salt-tolerant, and resistant to various diseases varieties with high grain quality.

Keywords: induced mutagenesis, surfactants, resistance.

Introduction

Creation of new wheat varieties is impossible without improving the existing genetic and breeding methods and techniques, one of which is the method of induced mutagenesis. To increase the efficiency of mutation breeding of plants it is necessary to study the conditions and methods of mutagenic effects, allowing to expand the spectra of genetic variation and to increase the yield of useful mutations. For this it is necessary to choose a chemical mutagen compound causing variation with positive effect. One of the representatives of the possible weak mutagens are surfactants [1, 2].

One of the most common and harmful diseases of wheat leaf rust is caused by the basidiomycete *Puccinia recondita* Rob. ex Desm. f. sp. *Tritici*, leading to reduction of assimilating surface and increased transpiration of plants, and as a result violations in the water balance, causing premature leaf death and reduced winter hardiness. Shortage of grain yield can reach up to 20-30%.

The aim of this research was to study the mutational variability of soft wheat under the influence of surfactant for highly resistant to *Puccinia recondita* agronomic wheat genotypes and development of scientific and methodological approaches for production of the original forms of wheat to improve the efficiency of selection for adaptability and productivity.

Materials and methods

The objects of study were the generation of mutant lines M_1 and M_2 from 4 varieties of soft wheat of local selection - Kayir, Melturn 490, Kazakhstanskaya early ripe and Shagala, obtained after treatment with various surfactants, which are used in biological research: Triton X-305, Triton X-100, Tween 85, Tween 65, and Tween 20.

To determine the resistance of plants from the mutant forms of wheat M_2 generation to brown rust, mutant forms of M_1 and control varieties of soft wheat Kayir, Kazakhstanskaya early ripe, Melturn 490 and Shagala were seeded on the infectious background of the Kazakh Research Institute of Agriculture and Crop production.

Estimation of resistance on the infectious background was carried out jointly with the staff of the laboratory of plant immunity of the same Institute. Phytopathological evaluation of resistance to leaf rust was performed 8-11 days after inoculation according to the standard procedure [3].

Results and their discussion

According to the McIntosh R.A. 5 types of reaction exist: 0 – immune, the degree of damage is not observed; R-resistant, the plant is able to resist the action of the pathogen; MR - moderately resistant; MS - moderately susceptible; S - susceptible [4].

Results of phytopathological assessment of resistance to the leaf rust of wheat M₂ generation mutant forms are presented in Table 1.

As seen from the Table 1, the mutant forms of wheat variety Kayir display the maximum resistance to the leaf rust.

Table 1 – Screening of the wheat M₂ generation mutant forms on their resistance to *Puccinia recondita*

Variety	Treatment of plants with surfactants	Degree of damage
Kayir	Control (without treatment)	R
	Tween 20	60R
	Tween 65	80R
	Tween 85	R
	Triton X-100	R
	Triton X-305	R
Kazakhstanskaya early ripe	Control (without treatment)	60MR
	Tween 20	80MR
	Tween 65	15MS
	Tween 85	50MR
	Triton X-100	30MR
	Triton X-305	40MS
Meltun 490	Control (without treatment)	40MS
	Tween 20	70MR
	Tween 65	80MR
	Tween 85	85MR
	Triton X-100	30MR
	Triton X-305	20MS
Shagala	Control (without treatment)	MS
	Tween 20	40MS
	Tween 65	30MS
	Tween 85	20MR
	Triton X-100	70MS
	Triton X-305	60MS

Note: R – resistant type of reaction; MR – moderately resistant; MS – moderately susceptible; S – susceptible

Treatment with surfactants might also increase the resistance to the leaf rust of Shagala and Meltun 490 mutant forms.

It should be noted that the mutant forms of Kayir variety during the primary screening show high resistance, when treated with the various types of surfactants, at the same time as moderate during the secondary screening. The mutant forms of Shagala variety treated with the surfactant Triton X-100 in the primary screening show moderately susceptible type of reaction to leaf rust, in the secondary - resistant type of reaction.

Comparative analysis of the results of wheat treatment with surfactants shows that the most effective is treatment with the surfactant Triton

X-100, for the mutant forms of Kazakhstanskaya early ripe and Meltun 490 varieties.

Mutant forms of Kayir variety are highly resistant to the leaf rust with the reaction type of «0» points. Whereas mutants derived on the basis of Meltun 490 and Shagala varieties display an intermediate type of inheritance – with the reaction type of «1-2» points. As a consequence, treatment with surfactants might affect the resistance to the leaf rust.

Results obtained show a definite prospect of chemical mutagenesis in wheat breeding.

Comparison of elements of productivity of Kazakhstanskaya early ripe variety and its experimental variants treated with different

surfactants shows that the inhibitory effect on the studied quantitative traits is on Triton X-100, while the stimulatory effect is observed on Tween 20. For

other variants of the experiment some variability performance characteristics are noted, which are not statistically significant (Table 2).

Table 2 – Elements of productivity of control and mutant forms of the M₂ generation of Kazakhstanskaya early ripe and Kayir varieties

Variants of treatment	Tillering, pcs.	Height, cm	Length of the main spike, cm	Number of flowers, pcs.	Number of seeds, pcs.	Weight of seeds, g	Weight of 1000 seeds, g
Kazakhstanskaya early ripe							
Control	4.9±0.2	89.6±1.4	11.2±0.2	53.9±1.9	47.1±1.5	1.9±0.1	31.3±4.5
Triton 305	4.6±0.2	90.2±0.8	10.5±0.2	50.6±1.9	45.8±1.7	1.9±0.1	33.9±2.7
Triton 100	4.3±0.2	76.4±1.4***	10.3±0.2***	47.9±1.6*	41.4±1.6**	1.7±0.1	29.4±1.0
Tween 855	4.7±0.3	88.5±1.1	11.8±0.3	53.5±2.5	48.9±2.5	2.1±0.1	38.1±2.0
Tween 65	4.4±0.2	89.1±0.6	11.1±0.2	56.1±1.1	51±1.1	2.2±0.1	40.8±1.2
Tween 20	4.0±0.2***	86.5±1.2	10.9±0.2	57.2±1.6	51.7±1.5	2.1±0.1	41.9±0.1*
Kayir							
Control	3.8±0.2	82.2±1.2	10.9±0.3	45.4±0.3	40.9±1.7	1.6±1.9	30.7±1.0
Triton 305	3.9±0.1	79.1±1.3	11.6±0.3	55.7±2.2**	50.4±2.1	2.3±0.1	30.0±2.5
Triton 100	3.3±0.1*	71.2±1.3***	11.7±0.1	43.5±2.3	39.2±2.7	1.6±0.1	28.6±1.0
Tween 855	4.6±0.2***	88.3±0.6***	12.1±0.2*	51.1±1.1***	47.9±1.2***	2.1±0.1	36.8±1.5**
Tween 65	3.9±0.2	78.4±0.6**	11.2±0.3	54.1±1.8**	48.7±1.9***	2.1±0.1	30.1±1.8
Tween 20	3.0±0.1***	81.4±0.8	11.7±0.2	53.2±2.6***	50.4±2.8***	2.2±0.2	35.5±1.6**

During the study of the mutant forms of Kayir variety on the quantitative traits that define the basic elements of productivity, it is observed that in comparison with the control of the surfactant - Tween 85 has a stimulating effect, which is expressed by a significant increase in a number of indicators on the studied traits. For instance, test plants have significant increase in the length of the spike on average of 12.1 ± 0.2 cm, in comparison with 10.9 ± 0.3 cm in control.

It is noted that the induction by surfactants Tween 85 and Tween 20 is characterized with a significant increase in the weight of 1000 seeds.

Thus, the study of the elements of productivity of mutant forms of the M₂ generation derived from local varieties of soft wheat make possible to estimate a positive stimulatory effect of surfactant - Tween 20 to improve the performance of important agronomic characters, one of which is the weight of 1000 seeds [5].

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