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Losses in Grain Yield of some Wheat Cultivars Infected with Powdery Mildew

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Powdery mildew caused by *Blumeria graminis* f.sp. *tritici* is one of the most important diseases affecting wheat plants under Egyptian conditions. The relationship between yield reduction and severity of powdery mildew was determined during 2012/13 and 2013/14 growing seasons at Sakha Agricultural Research Station on fourteen wheat cultivars. Powdery mildew disease severity ranged from 7 to 60% in 2012/13, while in 2013/14 ranged from 4 to 60%. Area under disease progress curve (AUDPC) was found to be correlated with powdery mildew severity during the two growing seasons. The yield losses ranged from 2.02% on wheat cultivar Giza 168 to 20% on Sakha 61 during 2012/13. While, at 2013/14 it ranged from 1.56% on the wheat cultivar Giza 168 to 22.52% on the wheat cultivar Sakha 94. Although, the yield losses of the other tested cultivars were depend on the values of powdery mildew severity for each cultivar.

Keywords: AUDPC, *Blumeria graminis* f.sp. *tritici*, crop losses, disease severity and wheat.

Wheat is the most important cereal crop in Egypt and all over the world. It provides more calories in diet than any other cereal crop. It is a staple food crop and also known as "king" of the cereals (Laghari *et al*., 2010). Wheat powdery mildew caused by *Blumeria graminis* (DC.) E.O. Speer f.sp. *tritici* Em. Marchal, is one of the most devastating diseases of common wheat worldwide in areas with cool climates (Bennett, 1984). Disease severity depends on many factors including agricultural practices (Broscious *et al*., 1985), variation in weather conditions (Large and Doling, 1963) and the level of cultivar susceptibility (Fried *et al*., 1979; Kingsland, 1982; Lipps and Madden, 1988 and Shaner, 1973). During the infection process metabolism of the attacked plants is quicker producing low volume of storage substances and consequently smaller grains in size and weight. Also, during the attack of powdery mildew the ability of the plant to resist other disease pathogens is decreases (Paulech, 1995).

Generally, the yield losses range from 13 to 34% due to this disease but if it attacks the flag leaf during the heading and or filling stage, loss may reach to 50% (Griffey *et al*., 1993 and Leath and Bowen, 1989). Development in resistant of commercial cultivars carryied out by introducing effective resistant genes is the most effective, economically and environmentally friendly approach to avoid the fungicide use and to reduce the crop losses caused by this disease (Alam *et al*., 2013). The most common breeding strategy has been the mainly approach of using major genes conferring hypersensitive types of resistance, but the effectiveness of this approach has commonly been ephemeral due to frequent changes in the pathogen population (Hsam and Zeller, 2002).

This study was designed to evaluate fourteen Egyptian wheat cultivars against powdery mildew disease and to study the effect of powdery mildew severity on grain yield reduction of the tested cultivars.

Materials and Methods

The experiments were carried out at Sakha Agric. Res. Station during 2012/13 and 2013/14 growing seasons under natural infection of powdery mildew. The experimental design was in a randomized complete block with three replicates. The tested fourteen wheat cultivars, *i.e.* Sids 1, Sids 12, Sids 13, Gemmeiza 7, Gemmeiza 9, Gemmeiza 10, Gemmeiza 11, Sakha 61, Sakha 69, Sakha 93, Sakha 94, Giza 168, Misr 1 and Misr 2, with their pedigree and year of release are shown in Table (1). Plots (6×7 m= 42 m^2) were prepared, each one contained 20 rows with 6 m long and 30 cm distance between rows. To keep protected plots free from powdery mildew, the fungicide Sumi-eight 5 EC (1H-1, 2, 4-Triazole-1-ethanol, beta-[(2,4-dichlorophenyl) methylene]-alpha-(1,1-dimethylethyl)-,(beta E), was applied (35 ml/100 l water) on 10^{th}, 25^{th} February and 10^{th} March (at 15 days intervals). Normal agricultural practices including recommended fertilization dose and irrigation schedule were followed.

Table 1. List of fourteen tested local bread wheat cultivars, their pedigree and year of release

Cultivar	Pedigree	Year of release
Sids1	HD2172/PAVON"S"//1158.574"S". SD46-4SD-2SD-1SD-0SD.	1996
Sids 12	BUC//7C/ALD/5/MAYA74/ON//1160-147/3/BB/GLL/4/CHAT"S"/6/MAYA/VUL//CMH74A.630/4*SX.SD7096-4SD-1SD-1SD-0SD.	2007
Sids 13	KAUZ"S"//TSI/SNB"S". ICW94-0375-4AP-2AP-030AP-0APS-3AP- 0APS-050AP-0AP-0SD.	2010
Gemmeiza 7	CMH74A.630/SX//SER182/3/AGENT. GM4611-2GM-3GM-1GM-0GM.	1999
Gemmeiza 9	ALD"S"/HUAC"S"//CMH74A.630/SX. GM4583-5GM-1GM-0GM.	1999
Gemmeiza 10	MAYA74"S"/0N//160-147/3/BB/GLL/4/CHAT"S"/5/CROW"S". GM5820-3GM-1GM-2GM-0GM.	2004
Gemmeiza 11	B0W"S"/KVZ"S"//7C/SERI82/3/GIZA168/SAKHA61. GM7892-2GM-1GM-2GM-1GM-0GM.	2011
Sakha 61	INIA/RL4220//7C/YR"S"CM15430-2S-5S-0S-0S	1980
Sakha 69	INIA/RL 4220//7C/Yr "S" CM 15430-25-65-0S-0S	1980
Sakha 93	Sakha 92/TR 810328 S 8871-1S-2S-1S-0S	1999
Sakha 94	OPATA/RAYON//KAUZ. CMBW90Y3280-0TOPM-3Y-010M-010M-010Y-10M-015Y-0Y-0AP-0S.	2004
Giza 168	MIL/BUC//Seri CM93046-8M-0Y-0M-2Y-0B	1999
Misr 1	OASIS/SKAUZ//4*BCN/3/2*PASTOR. CMSSOYO1881T-050M-030Y-O3OM-030WGY-33M-0Y-0S.	2011
Misr 2	SKAUZ/BAV92.CMSS96M0361S-1M-010SY-010M-010SY-8M-0Y-0S.	2011

Powdery mildew assessment:

The reaction of the tested cultivars at adult plant stage was assessed using a 0-9 scale (Saari and Prescott, 1975), based on the progression of symptoms along the stem axis (Table 2). This scale is divided into three classes of infection types, *i.e.* resistant (0-3), intermediate (4-6) and susceptible (7-9).

Table 2. Powdery mildew infection types used in disease assessment at adult plant stage*

Host response (Class)	Infection type	Disease symptom
Immune	0	Free from infection.
Very resistant	1	Few scattered colonies on the lowest most leaves only.
Resistant	2	Few colonies on both second and first leaves which infected at light intensity.
Moderately resistant	3	Light intensity of infection at lower third leaves of plant.
Low intermediate	4	Moderate to severe infection of lower leaves with scattered to light infection extending to the leaf immediately below the mid-point of the plant.
Intermediate	5	Moderate to light infection extending to the mid-point of the plant with severe infection of lower leaves and upper leaves free. Infections do not extend beyond mid-point of plant.
High intermediate	6	Severe infection of lower third leaves of plant, moderate degree on middle leaves and scattered colonies beyond the mid-point of the plant.
Moderately susceptible	7	Severe infection on both lower and middle leaves with light infection extending to the leaf below the flag leaf with few colonies on the flag leaf.
Susceptible	8	Severe infection on lower and middle leaves with moderate to severe infection of upper third of plant. Flag leaf infected in amounts more than a trace.
Very susceptible	9	Severe infection on all leaves and the spike infected to some degree. Spike infections are scored as a modified scale (1 to 9) or as the percentage of the total area covered. The spike infection score is separated from the foliar score.
--	N	Used to indicate no scoring possible due to necrosis as a result of other diseases or factors.

* Saari and Prescott (1975).

Powdery mildew severities were determined using the modified Cobb's scale 0 to100% (Peterson *et al*., 1948), as the percentage of leaf surface area covered by the fungus structure. Disease severity assessments were recorded four times at 10-day intervals from appearance of the colonies during the season; the first scoring was done when the majority of lines were in the late booting stage (GS 45) and the last scoring was taken around GS 75, when the most susceptible cultivar had reached maximum disease severity. These scores were used to calculate the area under disease progress curve (AUDPC) as described by Pandey *et al.* (1989). The AUDPC was calculated for each tested cultivar as follows:

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

Whereas: D = Days between two consecutive recording (time intervals).
$Y_1 + Y_k$ = Sum of the first and last scores.
$Y_2 + Y_3 + \text{- - - - -} + Y_{k-1}$ = Sum of all in between disease scores.

Yield assessment:

When the plants reached the commercial maturity, the spikes of all plots in the experiment were harvested by hand and threshed. Randomly selected thousand kernels from each cultivar were counted with a seed counter and were weighed with an electronic balance to calculate 1000-kernel weight (g). Also, grain weight from the threshed spikes was measured with an electronic balance to calculate grain yield per plot (42 m^2). The yield was estimated in kg for each cultivar.

The percentage of reduction (loss) in each component was calculated according to the formula described by Colpauzos *et al.* (1976) as follow:

$$\text{Reduction (\%)} = 1 - yd/yh \times 100$$

Whereas: yd= Yield of diseased plants.
yh= Yield of healthy plants.

Statistical analysis:

Least significant differences (LSD at 5%) test was performed to determine the significant differences between means according to Steel and Torrie (1980). Correlation and regression analyses were used to determine the relationships between AUDPC with the 1000-kernel weight and grain yield using Microsoft Excel 2010.

Results

Tested wheat cultivars showed variability in powdery mildew infection types and disease severity during the two growing seasons (2012/13 and 2013/14).

Evaluation of the tested wheat cultivars for powdery mildew under field conditions: Growing season of 2012/13:

Results in Table (3) indicate that tested wheat cultivars, *i.e*. Giza 168, Sids 12, Misr 1, Misr 2 and Sids 13, recorded the lowest infection types (1-3). Meanwhile, cvs. Sakha 61, Sakha 93 and Sakha 94 recorded the highest infection types (7-9). Meantime, cvs. Giza 168, Sids 12, Misr 1, Misr 2 and Sids 13 recorded the lowest

Table 3. Infection type, disease severity and AUDPC of fourteen wheat cultivars during 2012/13 & 2013/14 seasons under field conditions

Tested cultivar	2012/13			2013/14		
	Infection type*	Disease severity (%)	AUDPC	Infection type	Disease severity (%)	AUDPC
Sids 1	4	25.0	525.0	6	40.0	840.0
Sids 12	2	9.5	185.5	3	16.3	332.5
Sids 13	3	16.3	332.5	2	9.5	185.5
Gemmeiza 7	6	42.5	875.0	6	40.0	840.0
Gemmeiza 9	4	25.0	525.0	5	27.5	560.0
Gemmeiza 10	6	40.0	840.0	5	37.5	770.0
Gemmeiza 11	5	27.5	560.0	4	25.0	525.0
Sakha 61	9	60.0	1260.0	9	60.0	1260.0
Sakha 69	7	47.5	1015.0	8	55.0	1190.0
Sakha 93	9	55.0	1190.0	9	60.0	1260.0
Sakha 94	8	52.5	1120.0	9	60.0	1260.0
Giza 168	1	7.0	150.5	1	4.0	84.0
Misr 1	2	9.5	185.5	2	7.0	150.5
Misr 2	3	16.3	332.5	3	9.5	185.5
LSD at 5%		6.62	64.82		5.54	72.23

* Based on the scale described by Saari and Prescott (1975).

powdery mildew severity levels, *i.e.* 7.0, 9.5, 9.5, 16.3 and 16.3%, respectively. Whereas, cvs. Sakha 94, Sakha 93 and Sakha 61 recorded the highest severity levels, *i.e.* 52.5, 55.0 and 60.0%, respectively. Area under disease progress curve (AUDPC) was in parallel line with the disease severity. The lowest values of AUDPC were recorded on wheat cvs. Giza 168 (150.5), Sids 12 (185.5), Misr 1 (185.5), Misr 2 (332.5) and Sids 13 (332.5). Meanwhile, cvs. Sakha 94 (1120.0), Sakha 93 (1190.0) and Sakha 61 (1260.0) showed the highest values of AUDPC.

Growing season of 2013/14:

Results in Table (3) reveal also that tested wheat cultivars, *i.e.* Giza 168, Misr 1, Misr 2, Sids 13 and Sids 12, recorded the lowest infection types (1-3). Whereas, the cvs. Sakha 61, Sakha 93, Sakha 94 and Sakha 69 recorded the highest infection types. Meantime, cvs. Giza 168, Misr 1, Misr 2, Sids 13 and Sids 12, recorded low severity levels, *i.e.* 4.0, 7.0, 9.5, 9.5 and 16.3%, respectively. While, cv. Sakha 69 recorded 55.0% powdery mildew severity. Moreover, cvs. Sakha 61, Sakha 93 and Sakha 94 recorded 60.0% powdery mildew severity. The lowest values of AUDPC were recorded on the cvs. Giza 168 (84.0), Misr 1 (150.5), Misr 2 (185.5), Sids 13 (185.5) and Sids 12 (332.5). While, cvs. Sakha 69 (1190.0),Sakha 61, Sakha 93 and Sakha 94 (1260.0) recorded the highest AUDPC values during 2013/14 growing season.

Yield reduction:

Yield losses of tested wheat cultivars due to powdery mildew, were estimated during 2012/13 and 2013/14 growing seasons on basis of the effect of disease severity. Obtained results (Tables 4 and 5) reveal that the loss in yield components was correlated with disease severity during the two growing seasons.

Growing season of 2012/13:

Results in Tables (4 and 5) show that the loss in 1000-kernel weight ranged from 1.81 to 19.27% in 2012/13 growing season. Wheat cvs. Giza 168, Misr 2, Misr 1, Sids 12, Gemmeiza 9 and Sids 13 recorded the lowest percentages, *i.e.* 1.81, 2.78, 2.86, 3.20, 4.89 and 5.29%, respectively, of losses in 1000-kernel weight. Meanwhile, cvs. Sakha 94, Sakha 93 and Sakha 61 showed the highest values (14.53, 14.81 and 19.27%, respectively) of losses in 1000-kernel weight.

The loss in yield plot weight ranged from 2.02 to 20.00% in the first growing season. Wheat cvs. Giza 168, Misr 1, Misr 2, Sids 12, Gemmeiza 9 and Sids 13 showed the lowest percentages (2.02, 3.01, 3.01, 5.00, 5.00 and 6.01%, respectively) of loss values in plot weight. While, cvs. Sakha 93, Sakha 94 and Sakha 61 showed the highest percentages (15.00, Sakha 94 and 20.00%, respectively) of loss values in plot weight.

Table 4. Effect of powdery mildew infection on yield of 1000-kernel weight (g) of 14 wheat cultivars during 2012/13 and 2013/14 growing seasons

Wheat cultivar	2012/13			2013/14		
	Infected	Protected	Loss (%)	Infected	Protected	Loss (%)
Sids 1	39.85	43.40	8.18	37.49	41.21	9.02
Sids 12	40.51	41.85	3.20	37.80	40.10	5.74
Sids 13	38.50	40.65	5.29	38.25	40.35	5.20
Gemmeiza 7	40.25	45.49	11.52	39.80	43.61	8.73
Gemmeiza 9	36.73	38.62	4.89	37.69	40.62	7.21
Gemmeiza 10	39.25	44.49	11.78	40.15	44.25	9.27
Gemmeiza 11	38.33	43.50	11.89	37.33	42.53	12.23
Sakha 61	34.43	42.65	19.27	37.34	44.94	16.91
Sakha 69	38.49	43.27	11.04	36.91	43.51	15.17
Sakha 93	34.63	40.65	14.81	34.51	39.89	13.49
Sakha 94	33.81	39.56	14.53	30.57	38.27	20.12
Giza 168	38.50	39.21	1.81	36.90	37.40	1.33
Misr 1	37.30	38.40	2.86	38.90	39.60	1.76
Misr 2	38.40	39.50	2.78	37.71	38.50	2.05
LSD at 5%	0.237	0.150		1.285	0.067	

Growing season of 2013/14:

Results (Tables 4 and 5) show also that the loss in the 1000-kernel weight ranged from 1.33 to 20.12% in 2013/14 growing season. Wheat cvs. Giza 168, Misr 1, Misr 2, Sids 13, Sids12 and Gemmeiza 9 recorded the lowest percentages (1.33, 1.76, 2.05, 5.20, 5.74 and 7.21%, respectively) of loss values in 1000-kernel weight. Meanwhile, cvs. Sakha 69, Sakha 61 and Sakha 94 showed the highest percentages (15.17, 16.91 and 20.12%, respectively) of loss values in 1000-kernel weight.

Also, results indicate that loss in yield plot weight ranged from 1.56 to 22.52% in the second growing season. Wheat cvs. Giza 168, Misr 1, Sids 13, Misr 2, Sids 12 and Gemmeiza 9 showed the lowest percentages (1.56, 3.00, 5.13, 5.28, 6.04 and 8.00%, respectively) of loss values in plot weight. While, cvs. Sakha 69, Sakha 61 and Sakha 94 showed the highest percentages (15.03, 17.68 and 22.52%, respectively) of loss values in yield plot weight.

Table 5. Effect of powdery mildew infection on yield of plot weight (kg) of 14 wheat cultivars during 2012/13 and 2013/14 growing seasons

Wheat cultivar	2012/13			2013/14		
	Infected	Protected	Loss (%)	Infected	Protected	Loss (%)
Sids 1	17.65	19.40	9.02	17.50	19.51	10.30
Sids 12	24.32	25.60	5.00	24.91	26.51	6.04
Sids 13	23.78	25.30	6.01	24.20	25.51	5.13
Gemmeiza 7	14.91	16.95	12.04	15.51	17.31	10.39
Gemmeiza 9	21.66	22.80	5.00	21.62	23.50	8.00
Gemmeiza 10	22.26	25.30	12.02	22.86	25.41	10.04
Gemmeiza 11	22.79	25.90	12.01	23.31	26.80	13.02
Sakha 61	12.08	15.10	20.00	12.10	14.70	17.68
Sakha 69	14.50	16.60	12.65	14.02	16.50	15.03
Sakha 93	19.72	23.20	15.00	20.03	23.30	14.03
Sakha 94	20.60	24.90	17.26	19.60	25.30	22.52
Giza 168	24.30	24.80	2.02	25.10	25.50	1.56
Misr 1	25.17	25.95	3.01	25.51	26.30	3.00
Misr 2	25.12	25.90	3.01	25.10	26.50	5.28
LSD at 5%	1.097	1.000		0.810	1.188	

Association between AUDPC and yield parameters:

The association of kernel weight and grain yield with AUDPC was assessed through regression analysis (Fig. 1). The regression analysis revealed that low correlation between AUDPC and the loss in 1000-kernel weight recorded (R^2= 0.492) in season 2012/13. While, a high correlation between AUDPC and the loss in 1000-kernel weight for each cultivar during season 2013/14 recorded (R^2= 0.783). Moreover, a high correlation was detected between AUDPC and the loss in yield plot weight during seasons 2012/13 and 2013/14 (R^2= 0.891 and R^2= 0.833, respectively).

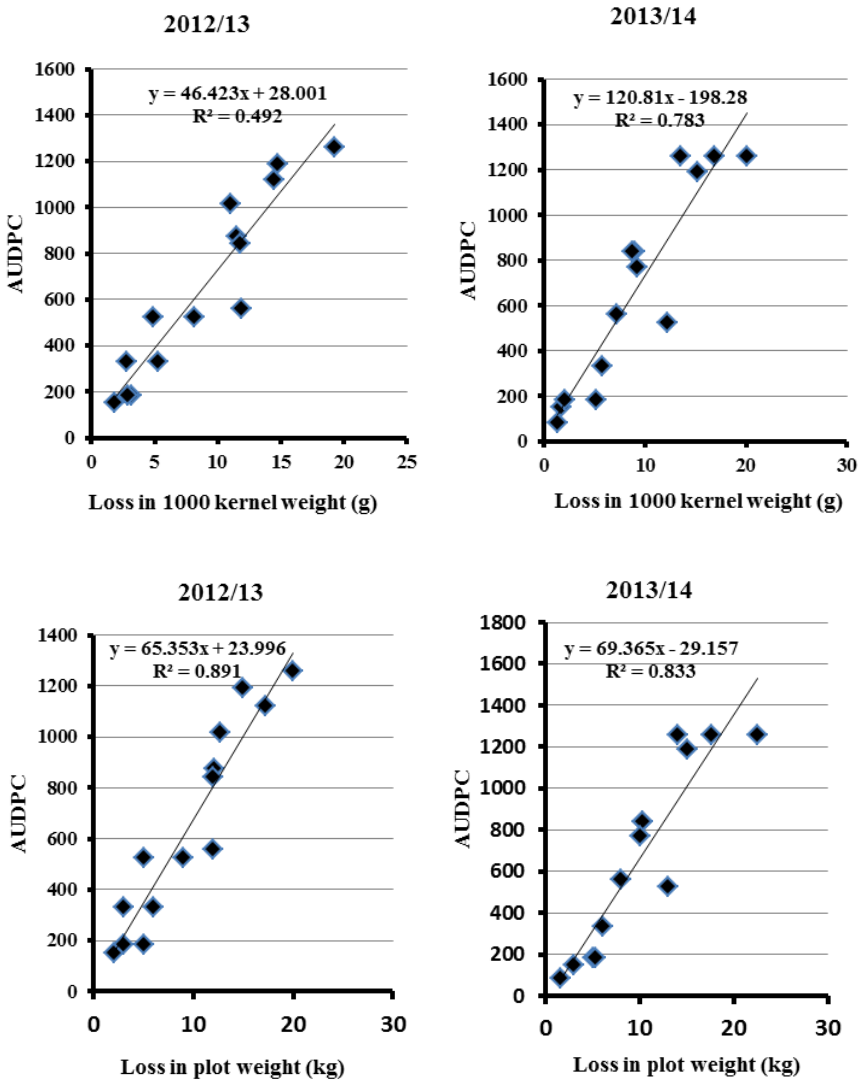

Fig. 1. Regression analysis between AUDPC with loss in 1000-kernel weight (above) and loss in plot weight (lower) on fourteen Egyptian wheat cultivars during 2012/13 and 2013/14 growing seasons.

Discussion

In this study, adult plants of fourteen wheat cultivars were evaluated for naturally powdery mildew inoculation under field conditions at Sakha Agric. Res. Station during two successive growing seasons of 2012/13 and 2013/14.

Infection types and powdery mildew severity were recorded for each of the tested cultivars. Wheat cvs. Giza 168, Sids 12, Misr 1, Misr 2 and Sids 13 were resistant to powdery mildew showing low infection types during the two tested growing seasons, when recorded low levels of disease severity (7 to 16.3%) during the first growing season (2012/13), while in 2013/14 it ranged from 4 to 16.3%. Vechet (2006) reported that wheat powdery mildew differed in its severity in two growing seasons of 1999 and 2000; when it was rather high in 1999, but very low in 2000. Also, he found that the wheat cvs. RE9607, Runal, Folke, Ferimegu and Asset were resistant either in 1999 or in 2000. These cultivars also had a very low infection type. Briceno-Felix *et al*. (2008) evaluated seven Spain wheat cultivars at adult plant stage under field conditions against powdery mildew infection. They found that disease severity varied from 6 to 82% on flag leaf, 12 to 87.3% on flag-1 and 25.3 to 90% on flag-2. El-Shamy *et al*. (2012) tested four Egyptian wheat cultivars at Gemmeiza Research Station during two successive growing seasons of 2009/10 and 2010/11 for powdery mildew infection. They found in the first season that tested cultivars showed high levels of disease severity ranged from 35 to 87%. While, in second season lower levels of disease severity were recorded from 6 to 15%.

According to the obtained results and depending on the values of AUDPC, it could be stated that wheat adult plants of cvs. Giza 168, Sids 12, Misr 1, Misr 2 and Sids 13 recorded high levels of resistance to powdery mildew infection under field conditions during the two tested seasons. These cultivars showed the lowest values (less than 350) of AUDPC; (El-Shamy *et al*., 2012; Ceron and Martel, 2003; Bowen *et al*., 1991; Briceno-Felix *et al*., 2008 and Bojanaska and Pavlovicova, 2004).

Grain yield and yield components were complex characters and are considered to be the cumulative result of different physiologic processes. In this study, the wheat cvs. Giza 168, Misr 1, Misr 2, Sids 12, Sids 13 and Gemmeiza 9 showed the lowest yield losses in 1000-kerenl weight and yield plot weight during the two tested seasons. While, the lowest yield was recorded in cvs. Sakha 94, Sakha 61 and Sakha 69, and that could be reflected by the susceptibility of these cultivars to powdery mildew and hence caused the lower yield. Tomas and Solis (2000) concluded that the reduction in grain yield of the durum wheat cultivars in South of Spain is mainly caused by powdery mildew. El-Shamy *et al*. (2012) found that the highest reduction in yield components, *i.e.* 1000 grain wheat (16.72%), and grain yield/m^2 (17.73%), was detected in cv. Gemmeiza 10 in 2009/10 growing season. On the other hand, in 2010/11 growing season, the loss in 1000 grain wheat ranged from 0.17 to 0.47%, while grain yield/m^2 ranged from 0.27 to 1.28%.

High correlation was found between the loss in 1000-kernel weight for each cultivar during 2013/14 growing season (R^2= 0.783). Therefore, the changes in 1000-kernel weight were observed in 2013/14 which may be due to variation in the

AUDPCs of powdery mildew in 78% of cases. While, in 2012/13 the changes in 1000-kernel weight could be due to variation in the AUDPCs of powdery mildew in 49% of cases and there are another factors affect the yield of 1000-kernel weight during this season such as environmental conditions. Similarly, a high correlation was found between AUDPC and the loss in plot weight of grains during growing seasons 2012/13 and 2013/14 (R^2=0.891 and R^2=0.833, respectively). In 2012/13 growing season, 89% of the changes in yield plot due to the changes in AUDPC values and in 2013/14 growing season, 83% the changes in yield plot due to the changes in AUDPC values. Ceron and Martel (2003) reported that high correlation was found between AUDPC of powdery mildew in some wheat cultivars and grain yield during seasons 1999/2000 (R^2= 0.6974) and 2001/2002 (R^2= 0.9083).

Finally, powdery mildew disease cause significant grain yield losses of the wheat cvs. Sakha 94, Sakha 61 and Sakha 69 grown at Sakha Agric. Res. Station during 2012/13 and 2013/14 growing seasons. Meanwhile, cvs. Giza 168, Sids 12, Misr 1, Misr 2 and Sids 13 were found to be resistant.

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الخسائر فى محصول الحبوب لبعض أصناف القمح المصابة بالبياض الدقيقى

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يعتبر مرض البياض الدقيقى فى القمح المتسبب عن الفطر *Blumeria graminis* f.sp. *tritici* واحد من أهم الأمراض التى تؤثر على إنتاجية القمح تحت الظروف المصرية. تم تحديد العلاقة بين الفقد فى المحصول وشدة الإصابة بالبياض الدقيقى خلال الموسمين الزراعيين ٢٠١٢/٢٠١٣ و ٢٠١٣/٢٠١٤ فى محطة البحوث الزراعية بسخا على ١٤ صنف قمح.

تراوحت شدة الإصابة بالبياض الدقيقى بين ٧ إلى ٦٠% فى موسم ٢٠١٢/٢٠١٣ ، بينما تراوحت فى موسم ٢٠١٣/٢٠١٤ بين ٤ إلى ٦٠%. وقد وجد أن المساحة الواقعة تحت منحنى تقدم المرض مرتبطة مع شدة الإصابة خلال موسمى الدراسة. كما وجد أن الفاقد فى المحصول تراوح من ٢.٠٢% فى الصنف جيزة ١٦٨ حتى ٢٠% فى الصنف سخا ٦١ خلال موسم ٢٠١٢/٢٠١٣. بينما تراوح الفاقد من ١.٥٦% فى الصنف جيزة ١٦٨ إلى ٢٢.٥٢% فى الصنف سخا ٩٤ خلال موسم ٢٠١٣/٢٠١٤. بينما الفاقد فى المحصول فى باقى الأصناف المختبرة أعتمد على قيم شدة الإصابة بالبياض الدقيقى لكل صنف.