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Identification of carriers of the wheat genotypes stem rust (*Puccinia graminis f.sp. tritici*) resistance genes

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Abstract. Stem rust in recent years has acquired an epiphytotic character, causing significant economic damage for wheat production in some parts of Kazakhstan. On the basis of a race composition study of the stem rust populations collected in 2016-2017 in South-Eastern and northern regions of Kazakhstan were identified. The race differentiation of stem rust using a tester set of 6 *Sr* genes differentiator lines was carried out. In different conditions of Kazakhstan, the *Sr22* and *Sr25/Lr19* gene sources are effective. As a result of PCR analysis, the *Sr22* gene was found in 5 lines of 6 samples taken for the study: Line C-19SB, Lutescens 7-04-4, Lutescens 220-03-45, GA961662-1-7/TAM107, Line D 25 77. *Sr25/Lr19* is a carrier of sources: Lutescens 220-03-45, Advance, Line D 25 77. The *Sr22 and Sr25/Lr19* gene was Lutescens 220-03-45 and Line D 25 77. These sources are recommended for inclusion in the breeding process for developing stem rust resistant varieties in the region.

1 Introduction

The wheat belt of Western Siberia and Northern Kazakhstan covers more than 15 million ha. While moisture stress is the main factor limiting production, rusts also represent a major challenge, especially in years with higher rainfall. Stem rust was not considered economically important until 2015 when a local epidemic occurred in the Omsk region of Russia and neighboring areas of Kazakhstan and affected more than 1 million ha. It occurred again in 2016 though the spread, severity and losses were less.

The spring wheat production region of Northern Kazakhstan and Western Siberia covers around 15 million ha, in a belt 600–1000 km wide between the desert of central Kazakhstan and boreal forests of Siberia (latitude 45–47 north). The crop is grown under continental

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climate conditions with long cold winters, short hot summers, and annual rainfall that varies from 280 to 300 mm in the south to 400–450 mm in the north. Spring wheat is normally planted in mid-May and harvested in September. A detailed description of the production environments, biotic and abiotic stresses, varieties, and breeding challenges is presented in (Morgounov et al. 2001)

Stem rust of wheat caused by *Puccinia graminis f. sp. tritici (Pgt)* is historically the most damaging wheat disease worldwide (Roelfs et al. 1992; Singh et al. 2015). Over the last 20 years, there has been significant concern about the spread of the Pgt aggressive race *Ug99*, which was first detected in Uganda in 1998 (Pretorius et al. 2000). To date, 13 races within the Ug99 race group have been identified in Eastern Africa and the Middle East, and it is projected to spread further, threatening critical wheat growing regions in the world (Singh et al. 2015; Patpour et al. 2016). In recent years, new races, that are not members of the Ug99 race group, have caused disease outbreaks on wheat crops in Europe (Bhattacharya, 2017; Lewis et al. 2018), Africa (Olivera et al. 2015) and the Caucasus region of Eurasia (Olivera et al. 2019). Recently, in the northern regions of Kazakhstan and in Western Siberia where spring wheat is mainly cultivated, stem rust has become a major disease. In 2015 and 2016 in the northern regions of Kazakhstan, as well as in the adjacent Omsk region of Russia, a major stem rust epidemic occurred, affecting, respectively, approximately one and two million ha of wheat (Shamanin et al. 2016, 2020; Koyshybaev 2018; Rsaliyev & Rsaliyev 2018). Stem rust occurred again in 2017–2018 in the northern and eastern regions of Kazakhstan and Omsk, Novosibirsk and the Altai Krai regions of Russia, and not only resulted in a marked yield reduction, but also in lower grain quality (Koishybaev 2018; Gultyaeva et al. 2020; Shamanin et al. 2020; Skolotneva et al. 2020). During 2015–2018 disease severity and incidence in the main wheat growing regions of Kazakhstan were up to 90 and 70%, respectively, and was substantially higher than found in previous years (Koyshybaev, 2018; Rsaliyev et al. 2019; Yskakova & Rsaliyev 2019). In a recent report (Hodson et al. 2017), researchers from the International Maize and Wheat Improvement Center (CIMMYT) and the Global Rust Reference Center (GRRC) called for urgent further research, both to understand the pathogen dynamics and to increase the proportion of resistant cultivars in these regions. With favourable weather conditions and an apparent high race diversity, the scale of the reported epidemics has serious implications for neighbouring regions and beyond (Hodson et al. 2017). The Kazakhstan-Siberian Network for Wheat Improvement responded to the threat of stem rust by systematically screening their bread and durum wheat varieties and locally-developed germplasm in Kazakhstan, Western Siberia and Kenya. An overwhelming majority of the locally-cultivated and new varieties were shown to be highly susceptible (Shamanin et al. 2016; Yskakova & Rsaliyev 2019; Gultyaeva et al. 2020). However, several years of screening resulted in a set of stem rust-resistant new spring bread and durum wheat varieties and breeding lines from Kazakhstan and Russia, which were analysed for stem rust resistance across several locations (including Kenya) (Shamanin et al. 2016; Gultyaeva et al. 2020). Recently, the pathogenic variability of the Pgt population has been investigated across Western Siberia. The virulence structure of the stem rust population spread in the Omsk, Novosibirsk and Altai Krai regions were identified at the GRRC (Denmark), and in the laboratory of molecular phytopathology at the Institute of Cytology and Genetics (Russia) (Hovmøller, 2017; Shamanin et al. 2020; Skolotneva et al. 2020). Despite the increasing importance of stem rust in Kazakhstan, the population structure of Pgt in this region has not been characterised and, so far, there were no attempts to determine the effectiveness of the *Sr* genes for the future application in local breeding programmes. The present study was, therefore, undertaken to describe the characteristics of the race structure of the Pgt populations and the effectiveness of the *Sr* genes in the major spring wheat regions of Kazakhstan in 2015–2018.

Severe epidemics of wheat stem rust caused by *Puccinia graminis f. sp. tritici (Pgt)* have been observed in recent years in major spring wheat producing regions in Kazakhstan. However, information on the virulence structure and race composition of Pgt is currently not available. Stem rust samples were collected in 2015–2018 in three regions of Kazakhstan to determine the virulence diversity and race distribution in the Pgt populations. A total of 203 single-pustule isolates were derived and evaluated on the stem rust differential and supplemental lines and 38 races were identified. Among them, the races QHHSF and THMTF were found in all the regions and in all the years. The races RFRTF, RHMRF, TKRPF and MHCTC were the most common races in the Akmola and Kostanay regions, and the races LHCSF, QKCSF and LKCSF were only widely distributed in East Kazakhstan. The virulence complexity (i.e., number of *Sr* genes on which the races were virulent) ranged from 5 to 16, with about 40% of the races having 14 or more virulence. The stem rust resistance genes *Sr11, Sr13, Sr22, Sr26, Sr31, Sr33* and *Sr35* were found to confer resistance to all the races identified during the study period. Hence, these genes can be used as sources of resistance in wheat breeding programmes in Kazakhstan. (Rsaliyev et al. 2020).

2 Materials and methods

This research was carried out at the fields of the Kazakh Research Institute of Agriculture and Crop Production. Sixteen genotype varieties taken from the International CIMMYT Research Center were selected as the object of the study, and Sonalika entries were selected as the control variety. The local population of Pgt was used as an epidemic material for the Almaty region. In the study of plant resistance to rust during vegetation, the Stackman scale was used (Table 1).

Table 1. Signs of infestation of wheat varieties with stem rust disease.

<table>
<tr><th colspan="3">Stackman, 1962</th><th colspan="2">CIMMYT, 2011</th></tr>
<tr><th>Reaction type</th><th>The nature of the disease</th><th>Resistant, unbearable level</th><th>Reaction type</th><th>The nature of the disease</th></tr>
<tr><td>0</td><td>Immune, no symptoms are visible</td><td>Immune</td><td>0</td><td>immune, no symptoms are visible</td></tr>
<tr><td>;</td><td>The presence of spots sensitive to the disease</td><td>Highly resistant</td><td>R</td><td>Resistant, with chlorosis spots, 5-10 %</td></tr>
<tr><td>1</td><td>Small rashes, surrounded by Necrosis</td><td>Moderately resistant</td><td>MR</td><td>Moderately resistant, rashes are small, 10-25 with chlorotic zones %</td></tr>
<tr><td>2</td><td>Small rashes, rashes are surrounded by necrosis and chlorosis</td><td>Medium resistant</td><td></td><td></td></tr>
<tr><td>3</td><td>There are moderate rashes, without chlorosis</td><td>Moderately susceptible</td><td>MS</td><td>Moderately intolerant. The bumps are small, 40-50 on the leaf surface %</td></tr>
<tr><td>4</td><td>Large pustules having chlorosis in the plant stem and leaf surfaces</td><td>Susceptible</td><td rowspan="4">S</td><td rowspan="4">The upper is intolerant, the rash is large, up to 50-100% on the leaf surface</td></tr>
<tr><td>X (1, 2) +</td><td>Various rashes</td><td>Susceptible</td></tr>
<tr><td>Y</td><td>The Shape of the bumps is different, enlarged on the upper leaves</td><td>Susceptible</td></tr>
<tr><td>Z</td><td>The Shape of the pods is different, enlarged on the main leaves</td><td>Susceptible</td></tr>
</table>

The research work was carried out at the fields of the Kazakh Research Institute of Agriculture and Crop Production. 6 genotype varieties taken from the International

CIMMYT Research Center were selected as the object of the study, and Sonalika samples were selected as the control variety. The local population of *Puccinia graminis f. sp tritici* was used as an epidemic material of the Almaty region.

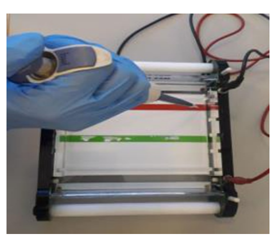
McIntosh et al in assessing the rate of disease development in cultivated areas. According to this method, 5 types of reaction are considered: 0-immune, without various symptoms of the lesion. Absence of damage based on the physiological incompatibility of the plant and the pathogen. R-resistance, the presence of the ability to resist pathogenic microorganisms (small pustules surrounded by necrosis). MR-normal (small and medium-sized pustules with chlorotic and necrotic zones). MS is moderately intolerant (medium-sized pustules, there is no necrosis, but there may be areas of chlorosis). S-intolerant (large pustules have chlorosis in both regions). (McIntosh et al. 1995).

Table 2. Description of the PCR program and molecular markers used in gene identification.

Primer name	Primary denaturation (°C, min)	The number of cycle	Denaturation (°C, sec)	Burn (°C, sec)	Extension (°C, sec)	Last Extension (°C, min)
Xgwm533	95(5)	35	95(40)	60(30)	72(120)	72(10)
CFA2019	95(3)	35	94(45)	60(45)	72(60)	72(4)
PSY-E1	94(4)	10	94(20)	63(20)	72(90)	
		35	94(20)	58(20)	72(80)	72(7)

A polymerase chain reaction was isolated from five-day-old seedlings of wheat plants by a well-known method using cetyltrimethylmoniumbromide (CTAB) (Murray et al. 1980). To determine the tolerance genes, the molecular brands of 2 *Sr* genes *(Sr22, Sr25)* were used in the work. The conditions of PCR are given in the work. The most optimal conditions were selected for each marker. The amplification products were divided into 2% agarose gel colored with ethidium bromide. GeneRulerTM 100bp polymerase chain reaction (Fermentas) was used as a molecular weight marker. Isogenic lines and varieties with known *Sr* genes served as a positive control. For PCR amplification, the reaction mixture was 10 μl, it contained 0.2 mm dNTP, 1 × QIAGEN PCR buffer, 0.2 μl from each primer, 0.25 U Taq polymerase chain reaction polymerase (Qiagen) and 50 ng of genomic polymerase chain reaction.


a


b


c

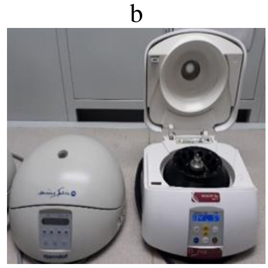

d

Fig. 1. Research tools used in molecular screening. Warning: a) Thermal cycler; b) Horizontal Electrophoresis; c) Electrophoresis product analysis geldok apparatus; d) Centrifuge.

3 Results

Research work in some farms of the fields of spring wheat of the north of Kazakhstan (2020-2022 year), the stem rust (Puccinia graminis f.sp tritici) it can be seen that the pathogen has become more wide spread and developed at a high level over the years. Phytosanitary observations conducted in some farms of Kostanay region in 2020 showed that the prevalence of stem rust was 74.1 %, the development was 26.7%. According to the monitoring carried out in some farms of Akmola region in 2021, the average development of classes was 7.8%, and the prevalence reached an average of 35.9%. In 2022, the incidence of stem rust spread to an average of 44.7% in the first milkweed maturation period, and development increased to an average of 17.7% (Figure 2).

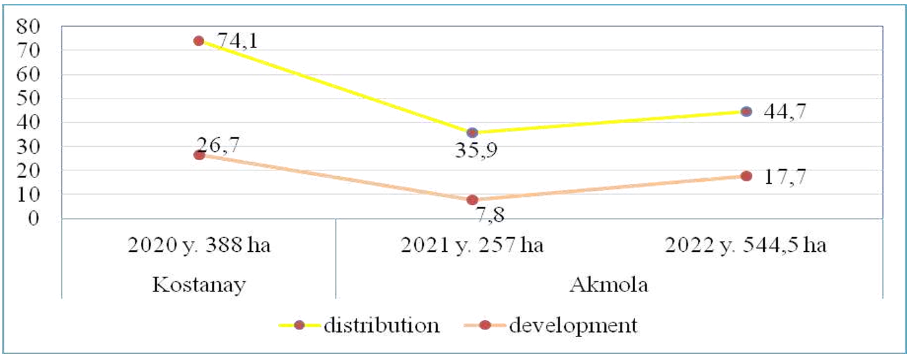


Fig. 2. Diagram of distribution of spring wheat varieties by susceptibility to stem rust during (2020-2022).

Normalized Difference Vegetation Index (NDVI) is a commonly used metric to quantify the density and health of vegetation. Its values range from -1 to 1, with negative values indicating water or bare soil, values near zero indicating sparse vegetation, and higher values indicating denser and healthier vegetation (Table 3).

Table 3. Dynamics of the biomass index (NDVI) of spring wheat genotypes, on average (Almaty region, Almalybak, 2020-2022 y.).

Variety name	NDVI				Average value	Reaction to stem rust, %
	Growing season					
	Dullness	Spike	Bloom	Milking		
1	2	3	4	5	6	7
Seri	0.43	0.66	0.68	0.42	0.55	5
Stepnaya 75	0.33	0.48	0.45	0.32	0.40	20
Stepnaya 1414	0.59	0.50	0.36	0.27	0.43	20
Gvk 2055-1	0.37	0.40	0.35	0.34	0.37	40
Lutescens 2	0.36	0.41	0.42	0.29	0.37	40
Line C-19.B	0.65	0.71	0.74	0.54	0.66	1
Karabalykskaya 20	0.35	0.38	0.37	0.29	0.35	30
Fantasy	0.36	0.43	0.39	0.33	0.38	30
Bostyk	0.39	0.43	0.42	0.35	0.40	20
Lutescens 30 69/97	0.26	0.35	0.39	0.25	0.31	30
Karagandinskaya 30	0.37	0.36	0.28	0.25	0.32	20
Karagandinskaya 31	0.50	0.42	0.35	0.31	0.40	20
Pavlodar Jubilee	0.42	0.50	0.46	0.31	0.42	40
Spring confectionery	0.63	0.68	0.57	0.55	0.61	5
Phyton C-50.B	0.62	0.39	0.40	0.34	0.44	20
Phyton 82	0.62	0.38	0.36	0.33	0.42	10
Phyton -C-54.B	0.65	0.44	0.36	0.29	0.44	40
Ekada 148	0.64	0.52	0.41	0.26	0.46	50
Ekada 113	0.57	0.51	0.37	0.36	0.45	20
Lubava	0.58	0.38	0.42	0.40	0.45	10
Phyton 41	0.51	0.49	0.37	0.32	0.42	40
Phyton 204	0.53	0.50	0.34	0.31	0.42	40
Vladimir	0.50	0.35	0.38	0.36	0.40	40
Celïnnaya 50	0.50	0.46	0.37	0.35	0.42	40

Variety name	NDVI				Average value	Reaction to stem rust, %
	Growing season					
	Dullness	Spike	Bloom	Milking		
1	2	3	4	5	6	7
Celïnnaya nïva	0.51	0.33	0.32	0.25	0.35	30
Asıl sapa	0.60	0.68	0.49	0.21	0.50	40
Akorda	0.59	0.66	0.55	0.19	0.50	40
Shortandinskaya 2012	0.61	0.66	0.52	0.23	0.51	60
Celinnaya 3	0.63	0.51	0.60	0.30	0.51	50
Altayskaya 70	0.43	0.44	0.43	0.42	0.43	40
Altayskaya 110	0.40	0.46	0.36	0.22	0.36	40
Tobol.kaya	0.37	0.44	0.61	0.27	0.42	40
Altayskaya zhnitsa	0.36	0.33	0.68	0.23	0.40	50
Stepnaya volna	0.43	0.41	0.43	0.38	0.41	40
Apasovka	0.50	0.45	0.48	0.34	0.44	30
Lutescens 89-06	0.56	0.29	0.46	0.43	0.44	40
Duet	0.58	0.30	0.40	0.26	0.39	40
Pavlogradka	0.54	0.34	0.36	0.25	0.37	60
Lutescens 29-12	0.62	0.65	0.68	0.54	0.62	1
Lutescens 106-11	0.56	0.64	0.57	0.56	0.58	5
Tulaykovskaya 110	0.43	0.58	0.46	0.45	0.48	10
Lutescens 916	0.44	0.52	0.40	0.39	0.44	10
Grekum 1003	0.36	0.40	0.43	0.41	0.40	10
Lutescens 1062	0.36	0.29	0.32	0.31	0.32	20
Erythrospermum 85-08	0.40	0.33	0.32	0.30	0.34	20
Serebristaya	0.37	0.32	0.35	0.34	0.35	30
Boevchanka	0.28	0.36	0.32	0.31	0.32	20
Омская 37	0.61	0.67	0.52	0.51	0.58	5
Lutescens 7-04-4	0.37	0.45	0.44	0.43	0.42	10
Lutescens 197-04-7	0.39	0.49	0.48	0.47	0.46	10
Lutescens 220-03-45	0.33	0.43	0.34	0.31	0.35	30
Tulaykovskaya 10	0.38	0.39	0.34	0.33	0.36	20
Tulaykovskaya золотистая	0.42	0.49	0.38	0.33	0.41	20
Tulaykovsk 100	0.43	0.31	0.44	0.32	0.38	15
Grekum 650	0.34	0.33	0.45	0.41	0.38	10
Lutescens 920	0.30	0.38	0.37	0.33	0.35	10
Ekada 121	0.42	0.38	0.27	0.25	0.33	40
Cimmyt	0.37	0.52	0.45	0.41	0.44	10
P-23-17	0.46	0.54	0.31	0.30	0.40	40
Pamyati rube	0.45	0.47	0.29	0.26	0.37	50
Chelyava 75	0.46	0.51	0.65	0.44	0.52	10
Erythrospermum 23707	0.43	0.56	0.48	0.34	0.45	30
Sy taira	0.45	0.50	0.37	0.34	0.42	20
Sy goliat	0.55	0.61	0.57	0.46	0.55	5
Kopen sy	0.56	0.62	0.51	0.47	0.54	5
Sy rouin	0.42	0.47	0.59	0.25	0.43	20
Sy Ingmar	0.65	0.73	0.68	0.67	0.68	0
Select	0.64	0.66	0.68	0.68	0.67	1
Fore front	0.65	0.69	0.67	0.66	0.67	1
Prevail	0.63	0.68	0.67	0.66	0.66	1
Advance	0.66	0.73	0.71	0.69	0.70	0
Brick	0.35	0.65	0.52	0.48	0.50	20
Carberry	0.62	0.73	0.72	0.71	0.70	1
Muchmore	0.61	0.72	0.71	0.7	0.69	1
Ural-Siberian	0.59	0.73	0.7	0.69	0.68	1
Tornado 22	0.33	0.63	0.57	0.56	0.52	40
Lutescens 1012	0.28	0.58	0.61	0.58	0.51	60
Lutescens 7-04-10	0.34	0.67	0.68	0.57	0.57	30
Lutescens 208-08-4	0.36	0.57	0.53	0.52	0.50	10
Lutescens 27-12	0.35	0.51	0.54	0.48	0.47	30
Lutescens 6-04-4	0.38	0.48	0.53	0.49	0.47	10
Lutescens 186-04-61	0.47	0.58	0.59	0.39	0.51	20
Chebarkulskaya 3	0.55	0.48	0.49	0.48	0.50	30
Line d 25	0.63	0.72	0.71	0.70	0.69	1
Line 654	0.54	0.68	0.63	0.58	0.61	10
Akmola 2	0.48	0.51	0.53	0.41	0.48	60
Arai	0.43	0.36	0.42	0.33	0.39	40
Saratovskaya 29	0.59	0.55	0.55	0.32	0.50	70
Aktobe 10	0.31	0.33	0.31	0.3	0.31	70
Kazakhstan 15	0.56	0.47	0.57	0.31	0.48	70
Astana	0.57	0.41	0.49	0.41	0.47	50
Kazakhstanskay 10	0.52	0.40	0.52	0.46	0.48	30
Jenis	0.53	0.51	0.52	0.48	0.51	20
Sx	0.02					-
Sx%	7.1					-
Sd	0.1					-
EEA $_{0,5}$	0.11					-

Note-NDVI-index biomass indicator of the plant, % - percentage, R - high resistance; Sx-average error; Sx% - accuracy of the experiment; Sd-difference error; EEA - the most significant difference

Thus, as a result of determining the indicators of the biomass index of wheat varieties, we found that the indicators of the biomass index of spring wheat varieties gave an average value. The Lutescens 1062 variety, which had a minimum value during the spike period, showed a scale of 20 S, because the damage to the stem with rust disease was average. The biomass index of the Aktobe 10 Variety, infected with rust on the scale of 90 S, reached 0.34 at the stage of milkweed maturation, the reason for being higher than that of the Lutescens 1062 Variety, the maturation period was late. Carberry, Advance, Uralo-Siberian, Muchmore, Line D 25 genotypes had a resistivity to stem rust disease, the reason for which the NDVI index was maximum (Table 3).

Under the conditions of Kazakhstan, most wheat varieties are intolerant for the local stem rust population, and most of them accept two or more pathotypes if they are resistant to one stem rust pathotype. At the same time, the effectiveness of *SR*-tolerance genes is gradually being lost. In connection with these urgent problems, Puccinia graminis f.sp. tritici in all periods of vegetation of the plant, it is important to find tolerance genes and gene owners (sorgenotypes) that allow pathotypes to be effectively protected. For this purpose, 7 wheat samples were selected from the international CIMMYT Research Center. The disease was studied in laboratory conditions and in an introduction nursery (Table 4).

As a result of the study of the resistance of wheat samples in a greenhouse to stem rust during germination of *Puccinia graminis f.* sp tritici 1 wheat samples to the pathogen were identified as immunodeficient: GA961662-1-7/tam107, samples Line c-19sb, Lutescens 7-04-4, Lutescens 220-03-45, Advance and Line D 25 77, which showed 1 point of reaction to the disease, were found to be resistant.

Puccinia graminis f in an artificial epidemic environment in a field. GA961662-1-7/The TAM107 models were distinguished by immunity. *Puccinia graminis f.* sp tritici it is possible to note the samples Lutescens 7-04-4 and Advance which showed resistance to the pathogen with the reaction index "R". The classes showed the average endurance of the samples Line c-19sb, Lutescens 220-03-45, Line D 25 77 and Sonalika the indicator of infection with the disease of which was 5 MR.

Table 4. Resistance of wheat genotypes to rust stem using the *Sr* molecular marker identification of resistant genes.

Line name	**Origin**	**Resistance of the stem to rust in an artificial epidemic environment**		***Sr22* primer- *Xgwm533***	***Sr25/Lr19* primer - *PSY-E1***	**Years**
		During germination	**In adulthood**	**238**	**191**	
Line C-19SB	Kazakhstan	1	5 MR	+	-	36.1
Lutescens 7-04-4	Samara	1	R	+	-	19.5
Lutescens 220-03-45	Omsk	1	5MR	+	+	31.4
Advance	USA	1	R	-	+	22.8
Line D 25 77	Russia	1	5 MR	+	+	27.9
GA961662-1-7/TAM107	USA, North Carolina	0	0	+	-	26.3
Sonalika (positive control)		2	5 MR	-	-	-

One of the ways to strengthen the result of breeding programs is the use of molecular markers along with classical methods. The use of molecular markers significantly expands the ability to assess plant diseases and tolerance genes.

The method of using molecular markers associated with genes that ensure plant resistance to the pathogen increases the speed of the selection process. With this method, research work can be carried out at any stage of plant development and independently of the state of the environment. During the research work, work was carried out on identification of wheat varieties resistant to the disease of stem rust. To achieve this goal, the rust stalk was conducted screening of polymerase chain reaction genotypes of wheat varieties using markers associated with rust resistance genes.

According to CIMMYT et al., the *Ug99* race *Sr28, Sr29, SrTmp, Sr2, Sr13, Sr14, Sr22, Sr35, Sr36, Sr37, Sr32, Sr39, Sr47, Sr33, Sr45, Sr40, Sr24, Sr25, Sr26, Sr43, Sr44, Sr27* and 1A. 1R gene sources have high efficiency (Shamanin, 2016). Therefore, we performed a molecular analysis of 6 wheat samples in order to identify effective genes *Sr22* and *Sr25/Lr19*.

As a result of the correlation analysis of spring wheat genotypes between the length of the main ears and the number of ears, the correlation coefficient R=0.63 in these two indicators was positively correlated.

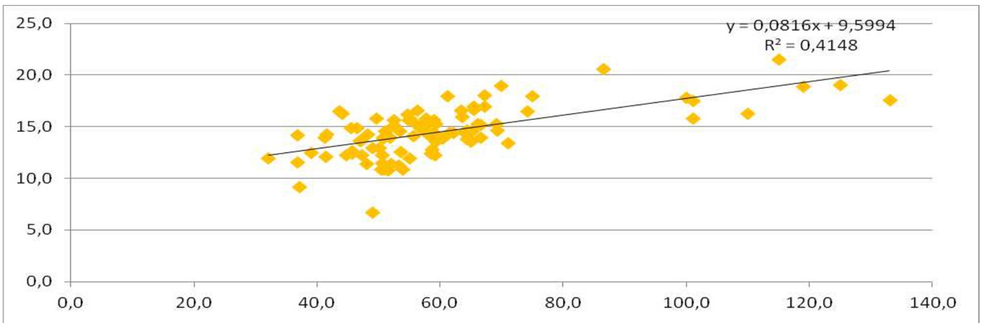


Fig. 3. Correlation indicator of spring wheat genotypes between the height of the main plant and the number of spikelets.

The correlation between the main length of the ears and the number of ears of spring wheat varieties, between the height of the plant and the number of ears (R=0.63 and R=0.42) was positive and moderately positive.

4 Discussion

In conclusion, phytopathological and molecular genetic studies of 6 wheat samples taken from the CIMMYT International Research Center were carried out. In the Almaty region, the population of *Puccinia graminis F. sp tritici* during the wheat germination period, 5 wheat samples were isolated as immune, these are GA961662-1-7/TAM107.

Rust on the stem in an artificial epidemic environment in field conditions GA961662-1-7/The TAM107 models were distinguished by immunity. PCR analysis was performed to identify rust-resistant sources of the *Sr22* and *Sr25/Lr19* genes. As a result of the study, it was found that 6 samples are carriers of the *Sr22* gene they, Line c-19SB, Lutescens 7-04-4, Lutescens 220-03-45, GA961662-1-7/tam107 and Line D 25 77. The tasmanian of the *Sr25* gene also revealed 3 samples: Lutescens 220-03-45, Advance and Line D 25 77.

5 Conclusion

Stem rust is common in the regions of Kazakhstan where wheat is grown. Wheat *Puccinia graminis f.sp.* protection against the pathogen tritici, despite all the studies of this disease, remains an urgent problem. Chemical control of the disease is ineffective and does not give accurate results, the only effective way to combat the disease is to produce samples and varieties that are resistant to the disease. Currently, about 50 genes that show resistance to this disease are known. In different conditions of Kazakhstan, the *Sr22* and *Sr25/Lr19* gene sources are effective. Molecular screening of *SSR* and *STS* type markers (Sequence Tagged Sites) was performed using *Xgwm533* and *PSY-E1*. As a result of PCR analysis, the *Sr22* gene was found in 5 lines of 6 samples taken for the study: Line C-19SB, Lutescens 7-04-4, Lutescens 220-03-45, GA961662-1-7/TAM107, Line D 25 77. *Sr25/Lr19* is a carrier of H sources: Lutescens 220-03-45, Advance, Line D 25 77. These lines can be used in Marker Assisted Selection programs to increase rust resistance in the stem.

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