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Identify New Wheat Genotypes Resistant to Leaf and Stem Rusts under Egyptian Conditions

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One hundred twenty three wheat genotypes derived from the International Maize and Wheat Improvement Centre (CIMMYT) were evaluated against leaf rust (*Puccinia triticina*) and stem rust (*Puccinia graminis* f.sp. *tritici*) as well as grain yield (1000 kernel weight and spike weight) at Gemmeiza Research Station during 2012/13 and 2013/14 growing seasons. Forty six and fifty nine wheat genotypes out of one hundred twenty three were resistant to leaf and stem rust diseases during 2012/13 growing season. While forty eight and sixty seven genotypes showed resistant reactions to both leaf and stem rusts during 2013/14. Regarding to 1000 kernel weight (g), 23 and 20 genotypes showed high yield during 2012/13 and 2013/14 growing seasons, respectively. Wheat genotypes No. 8, 31, 39, 40, 72, 80, 101 and 123 were resistant to leaf and stem rust diseases during the two successive seasons and showed high yield, these genotypes displayed various levels of adult plant resistance in the field and could be used as an important source for breeding high yielding resistant varieties.

Keywords: Leaf, resistance, stem rust, wheat and yield components.

Bread wheat (*Triticum aestivum* L.) is one of the most important field crops in Egypt. Nevertheless, the yield production is not sufficient to cover the local consumption in Egypt (Anonymous, 2013). Breeding high yield varieties resistant to leaf and stem rusts is a very important objective in Egypt. To fill the gap between the production and consumption, however yield of wheat can be increased by increasing the cultivated area (horizontally) or by increasing the yield per unit area (vertically). The only alternative method is to obtain higher yield per unit area by growing high yielding varieties resistant to diseases.

Rust diseases of wheat, *i.e*. leaf rust (*Puccinia triticina* Eriks.) and stem rust (*Puccinia graminis* Pers. f.sp. *tritici* Eriks. & E. Henn.), are still the most dangerous biotic stress that threaten wheat production in Egypt and in several wheat growing areas of the world. This is mainly due to the appearance of aggressive races of the pathogen (Singh *et al*., 2005).

Leaf rust causes severe losses in grain yield which may reach more than 20% on the susceptible cultivars depending on environmental conditions, level of resistance, stage of crop development at the initial stage of infection and the dominant physiologic races (Nazim *et al*., 1983). While, wheat stem rust fungus could affect the entire wheat crop, especially during the early growth stages leading to the blocking of the vascular system hence stunting and lodging of weak stalks eventually causing yield losses of even 100% due to shrivelled grain and damaged tillers (Kokhmetova *et al*., 2011 and Boukhatem *et al*., 2002). In Egypt, yield losses due to stem rust ranged from 1.96% to 8.21% on the Egyptian wheat cultivars (Ashmawy *et al*., 2013). In most cases, susceptible wheat cultivars were replaced with new resistant one (Rattu *et al*., 2007). Meanwhile, various control options are available for combating wheat rusts using resistant varieties is the most effective and safety one.

This aim of this study was to identify new wheat genotypes resistant to leaf and stem rusts under Egyptian conditions. Also, to evaluate these genotypes for yield components and select lines that perform high yield and showing desirable resistance against rust diseases to be used in Egyptian breeding program.

Materials and Methods

One hundred twenty three genotypes were used in this study (Table 1), these genotypes were derived from (CIMMYT). This experiment was carried out at Gemmeiza Research Station during 2012/13 and 2013/14 growing seasons. Each tested wheat genotype was planted in two rows of 1m length with 4 replicates. Normal agricultural wheat practices were applied and the plots were surrounded by spreader area planted with a mixture of highly susceptible wheat varieties, *i.e. Triticum spelta sahariensis*, Morocco, Thatcher and Max to spread rust inoculum. For field inoculation with leaf and stem rusts, the spreader plants were sprayed with a mist of water and dusted with mixture of urediniospores of the prevalent rust races mixed with talcum powder at a rate of 1 (spore): 20 (talcum powder). The inoculation of all plants was carried out at booting stage according to the method of Tervet and Cassel (1951).

Disease assessment:

Leaf and stem rust severities and reactions were recorded for each genotype using the modified Cobb's scale (Peterson *et al*., 1948). Area under disease progress curve (AUDPC) was assessed for each genotype according to the equation adopted by Stubbs *et al*. (1986).

$$AUDPC= D [1/2 (Y1 + Yk) + (Y2 + Y3 + \text{- - - - -} + Yk\text{-}1)]$$

Whereas: D= days between two consecutive recording (time intervals).
Y1 + Yk= Sum of the first and last scores.
Y2 + Y3 + - - - - - + Yk-1= Sum of all in between disease scores.

Coefficient of infection (CI) was calculated by multiplying rust severity with constant values of infection type (IT). The constant values for infection types were used based on; R=0.2, MR=0.4, MS=0.8 and S=1 (Stubbs *et al*., 1986). Average coefficient of infection (ACI) was derived from the sum of CI values of each line divided by the number of locations.

Yield components:

Thousand kernels weigh (g) and spike weight were studied for each genotype, thousand kernels weight was measured by threshing the kernels from the spikes and 1000 seed from each genotype were calculated and weighted.

Table 1. List of the tested wheat genotypes, cross name and origin

No.	Designation	Origin
1	PBW343	MXI10-11\M6SRRSN\210
2	KINGBIRD #1	MXI10-11\M6SRRSN\211
3	WBLL1*2/KURUKU//HEILO	MXI10-11\M6SRRSN\4
4	WBLL1*2/KURUKU//HEILO	MXI10-11\M6SRRSN\5
5	ATTILA*2/PBW65*2//KACHU	MXI10-11\M6SRRSN\6
6	ATTILA*2/PBW65*2//KACHU	MXI10-11\M6SRRSN\7
7	WBLL1*2/KUKUNA/5/PSN/BOW//SERI/3/MILAN/4/ATTILA/6/WBLL1*2/KKTS	MXI10-11\M6SRRSN\8
8	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311	MXI10-11\M6SRRSN\9
9	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7	MXI10-11\M6SRRSN\10
10	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7	MXI10-11\M6SRRSN\11
11	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7	MXI10-11\M6SRRSN\12
12	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7	MXI10-11\M6SRRSN\13
13	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7	MXI10-11\M6SRRSN\15
14	KACHU #1/KIRITATI//KACHU	MXI10-11\M6SRRSN\16
15	SAUAL/YANAC//SAUAL	MXI10-11\M6SRRSN\17
16	SAUAL/YANAC//SAUAL	MXI10-11\M6SRRSN\19
17	PRL/2*PASTOR*2//FH6-1-7	MXI10-11\M6SRRSN\20
18	PBW343*2/KUKUNA*2//FRTL/PIFED	MXI10-11\M6SRRSN\21
19	PBW343*2/KUKUNA*2//FRTL/PIFED	MXI10-11\M6SRRSN\22
20	PBW343*2/KUKUNA*2//FRTL/PIFED	MXI10-11\M6SRRSN\24
21	UP2338*2/KKTS*2//YANAC	MXI10-11\M6SRRSN\27
22	UP2338*2/KKTS*2//YANAC	MXI10-11\M6SRRSN\28
23	BAV92//IRENA/KAUZ/3/HUITES*2/4/MURGA	MXI10-11\M6SRRSN\35
24	BAV92//IRENA/KAUZ/3/HUITES*2/4/MURGA	MXI10-11\M6SRRSN\36
25	ROLF07*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES	MXI10-11\M6SRRSN\37
26	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA	MXI10-11\M6SRRSN\40
27	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA	MXI10-11\M6SRRSN\41
28	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA	MXI10-11\M6SRRSN\42
29	ROLF07*2/5/FCT/3/GOV/AZ//MUS/4/DOVE/BUC	MXI10-11\M6SRRSN\43
30	WAXWING/KIRITATI*2/3/C80.1/3*BATAVIA//2*WBLL1	MXI10-11\M6SRRSN\46
31	FRNCLN/ROLF07	MXI10-11\M6SRRSN\47
32	ALTAR84/AE.SQUARROSA(221)//3*BORL95/3/URES/JUN//KAUZ/4/WBLL1/5/MILAN/S87230//BAV92	MXI10-11\M6SRRSN\50
33	ALTAR84/AE.SQUARROSA(221)//3*BORL95/3/URES/JUN//KAUZ/4/WBLL1/5/MILAN/S87230//BAV92	MXI10-11\M6SRRSN\51
34	FRNCLN/TECUE #1	MXI10-11\M6SRRSN\52
35	TRCH/HUIRIVIS #1	MXI10-11\M6SRRSN\53
36	TRCH/KBIRD	MXI10-11\M6SRRSN\54
37	BECARD/AKURI	MXI10-11\M6SRRSN\56
38	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/AKURI	MXI10-11\M6SRRSN\60
39	KINGBIRD #1//INQALAB 91*2/TUKURU	MXI10-11\M6SRRSN\61
40	KINGBIRD #1//INQALAB 91*2/TUKURU	MXI10-11\M6SRRSN\62
41	PBW343*2/KUKUNA//TECUE #1	MXI10-11\M6SRRSN\63
42	PBW343*2/KUKUNA//TECUE #1	MXI10-11\M6SRRSN\64
43	BL2064//SW89-5124*2/FASAN/3/TILHI/5/KAUZ//ALTAR 84/AOS/3/KAUZ/4/SW94.15464	MXI10-11\M6SRRSN\66
44	ROLF07*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES	MXI10-11\M6SRRSN\68

Table 1: Continued

45	MUU #1//PBW343*2/KUKUNA/3/MUU	MXI10-11\M6SRRSN\73
46	WAXWING/4/BL 1496/MILAN/3/CROC_1/AE.SQUARROSA (205)//KAUZ/5/FRNCLN	MXI10-11\M6SRRSN\75
47	UP2338*2/VIVITSI/3/FRET2/TUKURU//FRET2/4/MISR 1	MXI10-11\M6SRRSN\76
48	WAXWING*2/HEILO	MXI10-11\M6SRRSN\82
49	KIRITATI/4/2*BAV92//IRENA/KAUZ/3/HUITES	MXI10-11\M6SRRSN\86
50	KIRITATI/4/2*BAV92//IRENA/KAUZ/3/HUITES	MXI10-11\M6SRRSN\87
51	OASIS/SKAUZ//4*BCN/3/2*PASTOR/5/FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/6/SAUAL #1	MXI10-11\M6SRRSN\89
52	KZA//WH 542/2*PASTOR/3/BACEU #1	MXI10-11\M6SRRSN\90
53	KFA/2*KACHU	MXI10-11\M6SRRSN\93
54	KFA/2*KACHU	MXI10-11\M6SRRSN\94
55	KFA/2*KACHU	MXI10-11\M6SRRSN\95
56	FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ*2/5/BOW/URES//2*WEAVER/3/CROC_1/AE.SQUARROSA (213)//PGO	MXI10-11\M6SRRSN\97
57	FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ*2/5/BOW/URES//2*WEAVER/3/CROC_1/AE.SQUARROSA (213)//PGO	MXI10-11\M6SRRSN\98
58	WBLL1/MUU #1	MXI10-11\M6SRRSN\101
59	ATTILA*2/PBW65//MURGA	MXI10-11\M6SRRSN\105
60	BAV92//IRENA/KAUZ/3/HUITES/6/ALD/CEP75630//CEP75234/PT7219/3/BUC/BJY/4/CBRD/5/TNMU/PF85487	MXI10-11\M6SRRSN\106
61	WBLL1*2/KURUKU//HEILO	MXI10-11\M6SRRSN\108
62	ROLF07*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN	MXI10-11\M6SRRSN\109
63	ROLF07*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN	MXI10-11\M6SRRSN\110
64	WBLL1*2/KUKUNA/5/PSN/BOW//SERI/3/MILAN/4/ATTILA/6/WBLL1*2/KKTS	MXI10-11\M6SRRSN\113
65	WAXWING/KIRITATI*2//YANAC	MXI10-11\M6SRRSN\115
66	BAV92//IRENA/KAUZ/3/HUITES*2/4/PVN	MXI10-11\M6SRRSN\116
67	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311	MXI10-11\M6SRRSN\117
68	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311	MXI10-11\M6SRRSN\118
69	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311	MXI10-11\M6SRRSN\119
70	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311	MXI10-11\M6SRRSN\124
71	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311	MXI10-11\M6SRRSN\126
72	TACUPETO 2001/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/PASTOR/7/ROLF07	MXI10-11\M6SRRSN\128
73	ROLF07*2/DIAMONDBIRD	MXI10-11\M6SRRSN\129
74	SAUAL/YANAC//SAUAL	MXI10-11\M6SRRSN\130
75	SAUAL/YANAC//SAUAL	MXI10-11\M6SRRSN\131
76	SAUAL/YANAC//SAUAL	MXI10-11\M6SRRSN\132
77	PRL/2*PASTOR*2//FH6-1-7	MXI10-11\M6SRRSN\133
78	CS/TH.SC//3*PVN/3/MIRLO/BUC/4/URES/JUN//KAUZ/5/HUITES/6/YANAC/7/CS/TH.SC//3*PVN/3/MIRLO/BUC/4/MILAN/5/TILHI	MXI10-11\M6SRRSN\134
79	KAUZ/PASTOR//PBW343/3/HAR311/5/OASIS/SKAUZ//4*BCN/3/PASTOR/4/KAUZ*2/YACO//KAUZ	MXI10-11\M6SRRSN\137
80	KAUZ/PASTOR//PBW343/3/HAR311/5/OASIS/SKAUZ//4*BCN/3/PASTOR/4/KAUZ*2/YACO//KAUZ	MXI10-11\M6SRRSN\138
81	INQALAB 91*2/KUKUNA*2//PVN	MXI10-11\M6SRRSN\139
82	UP2338*2/KKTS*2//YANAC	MXI10-11\M6SRRSN\140
83	UP2338*2/KKTS*2//YANAC	MXI10-11\M6SRRSN\141
84	ROLF07*2/KACHU #1	MXI10-11\M6SRRSN\142
85	ATTILA*2/PBW65*2//MURGA	MXI10-11\M6SRRSN\143
86	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA	MXI10-11\M6SRRSN\146

Table 1: Continued

87	PFAU/WEAVER*2//BRAMBLING/3/KAUZ//TRAP#1/BOW/4/PFAU/WEAVER*2//BRAMBLING	MXI10-11\M6SRRSN\150
88	FRNCLN/BECARD	MXI10-11\M6SRRSN\156
89	PARUS/FRANCOLIN #1	MXI10-11\M6SRRSN\157
90	SAUAL #1/KACHU	MXI10-11\M6SRRSN\158
91	WBLL1*2/BRAMBLING//KACHU	MXI10-11\M6SRRSN\159
92	MILAN/S87230//BAV92/3/AKURI #1	MXI10-11\M6SRRSN\163
93	QUAIU/TECUE #1	MXI10-11\M6SRRSN\165
94	ROLF07/KINGBIRD #1	MXI10-11\M6SRRSN\166
95	WBLL1*2/TUKURU//CROSBILL #1	MXI10-11\M6SRRSN\168
96	WBLL1*2/TUKURU//CROSBILL #1	MXI10-11\M6SRRSN\169
97	KINGBIRD #1/KACHU	MXI10-11\M6SRRSN\173
98	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/KBIRD	MXI10-11\M6SRRSN\174
99	KINGBIRD #1//INQALAB 91*2/TUKURU	MXI10-11\M6SRRSN\175
100	PBW343*2/KUKUNA//TECUE #1	MXI10-11\M6SRRSN\177
101	PBW343*2/KUKUNA//TECUE #1	MXI10-11\M6SRRSN\178
102	PBW343*2/KUKUNA//TECUE #1	MXI10-11\M6SRRSN\179
103	PVN//CAR422/ANA/5/BOW/CROW//BUC/PVN/3/YR/4/TRAP#1/6/AKURI #1	MXI10-11\M6SRRSN\182
104	BL2064//SW89-5124*2/FASAN/3/TILHI/5/KAUZ//ALTAR 84/AOS/3/KAUZ/4/SW94.15464	MXI10-11\M6SRRSN\184
105	PBW343*2/KHVAKI/5/KAUZ//ALTAR 84/AOS/3/KAUZ/4/SW94.15464	MXI10-11\M6SRRSN\185
106	TAM200/PASTOR//TOBA97/3/WHEAR	MXI10-11\M6SRRSN\186
107	C80.1/3*BATAVIA//2*WBLL1/3/2*FRET2/TUKURU//FRET2	MXI10-11\M6SRRSN\187
108	NAC/TH.AC//3*PVN/3/MIRLO/BUC/4/2*PASTOR/5/KACHU/6/KACHU	MXI10-11\M6SRRSN\189
109	SITE/MO//PASTOR/3/TILHI/4/WAXWING/KIRITATI/5/PBW343*2/TUKURU	MXI10-11\M6SRRSN\190
110	UP2338*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/2*WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ	MXI10-11\M6SRRSN\192
111	BAV92//IRENA/KAUZ/3/HUITES/4/GONDO/TNMU/5/BAV92//IRENA/KAUZ/3/HUITES	MXI10-11\M6SRRSN\195
112	WBLL1*2/KURUKU//HEILO/3/WBLL1*2/KURUKU	MXI10-11\M6SRRSN\196
113	CONI#1/2*HUIRIVIS #1	MXI10-11\M6SRRSN\197
114	KIRITATI/4/2*BAV92//IRENA/KAUZ/3/HUITES	MXI10-11\M6SRRSN\198
115	OASIS/SKAUZ//4*BCN/3/2*PASTOR/5/FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/6/SAUAL #1	MXI10-11\M6SRRSN\201
116	SKAUZ/BAV92//2*WBLL1*2/KKTS	MXI10-11\M6SRRSN\202
117	KENYA NYANGUMI//2*ATTILA*2/PBW65	MXI10-11\M6SRRSN\203
118	TACUPETO 2001/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/PASTOR/7/ROLF07	MXI10-11\M6SRRSN\204
119	TACUPETO 2001/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/PASTOR/7/ROLF07	MXI10-11\M6SRRSN\207
120	FRANCOLIN #1/KIRITATI	MXI10-11\M6SRRSN\208
121	KENYA NYANGUMI/3/2*KAUZ/PASTOR//PBW343	MXI10-11\M6SRRSN\209
122	PBW343*2/KUKUNA//TECUE #1	MXI10-11\M6SRRSN\65
123	KSW/SAUAL//SAUAL	MXI10-11\M6SRRSN\91

Results

A total of 123 wheat genotypes were tested for adult plant resistance to leaf and stem rust diseases as well as yield components (Tables 2, 3 and 4).

Evaluation of wheat genotypes against leaf rust under field conditions:
Season 2012/13:

Data presented in Table (2) show that the leaf rust severity of the tested genotypes varied from 0 to 80% with different infection types under field conditions. Out of 123 tested genotypes, 46 genotypes showed desirable/acceptable resistance to leaf rust, whereas rust severities ranged from 0 to 10R. Area under disease progress curve (AUDPC) and Coefficient of infection (CI) are in parallel line with rust severity, which gave values ranged from 0 to 80.5 (AUDPC) and from 0 to 2 (CI). High rust severity was scored on 32 genotypes during 2012/13 season with values ranged from 40-80%. The rest wheat genotypes were in between.

Season 2013/14:

Data in Table (2) prove that number of resistant genotypes was decreased to thirty eight which gave resistant reaction ranged from 0 to 10R. On the other hand, eighty five genotypes showed different infection types (MR, MS and S) with different disease severity values ranged from 5 to 80%. The highest values of Area under disease progress curve (AUDPC) and Coefficient of infection (CI) were observed on sixteen genotypes.

During the two successive seasons, twenty three genotypes, *i.e.* 1, 2, 8, 9, 10, 20, 21, 29, 31, 34, 39, 40, 65, 72, 73, 74, 80, 81, 82, 91, 101, 115 and 123, showed high levels of adult plant resistant to leaf rust which gave low rust severity (0-10R), low area under disease progress curve (0-80.5) and low coefficient of infection (0-2).

Regarding to leaf rust severity and infection types during the two seasons, out of the total entries tested, 39.02% were resistant, 6.09% were moderately resistant, 17% were moderately susceptible and the remaining (37.39%) were completely susceptible to the disease (Fig.1).

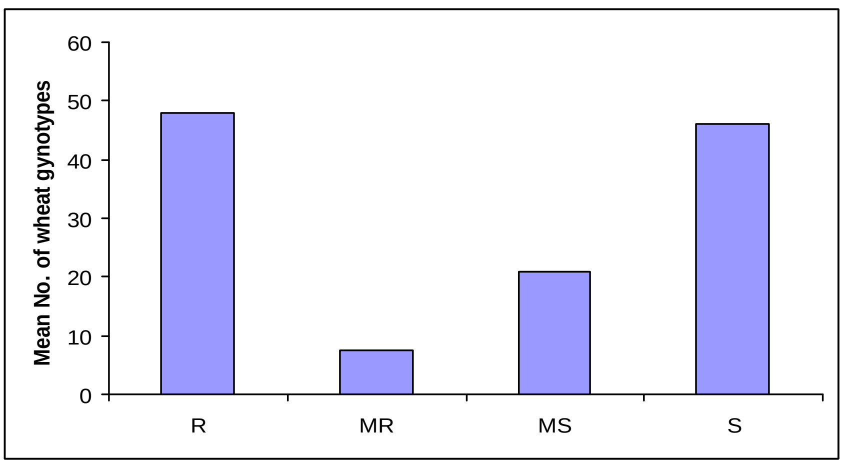

Fig. 1. Mean number of wheat genotypes distributed leaf rust infection types during the two seasons. Whereas: S= susceptible, MS= moderately susceptible, MR= moderately resistant and R= resistant.

Table 2. Area under disease progress curve (AUDPC) and Coefficient of Infection of the tested wheat genotypes during 2012/13 and 2013/14 growing seasons

No.	2012/13						2013/14					
	Leaf rust			stem rust			Leaf rust			stem rust		
	R.S.*	AUDPC	ACI	R.S.	AUDPC	ACI	R.S.	AUDPC	ACI	R.S.	AUDPC	ACI
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	60S	665	60	Tr S	15	3	40S	525	40	5Ms	55	4
4	0	0	0	30S	265	30	0	0	0	10Ms	91	8
5	10Mr	80.5	4	0	0	0	10Mr	91	4	TrR	15	0.6
6	30 Mr	300	12	Tr Ms	15	2.4	5R	55	1	5Ms	55	4
7	0	0	0	0	0	0	10S	91	10	5R	55	1
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	10S	155	10	0	0	0
10	30S	415	30	0	0	0	10S	165	10	0	0	0
11	20Mr	155	8	10S	80.5	10	40S	248	40	0	0	0
12	60Ms	665	48	30S	300	30	Trs	15	3	TrR	15	0.6
13	TrR	15	0.6	Tr S	15	3	20S	155	20	5R	55	1
14	20Ms	155	16	Tr S	15	3	30S	265	30	0	0	0
15	20Ms	155	16	0	0	0	0	0	0	0	0	0
16	0	0	0	10R	91	2	20R	155	4	10Ms	91	8
17	0	0	0	10S	91	10	0	0	0	20S	168	20
18	10Mr	98	4	0	0	0	5Ms	55	4	TrMs	15	2.4
19	10Mr	98	4	40S	322	40	30Ms	300	24	0	0	0
20	0	0	0	0	0	0	0	0	0	5S	55	5
21	0	0	0	0	0	0	0	0	0	5S	55	5
22	20Ms	157	16	20S	155	20	10S	165	10	TrS	15	3
23	10R	80.5	2	0	0	0	10R	80.5	2	0	0	0
24	10S	165	10	5S	55	5	5R	55	1	0	0	0
25	20Ms	157	16	0	0	0	40S	525	40	5S	55	5
26	10Mr	130	4	10S	130	10	10Ms	98	8	0	0	0
27	30S	415	30	Trs	15	3	60S	825	60	0	0	0
28	60S	825	60	Trs	15	3	60S	825	60	TrS	15	3
29	80S	925	80	0	0	0	40S	515	50	0	0	0
30	80S	915	80	0	0	0	TrS	15	3	40S	525	40
31	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	30S	300	30	0	0	0	5S	55	5
33	80S	925	80	5S	55	5	40S	322	40	40S	322	40
34	0	0	0	0	0	0	0	0	0	0	0	0
35	30Ms	265	24	Trs	15	3	10R	91	2	0	0	0
36	80S	1125	80	0	0	0	5Ms	55	4	0	0	0
37	80S	1125	80	TrMs	15	2.8	TrR	15	0.6	0	0	0
38	80S	1125	80	10Mr	91	4	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0
41	60S	825	60	10R	80.5	2	40Ms	248	32	0	0	0
42	10Ms	91	8	0	0	0	TrMs	15	2.4	0	0	0
43	40S	525	40	10R	91	2	TrMs	15	2.4	5S	55	5
44	40S	525	40	10S	165	10	0	0	0	30S	300	30
45	10Mr	98	4	20S	168	20	30Ms	300	24	40S	248	40
46	TrMs	15	2.4	0	0	0	10R	98	2	0	0	0

Table 2: Continued

47	0	0	0	TrS	15	3	0	0	0	10S	98	10
48	60S	825	60	10Ms	98	8	0	0	0	0	0	0
49	10R	91	2	30Ms	300	24	TrS	15	3	10Ms	91	8
50	10R	91	2	40S	322	40	5S	55	5	80S	1125	80
51	0	0	0	10Mr	0	0	20Ms	155	16	20Mr	155	8
52	30S	415	30	0	0	0	0	0	0	0	0	0
53	80S	925	80	20S	157	20	0	0	0	0	0	0
54	80S	925	80	Tr Mr	15	1.2	TrS	15	3	0	0	0
55	10S	130	10	0	0	0	20Mr	157	8	10Ms	130	8
56	0	0	0	0	0	0	10S	165	10	TrS	55	3
57	0	0	0	0	0	0	10S	165	10	10R	130	2
58	10S	165	10	10Ms	91	8	30Ms	280	24	0	0	0
59	0	0	0	TrMr	15	1.2	10Ms	91	8	40S	322	40
60	0	0	0	30S	300	30	10Ms	91	8	30S	415	30
61	60S	825	60	TrMs	15	2.4	TrS	15	3	30S	415	30
62	10Ms	80.5	8	TrMs	15	2.4	10Ms	91	8	TrS	15	3
63	TrMr	15	1.2	30S	415	30	20R	230	6	TrMs	15	2.4
64	30Ms	280	24	0	0	0	0	0	0	60S	925	60
65	0	0	0	0	0	0	0	0	0	0	0	0
66	10S	91	10	10Ms	98	8	0	0	0	10S	157	10
67	60S	925	60	0	0	0	10Ms	91	8	30S	300	30
68	10R	91	2	10S	130	10	TrMs	15	2.4	0	0	0
69	10Ms	91	8	TrS	15	3	TrMs	15	2.4	0	0	0
70	50S	425	50	TrMs	15	2.4	30S	415	30	0	0	0
71	0	0	0	0	0	0	5Ms	55	4	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0
73	80S	925	80	0	0	0	30S	415	30	0	0	0
74	80S	925	80	0	0	0	30S	385	30	0	0	0
75	40Ms	248	32	30S	280	30	0	0	0	0	0	0
76	60Ms	665	48	10S	98	10	30Ms	248	24	0	0	0
77	0	0	0	0	0	0	20Mr	155	8	60S	825	60
78	10S	130	10	20Mr	155	8	30S	300	30	30S	280	30
79	30Ms	280	24	TrS	15	3	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0	0	0
81	10Ms	130	8	0	0	0	30S	415	30	0	0	0
82	0	0	0	0	0	0	0	0	0	0	0	0
83	60S	825	60	20S	168	20	0	0	0	0	0	0
84	40S	322	40	0	0	0	5S	55	5	10Ms	91	8
85	10Mr	80.5	4	0	0	0	20Ms	157	16	40S	322	40
86	TrS	15	3	20Mr	155	8	0	0	0	10S	0	10
87	30S	415	30	60S	665	60	0	0	0	TrS	0	3
88	5R	55	1	30Ms	300	24	5S	55	5	30S	280	30
89	0	0	0	0	0	0	40Ms	248	32	0	0	0
90	10Ms	98	8	20S	168	20	10Mr	130	4	0	0	0
91	0	0	0	0	0	0	0	0	0	0	0	0
92	0	0	0	10S	130	10	0	0	0	20S	165	20
93	0	0	0	5R	55	1	20S	230	20	40S	525	40
94	60S	825	60	TrS	15	3	10S	165	10	5S	55	5
95	60S	665	60	30S	415	30	30S	300	30	0	0	0
96	10Ms	130	8	0	0	0	10S	165	10	5S	55	5
97	20Mr	155	8	TrMs	15	2.4	30Mr	248	12	TrS	15	10

Table 2: Continued

98	10S	130	10	5S	55	5	0	0	0	0	0	0
99	20Ms	157	16	0	0	0	5S	63	5	0	0	0
100	40S	322	40	0	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0	0	0	0	0
102	0	0	0	5S	55	5	0	0	0	0	0	0
103	TrMs	15	2.4	20S	157	20	10S	130	0	30Ms	280	24
104	60S	825	60	20Ms	155	16	60Ms	665	48	20S	168	20
105	30S	300	30	0	0	0	0	0	0	0	0	0
106	70S	975	70	TrMs	15	2.4	0	0	0	0	0	0
107	10S	165	10	0	0	0	TrS	15	3	50Ms	875	40
108	0	0	0	20S	168	20	40S	322	40	30S	280	30
109	0	0	0	5R	55	1	80S	925	80	80S	925	80
110	40S	525	40	40S	322	40	40S	525	40	TrS	15	3
111	TrMs	15	2.4	5Ms	55	4	40S	525	40	10S	165	10
112	10S	98	10	0	0	0	30S	300	30	0	0	0
113	80S	1125	80	20Mr	155	8	60S	825	60	30Ms	280	24
114	0	0	0	10Mr	80.5	4	0	0	0	0	0	0
115	0	0	0	0	0	0	0	0	0	0	0	0
116	10Ms	130	8	10R	80.5	2	30S	415	30	30S	415	30
117	80S	925	80	30S	415	30	30S	415	30	60S	925	60
118	60S	815	80	0	0	0	10S	157	10	0	0	0
119	10S	91	10	10S	168	10	10S	98	10	TrS	15	3
120	0	0	0	0	0	0	40S	322	40	TrS	15	3
121	0	0	0	0	0	0	10Ms	80.5	8	10S	98	10
122	40S	525	40	10Ms	155	8	0	0	0	0	0	0
123	0	0	0	0	0	0	0	0	0	0	0	0

* R.S: Rust Severity, AUDPC: Area under Progress Curve and ACI: Average Coefficient of infections.

Evaluation of wheat genotypes against stem rust under field conditions:
Season 2012/13:

Data presented in Table (2) show that the stem rust severity of the tested genotypes varied from 0 to 60% during 2012/13. Sixty wheat genotypes were resistant and showed infection type from 0 to R, whereas four genotypes, *i.e.* 19, 50, 87 and 110, showed high infection type ranged from 40S to 60S. Area under disease progress curve and coefficient of infection were in parallel line with rust severity.

Season 2013/14:

Data in Table (2) show that stem rust severity and disease incidence were low, as well as the highest numbers of resistant genotypes (67 genotypes) were observed during this season. High rust severity was scored on 12 genotypes ranged from 40-60%. Also, data show that there are 34 genotypes gave high levels of adult plant resistant to stem rust during the two seasons, *i.e.* 1, 2, 8, 9, 10, 15, 23, 29, 31, 34, 36, 39, 40, 42, 46, 52, 65, 71, 72, 73, 74, 80, 81, 82, 89, 91, 99, 100, 101, 105, 112, 115, 118 and 123.

Stem rust disease pressure during the two seasons was low compared with leaf rust, and out of the total entries tested, 51.21% were resistant, 3.6% were moderately resistant, 10.9% were moderately susceptible and the remaining (34.1%) were completely susceptible to the disease (Fig. 2).

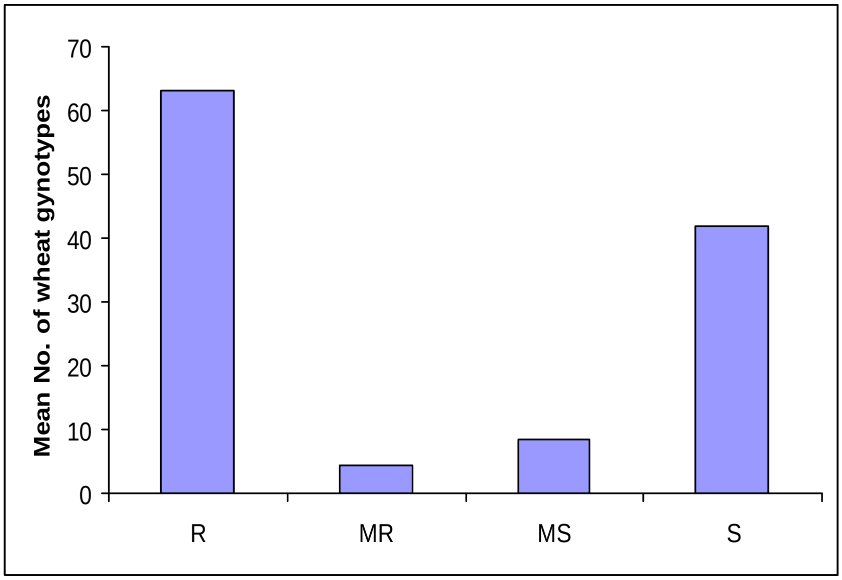

Fig. 2. Mean number of wheat genotypes distributed stem rust infection types during the two seasons. Whereas: S= susceptible, MS= moderately susceptible, MR= moderately resistant and R= resistant.

Yield components:

Season 2012/13:

Regarding 1000 kernels weigh and spike weight**,** data in Table (3) show that high values of 1000-kernel weight, were observed on 23 genotypes (8, 78, 4, 72, 101, 90, 40, 51, 92, 68, 96, 80, 31, 74, 70, 66, 39, 123, 76, 58, 101, 113 and 17) which gave 1000-kernel weigh ranged from (64.2-55.2g.). The rest wheat genotypes showed different 1000-kernel weight from 34.00 to 55.00g. On the other hand, 7 wheat genotypes exhibited the highest values of spike weight (g), these genotypes were, 57(5.64), 62(5.32), 13(4.9), 10(4.8), 106(4.84), 21(4.81) and 118(4.54).

Season 2013/14:

The obtained results in Table (3) reveal that 20 wheat genotypes showed the highest values of 1000-kernel weight, *i.e.* 43, 78, 90, 113, 92, 80, 74, 68, 70, 31, 39, 123, 40, 92, 87, 101, 8, 100, 96 and 17g, respectively. Eight wheat genotypes exhibited the highest values of spike weight (g), *i.e.* 62(5), 10(4.82), 63(4.8), 118(4.66), 23(4.62), 26(4.6), 106(4.61) and 52(4.5).

Table 3. 1000 kernel weight and Spike weight of the tested wheat genotypes during 2012/13 and 2013/14 growing seasons

No.	2012/13		2013/14	
	Spike weight (g)	1000 kernel weight (g)	Spike weight (g)	1000 kernel weight (g)
1	2.93	41.15	2.81	41.00
2	2.72	38.56	2.72	38.56
3	2.82	40.75	2.45	40.26
4	3.98	61.00	4.00	61.08
5	3.56	45.00	3.80	45.20
6	3.80	45.30	3.62	45.10
7	3.90	42.10	3.90	42.10
8	4.78	64.20	4.31	56.23
9	4.40	47.90	4.14	47.30
10	4.84	49.30	4.84	49.30
11	3.66	51.90	3.30	51.90
12	3.51	54.30	3.58	54.36
13	4.90	49.60	4.20	48.12
14	3.57	42.10	3.57	42.10
15	3.70	51.80	3.27	52.00
16	3.50	52.00	3.50	52.20
17	3.70	55.20	3.70	55.20
18	3.82	44.52	3.82	44.52
19	3.78	44.00	3.78	44.00
20	4.62	45.90	4.22	45.00
21	4.81	52.10	4.31	52.00
22	3.90	51.50	3.33	51.80
23	4.66	54.40	4.62	54.14
24	4.00	51.33	3.50	51.00
25	4.18	53.20	3.68	53.00
26	4.62	53.80	4.60	53.18
27	5.00	52.72	3.88	52.22
28	4.04	44.00	3.65	44.10
29	3.10	50.40	3.90	52.40
30	3.50	44.40	3.85	45.12
31	3.42	57.56	3.12	57.06
32	5.00	41.20	3.92	41.00
33	2.98	54.30	3.00	54.90
34	4.10	48.70	4.11	48.22
35	3.50	34.00	3.18	34.01
36	2.60	49.20	3.12	49.11
37	4.40	45.70	3.33	42.15
38	3.30	53.80	3.52	52.95
39	3.62	56.70	4.00	57.00
40	3.64	58.70	3.50	56.70

Table 3: Continued

41	2.90	46.70	3.12	45.22
42	3.00	48.50	3.25	49.50
43	3.10	45.70	3.25	45.65
44	4.58	54.50	3.64	52.22
45	4.00	52.15	3.52	51.18
46	2.72	41.46	2.72	41.46
47	4.47	50.40	4.03	50.10
48	3.18	42.40	3.12	42.80
49	3.12	52.17	3.00	52.02
50	3.66	52.20	3.13	50.20
51	4.04	58.50	2.95	51.18
52	4.54	45.69	4.50	44.19
53	3.40	53.90	3.62	52.88
54	3.10	51.32	3.65	51.75
55	3.20	52.80	3.00	52.18
56	3.80	44.60	4.11	45.32
57	5.64	54.90	4.32	53.11
58	4.34	56.00	4.20	54.00
59	3.93	54.29	3.11	53.20
60	3.50	41.99	3.50	40.48
61	2.82	40.90	3.00	40.10
62	5.32	54.28	5.00	52.20
63	4.28	49.65	4.80	49.80
64	3.60	49.00	4.00	49.20
65	3.36	45.60	3.06	44.22
66	3.10	56.98	3.23	57.00
67	3.92	50.36	3.90	48.33
68	3.30	57.89	3.70	57.36
69	2.66	50.95	3.11	52.00
70	3.29	57.10	3.20	57.25
71	4.36	60.30	3.83	56.30
72	3.08	41.96	3.28	43.00
73	3.88	52.00	3.80	52.00
74	3.76	57.33	3.65	57.36
75	3.96	53.36	3.42	53.30
76	4.25	56.06	4.05	54.00
77	3.52	52.00	3.58	52.50
78	4.34	61.47	4.30	59.03
79	4.01	46.45	4.58	48.22
80	4.40	57.70	4.60	58.11
81	4.14	50.24	4.31	52.10
82	4.10	49.75	4.20	50.70
83	3.89	51.06	3.81	51.00
84	3.12	47.10	3.00	44.52

Table 3: Continued

85	3.80	47.50	3.80	47.15
86	4.56	48.00	3.86	45.80
87	4.50	54.39	4.55	56.30
88	4.46	52.34	4.23	50.25
89	3.90	51.45	4.12	53.05
90	4.92	59.70	4.90	59.00
91	3.40	43.58	4.00	47.08
92	3.14	58.19	3.13	58.11
93	3.28	46.72	3.50	44.70
94	4.32	49.88	3.38	45.62
95	4.32	49.00	4.32	49.82
96	3.38	57.70	3.23	55.70
97	3.26	50.14	3.20	50.00
98	2.84	45.78	3.69	49.11
99	3.52	50.70	3.95	52.54
100	2.84	51.16	3.48	56.22
101	4.72	60.00	3.52	56.25
102	3.06	55.90	3.00	52.74
103	3.58	42.50	4.58	46.51
104	4.00	51.80	4.14	54.32
105	3.74	54.76	3.63	54.00
106	4.84	45.72	4.61	44.42
107	3.40	47.20	3.02	46.22
108	3.30	48.29	3.68	49.22
109	3.78	41.28	4.00	43.88
110	2.88	48.20	3.35	48.96
111	2.84	46.79	2.80	46.00
112	3.22	45.05	3.82	48.11
113	3.72	55.85	3.78	58.23
114	3.66	46.10	3.68	46.45
115	3.80	53.95	3.62	52.63
116	3.24	50.80	3.84	52.14
117	3.94	49.62	3.90	49.48
118	4.54	51.17	4.66	54.22
119	3.40	44.50	3.81	48.35
120	3.21	53.43	3.80	51.33
121	3.70	50.00	3.75	50.28
122	3.20	50.60	3.60	50.68
123	4.11	56.40	4.40	56.85

Discussion

Rust diseases of wheat not only reduce the yield but also reduce the grain quality. Using resistant wheat varieties will protect wheat production from disease infection and consequently from yield loss. In this study, 123 wheat genotypes were tested for their resistance to wheat leaf and stem rusts. The tested genotypes were grown at Gemmeiza Research Station during two growing seasons, *i.e.* 2012/13 and 2013/14. Data on rust incidence were recorded as rust severity (%), area under disease progress curve (AUDPC) and coefficient of infection (CI) according to the equation adopted by Stubbs *et al*. (1986).

High yielding and resistant varieties are the main objectives of breeding program in Egypt. In this study, 8 wheat genotypes, *i.e*. 8, 31, 39, 40, 72, 80, 101 and 123, showed adult plant resistance for both leaf and stem rust diseases during the two successive seasons ranged from 0-10R. Also, these genotypes gave the highest values of yield components. These wheat genotypes were resistant to rust diseases and can be safely used in wheat breeding programs and released as commercial cultivars under Egyptian conditions. Hussain *et al*. (2010a) found that the score of leaf rust of the wheat variety Mairaj-08 varied from Tr to 10 MR, while it had 0 to Tr for yellow rust during 2005/06 to 2007/08. Also, Mairaj-08 had RRI value of 8-8.9 for leaf rust. Due to better adaptability of the wheat variety Mairaj-08 it has the potential to be approved as a new variety. Hussain *et al*. (2010b) reported that the rust score of Fareed-06 varied from 5 R to 10 MS for leaf rust and 10 MR/MS to 10 MS for yellow rust as compared to 70 S to 100 S for leaf rust and 50 S to 90 S for yellow rust of the check variety, *i.e.* Morocco. Fareed-06, had RRI value of 8 for leaf and yellow rust. The wheat variety Fareed-06 was approved and released by Punjab Seed Council, Lahore as new variety for cultivation in irrigated areas of Punjab. Hussain *et al*. (2013) reported that the rust score of the cv. AaS-2011 varied from 10 R to 30R/ MR for leaf rust and 10 R to 20 MR/MS for yellow rust as compared to 20 S to 90 S for leaf rust and 10 S to 90 S for yellow rust of the check variety, *i.e.* Morocco. AaS-2011 had RRI value of 7.2 to 9 and 7.5 to 9 for leaf and yellow rust, respectively. Cultivar AaS-2011 was approved by Punjab seed Council, Lahore and released as a new variety for general cultivation in hot and drought areas of Punjab. Mahmoud *et al*. (2013) reported that the rust score of Chakwal-50 varied from 5 MR/MS to 30 MS for leaf rust and 5 MS to 30 MS for yellow rust. Also, cv. Chakwal-50 had RRI value of 7 to 8.6 and 8 to 8.3 for leaf and yellow rusts, respectively. Cultivar Chakwal-50 has the potential to be approved and released as a new variety. Tariq *et al*. (2013) stated that the rust score of cv. Dharabi-11 varied from 0 to 5 S for yellow rust as compared to 80 S to 90 S for yellow rust of the check variety Morocco. Cultivar Dharabi-11 had RRI value of 8.8 for yellow rust. Cultivar Dharabi-11 was adapted at different locations, also it has the potential to be approved and released as a new variety. Akhtar *et al*. (2002) found that seven promising candidate lines, *i.e*. NR-149, 95C004, 91BT010-5, V-97112, SD1200/14, B96038 and B92044, had desirable/acceptable RRI for leaf rust. So, these lines can be recommended in those areas where rust problem leaf. Rattu *et al*. (2009) found that out of 29 candidate lines, three lines were found resistant to both leaf and yellow rusts and showed desirable RRI during 2003/04 and 2004/05.

Worku and Badebo (2012) reported that out of the tested entries, 132 exhibited combined resistances to stem and leaf rust diseases and those were selected for further test in the 2010 off-season. In the subsequent test, 28 lines were identified to have high level of stem rust resistance comparable or better than the resistant checks. The selected durum landraces could be exploited in wheat breeding program.

To increase the wheat production in Egypt, the breeding programs must be selected for yield and its components like the traits studied in this investigation. In these regards data showed that 23 wheat genotypes and 20 wheat genotypes gave the highest values of 1000-kernel weight during the two successive seasons, respectively. On the other hand, 7 and 8 wheat genotypes gave the highest values of spike weight. These results are in harmony with those of Hendawy *et al.* (2007).

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تعريف تراكيب قمح جديدة مقاومة لمرضى صدأ الاوراق والساق تحت الظروف المصرية

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تم تقييم ١٢٣ تركيب وراثى من القمح مستوردة من مركز بحوث القمح والذرة (السيميت) ضد صدأ الاوراق وصدا الساق فى القمح, كما تم دراسة مكونات المحصول. أوضحت الدراسه ان ٤٦ تركيب وراثى من القمح كانت مقاومة لصدأ الاوراق بينما كان ٥٩ تركيب وراثى مقاومه لصدأ الساق خلال الموسم الزراعى ٢٠١٣/٢٠١٢. فى موسم ٢٠١٤/٢٠١٣ وجد ٤٨ و ٦٧ تركيب وراثى من القمح كانت مقاومة لصدأ الاوراق وصدأ الساق. كذلك تم دراسة بعض الصفات المحصولية مثل وزن الألف حبة ، ووزن السنبله. خلال الموسمين تحت الدراسه اوضحت النتائج ان التراكيب الوراثيه ٨ ، ٣١ ، ٣٩ ، ٤٠ ، ٧٢ ، ٨٠ ، ١٠١ و ١٢٣ كانت مقاومة لصدأ الاوراق وصدأ الساق وكانت أيضاً عالية المحصول ولذلك يوصى بادخال هذه التراكيب الوراثيه فى برنامج تربية القمح لانتاج اصناف جديدة ذات مقاومه عاليه ومحصول عالى.