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GRAIN YIELD LOSSES OF SOME WHEAT GENOTYPES TO STRIPE RUST IN EGYPT

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ABSTRACT: *Stripe rust, caused by Puccinia striifarmis f. sp. tritici is an dangerous disease of wheat worldwide. To estimate grain yield losses due to stripe rust, replicated experiments including forty wheat genotypes i.e. Gemmeiza 9, Gemmeiza 11, Sakha 61, Sakha 69, Sakha 93, Sakha 94, Sids 12, Sids 13, Misr 1, Misr 2, Giza 168, Giza 171, Shandweel 1 and Morocco were evaluated for adult plant resistance at Sakha Research Station, Kafr El-Sheikh, Egypt during 2013/14 and 2014/15 growing seasons. The field experiment was surrounded by spreader area of highly susceptible genotypes i.e. Triticum spelta saharences inoculated with a mixture of stripe rust races as a source of inoculum. In general, the rust severity of wheat genotypes was higher at second season than that at first season. Disease severity was recorded each 10 days (5MR to 80S) the first season (10MR to 90S) the second season. Area under disease progress curve (AUDPC) was estimated and ranged from26 to 1750 in 2013/14 and 26 to 2050 in 2014/15. It was found that, yield losses ranged between 3.86 % in the wheat genotypes Shandaweel 1 to 31.17 % in the wheat genotypes Morocco during 2013/14, while during 2014/15 ranged from 3.86 % in the wheat cultivar Misr 2 to 37.39 % in the wheat cultivar Morocco. Concerning yield losses in 1000-kernel weight, the genotype Sakha 61 recording less value 2.6 % white Morocco was higher value 30.49 % and 32.74 % in two growing seasons. High correlation was found between yield losses with disease severity and AUDPC.*

Key words:Wheat, Puccinia striifarmis, resistance, susceptibility, yields losses.*

INTRODUCTION

Stripe rust of wheat caused by *Puccinia striifarmis* f. sp. *tritici* can be as damaging as stem rust. However, stripe rust has a lower optimum temperature for development that limits it as a major disease in many areas of the world. Stripe rust is principally an important disease of wheat during winter or early spring or al high elevation. Roelfs *etal* (1992). Grain losses caused by this devastating pathogen have been reported from 10-70 percent Chen and Penman,(2005).

The frequency of epidemics and damage caused by stripe rust is different in each country. In Egypt stripe rust is the most common and important wheat disease, it caused severe losses in grain yield Abu El-Naga, *et*. *al*. (1998 and 2001). Man's methods are available to control wheat rusts. One of them, the economical and environmentally safe protection of wheat against rusts is possible by growing resistant relative humidity are the suitable factors to the wide distribution of the disease Stubbs, (1988); Johnson, (1988) and Denial, (1994).

In Egypt it is a sporadic disease because it appears in some years and diaspor in other years. Yellow rust disease in Egypt was appeared in 1990's it became familiar due to its continuous appearance. Abu El-Naga, *et*. *al*., (2001). Screening of genotypes against stripe rust is a regular activity due to the dynamic nature of the pathogen. This pathogen produces new races quickly through mutation and somatic hybridization Stubbs, (1985). Local yellow rust races can migrate to other areas and quickly become regionally and often globally predominant. Virulence for certain gene(s) combinations may still be absent regionally Singh *et. al*., (2002). The disease was recognized as epidemic in 1967 on the wheat genotypes Giza 144 at Manzala district, 1996 and 1997 on Sakha 69, Giza 163, Gemmeiza 1 and most of the commercial genotypes especially the long spiked ones, at the northern governorates during 2000 growing season Abd el- Hak, *et. al*., 1972; El- Daoudi, *et. al*., 1996 and Abu El- Naga,*et. al*., 1998, 1999, and 2001.

Seedling resistance is usually race specific and can be recognized by its characteristic resistance type at all plant stages Hong and Singh (1996). Adult plant resistance can be either specific or race non- specific and it usually better recognized after the seedling stage (Jonhson, 1988).

The objectives of this study were evaluated of some Egyptian wheat genotypes against stripe rust. Also, to estimate yield losses in grain yield these varieties against stripe rust.

MATERALS AND METHODS

This experiment was carried out at Sakha Agricultural Research Station in two successive growing seasons i.e. 2013/14 and 2014/15, using 14 wheat genotypes i.e. Gemmeiza 9, Gemmeiza 11, Sakha 61, Sakha 69, Sakha 93, Sakha 94, Sids 12, Sids 13, Misr 1, Misr 2 Giza 168, Giza 171, Shandweel 1 and Morocco (as a check variety) Table 1. The wheat varieties were arranged in a randomized complete block design (RCB) with three replicates. The plot size was 6 × 7 m; each plot contained 20 rows with 7 m long and 30 cm between rows. The experiment was planted 15 days after the regular sowing date (the first half of December) to expose the plants to suitable environment of yellow rust incidence and development. Plots were surrounded by spreader area planted with a mixture of highly susceptible wheat genotypes to stripe rust *i.e*. *Triticum spelta saharences* to spread inoculums. To provide and maintain the rust inoculum pressure, the experiment was also artificially inoculated at the first week of February. To maintain crop stand and vigor, normal agronomic practices including recommended fertilization dose and irrigation schedule were followed. To keep protected plots almost free from stripe rust, the fungicide Sumi-eight 5EC (1H-1, 2, 4-Triazole-1-ethanol,beta.-[(2,4-dichlorophenyl)methylene]-.alpha.-(1,1dimethylethyl)-,(.beta.E) (35 cm /100 litter water) was applied at 10 days.

Stripe rust severity and reaction were scored for each plot every 10 days intervals from rust appearance along with the stages of plant growth using the modified Cob's scale Peterson, *et al*., (1948) and the host response scale described by Roelfs, *et al*., (1992).

The area under disease progress curve (AUDPC) was calculated for each variety according to the equation adopted by Pandy, *et. al*., (1989).

AUDPC = D [1/2 (Y1 + Yk) + (Y2 + Y3 + - - - - - + Yk-1)]

Where: D = days between two consecutive records (time intervals)

Y1 + Yk = Sum of the first and last disease records.

Y2 + Y3 + - - - - - + Yk-1 = Sum of all in between disease

At maturity the crop was harvested and yield of each genotype of $42m^2$ was weighed by conventional balance. The influence of stripe rust severities on yield was determined by comparing the yield of infected and protected cultivars. Yield loss was estimated using the simple equation as follows:-

Loss % = 1-Yd/Yh X 100 (Colpauzos, *et al.,* 1976).

Where: Yd = Yield of diseased plants.

Yh = Yield of healthy plants.

Table 1: List of the local bread wheat genotypes that were used, pedigree and year of release

No.	Genotype	Designation	Year of release
1	Gemmeiza 9	ALD"S"/HUAC"S"//CMH74A.630/SX. GM4583-5GM-1GM-0GM.	1999
2	Gemmeiza 11	B0W"S"/KVZ"S"//7C/SERI82/3/GIZA168/SAKHA61.GGM7892-2GM-1GM-2GM-1GM-0GM.	2011
3	Sakha 61	INIA/RL4220//7C/YR”S”CM15430-2S-5S-0S-0S	1980
4	Sakha 69	INIA/RL4220//7C/YR”S”CM15430-2S-6S-0S-0S	1980
5	Sakha 93	Sakha 92/TR 810328 S 8871-1S-2S-1S-0S	1999
6	Sakha 94	OPATA/RAYON//KAUZ.CMBW90Y3280-0TOPM-3Y-010M-010M-010Y-10M-015Y-0Y-0AP-0S.	2004
7	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
8	Sids 13	KAUZ "S"//TSI/SNB"S". ICW94-0375-4AP-2AP-030AP -0APS-3AP-0APS-050AP-0AP-0SD.	2010
9	Misr 1	OASIS/SKAUZ//4*BCN/3/2*PASTOR.CCMSSOYO1881T-050M-030Y-O3OM-030WGY-33M-0Y-0S.	2011
10	Misr 2	SKAUZ/BAV92. CMSS96M0361S-1M-010SY-010M-010SY-8M-0Y-0S.	2011
11	Giza 168	MIL/BUC//Seri CM93046-8M-0Y-0M-2Y-0B	1999
12	Giza 171	Sakha93/Gemmeiza9 S6-1GZ-2GZ-2GZ-OS	2012
13	Shandaweel 1	SITE/MO/4/NAC//*PVN/3/MiRLO	2012

Data of 1000-kernel weight (g) and grain yield (kg) was calculated according Hassan (2004). Randomly selected thousand kernels from each genotype were counted with a seed counter and were weighed with an electronic balance to calculate 1000-kernel weight. The grain weight from the threshed spikes was measured entire harvested plots was weighed with an electronic balance to calculate grain yield per plot for each genotype.

Least significant differences (L.S.D. at 5%) were used to compare yield components according to Snedecor, (1957). Correlation coefficient was also used to detect the relationship between yield loss and AUDPC.

RESULTS AND DISCUSSION

The present study clearly showed that the wheat genotypes showed high stripe rust disease severity were exhibited maximum values of AUDPC and yield losses. While the wheat genotypes showed low disease severity displayed minimum values of AUDPC and yield losses. It was also evident that the susceptible wheat genotypes suffered more yield losses than those of moderately resistant to resistant to stripe rust.

Reaction of commercial wheat genotypes to stripe rust: The reaction of the commercial wheat genotypes to stripe rust at adult plant stage under field conditions is shown in (Tables 2 and 3). The fungicide-protected plots remained almost free from stripe rust during the two growing seasons of this study (2013/14and 2014/15).

In 2013/14 growing season, all of the tested wheat genotypes showed different disease severity ranged from 5MR to 80S (Tables 2). The genotypes Sakha 61, Misr 1, Misr 2 and Giza 168 showed the least disease severity (5MR- 20MR), followed by

Sakha 94, Sids 13, Giza 171 and Shandaweel 1 (10 MS). While, the rest of the tested cvs.exhibited rust severity ranged from 20MS – 80S.

In 2014/15 growing season, all of the tested genotypes exhibited susceptible infection type. The cvs. Sakha 61, Sids 13, Misr 1 and Misr2 showed lower rust severity ranged from 10MR- 20MR. While, the genotypes Sakha 69, Sakha 93, Sakha 94, Sids 12, Sids 13, Gimmeiza 9, Gimmeiza 11, Giza 168 and Morocco showed higher rust severity ranged from 10S to 90S. Ashmawy, (2005) found that the wheat genotype Sakha 61 was resistant at adult plant stage and has low terminal rust severity (5 R) under heavy stripe rust epidemic and its resistance may be attributed to the presence of the effective gene *Yr*5. The rust severity of the genotypes Gimmeiza 9, Gimmeiza 11 and Giza 168 was 20 MS, 30 MS and 20MR respectively in season 2013/14, while in season2014/15 the rust severity of the same genotypes were 20S, 30S and 40S respectively. This high severity occurred in these genotypes in season 2014/15 may be due to the appearance of new stripe rust race (s). Shahin, (2008) found that the wheat varieties Sakha 69 and Sakha 8 were highly susceptible at both seedling and adult growth stages despite their resistance in previous studies for stripe rust isolates from Sakha 93 and Gemmeiza 9. Also, the wheat genotypes Sakha 69 and Sakha 8 were susceptible at both growth stages Ashmawy, (2010) and this may be due to the widest virulence race in this study. However, they were resistant to Giza 168 and Gemmeiza 10 isolates of stripe rust of wheat both in the seedling and adult plant growth stages Ashmawy, (2010), Khodarahmi, *et. al,* (2001) Mundt, *et al,* (1995).

Table 2. Effect of stripe rust infection on yield component of 13 Egyptian wheat genotypes and Morocco genotypes at Sakha agricultural research station during 2013/014.

Genotype	Final rust severity	AUDPC	1000 kernel weight (gm)			Plot weight (kg)		
			infected	protected	Losses%	infected	protected	Losses%
Gemmeiza 9	20 MS	208	41.65	44.40	6.20	21.42	23.11	7.31
Gemmeiza 11	30 MS	380	41.83	44.55	6.20	23.21	25.25	8.07
Sakha 61	5 MR	26	38.50	39.50	2.60	13.50	14.10	4.25
Sakha 69	30 S	475	36.44	41.55	12.30	11.99	14.15	15.26
Sakha 93	30 S	475	36.86	40.95	9.90	18.99	21.3	10.84
Sakha 94	10 MS	160	38.68	40.88	5.38	20.10	21.45	6.29
Sids 12	40 S	750	38.60	43.58	11.50	21.30	24.60	13.41
Sids 13	10 MS	168	40.10	41.60	3.33	22.13	23.95	7.59
Misr 1	5 MR	26	40.55	42.58	2.60	22.12	23.14	4.40
Misr 2	5MR	26	41.38	42.99	3.74	22.55	23.56	4.28
Giza 168	20MR	265	42.12	43.94	4.32	23.02	24.45	5.84
Giza 171	10 MS	168	41.15	42.33	2.8	23.42	24.54	4.56
Shandaweel 1	10MR	84	41.34	42.93	3.70	22.65	23.56	3.86
Morocco	80S	1750	30.23	39.45	30.49	10.31	14.98	31.17
LSD				0.0644				0.0488

Table 3. Effect of stripe rust infection on yield component of 13 Egyptian wheat genotypes and Morocco genotype at Sakha agricultural research station during 2014/015.

Genotype	Final rust severity	AUDPC	1000 kernel weight (gm)			Plot weight (kg)		
			infected	protected	Losses%	infected	protected	Losses%
Gemmeiza 9	40 S	625	40.60	44.40	8.55	20.42	23.10	11.60
Gemmeiza 11	50 S	900	40.38	44.60	9.46	21.61	25.25	14.41
Sakha 61	20 MR	26	39.50	40.50	2.46	13.50	14.22	5.06
Sakha 69	70 S	1100	36.18	41.99	13.83	11.25	14.25	21.05
Sakha 93	60 S	950	36.60	40.90	10.51	18.12	21.3	14.92
Sakha 94	10 S	128	38.45	39.90	3.63	20.10	21.45	6.29
Sids 12	60 S	950	39.60	44.50	11.01	20.12	24.60	18.21
Sids 13	20 S	260	40.10	41.60	3.60	22.13	23.95	7.59
Misr 1	10 MR	84	40.25	42.10	4.39	22.12	23.14	4.40
Misr 2	10MR	84	41.34	42.93	3.70	22.65	23.56	3.86
Giza 168	40S	750	40.66	43.95	8.09	22.01	24.25	9.23
Gisa 171	20S	310	40.60	42.10	3.69	22.42	24.54	8.63
Shandaweel 1	5 S	105	41.04	42.97	4.70	22.35	23.66	5.83
Morocco	90S	2050	30.05	39.89	32.74	10.01	15.99	37.39
LSD				0.0828			0.0622	

Area under disease progress curve (AUDPC): Data in Tables 2, 3 and Figure 1 indicates that AUDPC run in a parallel line with disease severity. In 2013/14 growing season, the results obtained showed that the low values of AUDPC were observed on cvs. Sakha 61, Misr 1, Misr 2 and Sakha 94 (26, 26, 26 and 160). Whereas, cvs. Sids 13, Giza171, Gemmeiza 9, Giza 168, Gemmeiza 11, Sakha 93, Sakha 69, Sids 12 and Morocco exhibited highest values of AUDPC i.e. 168, 168, 208, 265, 380, 475, 475, 750 and 1750 respectively. According to these results in season 2013/14, the results obtained showed that the low values of AUDPC were observed on cvs. Sakha 61, Sakha 94 Misr 1, Misr 2 and Sids 13 (26, 128, 160, 160 and 168). Whereas, cvs. Giza171, Gemmeiza 9, Giza 168 Giza 168 Gemmeiza 11, , Sakha 93, Sids 12, Sakha 69 and Morocco exhibited highest values of AUDPC i.e. 310, 625,750, 900, 950, 950, 1100, 2050, respectively. the wheat genotypes were classified into two main groups, the first group included the fast rusting wheat genotypes that displayed the highest values of AUDPC (more than 200) i.e. Gemmeiza 9, Gemmeiza 11, Giza 168, Sakha 93, Sakha 69 and Sids 12. The second group included the slow rusting wheat genotypes that displayed the lowest values of AUDPC (less than 200) i.e. Sakha 61, Sakha 94 Misr 1, Misr 2 and Sids 13. In 2014/15 growing season, data in Tables 2 and 3 indicates that the cvs. Gemmeiza 9, Giza 168, Gemmeiza 11, Sakha 93, Sids 12, Sakha 69 and Morocco showed the highest values of AUDPC (fast rusting) i.e. 625, 750, 900, 950, 950, 1100 and 2050 respectively.

Omar, Hend abd el- naby(2015) found that the wheat cv. Giza 168, Misr 1 and Misr2 showed low level of AUDPC, while the wheat genotypes Sakha 93 and Gemmeiza 11 showed high levels of AUDPC to stripe rust. Kurt, (2002) Omara, (2009), Shahin,(2008).

Grain yield and yield losses: The 1000 kernel weight and grain yield per plot differences between protected and infected wheat genotypes due to the differences in the level of disease severity of stripe rust as shown in Tables 2 and 3. In 2013/14, the loss percent of the 1000 kernel weight ranged from 2.69 to 13.29 %. The cvs. Sakha 93, Sids 12, Sakha 69 and Morocco gave the highest percent of loss of 1000 kernel weight (9.98, 11.42, 12.29 and 30.90% respectively) compared to the other genotypes. In 2014/15, the loss percent in the 1000 kernel weight ranged from 2.46 to 13.83 %. The cvs. Gemmeiza 11, Sakha 93, Sids 12 and Sakha 69 gave the highest values of loss present of the 1000 kernel weight (9.46 , 10.51 , 11.01 and 13.83 %, respectively) followed by cvs. Gemmeiza 9, Giza 168, Misr 1, Misr 2, Sakha 61, Sakha 94 and Giza 171.The loss percent of gran yield per plot in 2013/14 ranged from 4.25 to 15.26 %. The cvs. Sakha 93, Sids 12 and Sakha 69 showed the highest values of loss percent of gran yield per plot (10.84, 13.41 and 15.26 %) compared to the other genotypes. In 2014/15, the loss percent of gran yield per plot ranged from 3.94 to 37.39 %. The cvs. Gemmeiza 11, Sakha 93, Sids 12, Sakha 69 and Morocco gave the highest values of loss percent of yield per plot (14.41, 14.92, 18.21, 21.05 and 37.39 %, respectively), while, the cvs. Sakha 61, Sakha 94, Misr 1, Misr 2, Giza 171 showed the lowest values of loss percent of yield per plot. This trend is in aharmony with losses reported in previous studies obtained by (Abu El- Naga, *et al*.,1999, Sing, *et al*., 2005 and Ochoa and Parlevliet 2007) reported that yield loss was correlated strongly with area under disease progress curve, which means that high levels of partial resistance are needed to prevent significant yield loss.

This study showed that stripe rust reduced yield respective of the type and level of resistance possessed by the cultivars (El- Daoudi *et. al*., 1996). The effect of rust on grain yield may be due to the energy expenditure in plant defense mechanisms rather than for growth and grain information (Smedegaard-Petersen and Tolstrup, 1985). Moreover, the tissue damage caused by hypersensitive reactions also contributes to yield reduction (Khanna*et al*., 2005). The present study showed that the infection with stripe rust can severely reduce grain yield on susceptible cultivars. Therefore, growing slow rusting genotypes will reduce the loss percent in grain yieldVechet andTvaruzek (2002)

Association between AUDPC and loss in the 1000 kernel weight and loss in grain yield/plot: The association of the 1000 kernel weight and loss percent of grain yield/ plot and AUDPC was determined through regression analysis during 2013/14 and 2014/15 growing seasons. Positive relation between AUDPC and loss percent of 1000 kernel weight during the two growing seasons (R^2 = 0.492 and 0.783 respectively) (Fig. 1). Also, regression analysis revealed a significant linear relationship (R^2 = 0.959 and 0.9447) between loss percent of grain yield/ plot and AUDPC. On overall basis cultivars with maximum disease severity had lower mean grain yield and vice versa (Shaner*et al*., 1978). Ochoa and Parlevliet (2007) reported that yield loss was correlated strongly with AUDPC found that a significant correlation between mean disease severity and percentage loss for 1000-kernel and grain yield/plant.

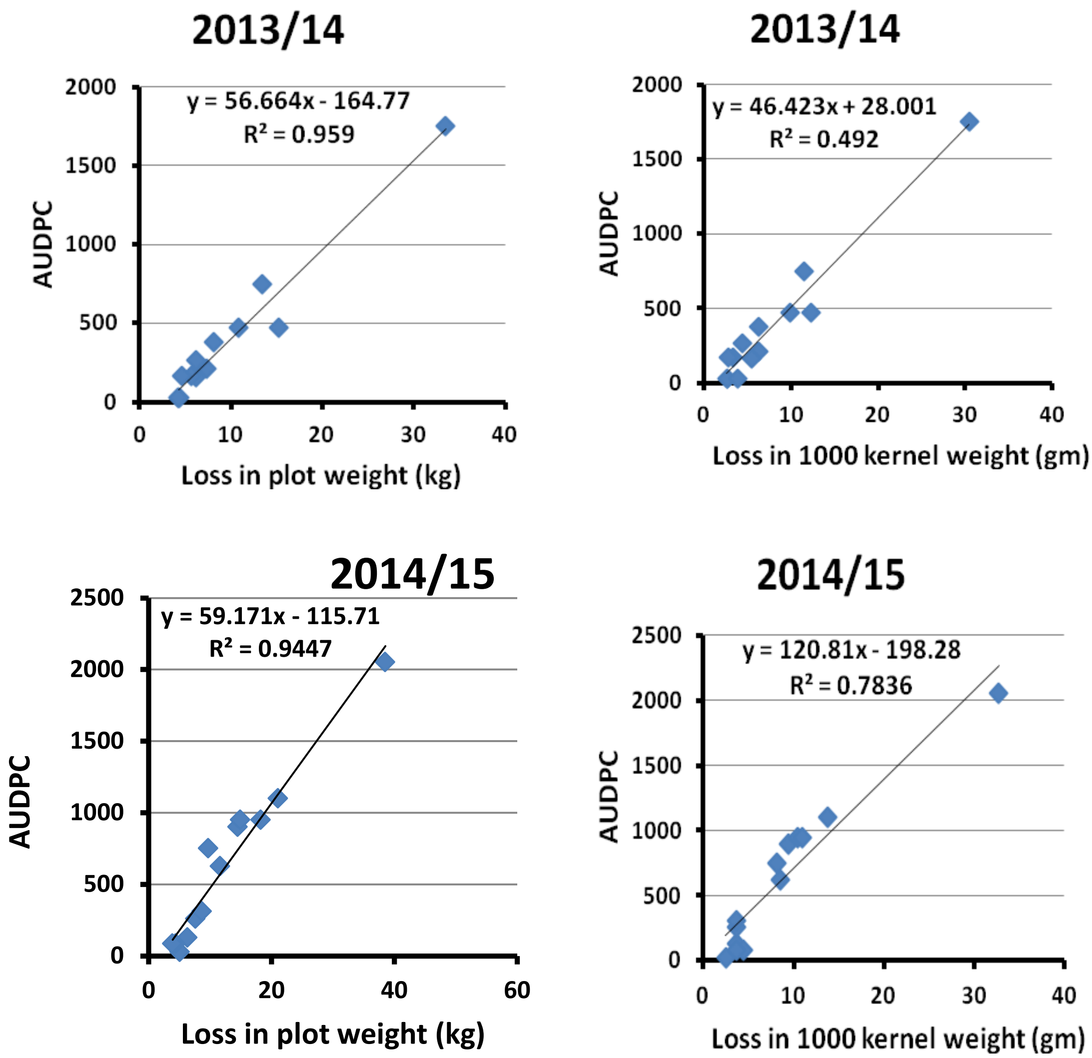

Fig. (1): Association between AUDPC with loss percent of1000 kernel weight and loss in grain yield/ plot for 13 Egyptian bread wheat genotypes and Morocco varieties tested during 2013/14 and 2014/15 growing seasons.

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تقدير الخسائر بمرض الصدأ الاصفر في بعض اصناف القمح في مصر

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[2] مركز البحوث الزراعية – معهد بحوث المحاصيل الحقلية – قسم بحوث القمح

الملخص العربي

يعتبر مرض الصدأ الأصفر من اهم امراض القمح في مصر وعلي مستوي العالم. تم تصميم تجربة الخسائر للصدأ الاصفر واختيار 13 صنف مصرية يتم زراعتها في مصر بالمقارنة بالصنف Morocco هي جميزة 9 وجميزة 11 وسخا 61 وسخا 69 وسخا 93 وسخا 94 وسدس 12 وسدس 13 ومصر 1 ومصر 2 وجيزة 168 وجيزة 171 وشندويل 1 وتقيمها في طور النبات البالغ وتحت الظروف المصرية في محطة البحوث الزراعية بسخا ولمدة موسمين 2014/2013– 2015/2014 . وكانت النتائج المتحصل عليها بصفة عامة كانت الاصابة اعلي في الموسم الثاني 2015/2014 عن الموسم الاول . الشدة المرضية وتم تسجيلها كل 10 ايام كانت شدة الاصابة تتراوح بين (5MR–80S) في الموسم الاول وتتراوح بين (10MR–90S) في الموسم الثاني. المساحة تحت المنحني المرضي تراوحت بين 26 الي 1750 في الموسم الاول وبين 26 الي 2050 في الموسم الثاني . قدرت الخسائر الناتجة عن الصدأ الأصفر 3.94% في شندويل 1 و33.39% في الصنف Morocco في موسم 2014/2013 و3.86% في مصر 2 و 37.39% في الصنف Morocco في موسم 2015/2014 . وسجلت الخسائر في وزن 1000 حبة كانت اقل في سخا 61 في الموسمين بينما كانت اعلي خسائر في الصنف Morocco 30.49 في الموسم الاول 32.74 % في الموسم الثاني. قد وجد علاقة بين الشدة المرضية والمساحة تحت المنحني المرضي وكمية الخسائر الناتجة عن الاصابة بمرض الصدأ الاصفر.

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