Enhancement of the genetic diversity and durability to stripe rust resistance in wheat genotypes

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Introduction

The importance of stripe (yellow) rust, caused by *Puccinia striiformis* f. sp. *tritici* (*Pst*), has increased destructively worldwide during the last decades in wheat (*Triticum aestivum*). In addition, the detection of the new races indicated continual changes of virulence in the *Pst* pathotypes population in Egypt. Breeding for resistance is still the most economic and necessary method for controlling the disease. Durability to stripe rust resistance is a kind of genetic resistance that, quantitatively inherited, race nonspecific (general). This type of resistance hopes to be for a long period, over a wide range of environments and against the broad-spectrum of the pathogen's races. The objective of this study was to understand the genetic bases of durability to stripe rust resistance in Egyptian hexaploid wheat.

Materials and Methods

A filed study was conducted at Sakha Agricultural Research Station during 2018-2021 wheat seasons to enhance stripe rust resistance of the some Egyptian bread wheat cultivars; Misr2, Giza 160, Giza 168 and Sids12 using the four parents; Jupateco 73 R, Opata 85, Anza, and Pavon 76 carrying the different durability resistant genes. In addition to identify of durability resistance genes *Yr's* by molecular marker in early generation of crosses.

Results and Discussion

The wheat genotypes showed a wide range of rust responses during the 2019 to 2020 growing seasons. Adult plant response to stripe rust for Misr2, Giza 160, Giza 168 and Sids12 cultivars, the four parents; Jupateco 73 R, Opata 85, Anza, and Pavon 76 and their eight F_1 crosses during 2019/2020 season are presented in Table 1.

Over 200 F_2 plants from each cross were scored for stripe rust field response during the 2020/2021 growing season. F_2 population indicated that the cross (Misr2/Opata) was segregated fitting the expected ratios 57(R): 7(S), while cross (Giza 168/Pavon 76) were observed phenotypic ratios fitted the theoretical expected ratios, 63(R) : 1(S). On the other hand, the cross (Giza168/Anza) showed no segregation and was directed to the side of dominance of resistance indicating the dominance of the durability of resistance. Genetic analysis have been conducted based on F_1, and F_2 of crosses. The results demonstrated the di-genic and tri-genic control of stripe rust resistance against the *Pst* pathotypes population (Ragab et al., 2020). The difference of segregation ratios indicate that there were different types of epistatic interactions (Table 2). Genotyping by molecular markers indicated the presence gene *Lr34/Yr18/Sr57/Pm38* in the majority of resistant F2 plants derived from the cross (Misr2/Opata. While the gene Lr46/Yr29/Sr58/Pm39 was present in cross (Giza 168/Pavon 76) (Fig1).

Table 1. The adult plant field response to stripe rust under field condition for the four Egyptian bread wheat cultivars, four monogenic lines and their 16 F_1 crosses 2019/2020 season.

Cross name	Adult plant reaction		
	P_1	P_2	F_1
Misr2/ Jupateco 73R	40S	60MS	60MSS
Misr2/ Opata 86	40S	10MR	20MR
Misr2/ Anza	40S	10MRMS	30MS
Misr2/ Pavion 76	40S	20MSS	30MSS
Giza 168/ Jupateco 73R	30MSS	30MS	30MS
Giza 168/ Opata 86	30MSS	10MR	20MR
Giza 168/ Anza	30MSS	10MRMS	20MRMS
Giza 168/ Pavion 76	30MSS	MSS	10MRMS
Sids 12/ Jupateco 73R	60S	60MSS	10MRMS
Sids 12/ Opata 86	60S	10MR	10R
Sids 12/ Anza	60S	10MRMS	20MRMS
Sids 12/ Pavion 76	60S	20MSS	30MSS
Giza 160/ Jupateco 73R	80S	60MS	60MS
Giza 160/ Opata 86	80S	10MR	10MR
Giza 160/Anza	80S	10MRMS	10MS
Giza 160/ Pavion 76	80S	20MSS	20MSS

Table 2. Adult plant response for stripe rust, observed hypothetical ratios, chi-square and probability values for 16 wheat F_2 populations inoculated with Pst under field conditions during 2020/2021.

Cross	No. of plants			Hypothetical ratio	Chi-Squared (χ^2)	P-value*
	R	S	Total			
Misr2/Jupateco 73R	170	40	210	13 : 3	0.0122	0.900-0.750
Misr2/Opata 85	180	25	205	57 : 7	0.5990	0.500-0.250
Misr2/Anza	210	10	220	15 : 1	1.0909	0.900-0.750
Misr2/Pavion76	170	45	215	13 : 3	0.6708	0.010-0.025
Giza 168/Jupateco 73R	35	180	215	3 : 13	0.2050	0.750-0.250
Giza 168/Opata 85	183	18	201	15 : 1	2.4600	0.250-0.100
Giza 168 /Anza	205	0	205	1 : 0	-	>0.99
Giza 168 /Pavion76	210	5	215	63 : 1	0.8140	0.500-0.250
Sids12/Jupateco 73R	130	80	210	9 : 7	2.7286	0.750-0.500
Sids12/Opata 85	150	70	220	13 : 3	1.3978	0.900-0.750
Sids 12/Anza	145	65	210	11 : 5	0.0087	0.950-0.900
Sids 12/Pavion76	90	125	215	7 : 9	0.3119	0.750-0.500
Giza 160/Jupateco 73R	95	125	220	7 : 9	0.0289	0.750-0.500
Giza 160/Opata 85	142	68	210	15 : 11	0.1250	0.750-0.500
Giza 160/Anza	50	170	220	1 : 3	0.6061	0.250-0.010
Giza 160/Pavion76	80	125	205	7 : 9	1.8602	0.250-0.100

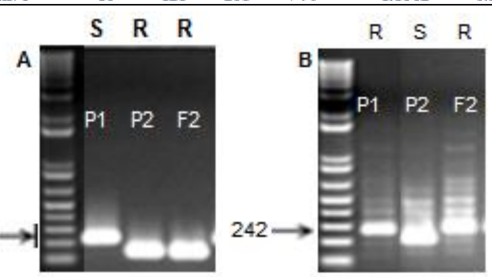

Fig. 1. Amplification products of PCR using **A**. *Yr18* marker (150bp) in F_2 of cross; Misr2/Opata and **B.** *Yr29* marker (242bp) in F_2 of cross; Giza168/Pavon 76.

Selected Reference

Kh.E. Ragab, A.A. Shahin and S.M. Abdelkhalik (2020). Efficiency of yellow rust resistance genes *Yr5, 10, 15* and *Sp* in improving the two Egyptian bread wheat cultivars Sids 12 and Gemmeiza 11. Egypt. J. Agron. Vol. 42, No.3, pp. 249-261.