EVALUATION AND CONTROL OF YELLOW CORN GRAIN DETERIORATION CAUSED BY *FUSARIUM* SPP.

By

El-Habbaa G. M.[*]; Mohamed, F. G. [*]; Abou-El-Ella, M. F.[**] and Sabek, I. A.[***]

[*]*Agric. Botany. Dept., Fac. Agric., Moshtohor, Zagazig Univ., Benha Branch, Egypt.*
[**]*Toxicology Dept., Central Lab. for Food and Feed, Agriculture Research Center (ARC), Giza, Egypt*
[***]*Researcher in Misr-Pioneer Seed Company, Egypt*

ABSTRACT

Fusarium moniliforme, *F. tabacinum, F. solani*, *F. semitectum*, *F. tricinectum,* and *F. nivale,* were isolated from un-sterilized and sterilized grains of the single cross (SC-3062), double cross (DC-Dahab) and the female inbred line (FIL-X) of yellow corns. *Fusarium moniliforme* was located in the most different seed parts. E ndosperm infection with *F. moniliforme* was high in FIL-X comparing with SC-3062, meanwhile, the embryo of DC-Dahab was free from the fungus. *Fusarium nivale* and *F. solani* caused highly significant infection percentage at 17% moisture content after 45 days post infestation of corn grains. The infections were increased significantly at 20 and 23% moisture content and reached 100% for all tested *Fusarium* spp. after 45 days post infestation. Corn grains of SC-3062 is more sensitive than DC-Dahab for infection with tested *Fusarium* species. Increasing moisture content levels comparing to control increased total protein, total carbohydrates and oil percent gradually in all infested yellow corn grains with *Fusarium* spp. The highest amount of fumonisins was recorded in infested yellow corn grains (17.1µg/g) with *F. moniliforme* at 23% moisture content. All fungicide treatments significantly reduced infection % on corn grains of DC-Dahab, SC-3062 and FIL-X and had no effect on germination % except vitavax in water reduced germination percent of DC-Dahab and SC-3062 corn grains. As well as, exposing corn grains of hybrid DC-Dahab and SC-3062 to different hot water treatments (45-70°C/5min.) had no effect on germination % but had a great effect on infection % at the same conditions. Treating corn grains with fungicides before storing at room temperature increased germination % and decreased infection percentage with kernel rot pathogens. The best effective fungicide was benlate on corn grains of SC-3062 and DC-Dahab. Treating corn grains with fungicides before storing at 8ºC revealed a great decrease in infection percentage with kernel rot pathogens at zero time. These decreases were clear after storage where increasing storage periods till 90 days decreased infection % of the two hybrids (SC-3062 & DC-Dahab) and FIL-X.

Additional key word: Corn grains hybrids, Fusarium mould, fumonisins and disease control.

INTRODUCTION

Corn (*Zea mays* L.) is one of the most important grain crops all over the world. It is used mainly for animal feeding, poultry wealth either as green fodder or a main component of dry feed and human consumption in some growing countries. Moreover, there are a new industrial uses of corn such as the industrial corn products for clean environment, production of corn oil and corn refining for producing corn germ, corn oil, starch, starch syrup conversion, alcohol by fermentation, dextrose and high fructose corn sweetness (**U.S. Feed Grains Council, 1994**).

A wide variety of microorganisms are present on and in grain kernels. **Jayaweera *et al.* (1988); Singh *et al.*, (1988**) mentioned that, several species of *Fusarium* are known to invade the seed coat, endosperm and the embryo resulting in, failure of germination. The kinds and abundance of these microorganisms depend on factors such as the climate under which the grains are produced, the conditions of storage, and the portion of the grains of which the products are composed **(Khalil *et al*., 1980; Schaafsma *et al*., 1993 and Sobek and Munkvold, 1999).** The fungi that invade and damage grains and their products are divided into two general groups *i.e.* field or storage fungi, according to their ecological requirement (**Payne *et al*., 1988 Desjardins *et al* 2000 and Perez *et al*. 2001**). These mold fungi are making un-desirable and measurable effects on grain quality like discoloration, reduced germination, heating, mustiness, sour odors, chemical changes, loss of weight, reduction in grade and mycotoxin contamination (**Gamal El-Din** *et al*, **1987; Logrieco *et al*., 1995; Kedera *et al*., 1999;and Paein *et al*., 2001**).

Many investigators were controlling of fungi that caused molds on corn seeds with several methods *i.e*., by fungicides (**Danils, 1983; Diab *et al*., 1989 and Li** et al**., 1999**); hot water (**Danils, 1983**) and varietal resistance (**Mesterhazy, 1983; and Zamani *et al*., 2000**).

Misr-Pioneer Seed Company produced a large number of good white and yellow corn hybrids. Pioneer yellow single cross hybrid 3062 is one of them and was developed locally by Pioneer Research Center, Egypt 1996. The only disadvantage of this hybrid is its susceptibility for infection with kernel rots. Thus, this work aimed to throw the light on the associated fungi with different hybrid seeds and their abilities for infection under different conditions as well as determining some chemical changes related to infection. Also, evaluation of some control techniques for limiting mold fungi associated with hybrids of corn seeds.

MATERIALS & METHODS

The present work was carried out during the period of 1999/2001, in the Plant Pathology Lab., Agric. Bot. Dept., Fac. Agric., at Moshtohor.

I- Sampling, Isolation and Identification

Sampling:

Randomized samples of two yellow corn seed hybrids (SC-3062 and DC-Dahab) and female inbred line (FIL-X) which used for producing SC-3062 hybrid, including rotted ears and/or grains which collected from Seed Station of Misr Pioneer Seed Company.

Isolation:

One hundred kernels of each tested yellow corn seed hybrids and inbred line were used for isolation. Corn grain samples were disinfested by immersing into 5% sodium hypochlorite solution for 2 minutes, washed thoroughly in three changes of sterilized water, and dried between sterilized filter paper. Sterilized grains were transferred to potato dextrose agar (PDA) plates then incubated at 25°C and observations were daily recorded **(Christensen, 1957)**. The isolated fungi were purified using hyphal tip technique **(Riker and Riker, 1936)** and then identified according to their morphological and microscopical characters as described by **Jens** *et al.*, **(1991)** and confirmed by Fungal Taxonomy Dept., Plant Pathology Institute, ARC, Egypt.

II- Location of ***Fusarium*** *moniliforme* in seed parts:

One hundred seeds were taken from artificially infested corn ears with spore suspension of *F. moniliforme* using silk spray infection method in the field. Each sample of SC-3062, DC-Dahab and FIL-X were used in this study to determine the location of ***Fusarium*** *moniliforme* in seed parts (i.e. endosperm, embryo and pericarp) according to the method described by **Donald, 1968**.

III- Artificial infection of yellow corn grains with *Fusarium* spp.

Samples preparation

Samples (each one 450 g) of tested yellow corn grains (SC-3062, DC-Dahab and FIL-X) collected from Seed Station of Misr Pioneer Seed Company were scratched by shaking with sand for 1 min (**Eisa (Nawal) *et al.* 1996**), disinfested by immersing in 5% sodium hypochlorite for 2 min, washed thoroughly with sterilized water and dried in hot-air oven at 44°C for 24 hrs **Osman** (**1982**). Each sample was divided into three equal amounts served as a replicates (for tested *Fusarium* spp. and control), then all samples were divided into sub-samples and transferred into three sterilized glass containers 1.0 liter (**Eisa (Nawal) *et al.*, 1996).**

- Moisture content percentage:

Moisture content percentages were determined in samples of tested corn grains (250 g) at room temperature (25–27°C) by Motomco apparatus Serial No. K-1799, USA as recommended by Federal Grain Inspection Services, USA, Dept. of Agric., 1994). The Motomco Model 919 (Moisture Meter) is a portable electronic measuring instrument designed for the determination of moisture content in cereal crops and in a wide variety of other products.

Preparation of spore suspension:

Spore suspension was prepared from pure cultures of *Fusarium spp* (15 days old) grown on PDA plates (9 cm). The tested grains were inoculated with final density of approximately 3000-3500 spore/gram of corn grains as described by (**Eisa (Nawal) *et al.*, 1996**). Moisture content of corn grains was adjusted to the required moisture (13, 15, 17, 20, and 23%) as described by approved method of American Association of Cereal Chemists (**A.O.A.C., 1990**).

A- Infection %

Infected grains were counted in three replicates, (each replicate was 100 kernel), then infection percentage of grain was calculated in the same replicates according to **Papvizas and Christensen** (**1960**).

B- Biochemical changes in corn grains associated with the Fusarium infection(s):

a- Total protein:

Protein was determined by Kjeldahl method according to **A.O.A.C** (**1990**).

b- Total carbohydrates:

Carbohydrate was determined using the phenol-sulphuric acid method described by **Dubois *et al.*** (**1956**) using the following equation.

Carbohydrates % $= \frac{\text{Read out of S} \times \text{concentration of st}}{\text{wt. of S} \times \text{Read out of the st}} \times 100$

where: S = the sample st = the standard wt = weight (grams)

c- Determination of totat oils %:

Oils % was determined using continuous extraction method as described by **A.O.A.C.** (**1990**) as follows:

$$\text{Ether \%} = \frac{(\text{flask weight} + \text{fat}) - \text{empty flask weight}}{(\text{sample weight})} \times 100$$

C- Determination of *Fusarium* spp. mycotoxins (fumonisins):

Fumonisin as a special mycotoxin produced by *Fusarium* spp. was determined as described in **A.O.A.C. (1990)** in sub-samples of corn grains previously infested with the different *Fusarium* spp. and incubated for 45-days.

IV- Control trials

1- Effect of hot water treatment on the development of *Fusarium* spp. **in tested corn seeds:**

In this experiment, maize seeds of SC- 3062, DC-Dahab and FIL-X were soaked in distilled sterile water at 18-22°C for 4 hrs. Then the seeds were subjected for soaking in hot water for 5 min at different temperatures i.e. 45, 50, 55, 60 and 70°C. Maize grains without any hot water treatment served as a control. Three replicates of each treatment (50 seeds/replicate) were done. Seeds were plated onto the special germination paper directly and incubated at 25-27°C for 12 days. Percentage of germinated seeds and infection by *Fusarium moniliforme* were recorded.

2- Effect of seed disinfection on Fusarium rot incidence and seed germination.

To carry out this experiment, 150 seeds of each of SC- 3062, DC- Dahab and FIL-X were used for each treatment in three replicates (50 seed for each). Corn seeds were soaked in a water solution of vitavax-200, and captan 50% at 2000 ppm for 24 hr before examining the presence of *F. moniliforme*. Also, corn seeds were soaked in acetone solution of vitavax-200, and captan 50% at 2000 ppm for 24 hr. before examination. Control treatment was seeds without surface sterilization. The aim of this experiment is to determine seed germination % and the presence of *Fusarium* throughout estimation infection % according to the visible symptoms and confirmed by microscopic examination in the tested seeds that incubated at 27°C for 7 days according to the method adopted by **Daniels** (**1983**).

3- Effect of systemic and non-systemic fungicides and storage for different periods at 8°C and room temperature on kernel rot development:

To carry out this experiment, corn seeds of SC-3062, DC-Dahab and FIL-X were stored at 8°C and at room temperature (Three replicates for each treatment and 150 g seeds/replicate). Seeds were tested soon after seed treatment, and after three months. The seeds were examined for presence of *Fusarium moniliforme* by the color or originated colonies and confirmed by microscopic examination.

The following systemic and non-systemic fungicides were applied as seed dressers i.e., benlate 50 % (Benomyl), vitavax 200 (Carboxin- Thiram), redomil-mancozeb 58% (Mitalaxil- Mancozeb), dithene-M-45 (Mancozeb 80%) and captan 50% (Orthocide). Seeds were mixed by the fungicides in three conc. 1, 2 and 3 g/kg seeds and stored for 3 months. Control treatment was left without any chemical treatment and stored for the same storage period as mentioned above. For examination, 150 kernels of maize seeds from each treatment were transferred onto moisten special germination paper (50 seed for each) and incubated at 25 °C for 7 days. Percentage of germinated seeds was determined, and, the developed visible fungal colonies were identified as mentioned before.

Statistical analysis:

Data obtained were subjected to the proper analysis of variance according to **Snedecor** and **Cochran** (**1989**).

EXPERIMENTAL RESULTS

1-Isolation and frequency of fungi associated with un-sterilized and sterilized kernels of two yellow corn hybrids and one female inbred line:

Data as shown in **Table (1)** revealed presence of 217 fungal isolate that isolated from un-sterilized kernels of two yellow corn hybrids (SC-3062 and DC-Dahab) and one female inbred line (FIL-X). These fungal isolates were belonging to 5 genera and 15 species. These isolated fungi were identified as *Aspergillus flavus* (36), *A. niger* (18), *A. versicolor* (17) and one isolate of *A. terrus* and *A. ochraceus*. On the other hand, 27 isolate belong to *Fusarium moniliforme*, 14 isolate for each of *F. tabacinum* and *F. solani*, 13 isolate for *F. semitectum*, 9 isolate for *F. tricinectum* and 8 isolate for *F. nivale*. Only one isolate is belonging to *Penicillium funculosum*. Meanwhile, 23 isolate were found to belong to each one of *Alternaria* and *Rhizopus* spp and 12 isolates were unknown fungi.

SC-3062 showed the highest frequency (112 isolate) followed by DC-Dahab (56 isolate) and FIL-X (49 isolate). Meanwhile, *A. flavus*, *F. moniliforme*, *F. semitectum*, *F. tabacinum*, *F. nivale*, *Alternaria* and *Rhizopus* spp were showed the highest frequency percentages on SC-3062. While, *A. flavus*, *F. solani*, *F. moniliforme*, and *Alternaria* and *Rhizopus* spp were showed the highest frequency percentages on FIL-X. As well as, *A. niger*, *A. flavus*, *A. versicolor*, *F. moniliforme* and *Rhizopus* spp were showed the highest frequency percentage on DC-Dahab.

On the other hand, data in the same table indicated also that, sum of 187 fungal isolate, isolated from sterilized kernels of two yellow corn hybrids (SC-3062 and DC- Dahab) and FIL-X. These fungal isolates belong also to 5 genera and 15 species. These isolates were identified as *A. flavus* (28 isolates), *A.niger* (26), *A. versicolor* (11), *A. terrus* (9) and 5 isolates of *A. ochraceus*. Meanwhile, 22 isolate belong to *F. solani*, 16 isolates to *F. moniliforme*, 15 isolate to *F. semitectum*, 10 isolate for *F. tricinectum* 8 isolate for *F. tabacinum* and 7 isolate for *F. nivale*. While 6 and 5 isolates for *P. funculosum* and *P. digitatum* respectively. Meanwhile, 16 isolate were found to belong to *Alternaria* and *2 isolate to Rhizopus* spp while only one isolate was unknown.

Table (1): Isolation and frequency of fungi associated with un-sterilized and sterilized kernels of two yellow corn hybrids and one female inbred line.

Isolates	Un-sterilized kernels of corn hybrids						Sterilized kernels of corn hybrids					
	SC-3062		FIL-X		DC.Dahab		SC-3062		FIL-X		DC.Dahab	
	No.	% to total	No.	% to total	No.	% to total	No.	% to total	No.	% to total	No.	% to total
A. flavus	18	16.1	10	20.4	8	14.3	9	11.1	9	13.8	10	24.4
A. niger	1	0.9	2	4.1	15	26.8	11	13.6	5	7.7	10	24.4
A. terrus	0	0.0	1	2.0	0	0.0	1	1.2	5	7.7	3	7.3
A. ochraceus	0	0.0	1	2.0	0	0.0	2	2.5	3	4.6	0	0.0
A. versicolor	8	7.1	1	2.0	8	14.3	6	7.4	3	4.6	2	4.9
F. moniliforme	18	16.1	3	6.1	6	10.7	6	7.4	10	15.4	0	0.0
F. semitectum	10	8.9	2	4.1	1	1.8	3	3.7	11	16.9	1	2.4
F. tabacinum	10	8.9	2	4.1	2	3.6	6	7.4	1	1.5	1	2.4
F. tricinectum	5	4.5	3	6.1	1	1.8	8	9.9	1	1.5	1	2.4
F. nivale	8	7.1	0	0.0	0	0.0	5	6.2	1	1.5	1	2.4
F. solani	7	6.3	7	14.3	0	0.0	8	9.9	13	20.0	1	2.4
P. funculosum	0	0.0	1	2.0	0	0.0	2	2.5	2	3.1	2	4.9
P. digitatum	0	0.0	0	0.0	0	0.0	3	3.7	1	1.5	1	2.4
Alternaria sp.	12	10.7	8	16.3	3	5.4	8	9.9	0	0.0	8	19.5
Rhizopus sp.	10	8.9	5	10.2	8	14.3	2	2.5	0	0.0	0	0.0
Unknown	5	4.5	3	6.1	4	7.1	1	1.2	0	0.0	0	0.0
Total	112		49		56		81		65		41	

SC-3062 showed the highest frequency (81 isolate) followed by FIL-X (65 isolate) and DC-Dahab (41 isolate). Meanwhile, *A. niger*, *A. flavus*, *F. tricinectum*, *F. solani*, *F. moniliforme*, *F. tabacinum*, *A. versicolor,* and *Alternaria* spp. were showed the highest frequency percentages on SC-3062. Meanwhile, *F. solani*, *F. semitectum,* *F. moniliforme* and *A. flavus*, were showed the highest frequency percentages on FIL-X. While, *A. flavus*, *A. niger*, and *Alternaria* spp were showed the highest frequency percentages on DC-Dahab.

2- Location of *Fusarium moniliforme* in seed parts:

Data in **Table (2)** clear that *F. moniliforme* was located in the most different seed parts. Meanwhile, the occurrence percentage of the fungus was high in the endosperm of FIL-X (88%) followed by 41% in the pericarp of SC-3062. The results indicated also that embryo infection with *F. moniliforme* was high in FIL-X comparing with SC-3062, meanwhile, the embryo of DC-Dahab was free from the fungus. The least occurrence percentage of *F. moniliforme* was recorded in all different parts of DC-Dahab.

Table (2): The occurrence percentage of *F. moniliforme* in different seed parts of yellow corn kernels (SC-3062, DC-Dahab and FIL-X.)

Seed parts	SC-3062	DC-Dahab	FIL-X
Embryo	6	0	18
Endosperm	11	2	88
Pericarp	41	3	12

3- Artificial infection of yellow corn grains with *Fusarium spp.*

A- Effect of seed infestation of yellow corn hybrids (SC-3062 and DC-Dahab) with some *Fusarium* species on infection percentage.

Data in **Table** (**3**) show that all *Fusarium* species can not able to infect seeds of yellow corn hybrid SC-3062 at 13 and 15% moisture contents. While, infection appeared at levels 17, 20 and 23%. The results clearly show that *F. nivale* and *F. solani* revealed highly significant infection percentage on seeds at 17% moisture content after 45 days post infestation. Meanwhile, *F. semitectum* and *F. moniliforme* gave the lowest infection % at the same condition respectively. It is pronounced that infection % were gradually increased proportionally to moisture content of seeds and incubation periods. The infections were increased significantly at 20 and 23% moisture content of seeds and reached 100% for all tested *Fusarium* spp. after 45 days post infestation. Also, the results show that all tested *Fusarium* species in this study are not able to infect yellow corn hybrid (DC-Dahab) under 13, 15 and 17% of moisture contents. While, 20 and 23% of moisture contents were favorable for infection. *F. moniliforme* caused 22 % infection at 45 days post inoculation followed by *F. semitectum* and *F. solani* at the same time. It is clear also that infection % were affected by the time of incubation periods and % of moisture content of seeds. The seeds of SC-3062 are more sensitive for infection with *Fusarium* species than DC-Dahab. Incubation periods, moisture content % and type of *Fusarium* affected infection percentages also.

Table (3) Infection percentage as a result of infestation of seed corn hybrids with *Fusarium* species

Tested fungi	*I.P (day)	Infection % of yellow corn seeds											
		SC-3062						DC-Dahab					
		Moisture contents %											
		13	15	17	20	23	M	13	15	17	20	23	**M**
F. moniliforme	15	0	0	1.5	10.0	75.0	17.3	0	0	0	0	3	0.6
	30	0	0	4.5	33.0	94.0	26.3	0	0	0	0	8	1.6
	45	0	0	12.0	68.0	100	36.0	0	0	0	2	22	4.8
	M	0.0	0.0	6.0	37.0	89.7	26.3	0.0	0.0	0.0	0.7	11.0	2.33
F. semitectum	15	0	0	1.0	22.0	70.0	18.6	0	0	0	0	0	0.0
	30	0	0	4.5	43.0	99.0	29.3	0	0	0	0	0	0.0
	45	0	0	8.0	59.0	100	33.4	0	0	0	1	16	3.4
	M	0.0	0.0	4.5	41.3	89.7	27.1	0.0	0.0	0.0	0.7	5.3	1.13
F. solani	15	0	0	7.5	14.0	81.0	20.5	0	0	0	0	0	0.0
	30	0	0	26.0	70.3	98.0	38.9	0	0	0	0	0	0.0
	45	0	0	41.0	91.0	100	46.4	0	0	0	2	7	1.8
	M	0.0	0.0	24.8	58.4	93.0	35.3	0.0	0.0	0.0	0.7	2.3	0.6
F. tabacinum	15	0	0	1.5	10.0	54.0	13.1	0	0	0	0	0	0.0
	30	0	0	3.3	36.3	96.6	27.2	0	0	0	0	1	0.2
	45	0	0	21.0	61.0	100	36.4	0	0	0	1	4	1.0
	M	0.0	0.0	8.6	35.8	83.5	25.6	0.0	0.0	0.0	0.33	1.7	0.4
F. nivale	15	0	0	2.1	46.6	65.0	22.7	0	0	0	0	0	0.0
	30	0	0	26.6	73.6	96.6	39.4	0	0	0	0	0	0.0
	45	0	0	52.0	90.0	100	48.4	0	0	0	1	5	1.2
	M	0.0	0.0	26.9	70.1	87.2	36.8	0.0	0.0	0.0	0.33	1.7	0.4
Control	15	0	0	0.0	4.0	10.0	2.8	0	0	0	0	0	0.0
	30	0	0	2.1	8.0	16.0	5.22	0	0	0	0	0	0.0
	45	0	0	4.0	13.0	29.0	9.20	0	0	0	0	2	0.4
	M	0.0	0.0	2.03	8.3	18.3	5.74	0.0	0.0	0.0	0.0	0.67	0.13
Grand Mean		0.0	0.0	12.1	41.8	76.9	26.2	0.0	0.0	0.0	0.39	3.78	0.83

- I.P. (day) = Incubation period (days)

L.S.D at 5% for:

Fungi (F) =	0.31	T x M =	0.49
Hybrid (H =	0.22	F x T =	0.55
Times (T) =	0.22	T x H =	0.31
Moisture =	0.22	**F x M =**	0.70
F x H =	0.45	H X M =	0.40

4- Determination of total protein, total carbohydrates and total oils in infested yellow corn grains (DC-Dhab & SC-3062) with *Fusarium* spp at different moisture contents.

Results in **Table (4)** show that total protein in infested yellow corn seeds of DC-Dahab and SC-3062 with *Fusarium* spp ranged between 7.5-9.5 and 7.5-9.1 respectively. In this respect, the highest total protein % was determined in infested seeds of DC-Dahab with *F. moniliforme* and *F. semitectum* (9.5%) followed by *F. tabacinum* at 23% moisture content while, the least total protein % was recorded in infested seeds with *F. moniliforme* at 13% moisture content. It is pronounced from results of DC-Dahab that increasing moisture content levels increased total protein percent gradually in all infested yellow corn seeds and control. Concerning SC-3062, the highest total protein % was determined in infested seeds of SC-3062 with *F. solani* and *F. tabacinum* at 23% moisture content while, the least total protein % was recorded in infested seeds with *F. nivale* at 15% moisture content. It is clear also that increasing moisture content levels comparing to control increased total protein percent gradually in all infested yellow corn seeds. On the other hand, total carbohydrates in infested yellow corn seeds of DC-Dahab were ranged between 66.0-72.6%. The minimum total carbohydrate % was recorded in infested seeds with *F. nivale* at 23% moisture content while the maximum percent was determined in infested seeds with *F. semitectum* at 17% moisture content. Concerning SC-3062, total carbohydrates were ranged between 68-74%, the minimum total carbohydrate % was recorded in infested seeds with *F. tabacinum* and *F. moniliforme* (68%) at 13 and 15% moisture content respectively. While. The maximum was in infested seeds with *F. solani* (74%) at 23% moisture content. Meanwhile, there was a positive correlation between the determined total carbohydrates and seed moisture contents of SC-3062 that infested with *Fusarium* spp comparing to control treatment. In this respect, the determined total carbohydrates were increased remarkably in all infested seeds of SC-3062 at moisture contents 20 and 23% comparing with control. Results show that total oils in infested yellow corn seeds of DC-Dahab with *Fusarium* spp. ranged between 4.2-5.8% and between 3.3-4.1 of SC-3062. The least oils % was determined at 13% moisture content in infested seeds of DC-Dahab with *F. moniliforme*, *F. solani* and *F. tabacinum* (4.2%). On the other hand, the highest oil percent were determined at 23% moisture content in seeds of DC-Dahab infested with *F. solani*, *F. tabacinum* and *F. moniliforme*. While, it was 4.1% at low moisture content (13-17) of seeds of SC-3062, which infested with *F. semitectum, F. nivale and F. moniliforme.* The results cleared also, that oil percent increased at the high moisture content (20& 23%) in infested seeds of DC-Dahab while, the reverse was true, where oils were decreased in infested yellow corn seeds of SC-3062 at moisture content levels 20 & 23% comparing to control.

5- Determination of fumonisins mycotoxin (µg/g) in infested corn grains with *Fusarium* spp. at different moisture content levels.

Data in **Table (5)** indicate that fumonisins mycotoxins began to appear in infested yellow corn seeds of SC-3062 at 17% moisture content level and reached the maximum production at 23%. Meanwhile, no production was recorded at low moisture levels (13 & 15%). Therefore, the highest amount of fumonisins was recorded in infested yellow corn seeds (17.1µg/g) with *F. moniliforme* at 23% moisture content. Also, all *Fusarium* species were able to produce these mycotoxins but differed in their produced amounts at 23% moisture except *F. tabacinum*. *F. moniliforme* followed by *F. nivale* are consider the highest producer isolates of fumonisins than other tested isolates On the other hand, un-infested treatment (control) recorded fumonisins production (1.2µg/g) at 23% moisture content only.

Table (4): Determination of total protein and total carbohydrates in infested yellow corn grains (DC-Dhab & SC-3062) with *Fusarium* spp at different moisture contents

Tested fungi	DC-Dahab					SC-3062				
	Moisture content % in infested corn grains									
	13	15	17	20	23	13	15	17	20	23
	Total protein									
F. moniliforme	7.5	7.5	8.2	9.1	9.5	7.7	7.7	8.4	8.0	8.9
F. semitectum	7.8	7.6	7.8	9.2	9.5	7.9	7.8	7.9	8.0	8.3
F. solani	7.6	7.9	7.9	9.0	9.2	7.8	7.9	7.9	8.4	9.1
F. tabacinum	7.6	7.9	8.2	9.0	9.4	7.8	7.6	7.9	8.4	9.0
F. nivale	7.8	7.9	8.2	9.0	9.3	7.9	7.5	8.0	8.1	8.5
Control	7.8	8.2	8.4	8.9	9.2	7.9	7.5	7.5	7.5	7.8
	Total carbohydrates									
F. moniliforme	71.8	71.3	71.9	70.1	68.0	68.4	68.0	68.5	70.0	71.3
F. semitectum	72.4	72.6	72.6	69.0	71.0	69.0	72.0	72.4	72.0	73.0
F. solani	72.4	72.2	72.2	71.0	67.0	69.0	69.0	69.0	71.9	74.0
F. tabacinum	71.5	71.9	71.0	70.0	69.1	68.0	68.9	70.0	70.2	73.0
F. nivale	72.3	71.8	70.1	68.0	66.0	68.9	68.4	69.0	71.0	72.1
Control	72.3	72.0	71.0	69.0	68.1	68.9	68.0	68.0	67.0	67.5
	Total fatty oils									
F. moniliforme	4.2	4.4	4.4	5.4	5.7	4.0	4.1	4.1	3.9	3.6
F. semitectum	4.3	4.6	4.9	5.6	5.5	4.1	3.9	3.6	3.6	3.3
F. solani	4.2	4.2	4.5	5.6	5.8	4.0	4.0	3.8	3.6	3.3
F. tabacinum	4.2	4.4	4.7	5.5	5.8	4.0	4.1	3.8	3.6	3.6
F. nivale	4.4	4.5	4.9	5.6	5.8	4.1	4.1	3.8	3.4	3.4
Control	4.4	4.7	4.8	5.0	5.5	4.1	4.0	4.0	4.3	4.2

Table (5): Determination of fumonisins mycotoxin (μg/g) in infested corn grains (SC-3062) with *Fusarium* spp. at different moisture content levels.

Tested fungi	Fumonisins mycotoxins (μg/g) (SC-3062)				
	Moisture content % in infested corn seeds				
	13	15	17	20	23
F. moniliforme	0	0	2.3	5.4	17.1
F. semitectum	0	0	0	0	1.2
F. solani	0	0	0	0	1.2
F. tabacinum	0	0	0	0	0
F. nivale	0	0	0.54	0.8	2.3
Control	0	0	0	0	1.2

6- Control trials:

A- Effect of hot water treatments on seed germination and infection % of *F. moniliforme* the causal agent of ear and kernel rots of yellow corn hybrids

Data in **Table (6)** revealed that exposing seeds of yellow corn hybrid DC-Dahab to different hot water treatments (45-70C/5min.) had no effect on germination % comparing to control treatment. Meanwhile, it has a great effect on infection % at the same conditions where, infection % at 45 and 50C were 10%. In the same time, infection percent were 1 and 1.5% at 70 and 60C respectively. Also, positive correlation between the high water temperature and disease control was noticed. On the other hand, The same trend was recorded on SC-3062 concerning germination % and infection % where, the hot water at 55-70C decreased significantly the infection % on seeds of SC-3062. Concerning FIL-X, all hot water treatments had no clear effect on germination % or infection % comparing to un-treated ones.

B- Effect of disinfection seeds of yellow corn hybrids using fungicides for controlling *Fusarium moniliforme* the causal agent of kernel rots.

Data in **Table (7)** show that all fungicide treatments reduced significantly the infection % on seeds of DC-Dahab, SC-3062 and FIL-X comparing with control treatment. Therefore, all used treatments had no effect on germination % except vitavax in water reduced germination percent of DC-Dahab and SC-3062 seeds comparing to control treatments. On the other hand, vitavax and captan in water as well as vitavax and captan in acetone decreased significantly infection incidence on seeds of SC-3062 and FIL-X and to 0% on seeds of DC-Dahab.

Table (6): Effect of hot water treatments on seed germination and infection % of *F. moniliforme* the causal agent of ear and kernel rots of yellow corn hybrids

Hot water for (5min.)	DC-Dahab		SC-3062		FIL-X		Grand Mean	
	Germ. %	Infection%	Germ. %	Infection%	Germ. %	Infection%	Germ. %	Infection%
45°C	100	10.0	92.0	48	70.0	48	**87.33**	**35.33**
50°C	100	10.0	93.0	44	66.0	42	**86.33**	**32.00**
55°C	100	6.0	93.0	31	76.0	40	**89.67**	**25.67**
60°C	100	1.5	93.0	29	77.5	45	**90.17**	**25.17**
70°C	99	1.0	93.5	25	77.0	39	**89.83**	**21.67**
Control	100	8.0	92.0	48	86.0	49	**92.67**	**35.00**
Grand Mean	**99.83**	**6.083**	**92.75**	**37.50**	**75.42**	**43.83**	**89.33**	**29.14**

L.S.D at 5% for:

Temperature (T)/ germination (G)=	1.20	Hybrid (H)/Infection (I)	1.138
Temperature (T)/ infection (I)	1.61	T x H x G	2.08
Hybrid (H)/germination (G)	085	T x H x I	2.79
Hybrid (H)/germination (G)	085	T x H x I	2.79

Table (7): Influence of corn seed disinfestation treatments on seed germination and % of infected grains with *Fusarium spp.*

Fungicides (2000 ppm/24 hrs soak)	DC- Dahab		SC-3062		FIL-X		Grand Mean	
	Ger %	Inf. %	Ger.%	Inf. %	Ger. %	Inf.%	Ger. %	Inf.%
Vetavax in H_2O	90	0	86	6	67	34	81.0	13.3
Captan in H_2O	99	0	93	2	70	16	87.3	6.0
Vetavax in Acetone	100	0	93	18	70	26	87.7	14.7
Captan in Acetone	99	0	93	10	72	28	88.0	12.7
Untreated (control)	100	8	92	48	86	49	92.7	35.0
Grand Mean	97.6	1.6	91.4	16.8	73.0	30.6	87.3	16.3

L.S.D at 5% for:

Treatments(T)/ germination (G)	1.84	Hybrid (H)/Infection (I)	1.27
Treatments(T)/ infection (I)	1.94	T x H x G	3.18
Hybrid (H)/germination (G)	1.20	T x H x I	3.36

C- Effect of dressing grains of three corn cultivars with different doses of five fungicides on % seed germination and % infection with kernel rot pathogens after storage for 0 and 90 days at room temperature and at 8ºC

Results in **Table** (**8a**) indicated that treating corn seeds with fungicides increased germination % and decreased infection percentage with kernel rot pathogens. The best effective fungicide was benlate when used at rate 1g/kg seeds on seeds of SC-3062 and DC-Dahab where the germination % reached 100% and infection % stilled 0% at zero time. The same trend was similar also on seeds of SC-3062 and DC-Dahab at 90 days storage period followed by vitavax on DC-Dahab only, meanwhile, increasing storage period decreased germination % of stored seeds to somewhat. Also, using all fungicides at 1g/kg seeds had different fluctuated effect where the infection appeared and the germination decreased in case of FIL-X as well as increasing storage periods for all treated seeds decreased infection %. On the other hand, using fungicides as seed dressing at rate 2 and 3 g/kg seeds resulted in similar trend to the previously recorded results on DC-Dahab and SC-3062 with some slight differences in germination %. In all cases, using different fungicides reduced infection percent comparing to control as well as using fungicides led to reducing infection on FIL-X with increasing storage periods. Dithene-M45, captan and redomil-mancozeb were the least effective fungicides comparing with benlate and vitavax. Also, increasing storage periods gradually affected germination of corn seeds but generally it was better than un-treated ones in all cases at all storage periods.

Results in **Table** (**8b**) indicated that treating corn seeds with fungicides at rate 1g/kg seeds before storing them at 8ºC realized slight increase in germination %. In this respect benlate fungicide was the best. On the other hand, treating corn grains with fungicides before storing at 8ºC revealed a great decrease in infection percentage with kernel rot pathogens at zero time comparing to control treatment (untreated seeds). These decreases were clear after storage where increasing storage periods till 90 days decreased infection % of the two hybrids (SC-3062 & DC-Dahab) and FIL-X. The best effective fungicide was benlate when used at rate 1g/kg seeds on seeds of SC-3062 and DC-Dahab where the germination and infection % were 100% and 0% of most cases at different storage periods at 8ºC. On the other hand, using fungicides as seed dressing at rate 2 and 3 g/kg seeds before storage at 8ºC resulted in similar trend to the previously recorded results on DC-Dahab, SC-3062 and FIL-X with some slight differences in germination % at different storage periods. In this respect, increasing concentrations of used fungicides (2-3g/kg seeds) decreased infection % to high extent reached in most cases to 0% comparing to control treatment at the same conditions. Also, these treatments improved germination % of SC-3062 and its FIL-X but this effect was not clear on DC-Dahab. In general, dressing corn seeds with fungicides reduced infection percent comparing to control as well as integration between dressing and seed storage at 8ºC led to reducing infection to high extent reached in most cases 0% depending on types of stored seeds. Furthermore, all tested fungicides (Captan, vitavax, Dithene-M45, Redomil-mancozeb and Benlate) were more effective in reducing infection under storage at 8ºC.

Table (8a): Effect of dressing seeds of three corn cultivars with different doses of five fungicides on % seed germination and % infection with kernel rot pathogens after storage for 0 and 90 days at room temperature.

Fungicides	% Germination						% Infection					
	SC-3062		FIL-X		DC-Dahab		SC-3062		FIL-X		DC-Dahab	
	0 d	90 d	0 d	90 d	0 d	90 d	0 d	90 d	0 d	90 d	0 d	90 d
1g/kg seeds												
Captan	94	80	82	84	98	100	51	5	56	5	4	0
Vetavax	93	88	85	80	100	94	54	6	53	10	3	2
Diathene M45	96	88	86	88	98	100	14	10	28	4	2	4
Radomil mancozib	96	86	80	92	94	100	10	13	44	8	10	2
Benlate	100	98	86	96	100	100	0	2	32	2	0	0
2 g/kg seeds												
Captan	98	88	90	86	100	100	50	3	49	7	4	0
Vetavax	96	92	86	88	98	96	33	4	47	6	3	4
Diathene M45	98	92	90	92	96	100	8	7	16	4	14	3
Radomil mancozib	98	96	86	90	94	98	6	3	10	5	8	3
Benlate	96	100	94	96	100	98	0	0	16	1	0	0
3 g/kg seeds												
Captan	96	84	92	88	100	100	51	2	41	4	2	0
Vetavax	94	90	84	82	100	94	22	0	47	6	4	4
Diathene M45	94	94	90	88	100	100	10	4	16	6	1	0
Radomil mancozib	88	98	84	94	100	98	10	2	6	4	4	2
Benlate	100	98	90	98	100	100	0	2	2	0	0	0
Control	**92**	**72**	**76**	**76**	**100**	**86**	**55**	**28**	**71**	**28**	**6**	**16**

Table (8a): Effect of dressing seeds of three corn cultivars with different doses of five fungicides on % seed germination and % infection with kernel rot pathogens after storage for 0 and 90 days at 8 °C.

Fungicides	% Germination						% Infection					
	SC-3062		FIL-X		DC-Dahab		SC-3062		FIL-X		DC-Dahab	
	0 d	90 d	0 d	90 d	0 d	90 d	0 d	90 d	0 d	90 d	0 d	90 d
1g/kg seeds												
Captan	94	94	84	88	98	96	51	4	20	10	0	0
Vetavax	93	90	90	90	96	100	54	4	18	6	0	0
Diathene M45	96	98	84	92	94	96	14	6	28	8	2	2
Radomil mancozib	96	94	84	94	96	96	10	5	24	16	2	2
Benlate	100	100	90	96	100	94	0	0	6	0	0	0
2 g/kg seeds												
Captan	98	94	80	90	98	98	50	1	10	6	0	0
Vetavax	96	94	86	88	96	98	33	1	10	8	2	0
Diathene M45	98	96	86	88	98	98	8	5	16	6	0	2
Radomil mancozib	98	98	82	96	100	98	6	2	16	10	0	2
Benlate	96	94	92	96	98	100	0	0	4	0	0	0
3 g/kg seeds												
Captan	96	92	80	82	100	98	51	0	9	6	0	2
Vetavax	94	92	82	90	98	100	22	0	4	4	0	0
Diathene M45	94	96	94	86	100	98	10	2	8	6	0	0
Radomil mancozib	88	94	80	92	98	96	10	2	10	6	2	4
Benlate	100	96	92	90	100	98	0	0	2	0	0	1
Control	92	88	78	82	100	98	55	8	33	39	2	3

DISCUSSION

Corn (*Zea mays* L.) is one of the most important grain crops all over the world. A wide variety of microorganisms are present on and in grain kernels. Stored ears and grains are subject to attack by different fungi upon harvest i.e. *Fusarium moniliforme*, *F. graminearum*, *F. oxysporum*, *Aspergillus flavus*, *Aspergillus niger*, *Penicillium* spp., *Nigrospora oryzae*, *Mucor* sp. and *Rhizopus* spp. (**Ibrahim** and **Farag**, **1965**, **Gamal El-Din** *et al*, **1987**).

Isolation and identification of fungi associated with un-sterilized and sterilized kernels of two yellow corn hybrids (SC-3062 and DC-Dahab) and one female inbred line (FIL-X) revealed presence of 217 and 187 fungal isolate respectively that belonged to 5 genra and 15 species. These isolated fungi were identified as follows, *A. flavus*, *A. niger, A. versicolor* and *A. terrus* and *A. ochraceus*. On the other hand, *F. monliforme, F. tabacinum, F. solani, F. semitectum, F. tricinectum* and *F. nivale* were isolated. Also. *P. funculosum* and *P. digitatum*, as well as *Alternaria* and *Rhizopus* spp were isolated. The above mentioned results are in agreement with **Osman *et al*. (1988), Naguib *et al*. (1989), Paul** and **Mishra (1992)** and **Eisa (Nawal) *et al*. (1996)** they reported in general that there are a large number of fungi associated with cereal grains i.e., *Alternaria*, *Cladosporium*, *Macrophomina*, *Fusarium*, *Rhizopus*, *Aspergillus* and *Penicillium* were the most common and wide spread field fungi.

Concerning frequency of fungi on un-sterilized seeds, *A. flavus*, *F. monliforme*, *F. semitectum, F. tabacinum, F. nivale*, *Alternaria* and *Rhizopus* spp showed the highest frequency percentages on SC-3062. While, *A. flavus*, *F. solani, F. monliforme*, and *Alternaria* and *Rhizopus* spp revealed the highest frequency percentages on FIL-X. As well as, *A. niger, A. flavus, A. versicolor, F. monliforme* and *Rhizopus* spp showed the highest frequency percentage on DC-Dahab. In contrary their frequency on sterilized seeds, *A. niger*, *A. flavus*, *F. tricinectum, F. solani*, *F. monliforme*, *F. tabacinum*, *A. versicolor*, and *Alternaria* spp. showed the highest frequency percentages on SC-3062. Meanwhile, *F. solani*, *F. semitectum, F. monliforme* and *A. flavus*, showed the highest frequency percentages on FIL-X.. While, *A. flavus*, *A. niger*, and *Alternaria* spp showed the highest frequency percentages on DC-Dahab. These results are in harmony with **Abbas *et al.* (1988b)** they isolated 81 isolates of *Fusarium* sp from corn ears in Minnesota, USA and Similar results were obtained also by **Abou-El-Ella (2002)** verified this results where he isolated 7 genera and 31 species of fungi from varieties, hybrids and imported corn grains. Most of his isolated fungi were in agreement with these results in type and frequencies. It was clear that *Fusarium* spp. were the highly fungi from both the sterilized or un-sterilized grains. Meanwhile they were used in all this study.

Isolation trials from different seed parts of yellow corn kernels of SC-3062, DC-Dahab and FIL-X cleared that *Fusarium* spp were located in the most different seed parts. Meanwhile, the occurrence percentage of the fungus was high in the endosperm of FIL-X followed by the pericarp of SC-3062. The results indicated also that embryo infection with *Fusarium* spp was high in FIL-X comparing with SC-3062, meanwhile, the embryo of DC-Dahab was free from the fungus. The least occurrence percentage of *Fusarium* spp was recorded in all different parts of DC-Dahab. Similar results were obtained by **Wicklow** (**1988**) and **Singh** *et al.*, (**1988**) who found that *Fusarium moniliforme*, the most common fungus, grew on 52 % of maize kernels as well as **Jayaweera** *et al*., (**1988**) who mentioned that several species of *Fusarium* are known to invade the seed coat, endosperm and the embryo resulting in, failure of germination.

F. nivale and *F. solani* caused the highest infection percentage on infested seeds at 17% moisture content after 45 days post infestation. It is pronounced that infection % were gradually increased proportionally to moisture content of seeds and incubation periods. The infections were high at 20 and 23% moisture content of seeds. Also, all tested *Fusarium* species in this study are not able to infect seeds of yellow corn hybrid (DC-Dahab) under 13, 15 and 17% of moisture contents. While, 20 and 23% of moisture contents were favorable for seed infection with all *Fusarium* species.

F. moniliforme caused the highest infection % at 45 days post inoculation followed by *F. semitectum* and *F. solani* at the same time. These results could be interpret in light the findings of **Khalil *et al*.** (**1980**) and **Kedera *et al.* (1999)** who, showed that infection of inbreds and of their hybrids by *Fusarium moniliforme* was 19-79% and 5-60% respectively. Seeds of SC-3062 are more sensitive than DC-Dahab for infection with tested Fusarium species and infection percentages affected also by incubation periods, moisture content % and type of Fusaruim. The findings of **Hoenisch and Davis (1994)** supported these results where they attributed the differences among hybrids for resistance and susceptibility to infection with Fusarium to different factors like differences between inbred and hybrids, since the inbreds were generally more susceptible than the hybrids. The resistance to kernel infection by a fungus *Fusarium moniliforme* could result from factors in the cytoplasm or nuclear factors operating in the pericarp, endosperm and embryo or it may be the thickness of grain pericarp and aleurone layers of maize hybrids play a role in resistance to ear rot caused by *Fusarium moniliforme* (**Scott** and **King 1984**).

The highest total protein % was determined in infested seeds of DC-Dahab with *F. moniliforme* and *F. semitectum* followed by *F. tabacinum* at 23% moisture content while, the least total protein % was recorded in infested seeds with *F. moniliforme* at 13% moisture content. It is pronounced from results of DC-Dahab that increasing moisture content levels increased total protein percent gradually in all infested yellow corn seeds and control. While, in SC-3062, the highest total protein % was determined in infested seeds with *F. solani* and *F. tabacinum* at 23% moisture content. Regarding total carbohydrates in infested yellow corn seeds of DC-Dahab, the minimum total carbohydrate % was recorded in infested seeds with *F. nivale* at 23% moisture content while the maximum percent was determined in infested seeds with *F. semitectum* at 17% moisture content. Concerning SC-3062, the maximum total carbohydrate % was in infested seeds with *F. solani* at 23% moisture content. Meanwhile, there was a positive correlation between the determined total carbohydrates and seed moisture contents of SC-3062 that infested with *Fusarium* spp comparing to control treatment. The least total oils % in infested yellow corn seeds of DC-Dahab with *Fusarium* spp was determined at 13% moisture content with *F. moniliforme*, *F. solani* and *F. tabacinum.* On the other hand, the highest total oil percent were determined at 23% moisture content in seeds of DC-Dahab infested with *F. solani*, *F. tabacinum* and *F. moniliforme*. The results cleared also, that total oil percent increased at the high moisture content (20& 23%) in infested seeds of DC-Dahab while, the reverse was true, where total oils were decreased in infested yellow corn seeds of SC-3062 at moisture content levels 20 & 23% comparing to control. These results could be interpret in light the findings of **Arinze** and **Yubedee (2000)** who mentioned that *Fusarium moniliforme* [*Gibberella fujikuroi*] caused biochemical changes in maize grains as result of infection and added that levels of starch, sugar, protein, fat, fiber and dry matter were reduced.

Concerning the production of fumonisins mycotoxins in infested yellow corn grains. Results indicated that fumonisins mycotoxins began to appear in seeds of SC-3062 at 17% moisture content level and reached the maximum production at 23%. Meanwhile, no production was recorded at low moisture levels (13 & 15%). Therefore, the highest amount of fumonisins was recorded in infested yellow corn seeds (SC-3062) with *F. moniliforme* at 23% moisture content. Also, all *Fusarium* species were able to produce these mycotoxins but differed in their produced amounts at 23% moisture except *F. tabacinum*. The results indicated also that *F. moniliforme* followed by *F. nivale* are consider the highest producer isolates of fumonisins than other tested isolates. These results are in harmony with the findings of **Logrieco *et al.* (1995)** and **Kedera *et al.* (1999)** who found that *F. moniliforme* (*G. fujikuroi*) were high fumonisin-producing species on Kenyan maize. Similar results were obtained also by **Desjardins** and **Plattner (2000)** and **Pacin *et al.* (2001)**

Exposing seeds of yellow corn hybrid DC-Dahab and SC-3062 to different hot water treatments (45-70°C/5min.) had no effect on germination % comparing to control treatment. Meanwhile, it has a great effect on infection % at the same conditions where, infection % at 45 and 50°C was higher than at 70 and 60°C respectively. While, FIL-X, all hot water treatments had no clear effect on germination % or infection % comparing to un-treated ones. These results are in harmony with the results of **El-Meleigi** *et al*., (**1980**) who reported that seeds free from *Fusarium moniliforme* could be obtained by combined ethanol and hot water treatments and **Salama** and **Mishricky** (**1973**) they suggested that corn seeds could be disinfected by soaking in tap water for 5 hrs at room temperature and then for 10 min at 53-56°C.

As for control treatments, all fungicide treatments reduced infection % on seeds of DC-Dahab, SC-3062 and FIL-X comparing with control treatment. Therefore, all used treatments had no effect on germination % except vitavax in water reduced germination percent of DC-Dahab and SC-3062 seeds comparing to control treatments. On the other hand, vitavax and captan in water as well as vitavax and captan in acetone decreased infection incidence to high extent on seeds of SC-3062, FIL-X and DC-Dahab. Regarding to storing treated corn seeds with fungicides at room temperature (20-28ºC) or at 8ºC, treating corn seeds with fungicides and stored at room temperature increased germination % and decreased infection percentage with kernel rot pathogens. The best effective fungicide was benlate when used at rate 1g/kg seeds on seeds of SC-3062 and DC-Dahab at zero time till 90 days storage periods. Meanwhile, increasing storage period decreased germination % of stored seeds to somewhat. On the other hand, using fungicides as seed dressing at rate 2 and 3 g/kg seeds resulted in similar trend to the previously recorded results on DC-Dahab and SC-3062 with some slight differences in germination %. In all cases, using different fungicides reduced infection percent comparing to control as well as using fungicides led to reduce infection on FIL-X with increasing storage periods. Dithene-M45, captan and redomil-mancozeb were the least effective fungicides comparing with benlate and vitavax. Also, increasing storage periods gradually affected germination of corn seeds but generally it was better than un-treated ones in all cases at all storage periods. The same trend was noticed when seeds were stored at 8ºC with clearly minimizing kernel rot %. In this respect, the previously results were confirmed by **Singh** *et al.* (**1971**), **Papayan** *et al.* (**1975**) **El-Khadem** *et al.* (**1979**) they showed that benlate was very effective in eliminating seed rot fungi. While, vitavax-captan was very effective in controlling post-emergence losses caused by *Fusarium monilifonne*. Also, similar results were obtained by **Daniels** (**1983**) **El-Sawah** *et al*. (**1984**), **Diab** *et al*., (**1989**) **Xu *et al.* (1997)** and **Li *et al.* (1999)**. All of them verified that seed treatment by fungicides i.e. benlate and vitavax and some others controlled grain rot and minimized loss of grain germination.

REFERENCES

A.O.A.C. (1990): Official Methods of Official Analysis, *15th ed, Kenneth Helrich edit, published by the Association of Official Analytical Chemists, Inc., Virginia, USA.*

Abbas, H.K.; Mirocha, C.J.; Meronuck, R.A.; Pokorny, J.D.; Gould, S.L. and Kommedahl, T. (1988b): Mycotoxins and *Fusarium* spp. associated with infected ears of corn in Minnesota. *Applied-and-Environmental-Microbiology, 54(8): 1930-1933.*

Abou-El-Ella, M. F. (2002): Studies on maize grains deterioration under Egyptian conditions. *Ph.D. Thesis, Fac. Agric. Moshtohor, Benha Branch, Zagazig Univ., Egypt, 139 pp.*

Arinze, A. E. and Yubedee, A.G. (2000): Effect of fungicides on fusarium grain rot and enzyme production in maize (*Zea mays* L.). *Global J. of Pure and Applied Sciences, 6(4): 629-634.*

Christensen, C.M. (1957): Deterioration of stored grains by fungi. *Botan. Rev., 23: 108-134.*

Daniels, B.A. (1983): Elimination of *Fusarium moniliforme* from corn seed. Plant Didease, **67**: 609-611.

Desjardins, A.E. and Plattner, R.D. (2000): Fumonisin B1-nonproducing strains of *Fusarium verticillioides* cause maize (*Zea mays*) ear infection and ear rot. *Journal-of-Agricultural-and-Food-Chemistry, 48(11): 5773-5780.*

Desjardins, A.E.; Gyanu, M.; Plattner, R.D.; Maragos, C.M.; Krishna, S.; McCormick, S.P.; Manandhar, G. and Shrestha, K. (2000): Occurrence of Fusarium species and mycotoxins in Nepalese maize and wheat and the effect of traditional processing methods on mycotoxin levels. *Journal-of-Agricultural-and-Food-Chemistry, 48(4): 1377-1383.*

Diab, M .M.; Awad, M. A.; Younis, S. and Mohamed, S. A. (1989): Factors affecting grain rot of maize. *Minufiya J. Agric. Res. 14 (2): 1440 - 1452.*

Dubois, M.; Gilles, K.A.; Hamilton, J.K.; Repers, B.A. and Smith, F. (1956): Colorimetric method for determination of sugar related substances. *Analytical Chemistry, 28(3):350-356.*

Eisa, (Nawal) A.N.; S.K. Abdel-Reheem; A.E. Badr and M.F. Abol-Ela, (1996a): Pathological studies on deterioration of yellow corn during storage and its control. I-Associated fungi, percentage of infection and its control. *Al-Azhar, J. Agric. Res., 24(12): 65-81.*

El-Khadem, M.; Mehiar, F. F.; Fadel, F. and El - Sharawi, M. M. (1979): Fungicidal treatments of maize seed against stalk and root rot fungi. *Proc . 3rd Arab Pesticide Conf. Tanta Univ. September 111: 421 - 427.*

El-Meleigi, M. A.; Uyemoto, J. K. and Claflin, L. E. (1980): A method for removing *Fusarium moniliforme* from infested corn kernels. (Abstr.) *Phytopathology, 71: 215.*

El-Sawah, M. Y.; Eid, E.; Ikbal Khalil, L.; Diab, M. M. and El - Assiuty, E. M. (1984): Effect of fungicides on control of maize seed rot fungi and viability of stored seed. *Agricultural Research Review., 62 (2): 41 - 53.*

FGIS (1994): *Federal Grains Inspection Service, United States Department of Agriculture, Kansas, Missouri, USA.*

Gamal El -Din, L. F.; Ahmed, K. G. M.; Mahdy, A. M. M. and Abdel -Wahab (Mervat), E. E. (1987): Studies on some fungi causing deterioration of maize grains during storage. *Proc . 5th Cong . Phytopath . Soc., Giza.*

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(5): 517-519.*

Ibrahim, I. A. and Farag, S. A. (1965): A study on some fungi isolated from grains of Egyptian maize varieties. *Alex. J. Agric. Res., 13: 401 - 413.*

Jayaweera, K. P.; Wijesundera, R. L. C. and Medis, S. A. (1988): Seed - borne fungi of *Oryza sativa*. *Indian Phytopath. 41 (3): 355 - 358.*

Jens, C.F.; V. Thrane and S.B. Mathur (1991): An illustrated Manual on identification of some seed-borne Aspergilli, Fusaria, Penicillia and their Mycotoxins. *Danish*

Government Institute of Seed Pathology for Developing Countries. Ryvans Alle 78, DK, 2900 Hellerue, Denmark.

Kedera, C.J.; Plattner, R.D. and Desjardins, A.E .(1999): Incidence of *Fusarium* spp. and levels of fumonisin B1 in maize in western Kenya. *App. and-Envi.-Microbiology, 65(1): 41-44.*

Khalil, I.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., 58(2): 27-40.*

Li, J. Q.; Li, H. L.; Yuan, H. X.; Zhang, S. X. ; Li, J.Q.; Li, H.L.; Yuan, H.X. and Zhang, S.X. (1999): Effect of seed coating treatment on the control of seedling disease, growth and yield of corn. *Journal-of-China-Agricultural-University. 1999, 4: 5, 82-86.*

Logrieco, A.; Moretti, A.; Ritieni, A.; Bottalico, A. and Corda, P. (1995): Occurrence and toxigenicity of *Fusarium proliferatum* from preharvest maize ear rot, and associated mycotoxins, in Italy. *Plant-Disease, 79(7): 727-731.*

Mesterhazy, A. (1983): Breeding of wheat and corn for resistance against Fusarium diseases. *Demokratischen-Republik. 216 (II): 517-522.*

Naguib, K.; Sahab, A.F.; Metwally, M. and El-Sayed, A.A. (1989): Fungal flora associated with corn grains with special references to vomitoxin production. *African-Journal-of-Agricultural-Sciences, 16(1-2): 31-4.*

Osman, A.R. (1982): Studies on fungi associated on the sorghum grains during storage. *Ph. D. Thesis, Fac. of Agric., Cairo Univ*.

Osman, A.R.; M.S. Mikhail; H.Y. Aly and N.K. Soleman (1988): Sorghum grain-borne fungi and their effect on grain viability under different storage conditions. *Egypt. J. of Phytopathol., 20(1): 47-61.*

Pacin, A.M.; Broggi, L.E.; Resnik, S.L.; Gonzalez, H.H.L. (2001): Mycoflora and mycotoxins natural occurrence in corn from Entre Rios province, Argentina. *Mycotoxin-Research. 2001, 17: 1, 31-38.*

Papayan, F. A.; Mkrtchgon, G. A.; Azatyan, S. A. and Nikogosyan, E. F. (1975): Vitavax-highly effective disinfectant of wheat seed against loose smut and common bunt infection. *Khimiya V sel Skom Khozyaistve B (5): 50-52. (c.f. Selective Dissemination of information (SDI) Provided by international Maize and wheat improvement center (CIMMYT), Personal communications).*

Papvizas, C. C. and Christensen, C. M. (1960): Grain storage studies. 29: Effect of invasion by individual species and mixture of species of Aspergillus upon germination and development of discolored germs in wheat. *Cereal Chem., 37: 197-203.*

Paul, M.C. and R.R. Mishra (1992): Studies on seed mycoflora of maize. *I- Seasonal variation in mycoflora. Crop Research (Hisar), 5: 225-232. (c.f. Plant Path., 1993, 72(9): 684).*

Payne, G. A. ; Thompson, D. L.; Lallchor, I. B. ; Zuber, M. S. and Adkins, C. R. (1988): Effect of temperature on the preharvest infection of maize kernels by *Aspergillus flavus. Phytopathology, 78 : 1376 - 1379* .

Perez, B. D.; Jeffers, D.; Gonzalez, L.D.; Khairallah, M.; Cortes, C.M.; Velazquez, C. G.; Azpiroz, R.S.; Ganesan, S. and Srinivasan, G. (2001): QTL mapping of *Fusarium moniliforme* ear rot resistance in highland maize, Mexico. *Agrociencia. 2001, 35: 2, 181-196.*

Riker, A.J. and R. S. Riker (1936): Introduction to research on plant disease. John, S. Swipt, Co., Inc. Sta. Lovis, Chicago, New York, 117pp. (*c.f. Osman, Y.A., Studies on fungi association sorghum grains during storage. Ph. D. Thesis, Fac. of Agric., Cairo Univ., 1982.*

Salama, A. M. and Mishricky, A. G. (1973): Seed transmission of maize wilt fungi with special reference to *Fusarium moniliforme* sheld. *Phytopathology Z., 77: 356 -362* .

Schaafsma, A.W.; Miller, J.D.; Savard, M.E. and Ewing, R.J. (1993): Ear rot development and mycotoxin production in corn in relation to inoculation method, corn hybrid, and species of *Fusarium. Canadian-Journal-of-Plant-Pathology, 15(3): 185-192.*

Scott, G. E. and King, S. B. (1984): Site of action of factors for resistance to *Fusarium moniliforme* in maize. *Plant Disease, 68: 804 -806 .*

Singh, D. P.; Agarwall, V. K. and Khetarpal, R. K. (1988): Etiology and host - pathogen relationship of grain mold of sorghum. *Indian Phytopath., 41(3): 389 - 397.*

Singh, R. S.; Chanbe, H. S. and Singh, N. (1971): Toxicity of systemic fungicides against internal seed -borne pathogens of maize. *Indian J . Agric . Sci.; 41: 572 -576 .*

Snedecor, G.W. and Cochran, W.G. (1989): Statistical methods. *The Iowa State Univ. Press, Ames, USA, 7th Ed. pp.77.*

Sobek, E.A. and Munkvold, G.P. (1999): European corn borer (*Lepidoptera*: *Pyralidae*) larvae as vectors of *Fusarium moniliforme*, causing kernel rot and symptomless infection of maize kernels. *Journal-of-Economic-Entomology, 92(3): 503-509.*

Wicklow, D. T. (1988): Patterns of fungal association within maize kernels harvested in north Carolina . *Plant disease 72 : 113 - 115 .*

Xu, Z.T.; Li, L.; Wang, D.J.; Zhang, G.X.; Xu, Z.T.; Li, L.; Wang, D.J. and Zhang, G.X. (1997): Control of corn stem rot caused by *P. aphanidermatum* and *Fusarium graminearum* with Genbao mixtures. *Plant-Protection, 23(1): 44-45.*

Zamani, M.; Alizadeh, A. and Choukan, R. (2000): Evaluation of resistance of selected corn lines to *Fusarium moniliforme* ear rot. *Seed-and-Plant, 15(4): 331- 342.*

تقييم ومقاومة تلف حبوب الذرة الصفراء الناتج عن الإصابة بفطريات الفيوزاريوم

جهاد محمد دسوقي الهباء* – فتحى جاد محمد* – محمد فتحي أبو العلا– إبراهيم سابق أحمد سابق***
* قسم النبات الزراعى – كلية الزراعة بمشتهر – جامعة الزقازيق (فرع بنها) – مصر.
** قسم السموم – المعمل المركزي للأغذية والأعلاف– مركز البحوث الزراعية – الجيزة– مصر.
*** باحث في شركة مصر بيونير للبذور– مصر.**

عزلت فطريات فيوزاريوم مونيليفورم و فيوزاريوم تابسينيم و فيوزاريوم ســولاني ، و فيوزاريــوم سيمتكتم ، و فيوزاريوم تريسينيكتم و فيوزاريوم نيفال من حبوب الذرة الصفراء المعقمة و الغير معقمة للهجين فردي– 3062 والهجين الزوجي–دهب و السلالة -X المستخدمة كأم لإنتاج الهجين فردي– 3062. وقد أثبت الفحص وجود فطر فيوزاريوم مونيليفورم في معظم أجزاء حبة الذرة للهجن السابقة. حيث كان تواجد هــذا الفطر مرتفعاً في اندوسبيرم السلالة -X المستخدمة كأم مقارنة بالهجين الفردي– 3062 في حين كان جنــين الهجين الزوجي–دهب خالياً تماما من هذا الفطر.

وقد أثبتت تجارب العدوي الصناعية أن فطري فيوزاريوم نيفال وفيوزاريوم سولاني هما اللذان سببا أعلي نسبة اصابة عند محتوي رطوبة 17% في الحبوب بعد 45 يوما من العدوي. وازدادت نسبة الإصــابة زيادة معنوية عند مستويات الرطوبة 20 و 23% حيث وصلت إلي 100% لكل عزلات الفيوزاريوم بعد 45 يوما من العدوي. وكانت حبوب الهجين الفردي– 3062 أكثر حساسية للإصابة بعزلات الفيوزاريــوم عــن الهجين الزوجي–دهب. واتضح أن زيادة مستويات الرطوبة أدت لزيادة كل من البروتينات والكربوهيــدرات الكلية وكذلك كمية الزيت في حبوب الذرة المصابة. وقد لوحظ أن أعلي نسبة مــن توكــسين الفيــومينزنس (17.1 ميكروجرام/جرام) قد سجلت في حبوب الذرة المعداة بالفطر فيوزاريوم مونيليفــورم عنــد مــستوي رطوبة 23%. من ناحية أخري كل المبيدات المستخدمة خفضت معنويا من نسبة الإصابة في حبوب الــذرة ولم يكن لها تأثير علي نسبة إنباتها باستثناء مبيد الفيتافاكس المذاب في الماء حيث قلل من نسبة إنبات حبــوب كل من الهجين الزوجي–دهب و الهجين الفردي– 3062. أيضا فإن تعريض حبوب هجــن الــذرة الــسابقة لمعاملات مختلفة من الماء الساخن (45–70°م/ 5ق) لم يكن لها تأثير علي نسبة الإنبات بل كان لهــا تــأثير كبيراً في خفض نسبة الإصابة. كما أدت معاملة حبوب الذرة بالمبيدات قبل تخزينها علي درجة حرارة الغرفة إلي زيادة نسبة الإنبات وخفض نسبة الإصابة بأعفان الكيزان. وكان مبيد البنليت هو الأفضل عند اســتخدامه في معاملة حبوب الهجن السابقة. وكان نفس الاتجاة صحيحا عند معاملة الحبوب بالمبيدات قبل تخزينها علــي درجة 8°م. وكان تأثير المعاملة بالمبيدات واضحا في خفض الاصابة حتى 90 يوما مــن تخــزين تقــاوي الهجينان والسلالة -X المستخدمة كأم.