

Stem Rust Partial Resistance in Eight Egyptian Durum Wheat Cultivars

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Stem rust caused by *Puccinia graminis* Pers. f. sp. *tritici* Eriks. & E. Henn., has become a globally important disease for durum wheat (*Triticum turgidum* subsp. *durum*). The major obstacle in the control of such disease is the rapid loss of host genetic resistance, due to the high evolutionary potentiality of pathogen population that enables it to evolve new virulent pathotypes. Therefore, this study was carried out to characterize partial resistance (PR), as a more durable form of resistance in eight Egyptian durum wheat cultivars, compared to the check variety (Morocco) during seedling and adult plant stages. At seedling stage, TKTTC virulent race was used to study the components of partial resistant under greenhouse conditions. Partially resistance in cv. Sohag 3, characterized by its capacity to reduce both number of pustules/cm² in leaf area, a pustule eruption percentage (%), and consequently prolonged latent period (LP). Out of the tested cultivars, four cvs., Sohag 5, Bani sweif 4, Bani sweif 6 and Sohag 3 proved to have an adequate and high level of PR, compared to the highly susceptible check, Morocco, as they exhibited low levels of stem rust severity under field conditions (3.99, 4.33, 7.49, 9.165, and 76.66%, respectively). The final rust severity (FRS%) percentages and area under disease progress curve (AUDPC) estimates, were found to be lower in its magnitude on PR cultivars than those in the highly susceptible ones, under field conditions in the two growing seasons: 2014/2015 and 2015/2016.

Keywords: Durum wheat, *Puccinia graminis* f. sp. *tritici* and stem rust.

Wheat stem rust caused by *Puccinia graminis* Pers. f. sp. *tritici* Eriks. & E. Henn., is one of the most devastating diseases affecting wheat production in Egypt and worldwide. Stem rust is very important due to its effects on wheat grain quantity and quality (Leonard and Szabo, 2005). Stem rust affects the entire wheat crop, especially during the early growth stages. Early and severe infection led to blocking a plant vascular system, hence stunting and lodging of weak stalks, eventually caused yield losses of even 100%, due to the damaged tillers and shrivelled grains (Boukhatem *et al.*, 2002 and Kokhmetova *et al.*, 2011). Under field Egyptian conditions, when stem rust started early 10th March 2015, disease severity percentage reached its relatively high percentage (80%) with the highest loss in both 1000 kernel weight (36.3%) and plot yield weight (37.8%) on the highly susceptible Egyptian wheat cultivars (Hasan *et al.*, 2016). Also, yield losses due to stem rust

incidence ranged from 1.96 to 8.21% in some Egyptian wheat cultivars (Asmmawy *et al.*, 2013). Wheat breeding program for rust resistance is still an economical, environmentally safe and most effective method for successful disease control via avoiding the sudden occurrence of damaging rust epidemics. However, the major obstacle in the control of wheat rust is the short duration and rapid loss of the host genetic inherited resistance (Nazim *et al.*, 1990 and Sayre *et al.*, 1998). Nevertheless, many of wheat cultivars served in agriculture for a long period of time, showing acceptable and high levels of disease resistance during their wide use in different agriculture environmental conditions. These cultivars were characterized by their ability to retard and slowdown the development of disease during an epidemic. Consequently, they reduce and restrict the rate of rust pathogen progress and minimize the amount of disease in infected tissues, irrespective of their susceptibility to stem rust in terms of infection type. Such form of resistance has been early defined by Parlevliet (1976), as a partial resistance (PR) and/or adult plant resistance (APR), that assumed to be more durable and more stable compared to the other forms of resistance (Broers, 1989, Broers and Parlevliet, 1989 and Boulot, 2007).

The aim of this research work is to evaluate and estimate partial resistance to stem rust in eight Egyptian durum wheat cultivars, at both seedling and adult plant stages.

Materials and Methods

Partial resistance (PR) to stem rust caused by *Puccinia graminis* Pers. f.sp. *tritici* Eriks. & E. Henn. in eight Egyptian wheat cultivars was studied at seedling and adult plant stages. The tested wheat cultivars, Sohag 1, Sohag 3, Sohag 4, Sohag 5, Bani sweif 1, Bani sweif 4, Bani sweif 5, and Bani sweif 6, as well as the check cultivar; Morocco, were grown under greenhouse and field conditions to evaluate their partial resistance, at Gemmeiza Agric. Res. Station, in the two successive growing seasons, 2014/015 and 2015/016.

Greenhouse experiments:

The main components of PR to stem rust at seedling stage, *i.e.* number of pustules/cm², percentage of pustule eruption (%) and latent period (LP) in days, were measured in the eight tested wheat cultivars, under greenhouse conditions (20±2°C). Ten grains of the eight wheat cultivars were sown in a natural soil dispensed in 10 cm pot diam.

Inoculation of wheat seedlings was carried out by using a mixture of the freshly collected urediniospores of TKTTC virulent stem rust race, previously isolated and identified in wheat Dis. Res. Dept., and talcum powder, at the rate of 1: 25 w/w, using the method of aspirator or even a cloth pag. After inoculation, the inoculated seedlings were incubated in a dark moist chamber for 24 hrs. under approximately 100% relative humidity. Then the pots were distributed in a randomized complete design of three replicates in the greenhouse benches and the following pathological parameters were evaluated.

Latent period (LP):

Latent period was determined as the time in days from that of inoculation to the day when 50% of the pustule had erupted and ruptured the epidermis of leaves. Latent period (LP) was accurately estimated, using the formula adopted by Das *et al.* (1993), as follows:

$$\text{Latent period (days)} = t1 + ((F/2 \text{ nt1}) (t2 - t1) / \text{nt2} - \text{nt1})$$

Where:

F= Final count of pustules number.

t1= Day prior to 50% pustules erupted.

t2= Day after 50% pustules erupted.

nt1= Number of pustules erupted at t1.

nt2= Number of pustules erupted at t2.

Pustule eruption (%):

The number of uredinia erupted and ruptured the epidermis of leaves, number of non-erupted and total number of pustule per one square centimetre of leaf area were daily counted for the tested cultivars, 6 days after inoculation and until the leaves withered. The percentage of erupted pustule, eruption (%) was calculated according to the following equation:

$$\text{Pustule eruption (\%)} = \text{Number of uredinia eruption} / \text{Total number of uredinia} \times 100.$$

Field experiments:

The experiments were carried out in a randomized complete block design, with three replicates. The grains of the tested durum wheat cultivars were kindly obtained from Wheat Res. Department, Field Crops Research Institute. The grains for each cultivar were sown in 6 rows in the second half of November; each row was 3 m long and 30 cm apart, where the plot area was 3 x 3.5 m. All plots were surrounded by rust spreader belt, planted with a mixture of the highly susceptible varieties to stem rust as a predominant and continuous source for the disease infection. Artificial inoculation with a mixture of freshly collected urediniospores of the most prevalent stem rust races, obtained from Wheat Disease Research Department, Plant Pathol. Res. Inst., ARC, Giza, Egypt, and talcum powder in a ratio of 1:20 (v/v) was carried out, to maintain regular rust inocula with urediospores on all spreader plants and generate stem rust epidemic. Stem rust severity (%) was measured for the eight wheat cultivars, as a percentage of area infected or rusted according to the modified Cobb's scale (Peterson *et al.*, 1948). Rust severity data were recorded starting with the appearance of the first pustule on each of the tested cultivars and continued at 7 days intervals, until the termination of the experiment.

Final rust severity (FRS %):

Percentage of final rust severity (FRS%) was assessed as a percentage of disease severity for each of the tested wheat cultivars, when the highly susceptible cultivar, Morocco was severely rusted and the disease severity reached its maximum and final level (Das *et al.*, 1993).

Area under Disease Progress Curve (AUDPC):

To estimate more accurately the level of partial resistance (PR) or adult plant resistance in the tested wheat cultivars, under field conditions, area under disease progress curve (AUDPC) values were calculated for each cultivar by using the equation of Pandey *et al.* (1989) as follows:

$$\text{AUDPC} = D [1/2(Y_1 + Y_k) + (Y_2 + Y_3 + \dots + Y_{k-1})]$$

D: Days between two consecutive recordings (time intervals)

$Y_1 + Y_k$: Sum of the first and last disease scores.

$Y_2 + Y_3 + \dots + Y_{k-1}$: Sum of all in between disease scores.

Rate of disease increase:

Rate of stem rust increase (r-value), as a function of time, was also estimated, according to the formula of Van der Plank (1963) as follows:

$$r\text{-value} = 1/t_2 - t_1 [(\log_e x_2/1-x_2) - (\log_e x_1/1-x_1)]$$

where:

x_1 : The proportion of the susceptible infected tissues (disease severity) at t_1 date.

x_2 : The proportion of the susceptible infected tissues (disease severity) at t_2 date.

$t_2 - t_1$: Number of days between these two dates.

Statistical analysis:

Least significant difference (LSD) at 5% level of probability was calculated to determine the significant differences between means (Snedecor and Cochran, 1967).

R e s u l t s

The present study was carried out to characterize partial resistance (PR) to stem rust (*Puccinia graminis* Pers. f. sp. *tritici*) in eight durum wheat, *i.e.* Sohag 1, Sohag 3, Sohag 4, Sohag 5, Bani sweif 1, Bani sweif 4, Bani sweif 5 and Bani sweif 6.

Seedling stage study:

The components of partial resistance (PR) were determined in the seedlings of the tested cultivars, *i.e.* latent period (LP), number of pustules/cm² and pustule eruption (%).

1- Latent period (LP):

Latent period (LP₅₀), in terms of time in days, between infection and 50% of total uredinia erupted and ruptured the leaf epidermis, has been estimated, at seedling stage. Partial resistant cultivars exhibited longer mean of latent period, than that of the highly susceptible, Morocco. However, latent period (LP) was generally, longer (reached to 12.45 days) in PR cultivars, than that of the highly susceptible cultivars, which reached to only 10.03 and 10.13 days in the highly susceptible cvs., Morocco (check), and Bani-sweif 1, respectively. In contrast, seedlings of the PR wheat cultivars, artificially inoculated with race TKTTC, characterized by a longer LP₅₀, as it was 12.45 days (Sohag 5), 12.29 days (Bani sweif 4), and 12.17 days (Bani-sweif 6), respectively (Table, 1). While, the highly resistant wheat cultivar, no visible pustules could be detected on the artificially inoculated leaves with race TKTTC. Sohag3 seedlings showed or exhibited a complete stem rust resistance, with race TKTTC, However, this race was found to be avirulent, and can not able to

infect this wheat cultivar due to its resistance to the pathogen, at artificially inoculation, under greenhouse conditions (Table 1).

2- Number of pustules/cm²:

Number of pustules/cm² of leaf area, presented in Table 1 also gives an indicator as the main component of PR at seedling stage, whereas the partially resistant cultivars showed the least and minimum numbers of pustules/cm².

Where in, the number of the erupted pustules per cm² of leaf, that estimated in PR cv., Bani-sweif 6 was (15 P/cm²), followed by the other PR cvs., Sohag5 and Bani-sweif 4 (each 21 pustules/cm²). As well as Sohag 4 (23 pustules/cm²), respectively. The highly resistant wheat cultivar Sohag 3 exhibited (0) number of pustules. Thus, it considered as, exhibited or had complete resistance, against this race. On the other hand, the highly susceptible cvs., Sohag 1, Bani-sweif 1, and Bani-sweif 5, as well as the check variety, Morocco, revealed the highest number of erupted pustules/cm², as they were, 34, 36, 41 and 52 pustules/cm² of leaf area of these cvs., respectively. Morocco cultivar revealed the highest number of pustules/cm².

Table 1. Stem rust resistance components; latent period (LP) in days, number of pustules/cm² of leaf area and percentage of pustule eruption on eight Egyptian durum wheat cultivars, at seedling stage under greenhouse conditions

Cultivar	Latent period (L.P) (in days)	No. of pustules/cm ²	Pustule eruption %
Sohag 1	10.2	34	81.2
Sohag 3	0	0	0
Sohag 4	11.1	23	14.3
Sohag 5	12.4	21	43.5
Bani sweif 1	10.1	36	89.4
Bani sweif 4	12.3	21	14.3
Bani sweif 5	10.1	41	80.4
Bani sweif 6	12.2	15	36.7
Morocco (check)	10.0	52	95.1
LSD at 5%	1.72	1.96	1.27

3- Pustule eruption (%):

Partially resistant cultivars were distinguished from the highly susceptible ones by their potentiality to minimize the rate of pustule eruption, at seedling stage. Although, all the tested cultivars were uniformly inoculated with the same stem rust race TKTTC, the rate of pustule eruption%, was obviously higher (up to 80%), in the seedlings of the highly susceptible cultivars, than those of the partial resistance ones. In general, the percentage of pustule eruption was significantly varied among the different cultivars, under study. The pustule eruption (%) reached to its highest levels 89.37, 81.23 and 80.39% on the seedlings of the tested wheat cultivars, Bani-sweif 1, Sohag 1 and Bani sweif 5, respectively. In contrast, lower pustule eruption

(%) (14.28%) has been recorded in the seedlings of PR cultivars, Bani sweif 4 and Sohag 4 inoculated with the same race (TKTTC), respectively (Table 1).

Field study:

The level of partial resistance (PR) to stem rust was evaluated under field conditions, for each of the tested cultivars, by estimating the three epidemiological parameters, *i.e.* percentage of final rust severity (FRS%), area under disease progress curve (AUDPC) and rate of disease increase (r-value) under disease stress, during the two growing seasons of the study (Tables 2 and 3).

1- Final rust severity (FRS %):

The ability of the tested cultivars to slowdown the development of stem rust infection was estimated as adult plant resistance (APR) or field resistance expressed on these cultivars. The tested Egyptian durum wheat cultivars compared with the highly susceptible check variety, Morocco, were tested under field conditions at Gemmeiza station, during two successive growing seasons, 2014/2015 and 2015/2016. The obtained data indicated that rust severity (%) was ranged between 3.7 to 83.3% and 3.7 to 70% during the two growing seasons, respectively of the study (Table 2).

In 2014/2015 growing season wheat cultivars, Bani sweif 1, Sohag 1 and Bani sweif 5, as well as the check variety Morocco, exhibited the lowest levels of field resistance to stem rust infection, as they showed the highest final rust severity percentages (63.3, 43.3, 36.7 and 83.3%, respectively). Because of the relatively high epidemic of stem rust during this season, the final rust severity (FRS %) was mainly higher in most of the tested cultivars, also reached its maximum level (83.3%) in the highly susceptible variety, Morocco (Table 2). On the other hand, wheat cultivars, Bani sueif 4 and Sohag 5 exhibited adequate and high levels of adult plant resistance (APR) to stem rust infection, under the same filed conditions. They exhibited lower estimates of FRS (%), as it was 3.7% and 4.3%, in the aforementioned two cultivars, respectively (Table 2).

Table 2. Final rust severity (FRS%) of stem rust in eight Egyptian durum wheat cultivars under field conditions during 2014/2015 and 2015/2016 growing seasons

Wheat Cultivar	FRS%/Growing seasons		
	2014/2015	2015/2016	Mean
Sohag 1	43.3	33.3	38.3
Sohag 3	8.3	10.0	9.16
Sohag 4	16.7	13.3	15.0
Sohag 5	4.3	3.7	3.99
Bani sweif 1	63.	60.0	61.7
Bani sweif 4	3.7	5.0	4.3
Bani sweif 5	36.7	33.3	35.0
Bani sweif 6	8.3	6.7	7.5
Morocco	83.3	70.0	76.7
Mean	29.8	26.1	
LSD at 5%	1.61	1.29	

During 2015/2016 growing season stem rust severity was found to be less severe in its magnitude, compared to the first season. Therefore, FRS (%) in the check variety; Morocco reached only to 70%. Also, the three susceptible cvs., Bani sweif 1, Sohag 1 and Bani sweif 5 showed the reactively high percentages of FRS (%), being 33.3, 33.3 and 60% for these cvs., respectively. Meanwhile, Sohag 5, exhibited the lowest final rust severity (3.7%) followed by Bani sweif 4 (5%), Bani sweif 6 (6.7%), and Sohag 3 (10%), respectively.

2- Area under disease progress curve (AUDPC):

Area under disease progress curve (AUDPC), as a convenient and a good reliable estimator of the PR character, was also estimated for the tested wheat cultivars (Table, 3). Different values of AUDPC were obtained from the tested durum wheat cultivars during the two growing seasons of the study, as affected by the slight changes in environmental condition, in each growing season. Thus, higher estimates of AUDPC more than 350 were recorded in the highly susceptible cultivars, as well as the check variety, Morocco, during the first growing season. Depending on the data found in Table (2) and on the basis of AUDPC estimates, over the two seasons, the tested wheat cultivars may be classified into two main groups. The first group included wheat cultivars with the lowest AUDPC estimates (less than 300), *i.e.* Bani sweif 4 (38.5 & 43.1), Sohag 5 (38.7 & 40.1), Bani sweif 6 (88.2 & 71.1), Sohag 3 (91.0 & 94.1) and Sohag 4 (217 and 92.3) in 2014/2015 and 2015/2016 growing seasons, respectively (Table 3). These cultivars were therefore, designated as the partially resistant (PR) ones, since they displayed the highest and satisfactory levels of adult plant resistance (APR) or field resistance, against stem rust infection.

Table 3. Area under disease progress curve (AUDPC) and rate of disease increase (*r*-value) on the tested durum wheat cultivars, under field conditions during 2014/2015 and 2015/2016 growing seasons

Cultivar	AUDPC			<i>(r</i> -value)		
	2014/2015	2015/2016	Mean	2014/2015	2015/2016	Mean
Sohag 1	360.5	332.2	346.4	0.11	0.10	0.11
Sohag 3	91.0	94.1	92.5	0.06	0.09	0.07
Sohag 4	217.0	92.3	154.6	0.10	0.071	0.09
Sohag 5	38.7	40.1	39.4	0.01	0.02	0.01
Bani sweif 1	612.5	589.2	600.8	0.13	0.11	0.12
Bani sweif 4	38.5	43.1	40.8	0.01	0.02	0.01
Bani sweif 5	437.2	313.5	375.3	0.16	0.15	0.15
Bani sweif 6	88.2	71.1	79.6	0.08	0.06	0.07
Morocco	875.6	682.5	779.1	0.17	0.16	0.16
Mean	306.6	250.9		0.09	0.09	
LSD at 5%	0.61	1.74		0.06	0.11	

Through the two growing seasons of the study, the second group of the tested wheat cultivars included the highly susceptible cultivars, (AUDPC more than 350), *i.e.* Sohag 1, Bani sweif 1, Bani sweif 5, as well as the check variety, Morocco. These cultivars revealed the lowest levels of adult plant resistance (APR) to stem rust infection under field conditions, during the two growing seasons of the study.

Accordingly, it has been, reasonably, suggested that this group of cultivars, could be classified as the highly susceptible on the fast rusting cultivar group.

3- Rate of disease increase (*r*-value):

In general, stem rust developed more slowly and increased in relatively lower rate (*r*-values) on most of the tested cultivars, during the second growing season, compared to the first season. In 2014/2015 season, wheat cultivars, Morocco, Bani sweif 5, Bani sweif 1 and Sohag 4, have rusted faster and with higher rate of disease increase or development than others, under the same field conditions. These cultivars exhibited higher rate of stem rust increase (*r*-values), during that growing season, being 0.17, 0.16, 0.13 and 0.11, respectively (Table, 3). On the other hand, rust developed more slowly and at the lowest rate of disease increase (*r*-values) in the rest of the tested durum wheat cultivars, under the same field conditions.

In 2015/2016 growing season, stem rust developed at a relatively lower rate on all cultivars, especially on the PR cvs., Bani sweif 4 and Sohag 5 wheat cultivars. They revealed lower rate of rust development during that season, 0.016 and 0.018, respectively. Therefore, they were characterized as PR cultivars (Table, 3). Other cultivars including the six durum wheat cultivars and the check variety Morocco, which showed high estimates of *r*-values, thus they were classified as the fast-rusting or highly susceptible wheat cultivars (Table 3).

Discussion

Partial resistance in wheat plants against rust pathogens, in general can only be determined on the genotypes that exhibit a compatible infection type or a susceptible reaction, and characterized by the ability to slowdown rust development and low terminal rust response on field-grown, adult plants (McIntosh *et al.*, 1995).

At seedling stage, from a practical point of view, latent period (LP) has been widely used to evaluate partial resistance (PR) in different plant pathogen systems, because it can be easily evaluated or handled and with more accuracy than other components (Yang *et al.*, 1987). Data in the present study showed in general that, longer latent period, lowest number of pustules/cm² lesser rates of pustule eruption%, were obtained by the partially resistant durum wheat cultivars; Sohag 3 and Bani Sweif 4. On the other hand, the highly susceptible check Morocco, as well as the other susceptible cultivars under study showed the shortest latent period and the highest no. of pustules/cm² and the highest percentages of pustule eruption.

Under field conditions, at Gemmeiza Research Station, adult plant resistance (APR) that exhibited by durum wheats, was experimentally evaluated and characterized by using three epidemiological parameters, *i.e.* final rust severity (FRS %), area under disease progress curve (AUDPC) and rate of disease increase (*r*-value). These disease parameters were found to be higher in its magnitude for partially resistant (PR) wheat cultivars; Sohag 5, Bani sweif 4, Sohag 3, Sohag 4 and Bani sweif 6, than those in the highly susceptible ones; Bani sweif 1, Bani sweif 5, Sohag1 and Morocco (check), during 2014/2015 and 2015 /2016 growing seasons. In this regard, Asmmawy *et al.* (2013) found that slow-rusting resistant wheat cultivars; Gemmeiza 7 and Sakha 61, exhibited low stem rust severity% and low

values of area under disease progress curve, compared to the fast-rusting cultivars under the same field conditions in Egypt.

Wide application of AUDPC as a good and more reliable estimator to evaluate and characterize PR in wheat cultivars, rather than other epidemiological parameters, is due to enclosure of all factors that influence or affect the disease development, during an epidemic under field conditions. (Pandey *et al.*, 1989, Nazim *et al.*, 1990; Das *et al.*, 1993; Lal Ahamed *et al.*, 2004 and Boulot, 2007).

It was possible to distinguish partially resistant (PR) cultivars from susceptible ones by their capacity to reduce the rate of disease increase and development under field conditions during the two seasons of the study. Whereas, PR cultivars were substantially characterized by delaying rates of disease increase (r values) less than the highly susceptible or the fast-rusting ones, when all were subjected to the same pathogen populations and under the same field conditions of the current study. During the two years seasons of study, the two PR resistant cultivars, *i.e.* Bani sweif 4 and Sohag 5, revealed the lowest rates of rust development (0.014), while the check variety; Morocco, showed the highest rate of disease increase, 0.163 (r-value).

However, difference in r-values between any two wheat cultivars tested, during an epidemic, was mainly due to the main two limiting factors. The first is the disease severity (%) in each, and the second is the spread of the fungus propagules, or the time of disease increase (Van der Plank, 1963 and Gregory, 1968).

Results previously obtained from different pathosystems, clearly demonstrated the major importance of one or more of these resistance components, as an accurate indicators, to characterize PR in the host plants of the tested wheat genotypes. In addition, these components have been used as the reliable indicators for the variation of this pattern of resistance observed in the field for wheat and barley (Broers, 1989, Nazim *et al.*, 1990; Torabi, 1992; Boulot, 2007 and Tiang *et al.*, 2007).

Conclusion

It is possible to conclude that, the most important components of resistance involved in PR against wheat stem rust infection were latency period (LP50) at seedling stage and AUDPC at adult plant stage. It is reasonable to mention that PR measured by the components under the study, was clearly better expressed in the adult plant stage, than in the seedling stage. PR cultivars could be well distinguished from the highly susceptible ones, by the significant variation of the resistance components used in this study.

On the basis of the obtained results, it may be concluded that rapid and considerable progress in breeding for PR could be expected in plant breeding programs by using one or more of the aforementioned PR components, as they are considered as the most reliable indicators and good for evaluating and selecting this type of resistance in any germplasm screening program.

Wheat cultivars; Sohag 3, Sohag 5 and Bani sweif 4 exhibited higher levels of Partially resistant PR, expressed as longer latent periods, lower number of pustules/cm² of leaf area and lesser rates of pustule eruption at seedling stage as well

as the lowest values of FRS%, AUDPC and r-values under field conditions at adult stage. Therefore, they should be used as a good source of this type of resistance against stem rust.

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المقاومة الجزئية لصدأ الساق فى ثمانية

أصناف من قمح الديورم المصرية

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يعتبر مرض صدأ الساق المتسبب عن الفطر بكسينيا جرامينيوز من الأمراض ذات الأهمية الاقتصادية عالمياً لإصابته أقماح الديورم، ومن أهم العقبات التي تواجه المقاومة الوراثية لهذا المرض هو فقد تلك المقاومة لأصناف القمح التي تحمل تلك المقاومة، حيث يرجع ذلك إلى قدرة الفطر المسبب على إنتاج سلالات جديدة ذات قدرة مرضية عالية. ولذلك فقد أجريت هذه الدراسة لتقدير وتشخيص صفة المقاومة الجزئية كنوع مهم من أنواع المقاومة الوراثية التي يتوقع أن تكون مستدامة أو طويلة الأجل وذلك لثمانية أصناف من أقماح الديورم المصرية مقارنة بالصنف الحساس "موروكو" وذلك أثناء طوري البادرة والنبات البالغ. أظهرت الدراسة تحت ظروف الصوبة باستخدام أحد سلالات الفطر المسبب شديدة القدرة المرضية TKTTC لدراسة مكونات المقاومة الجزئية. أظهر الصنف سوهاج ٣ مقاومة جزئية تمثلت في تقليل عدد البثرات/سم² من الورقة المصابة وخفض النسبة المئوية لأنفجار البثرات اليوريدية وإطالة فترة حضانة المرض داخل أوراق بادرات القمح المعدية صناعياً بتلك السلالة في طور البادرة وذلك بمقارنتها بالأصناف الأخرى عالية القابلية للإصابة وكذا بالصنف الحساس للمرض والمستخدم كمقارنة "موروكو". ومن ناحية أخرى أظهرت الدراسة تحت ظروف الحقل بمحطة البحوث الزراعية بالجميزة أن الأصناف سوهاج ٣، سوهاج ٥ وبنى سويف ٤ وبنى سويف ٦ مستوى عالٍ من المقاومة الجزئية مقارنة بغيرها من الأصناف تحت الاختبار، وأيضاً بالصنف موروكو المستخدم كمقارنة. أظهرت تلك الأصناف شدة إصابة نهائية ضعيفة وقدرها ٩,١٦، ٣,٩٩، ٤,٣٣، ٧,٤٩، ٧,٦٦% على التوالي. وقد أظهرت النتائج بصفة عامة انخفاض نسبة الإصابة النهائية وانخفاض قيم المساحة الواقعة تحت المنحى المرضى وكانت بقم أقل في الأصناف التي أظهرت مقاومة جزئية عن الأصناف الحساسة تحت ظروف الحقل في محطة البحوث الزراعية بالجميزة في موسمي الدراسة ٢٠١٤/٢٠١٥ و ٢٠١٥/٢٠١٦م.