J. Plant Prot. and Path., Mansoura Univ., Vol. 1 (11): 921 - 927, 2010

DEVELOPMENT OF FUSARIUM EAR ROT DISEASE OF MAIZE IN THREE DIFFERENT GEOGRAPHIC LOCATIONS

El-Naggar, A. A. A. and A. M. Sabry
Maize and Sugar cane Dis. Res. Sec., Plant Pathol. Res. Inst., ARC, Giza, Egypt.

ABSTRACT

The profile of maize Fusarium ear rot was conducted in three different geographic locations including Gemmeza and Sakha at the Nile delta while the relative humidity (RH) is above 50% and Sids of upper Egypt while RH is less than 50 %. Field experiments were carried out on 31 commercial maize cultivars. Among these cultivars, seven of them were hybrids of partial resistance against Fusarium ear rot. Collected data during the two successive growing seasons of 2007 and 2008 showed that the disease severity (DS) was correlated to the relative humidity in the tested locations (4-44% in the Delta while RH was 54-58% and 0.3-12% in upper Egypt while RH was 44-45%). The results also showed that the difference in temperature has no role in disease severity of the disease in the three locations. Results of this study could be used to classify maize growing areas, based solely on environmental variables especially RH, for their propensity to Fusarium ear rot.

Keywords: Fusarium ear rot, Egypt, geographical locations, disease severity, Relative Humidity.

INTRODUCTION

Species of *Fusarium* Link, are among the most common fungi associated with maize plants, causing diseases of seedlings, roots, stalks, and kernels (White, 1999; Kommedahl & Windels, 1981; and Hoenisch & Davis, 1994). In Egypt, El-Shabrawi, 2007 found that the most common Fusaria infecting maize ears are *F. verticillioides* (Syns. *F. moniliforme*); *F. proliferatum*, belonging to section Liseola; *F. semitectum* (section Arthrospoiella); *F. oxysporium* (section Elegans) and *F. solani* (section Martiella and Ventricosum). However, the prevalent one is *F. verticillioides*. The disease on maize ears caused by the previous members of section Liseola is known as *Fusarium* ear or kernel rot. Kernel infection by any of these fungi can reduce yield and quality, and result in mycotoxin accumulation in grain (Kommedahl and Windels, 1981 & Marasas *et. al*., 1984). Fusarium ear rot is being occur wherever corn is grown. It is severe when hot, dry weather occur at and after flowering (White, 1999). Environmental conditions play an effective role on the incidence of Fusarium diseases (Tesso *et. al*., 2005 & Kriss *et. al*., 2010) as well as on the incidence of other diseases (Khan and Khan, 2009). Although, the Fusarium ear rot disease of maize is known from along time ago in Egypt (El-Shabrawi, 2001; El-Shabrawi, 2007; Khalil, Ikbal *et. al*., 1980 and El-Sayed, Fawzeia 1996), there is no investigations about fluctuations in disease incidence or severity which are likely to be caused by weather variations; resulting in air conditions favorable or unfavorable to infection and disease expression. The purpose of this study was to evaluate the performance of commercial maize cultivars against Fusarium ear rot under natural infection as an attempt to understand the relationship between the relative humidity and disease severity of Fusarium ear rot of maize.

MATERIALS AND METHODS

Thirty-one maize cultivars were tested for their susceptibility to Fusarium ear rot in two environmentally different locations (Gemmeza & Sids agricultural research stations) in 2007 and in Sakha, Gemmeza, and Sids agricultural research stations during 2008 growing seasons. Although most of the cultivars were grown in the three locations, only few were grown in two locations under natural infection. A randomized complete block design with three replications was used for each experiment. Each plot was two rows; 5m long; containing 25cm plant apart. Ears of the tested cultivars were harvested, 60 days after silking and tested for infection with Fusarium ear rot. Disease severity was recorded based on a 1-6 scale described by Jeffers *et al*. (1981), where: 1= no disease; 2= 1-10%; 3= 11-25 %; 4= 25-50 %; 5= 51-75 %; and 6=76-100%. Percent disease severity index was calculated using a formula described by Jeffers *et al.* (1981) as follows:

$$\frac{n1(1\text{-}1) + n2(2\text{-}1) + n3(3\text{-}1)+n4(4\text{-}1)+n5(5\text{-}1)}{N} \times 100$$

Where, *n1*-*n5*= number of ears with different disease grades described in the 1-5 scale; N= total number of tested ears. The collected data were statistically analyzed by SAS virgin 9. To interpret the relationship between the environmental conditions and the disease severity, the climatic data (temperature and relative humidity) were collected for the period August to November (2007 & 2008) favorable to Fusarium ear rot. Climatic data were kindly provided by the Laboratory of Agricultural Climate, of the Ministry of Agriculture, Giza, Egypt.

Table 1: Weather variables (temperature, T, and relative humidity, RH) mean of four months during two successive seasons 2007 &2008 at the locations of experiments.

Month	2007						2008								
	GM*			SD*			GM*			SK*			SD*		
	T		RH**	T		RH**	T		RH**	T		RH**	T		RH**
	Max	Mini		Max	Mini		Max	Mini		Max	Mini		Max	Mini	
Aug.	40	23	53	37	22	40	35	25	49	32	25	51	38	24	38
Sept.	35	21	59	33	21	42	32	24	54	31	23	57	36	22	38
Oct.	31	17	59	32	18	48	29	20	55	27	20	57	30	17	46
Nov.	23	12	61	27	12	50	24	16	57	25	17	60	27	12	52
Mean	32	18	58	32	18	45	30	21	54	29	21	56	33	19	44

*** = Gemmeza, Sids and Sakha agricultural research stations.**
**** = average of monthly relative humidity.**

RESULTS

Table 2 shows that out of the 31 commercial maize cultivars tested against Fusarium ear rot; 25, 26 and 8 were evaluated in Gemmeza & Sids 2007, Gemmeza & Sakha 2008, and Sids 2008 respectively. All cultivars showed Fusarium ear rot and exhibited a wide range of disease severity during the two successive seasons ranging between 0.3 to 44% at Sids and Gemmeza, respectively (Table 2). In 2007 growing season, the recorded range of disease severity was 13 - 44% at Gemmeza and 1 - 12% at Sids. However, in 2008 growing season disease severity was 9 - 40% at Sakha and 4 - 26% at Gemmeza. At Sids it was 0.3% - 6%. In all tests (locations & years) the hybrid SC155 showed low degree of disease severity which did not exceed 17%, while disease severity reached 40% in SC103. At Gemmeza, the tested cultivars recorded higher severity in 2007 than in 2008 with fewer exceptions (hybrids SC103 and SC124 showing higher disease severity in 2008 than 2007). Similarly, the levels of disease severity at Sids were higher in 2007 than in 2008.

Table 2: Mean of ear rot severity on 31 maize cultivars in 2007 and 2008 growing seasons at Gemmeza, Sids and Sakha agricultural research stations.

Hybrids	2007			2008		
	GM	SD		SK	GM	SD
SC10	25	8		22	9	1
SC11	20	3		16	16	*
SC12	23	3		20	14	1
SC103	24	12		40	31	1
SC122	20	2		35	13	*
SC123	36	2		26	24	*
SC124	22	5		20	26	1
SC125	*	*		29	17	*
SC128	*	*		16	10	*
SC129	34	4		16	14	6
SC155	13	1		17	5	0.3
SC162	*	*		9	4	*
SC166	*	*		19	20	*
SC1100	18	4		*	*	*
SC shams	41	2		*	*	*
SC2030	16	5		*	*	2
TWC310	28	10		30	15	*
TWC311	24	5		15	22	*
TWC314	*	*		25	21	*
TWC320	44	6		18	14	*
TWC321	22	3		13	13	*
TWC322	19	5		12	13	*
TWC323	30	5		17	17	*
TWC324	23	7		18	19	*
TWC325	27	8		*	*	*
TWC327	30	3		15	24	*
TWC329	*	*		41	21	*
TWC351	21	2		13	20	*
TWC352	26	4		12	9	*
Pop 45	16	6		*	*	*
G-2	25	7		25	25	4

*** = not grown.**

At Sakha, eighteen cultivars out of twenty-six exhibited disease severity equal or exceed those exhibited at Gemmeza in season 2008. Generally, disease severity of all tested cultivars was very high at Gemmeza and Sakha localities than in Sids. Analysis of variance (Table 3) shows high significant differences among cultivars and locations while the combined analysis revealed that no significant differences was recorded between the two successive seasons, but was highly significant between locations by years.

Table (3): Analysis of variance for response of thirty-one maize cultivars to infection with Fusarium ear rot at Sakha, Gemmeza and Sids locations, 2007 and 2008 growing seasons.

Source of variance	df [a]	MS [b]	F value	Pr ≥ F
Location	2	9383.97**	118.55	0.0001
Year	1	172.55	2.18	0.1414
Location x Year	1	2433.68**	30.74	0.0001
Replication (Location x Year)	10	215.86	2.73	0.0036
Entry	30	247.98**	3.13	0.0001
Entry x Location	49	77.11	0.97	0.5278
Entry x Year	20	72.82	6.68	0.5623
Entry x Year x Location	6	61.414	0.78	0.5897

[a] df = degrees of freedom. [b] MS = mean square. ** = significant at $P \leq 0.01$

DISCUSSION

The results presented here is an attempt to understand the influence of the geographical locations (environmental conditions) on the fluctuations of Fusarium maize ear rot occurrence and severity in Egypt. Results show that maize cultivars were varied in their susceptibility to Fusarium ear rot infection at the same location. This variation in disease expression of the tested cultivars may be attributed to the variation in genetic background for the resistance to Fusarium ear rot (Scott and King, 1984). Recent findings reveled that the hybrids SC128, SC155, SC162, SC1100, SC2030, TWC322 and population45 may serve as a source of partial resistance to Fusarium ear rot (irrespective of 19%, maximum disease severity). According to the fact that infection by Fusarium ear rot, especially *F. verticillioides*, results from airborne conidia that germinate on and grow down maize silks to infect the ear (Hesseltine & Bothast, 1977 and Warren, 1978), and due to nature of this pathogen and its ability to survive in seed and debris (Warren & Kommedahl, 1973), crop rotation and chemical control generally have been ineffective. Therefore, genetic resistance offers the feasible potential for disease control. Reduction of *Fusarium* infection in maize cultivars results in better grain quality, less mold, and decrease accumulation of the toxin fumonisins, as a result of lower disease severity and infection incidence (Munkvold *et al*.,1997 & Rheeder *et al*., 1992). Under resent conditions, the results showed that most of the cultivars exhibited susceptibility to Fusarium ear rot. Results show a need for breeding for Fusarium ear rot resistance. Results also show high significant differences between locations and locations by years (ibid), for disease severity and could be explained by the variation in the relative humidity in tested locations and years. Results also show positive relationship between relative humidity and disease severity. At the same time there were no considerable differences in temperatures among locations (Gemmeza, Sakha and Sids). Results differed in some aspects from those obtained by white (1999) who reported that Fusarium ear rot is most severe when hot, dry weather occurs at and after flowering. In this study it is found that the high levels of RH is a critical variable affecting incidence of Fusarium ear rot disease of maize and it explained fluctuations in disease severity among locations. These results agree with those obtained by Headrick *et.al*., (1990) who reported that, infection of kernels of sweet corn inbred lines by *F. moniliforme* in the hot dry year was lower than other years which has high level of relative humidity. The role of the RH on the incidence of the disease may be due to the importance of its effect on germination and reproduction of conidial spores (Gilbert *et al*., 2008). At the same trend, El-Shabrawi (2007) reported that disease severity of the tested cultivars was higher at Sakha than at Sids under natural and artificial infection by *Fusarium verticillioides*. Recent results conclude that: (i) there is a strong influence of locations (environmental variables especially RH) on disease severity; and (ii) results could be used to classify maize growing areas (geographically), based solely on environmental variables especially RH, for their propensity to Fusarium ear rot.

REFERENCES

El-Sayed, Fawzeia, M. B. 1996. Mycotoxin pollution in stored corn grains. Ph.D. Thesis. Institute of Environmental Studies and Research, Ain Shams Univ. Cairo, Egypt.

El-Shabrawi, E. M. 2001. Studies on ear and kernel rot of maize caused by *Aspergillus* and *Fusarium* spp. M. Sc. Thesis, Fac. Agric., Tanta Univ. 80pp.

El-Shabrawi, E. M. 2007. Maize grains infected with *Fusarium* spp. In relation to toxin production. Ph.D Theses . Cairo University, Egypt. PP 80.

Gilbert, J., Woods, S. M., and Kormer, U. 2008. Germination of ascospores of *Gibberlla zeae* after exposure to various levels of relative humidity and temperature. Phytopathology 98: 504-508.

Headrick, J. M., Pataky, J. K., and Juvik, J. A. 1990. Relationships among carbohydrate content of kernels, condition of silks after pollination, and the response of sweet corn inbred lines to infection of kernels by *Fusarium moniliforme*. Phytopathology 80:487-494.

Hesseltine, C. W., and Bothast, R. J. 1977. Mold development in ears of corn from tasseling to harvest. Mycologia 69: 328-340.

Hoenisch, R.W. and Davis, R.M.1994. Relationship between kernel pericarp thickness and susceptibility to *Fusarium* ear rot in field corn. Plant Dis., 78: 517-519.

Jeffers, D., Cordova, H., Srinivasan, G., Beck, D., Bergvinson, D., and Martinez, L. 2002. Sources of resistance to *Fusarium moniliforme* ear rot in CIMMYT elite maize germplasm. Proceeding, 8 Asian Regional Maize Workshop Thailand: August 5-9, pp. 339-334.

Khalil, Ikbal, I., Abdel-Azim, O.Z. and Sabet, K. A. 1980. Parasitic behaviour of fusaria encountered in the stalk-rot complex of maize. Agric. Res. Rev. 2:27-39.

Khan, J., Qi, A., and Khan, M. F. R. 2009. Flactuations in number of *Cercospora beticola* conidia in relation to environment and disease severity in sugar beet. Phytopathology 99:796-801.

Kommedahl, T., and Windels, C. F. 1981. Root, stalk, and ear infecting fusarium species on corn in the USA. Pages 94-103 in: *Fusarium*: Diseases, Bioloy and Taxonomy. P. F. Nelson, T. A. Toussoun, and R.J. Cook, eds. Pennsylvania State University Press. University Park.

Kriss, A.B., Paul, P. A., and Madden, L. V. 2010. Relationship between yearly fluctuations in *Fusarium* head blight intensity and environmental variables: A windo-pane analysis. Phytopathology 100: 784-797.

Marasas, W. F. O., Nelson, P. E., Toussoun, T. A. 1984. Toxigenic *Fusarium* species: Identity and Toxicology, Pennsylvania State University Press. University Park.

Munkvold, G. P., and Desiardins, A. F. 1997. Fumonisins in maize: Can we reduce their occurrence? Plant Dis. 81: 556-565.

Rheeder, J. P., Marasa, W. F.O., Thiel, P. G., Sydenham, E. W., Shephard, G. S., and Van Schalkwyk, D. J. 1992. *Fusarium moniliforme* and fumonisins in corn relation to human esophageal cancer in Transkei. Phytopathology 82: 353-357.

Scott, G. E., and King, S. B. 1984. Site of action of factors for resistance to fusarium moniliforme in maize. Plant Dis. 68: 804-806.

Tesso, T. T., Claflin, L.E., and Tuinstra, M. R. 2005. Analysis of stalk rot resistance and genetic diversity among drought tolerant sorghum genotypes. Crop Sci. 45: 645-652.

Warren, H. L. 1978. Comparison of normal and high-lysine maize inbreds for resistance to kernel rot caused by *Fusarium moniliforme*. Phytopathology 68: 1331-1335.

Warren, H. L. and Kommedahl, T. 1973. Prevalence and pathogenicity to corn of *Fusarium* species from roots, rhizosphere, residues, and soil. Phytopathology 63: 1288-1290.

White, G. D. Ed. 1999. Compendium of Corn Diseases. 3^{rd} ed. The American Phytopathological Society, St. Paul. MN.

تكشف مرض عفن الكيزان الفيوزاريومى فى الذرة الشامية بثلاثة مواقع جغرافية مختلفة

عبدالله أحمد على النجار و أحمد محمدبشير صبرى
قسم بحوث امراض الذرة الشامية - معهد بحوث أمراض النباتات- مركز البحوث الزراعية - الجيزة - مصر

أختبر 31 صنف تجارى من الذرة الشامية لمرض عفن الكيزان الفيوزاريومى فى ثلاثة مناطق جغرافية هى محطتى بحوث الجميزة وسخا بالدلتا حيث الرطوبة النسبية أعلى من 50% و محطة بحوث سدس بالوجه القبلى حيث الرطوبة النسبية أقل من 50%. أظهرت النتائج أن سبعة هجن من الهجن المختبرة تحمل صفة المقاومة الجزئية للمرض. أظهرت النتائج كذلك أن هناك إرتباط بين الشدة المرضية و الرطوبة النسبية خلال موسمى الإختبار2007 و 2008 (فبينما كانت الشدة المرضية من 4-44% بمحطتى الدلتا تراوحت الرطوبة النسبية من 53-58% وبينما كانت من 3،.- 12 % تراوحت الرطوبة النسبية من 43،5-45% بمحطة الوجه القبلى). كما أظهرت النتائج أنه ليس للفروق فى درجات الحرارة دورفى التأثير على شدة المرض. يمكن إستخدام نتائج هذه الدراسة فى تقسيم مناطق زراعة الذرة الشامية بناءا على مدى ملائمتها للإصابة بمرض عفن الكيزان الفيوزاريومى فى الذرة الشامية.

قام بتحكيم البحث

أ.د / محمد عبد الرحمن الوكيل	**كلية الزراعة – جامعة المنصورة**
أ.د / ابراهيم محمد سليمان منصور	**مركز البحوث الزراعية**