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IDENTIFICATION OF Lr-GENES RESISTANCE TO BROWN RUST OF SPRING SOFT WHEAT VARIETIES AND KASIB LINES

Abstract. The article describes the Lr-gene resistance to brown rust of the spring soft wheat variety and KASIB lines. The carriers of the Lr1, Lr9 and Lr19 gene were identified as a result of screening using molecular markers. Well-known genetic carriers were sent to breeding institutions as a valuable material for the selection of brown tolerance.

Key words: wheat, brown rust, KASIB, Lr1-genes.

Introduction. The land and weather conditions of the Republic of Kazakhstan are optimal for the development of agriculture and livestock. If agriculture occupies 1678.0 million hectares of the total crop area, the volume of sowing fields of cereals is 1320.7 million hectares. The main and strategically important direction of agriculture in our country is the grain production. Nationwide area of wheat crops is 17 million hectares. Therefore, the accelerated development of grain production is one of the primary tasks of the state agrarian policy on the way to ensuring food security. Grain growing is a priority direction of development of agriculture in Kazakhstan, while the wheat both becomes a strategically important culture and is considered a national treasure, which has a significant role in the national economy. Around the globe, Kazakhstan annually produces up to 15 million tons of high-quality wheat. Cereals are considered the objects of social, economic and strategic importance for Kazakhstan. The main goal of domestic agriculture is to get a worthy place in the list of wheat exporters in the world market, to ensure food security and independence of the country, to stabilize grain production, and to satisfy the food needs of the population. Kazakhstan is one of the major producers of grain crops, especially spring wheat (*Triticum aestivum L.*). In the world's agricultural production, cereals are the main ones. The cereal crops economy is the main sphere of agriculture in the country. Of cereals, spring wheat is both a strategic culture and a national treasure, which has a significant role in the national economy [1]. The introduction of productive and high-quality varieties of spring wheat into production is one of the main challenges of the grain economy. The wheat yield depends on the seed quality, the agricultural technology of cultivation, the ecological situation of local land, as well as the resistance of varieties to diseases [2]. Infection of cereals with brown rust leads to a sharp decrease in yield and a decrease in the grain quality.

The rust resistance genes are quickly identified and there are 71 genes of resistance to brown rust. There is a significant proportion of resistance genes characteristic of the pathotype, there are germinative effective genes and the resistance of adult plants (APR). In general, APR genes show semi- and slow phenotypes of rust [3].

Brown rust resistance genes. 71 genes of brown rust resistance were identified, they were mapped in a special chromosome and were given official names in the catalog of wheat genes. These are *Lr*1, *Lr*2a,

*Lr*2b, *Lr*2c, *Lr*3a, *Lr*3bg, *Lr*3ka, *Lr*9, *Lr*10, *Lr*11, *Lr*12, *Lr*13, *Lr*14a, *Lr*14b, *Lr*14ab, *Lr*15, *Lr*16, *Lr*17a, *Lr*17b, *Lr*18, *Lr*19, *Lr*20, *Lr*21, *Lr*22a, *Lr*22b, *Lr*23, *Lr*24, *Lr*25, *Lr*26, *Lr*27, *Lr*28, *Lr*29, *Lr*30, *Lr*31, *Lr*32, *Lr*33, *Lr*34, *Lr*35, *Lr*36, *Lr*37, *Lr*38, *Lr*39, *Lr*42, *Lr*44, *Lr*45, *Lr*46, *Lr*47, *Lr*48, *Lr*49, *Lr*50, *Lr*51, *Lr*52, *Lr*53, *Lr*54, *Lr*55, *Lr*56, *Lr*57, *Lr*58, *Lr*59, *Lr*60, *Lr*61, *Lr*62, *Lr*63, *Lr*64, *Lr*65, *Lr*66, *Lr*67, *Lr*68, *Lr*69, *Lr*70 and *Lr*71 [4, 5].

Material and methods of research. 95 lines and varieties of spring soft wheat of the KASIB line were taken for the study. From the wheat germ material, genomic DNA was taken from 5-6 day old sprouts, the genomic DNA was separated on the basis of the CTAB method. The DNA concentration was measured on a Nanodrop device. In accordance with the special resistance genes, the PCR reaction was carried out under different protocols. For molecular screening intended for determination of Lr1, Lr9 and Lr19 gene carriers, the markers WR003, SCS5 and SCS265 were used. The production of amplified PCR was carried out on an agarous 2%-gel on a horizontal electrophoresis device. After the electrophoresis was completed, the gels were photographed by means of the BioRAD device and processed on the computer using the Paint software to view the result of the work and the expected product. The *Lr* genetic carriers were identified through a polymerase chain reaction (PCR). The molecular markers were selected as proposed by the scientists working in this field [6].

Results and discussion. The WR003 molecular marker was used to determine the carriers of Lr1-genes. The PCR was used to determine the gene carriers. As a positive control, the Thatcher isogenic lines are taken, and ddH_2O is taken as the negative control . As a result of PCR on genotypes selected from spring wheat samples of the KASIB line, the carriers of this gene have shaped an amplification product of 760 b.p. (figure 1).

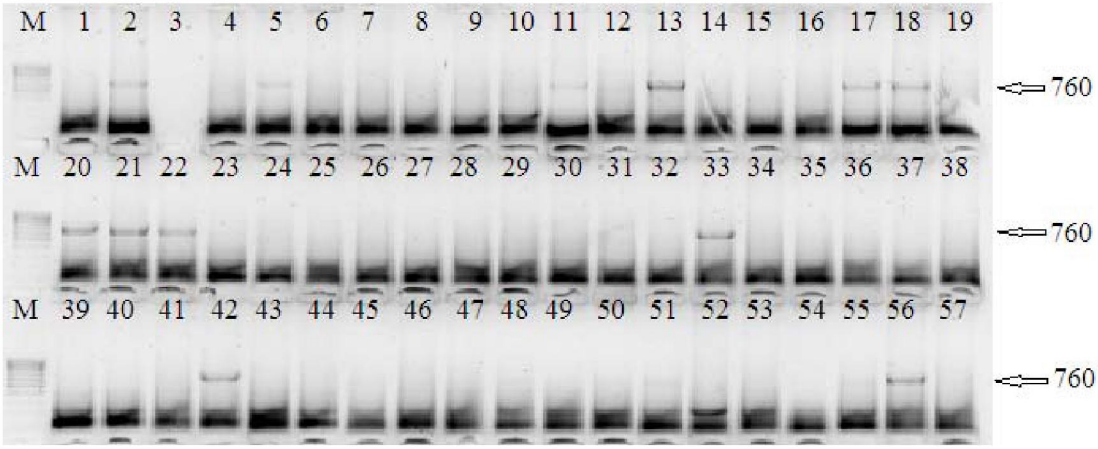

Figure 1 – Electrophoregram of the amplified DNA of wheat varieties
as a result of the application of WR003 markers, associated with the *Lr1* gene.

M – molecular marker, 1 – Lutescens 53/95-98-1, 2 – Lutescens 706, 3 – A-125, 4 – SAD-114, 5 – Sibakovskaya lyubileynaya, 6 – Erythrospermum 78, 7 – Omskaya 38 (Lut. 242/97-1), 8 – Chelyaba lyubileynaya, 9 – Velyatinum 15, 10 – Erythrospermum 65, 11 – Pavlodar 11, 12 – Fiton C 36 shuttle, 13 – Fiton C41, 14 – VK-1, 15 – Lut.363/96-4, 16 – L.415/00, 17 – Lutescens 360/90-6, 18 – Lutescens 290/99-7, 19 – OmGAU 90, 20 – Lutescens 120-03, 21 – Omskaya 39, 22 – Chelyaba 75, 23 – GVK 2033-7, 24 – SERI, 25-GVK 2036-15, 26 – Lutescens 2, 27 – Lutescens 1569, 28 – Line 18001, 29 – Fiton 43, 30 – Tertium, 31 – Omsk 35, 32 – Stepnaya volna, 33 – Lutescens 844, 34 – P-23-14, 35 – Line 96 / 99-14, 36 – Lutescens 89-06, 37 – Erythrospermum 95-07, 38 – Omsk 41, 39 – Lutescens 151, 03-85, 40 – Lutescens 740, 41 – Fiton C-54, 42 – Ekada 148, 43 – Lutescens P-23-18, 44 – Lutescens 1147, 45 – Lutescens 126-05, 46 – Lutescens 128- 05, 47 – Lutescens 7/04-26, 48 – Aina, 49 – Tornado 22, 50 – Lutescens 1012, 51 – Lutescens 34/08-19, 52 – Obskaya 2, 53 – Lutescens 27-12, 54 – Lutescens 96-12, 55 – Erythrospermum 85-08, 56 – Lutescens 6/04-4, 57 – Lutescens 186/04-61.

It became known that the specified gene is in 18 of all studied 95 genotypes. *Lr1* genetic carriers: Line 241-00-4, Chebarkulskaya, Pavlodar 11, Lutescens 443, Lutescens 148-97-16, Fiton 156, Lutescens 706, Sibakovskaya yubileynaya, Chelyaba yubileynaya, Pavlodar 11, Lutescens 360/96-6, Lutescens 290/99-7, Lutescens 120-03, Sibakovskaya lyubileynaya, Chelyaba 75, Lutescens 844, Ekada 148, Lutescens 6/04-4.

The SCS5 molecular marker was used to determine the *Lr9* genetic carriers. The PCR was used to determine the gene carriers. As a positive control, the Thatcher isogenic lines are taken, and ddH_2O is taken as the negative control . As a result of PCR on genotypes selected from spring wheat samples of the KASIB line, the carriers of this gene have shaped an amplification product of 760 b.p. (figure 2).

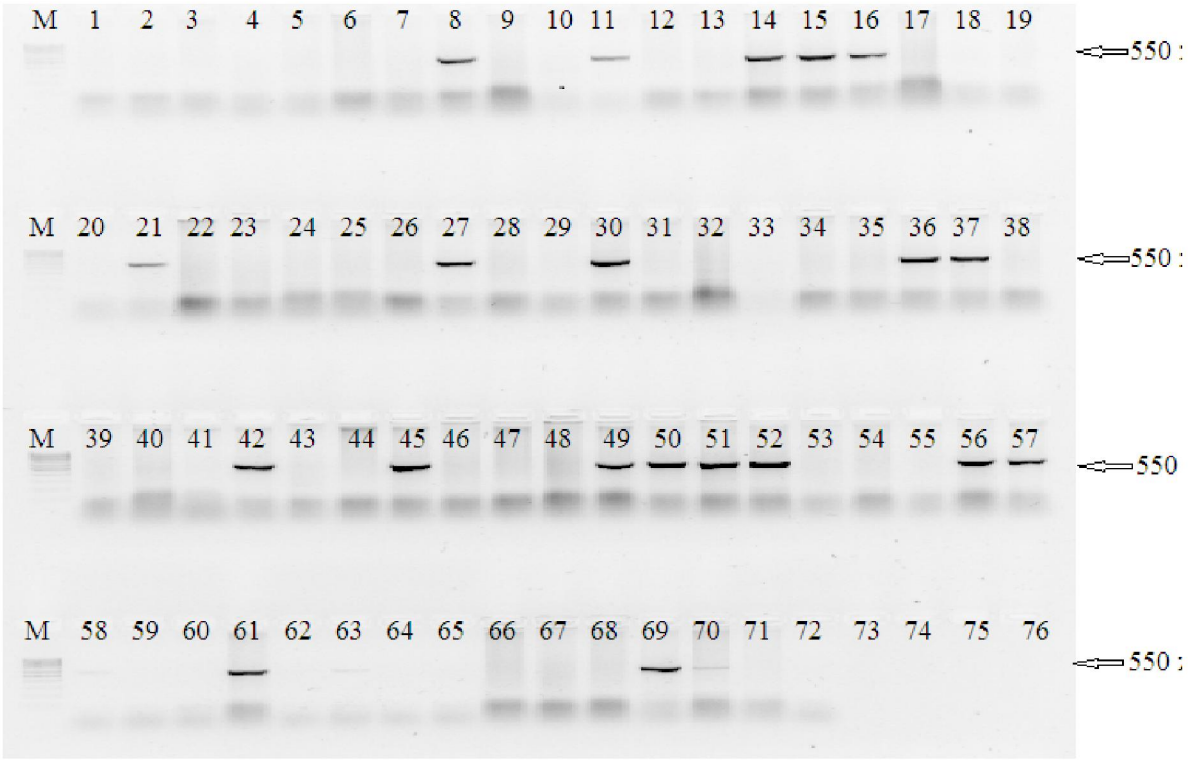

Figure 2 – Electrophoregram of the amplified DNA of wheat varieties
as a result of the application of SCS5 markers, associated with the *Lr9* gene.

M – molecular marker, 1 – Kazakhstan 15, 2 – Erythrospermum 727, 3 – Erythrospermum 78, 4 – Zhazira, 5 – Lutescens 30-94, 6 – Erythrospermum 55/94-01, 7 – Stepnaya 75, 8 – Phytone L9, 9 – Ekada 113, 10 – Lutescens 307/97-23, 11 – Sibakovskaya 17, 12 – Novosibirsk 31, 13 – Lutescens 697, 14 – Apasovka, 15 – Lutescens 158-01, 16 – Lutescens 16-04, 17 – Lutescens 43-04, 18 – OK-1, 19 – Lutescens 220/03-83, 20 – SERI, 21 – Chelyaba 2, 22 – Tertium, 23 – Omsk 35, 24 – Saratov 29, 25 – Lutescens 120-03, 26 – Lutescens 13, 27 – Lutescens 443, 28 – Lutescens 220/03-83, 29 – Kazakhstan 19, 30 – Aria, 31 – Erythrospermum 78, 32 – E-607, 33 – Lutescens 20, 34 – Lutescens 53/95- 98-1, 35 – Lutescens 706, 36 – SAD-114, 37 – Sibakovskaya yubileynaya, 38 – Erythrospermum 78, 39 – Omsk 38 (Lut.242 / 97-1), 40 – Chelyaba yubileynaya, 41 – Velyatinum 15, 42 – Fiton C 41, 43 – VK-1, 44 – OmGAU 90, 45 – Lutescens 120-03, 46 – Chelyaba 75, 47 – Lutescens 2, 48 – Lutescens 1569, 49 – Tertium, 50 – P-23-14, 51 – Lutescens 89-06, 52 – Erythrospermum 95-07, 53 – Omsk 41, 54 – Lutescens 151/03-85, 55 – Ekada 148, 56 – Lutescens P-23-18, 57 – Lutescens 1147, 58 – Lutescens 126-05, 59 – Lutescens 96-12, 60 – Erythrospermum 85-08, 61 – Lutescens 128-05, 62 – Aina, 63 – Tornado 22, 64 – Lutescens 1012, 65 – Lutescens 34/08-19, 66 – Obskaya 2, 67 – Lutescens 27-12, 68 – Lutescens 186/04 -61, 69 – Chebarkulskaya 3, 70 – Saratov 75, 71 – LD 25, 72 – L 654.

It became known that the specified gene is in 25 of all studied 95 genotypes. *Lr9* genetic carriers: Fiton L 9, Sibirskaya 17, Apasovka, Lutescens 158-01, Lutescens 16-04, Lutescens 43-04, Chelyaba 2, Lutescens 120-03, Lutescens 443, Aria, SAD-114, Sibakovskaya yubileynaya, Chelyaba yubileynaya, Lutescens 120-03, Tertium, P-23-14, Lutescens 89-06, Erythrospermum 95-07, Lutescens P-23-18, Lutescens 1147, Lutescens 126-05, Lutescens 128-05, Tornado 22, Lutescens 34 / 08-19, Chebarkulskaya 3.

The SCS265 molecular marker was used to determine the *Lr19* genetic carriers. The PCR was used to determine the gene carriers. As a positive control, the Thatcher isogenic lines are taken, and ddH_2O is taken as the negative control . As a result of PCR on genotypes selected from spring wheat samples of the KASIB line, the carriers of this gene have shaped an amplification product of 512 b.p. (figure 3).

It became known that the specified gene is in 14 of all studied 95 genotypes. *Lr19* genetic carriers: Ekada 113. Alfa 79, Lutescens 220/03-83, Lutescens 220/03-83, Omsk 38 (Lut. 242/97-1), Fiton C 41 Chelnichno, Omsk 41, Lutescens 151/03-85, Ekada 148, Lutescens 186/04-61, ЛД 25 and L 654.

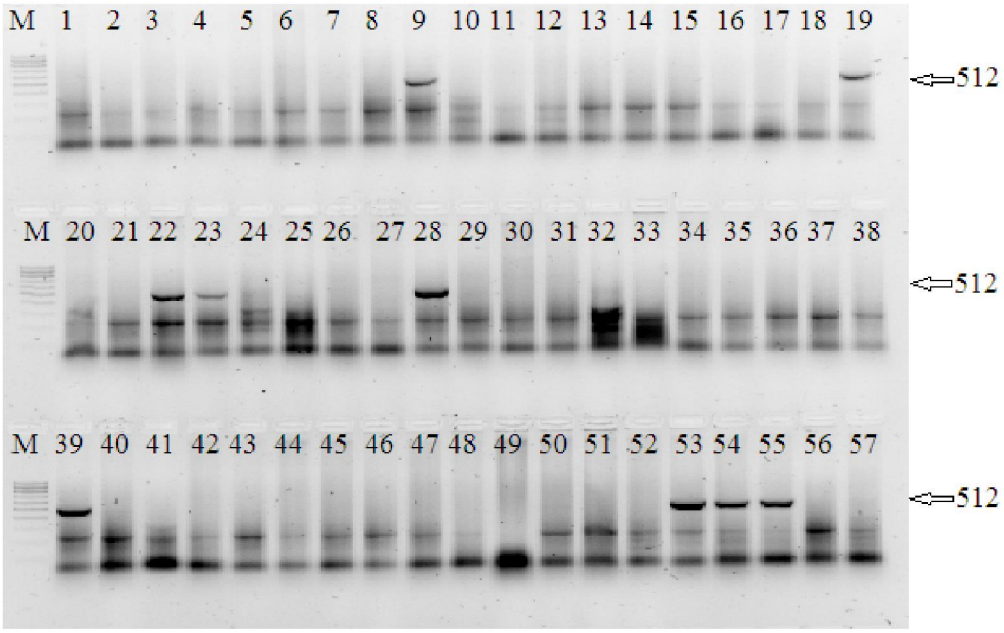

Figure 3 – Electrophoregram of the amplified DNA of wheat varieties
as a result of the application of SCS265 markers, associated with the *Lr19* gene.

M – molecular marker, 1 – Kazakhstan 15, 2 – Erythrospermum 727, 3 – Erythrospermum 78, 4 – Zhazira, 5 – Lutescens 30-94, 6 – Erythrospermum 55/94-01, 7 – Stepnaya 75, 8 – Phytol L9, 9 – Ekada 113, 10 – Lutescens 307/97-23, 11 – Sibirskaya 17, 12 – Novosibirsk, 31, 13 – Lutescens 697, 14 – Apasovka, 15 – Lutescens 158-01, 16 – Lutescens 16-04, 17 – Lutescens 43-04, 18 – OK-1, 19 – Alfa 79, 20 – SERI, 21 – Chelyaba 2, 22 – Tertium, 23 – Omskaya 35, 24 – Saratov 29, 25 – Lutescens 120-03, 26 – Lutescens 13, 27 – Lutescens 443, 28 – Lutescens 220/03-83, 29 – Kazakhstan 19, 30 – Aria, 31 – Erythrospermum 78, 32 – E-607, 33 – Lutescens 20, 34 – Lutescens 53/95-98-1, 35 – Lutescens 706, 36 – SAD-114, 37 – Sibakovskaya yubileinaya, 38 – Erythrospermum 78, 39 – Omsk 38 (Lut.242/97-1), 40 – Chelyaba yubileinaya, 41 – Veliatinum 15, 42 – Fiton C 41 shuttle, 43 – VK-1, 44 – OmGAU 90, 45 – Lutescens 120-03, 46 – Chelyaba 75, 47 – Lutescens 2, 48 – Lutescens 1569, 49 – Tertium, 50 – P-23-14, 51 – Lutescens 89-06, 52 – Erythrospermum 95-07, 53 – Omsk 41, 54 – Lutescens 151/03-85, 55 – Ekada 148, 56 – Lutescens R-23-18, 57 – Lutescens 1147.

Thus, as a result of molecular screening, the Lr1, Lr9 and Lr19 genetic carriers were determined. The identified genetic carriers will be sent to breeding institutions as a valuable material for selection of resistance to brown rust.

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КАСИБ ЖЕЛІСІНІҢ ЖАЗДЫҚ ЖҰМСАҚ БИДАЙ СОРТТАРЫ МЕН ЛИНИЯЛАРЫНАН ҚОҢЫР ТАТҚА ТӨЗІМДІЛІКТІҢ Lr-ГЕНДЕРІН ИДЕНТИФИКАЦИЯЛАУ

Аннотация. Мақалада КАСИБ желісінің жаздық жұмсақ бидай сорттары мен линияларынан қоңыр татқа төзімділіктің Lr-гендері анықталған. Молекулалық маркерлердің көмегімен жасалған скрининг нәтижесінде Lr1, Lr9 және Lr19 гендерінің тасымалдаушылары анықталды. Белгілі болған ген тасымалдаушылары қоңыр татқа төзімділік селекциясы үшін құнды материал ретінде селекциялық мекемелерге жіберілді.

Түйін сөздер: бидай, қоңыр тат, КАСИБ, Lr1-гендер.

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ИДЕНТИФИКАЦИЯ УСТОЙЧИВОСТИ Lr-ГЕНА К БУРОЙ РЖАВЧИНА СОРТ ЯРОВОЙ МЯГКОЙ ПШЕНИЦЫ И ЛИНИЙ СЕТИ КАСИБ

Аннотация. В статье описывается устойчивость Lr-гена к бурой ржавчина сорта яровой мягкой пшеницы и линий KASIB. В результате скрининга с использованием молекулярных маркеров были обнаружены носители гена Lr1, Lr9 и Lr19. Известные носители генов были отправлены в селекционные учреждения в качестве ценного материала для отбора коричневой толерантности.

Ключевые слова: пшеница, бурой ржавчина, КАСИБ, Lr1-генов.

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