Role of Some Insects in Transmission Some Apple Orchard Diseases in Egypt

Shadia E. Abd El-Aziz[1], N.Y. Abd El-Ghafar[2] and E.M.Embaby[3*]

[1.] Pests & Plant Protection Dept., National Research Centre
[2.] Plant Pathology Dept., Faculty of Agriculture, Ain Shams Univ.
[3.] Plant Pathology Dept., National Research Centre, Egypt
*embaby.elsayed@yahoo.com

Abstract: Insects are probably the most important agents for spreading certain pathogenic diseases. Honeybee, *Apis mellifera* and rose chafer beetle, *Epicometic (Tropinota) squalida* played an important role to disseminate plant pathogenic diseases. Isolation from diseased apple orchard trees (*Malus domestica*) at EL-Nobaria location, Behira Governorate, Egypt, resulted that, three bacterial genera i.e. *Erwinia amylovora*, *Pseudomonas syringae*, *P. cichurii and Planococcus* spp., in addition the fungus *Monilinia mali* were isolated and identified from infected apple samples. *Erwinia amylovora* and *P. syringae* were the most frequency than others which recorded 30%, followed by *M. mali* fungus which gaves 20%. Both *P. cichurii* and *Planococcus* spp. were the less frequency and each occurred with 10%. Honeybee *(Apis mellifera)* and rose chafer (*E. squalida*) insects were more efficacy to borne and transfer *M. mali* fungus, *E. amylovora* and *P. syringae* as externally than internally. Population of these pathogens and percentage of contaminated insects were more effective during February and March than April. *A. mellifera* was more efficacy than *E. squalida* to transmit bacterial pathogens compared with pathogenic fungus. Meanwhile, *E. squalida* was more efficacy than *A. mellifera* to transmit pathogenic fungus than bacteria. However, insects were the most efficacious to transfer all tested pathogens mechanically. *A. mellifera* was more effective than *E. squalida* to transmit all tested pathogens.
[Shadia E. Abd El-Aziz, N.Y. Abd El-Ghafar and E.M.Embaby. Role of Some Insects in Transmission Some Apple Orchard Diseases in Egypt. Journal of American Science 2011;7(4):51-59]. (ISSN: 1545-1003). http://www.americanscience.org.

Keywords: Apple diseases, *Erwinia amylovora*; *Pseudomonas syringae* bacteria; *Monilinia mali* fungus; *Apis mellifera*; *Epicometic squalida*; insects

1. Introduction

Apple (*Malus pumila*, Mill) is one of the most important fruit crops and the fruits are considered as one of the popular fruits in many countries in the world. Apple trees attack by several microorganisms i.e. fungi, bacteria, viruses ….etc. in many of the important pomes fruit producing countries, and causing sever disease in different developmental stages as well as causing economic losses. So, the total cultivated areas of apple orchard in Egypt. were decreased from 26777.42 hectares in season (2006) to 24558.48 hectares in season (2008). Also, the total production area was decreased from 24518.41 hectares in season (2005) to 23010.93 hectares in season (2008). On the other hand, the total productivity were reduced from 23.57 to 15.67 (Ton/hectare) from 2005 to 2008 seasons, respectively. The presence data were tabulated in Table (1)*.

Generally: Vector-pathogen relationships are important factors of epidemiologies of many plant diseases. Insects can be vectors of many plant pathogens including bacteria, mycoplasmas, viruses and fungi. They spread diseases by two basic methods; first, they carry fungal spores around with them like a bee pollinating plants. These spores are superficial and simply contaminate the insect. Other insects spread disease when they feed on an infected plant or weeds (Purcell and Almeida, 2005).

Table 1. The total cultivated area (hec.), total production area (hec.) and yield production (Ton/hec.) of apple orchards in Egypt during (2005- 2008) seasons.

Season	Total cultivated area (hectare)	Total production area (hectare)	Yield production (Ton/ hectare)
2005	26483.61	24518.41	23.57
2006	26777.42	24188.99	23.57
2007	24798.87	23262.24	23.99
2008	24558.48	23010.93	15.67

*Calculated by the General Department of agricultural statistics Ministry of Agriculture 2009.

Loss: In 1995, considerable loss of apple and pear flowers in parts of Switzerland was caused by fire blight. A chemical treatment is not available, so it is recommended that honey bees - which are possible vectors of the bacteria [*Erwinia amylovora*]

- should not be moved from areas with fire blight to fruit growing areas without it. Many plant diseases in the field or in harvested plant produce become much more serious and damaging in the presence of specific or non-specific insect vectors that spread the pathogen to new hosts. Insect vectors directly or indirectly caused about 30-40% of the plants damage and losses (Agrios, 1997). Destructive bacterial fire blight disease caused by *Erwinia amylovora* was introduced by bringing honey bee hives from Samsun to Gokhoyuk State Farm in Amasya in 1988. Since then infection has destroyed orchards of pears and quinces year by year with an increasing rate. In 1997 the orchards of pomes fruits in all the districts of Amasya except Gumushackoy and Hamamozu were infected with disease. Despite the late contamination to Tokat, orchards of pomes fruit in the districts of Pazar, Turhal, Yesilyurt and Zile as well as Central district were infected by up to 14.42% with fire blight.

Causal organisms: Fire blight occurs in many of the important pomes fruit producing countries. Other names formerly used are twig blight, blossom blight, fruit blight and spur blight. The leaves, green shoots, fruits, mature branches, and roots are attacked. Symptoms first appear on the blossom, which wither and die. Under humid conditions the affected blossoms and fruit exude creamy yellow of the ooze. Insects are the major agents of transmission (fire blight) from canker to blossom and from blossom to blossom, the honeybee is capable of transmitting the pathogen from blossom to blossom, but this insect is not known to visit cankers. Fire blight caused by *Erwinia amylovora* and is undoubtedly the most devastating diseases affecting apple, pear and other rosaceous plants (Fahy & Persly, 1983; Jones & Aldwinckle, 1990; Thomson, 1992; Zwet & Beer, 1995 and Vanneste, 2000). Bacterial ooze on cankers is carried into open blossoms by rainfall and probably more commonly by flies, ants and honey-bees. Aphids and leafhoppers also transmit the pathogen to growing terminals and water-sprouts (Hayward and Waterston, 1965). When *E. amylovora,* is present in nectar in flowers, nectar-collecting honey bees may carry the bacteria back to their colony. When flowers are infected, honey bees can spread bacteria to other trees. The life cycles of *Erwinia amylovora* on apples, pears and other rosaceae and its insect vectors, particularly pollinating insects, are outlined. Transmission of *E. amylovora* by domestic bees is considered in more detail. *Erwinia amylovora*, the causal agent of pomes fruit fire blight, it is a minor problem on apples. Insects are considered to play an important role in the spread of the inoculum especially pollinating insects, as well as sucking, chewing and boring insects are claimed to be active in infection, and even a certain level of specificity between some insects and their role disseminating the bacteria is supposed. Insects were formerly supposed to be the major cause of infection and infections may take place even without a wound on young tissues (shoots and leaves) provided the level of moisture is high (Jean, 1997). The disease effects essentially the transportation of honey bee (*Apis mellifera*) colonies. Bees are recognized as very successful short-distance disseminators of bacteria in the spring time. They may also act as vectors of the disease over large distances, when bee colonies are moved from infected to clear areas in April, May and June.

Blossom blight caused by *Pseudomonas syringae* and attack several hosts (Fahy & Persly, 1983, Jones & Aldwinckle, 1990 and Zwet & Beer, 1995). Three pathovars of *Pseudomonas syringae* are involved in the blast, canker and fruit spot syndrome of pomes fruit. Two pathovars caused of *P. syringae* are occasionally involved in a blossom blast and canker disease. A third pathovar caused branch cankers, bud blight, dead buds and leaf spots. Pollination is a predisposing factor in blossom blast.

Monilia blast caused by *M. mali* is an important diseases of apple and pear of wild species of Malus (Jones and Aldwinckle, 1990). Newly opened flower are normally free of pathogens and remain if protected from insect visitation or rain splash (Johnson & Stockwell, 1998). A variety of sucking insects that feed on fruits can introduce the fungus *Nematospora corylii*, which causes yeast spot disease of bean, coffee, cotton, and a variety of other crops. The feeding of a sucking insect, the grape phylloxera, causes lesions on the roots of grapevines that are invaded by soil fungi that deteriorate the roots, (Granett et al., 2001). Insects are definitely involved in secondary spread and many reports and its of potential insects have been published (Zwet & Beer, 1995; Vanneste, 2000; Kluth et. al., 2002 and Sasuclark, *et.al*., 2008).

The aim of this work is to isolation and identification the causal agent of apple disease(s), to study the role of some insects to borne and transfer these pathogens which attack apple trees, as well as efficacy of these insects to borne and transfer the causal agent of apple disease(s).

2. Material and Methods

2.1. Samples of plants

Samples of infected apple tree were collected from EL-Nobaria location, Behira Governorate in Egypt during (October 2009- June 2010 period) by examining, flowers, blossoms, twigs, young shoots or branches leaves and young fruits on a suitable number of trees according to

(OEPP. 1990a). Visual inspection of apple orchards in spring will show up characteristic symptoms of the disease causing blight and necrosis of shoots, branches and trunks. A characteristic symptom is apple green discoloration, rapidly browning round dormant buds on young shoots can be observed, affected tissues appearing brownish red. Symptoms on leaves (necrotic spots with chlorotic halo) are produced in wet conditions and are not very characteristic, though symptoms may be seen on fruits (Fig 1), (Jeans-Pierre, 1997).

Figure 1. Symptoms on apple trees orchard (Natural infection).

2.2. Isolation and identification of the causal organisms

Diseased samples of apple trees showing blight symptoms on flowers, leaves, blossoms, twigs, shoots and small fruits (Fig 2) which were collected from EL-Nobaria district, Behira Governorate in Egypt were cut into small pieces, surface sterilized using 2% sodium hypochlorite for 2 min, then washed several times with sterilized distilled water (SDW) and divided into two groups:

First group

Sterilized pieces were placed (planted) on sterilized Petri dishes each contained 10 ml of PDA medium (Ronald, 1995) and incubated at 25^{O}C±2 for 3-5 days for fungal isolation. After incubation period, all fungal colony were purified on PDA medium and identified based on morphological characteristics and the available of literatures according to (Gilman, 1957 and Barnett and Hunter, 1972).

Second group

Sterilized pieces were soaked and suspended in SDW 30 minutes for bacterial isolate, streaked on general N. A. medium (nutrient agar) and incubated at 28^{o}C±2 for 2-3 days. After incubation period, single colony of the presence bacteria were purified by re-streaking on N.A. medium, and then identified based on the morphological and physiological characteristics according to (Schaad, 1980; Fahy & Persly, 1983; Lelliott and Stead, 1987.

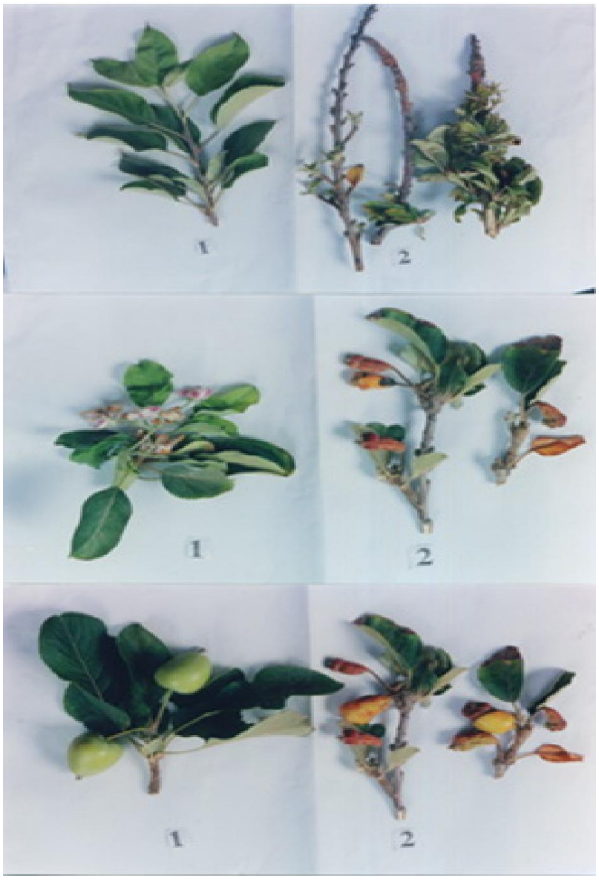


Figure 2. 1 = Healthy. 2 = Infected. A = Infected branch. B = Infected flowers. C = Infected fruits.

2.3. Samples of insects

Apis mellifera and *E. squalida* which spread in apple orchards (EL-Nobaria district, Behira Governorate) were collected during February, March, and April period as a vector and transmitted the causal agent of apple diseases which attacks apple orchards.

2.4. Isolation and identification of the microorganisms associated with *A. mellifera* and *E. squalida*

Samples of these insects were treated and divided as followed:

First group of insect(s) were surface sterilized using H_2O_2 for 30 second, washed several times by (SWD), then dried carefully using sterilized filter paper and transferred into Petri dishes, each contained 9ml of PDA medium for fungal isolation (Dhingra & Sinclair, 1995).

Second group of insect were sterilized as mentioned, then suspended in (SWD) and streaking on King's B medium (K.B.) to isolate Pseudomonas syringae (Fahy and Persly, 1983) and Kado & Hes-Rett D3 medium for *Erwinia amylovora* (Kado and Hes-Rett, 1970).

Third group were applied as it is without sterilized. Six insects per plates and 10 plates were used as replicates per treatment. All dishes were incubated at 28^{o} C ±2 for 3 days.
Percentage of contaminated insects were calculated and recorded as:
T.N.C.I / T.T.I X100.
Whereas: T.N.C.I = Total Number of Contaminated Insects (showing fungal or bacterial colony).
T.T.I = Total of Tested Insects.

Fourth group: Unsterilized insects were suspended (10 insects / 100ml.) in sterilized saline solution (o.85% sodium chloride), then was shaked at 3000 rpm. for 5 min and diluted by added 1ml. of this stoke to 9 ml of SDW in sterilized tubes. Approximately $1X10^{3}$ dilutions were placed onto sterilized Petri dishes each contained selective media as mentioned previously. Four plates were used as replicates for each treatment. All plates were incubated at 28^{o}C±2 for 3 days. Population density of pathogen(s) was calculated (conc.) as followed:
Population density = M.N.C / T.N.T.I X 100
Whereas: M.N.C = Mean Number of Colonies.
T.N.T.I = Total Number of Tested Insects (Abd EL-Ghafar, 1998).

2.5. Insect transmission

The role and efficacy of both, *A. mellifera* and *E. squalida* as a vector for transmitting the apple tree pathogens were studied as follow:

2.5.1. Inoculums preparation

E. amylovora was grown on yeast extract, peptone, and dextrose agar (YPDA) medium for 48 hr. at 28^{o}C. Bacterial culture cells were suspended in sterile saline solution (0.85% sodium chloride) and adjusted to concentration of 10^{8} colony forming unit (cfu / ml) according to standard curve based on absorbance at 720 nm using spectrophotometer. While *Monilia mali* fungus was grown on potato dextrose agar (PDA) medium for 15 days at 26^{o}C± 2. Fungal spores were flooded and harvested in sterile saline solution then suspended and diluted adjusted to concentration of 10^{7} spore / ml.

2.5.2. Insect treatments

Transmission of plant pathogens by tested insects were examined in two experiments**:**

2.5.2.1. Spraying treatment(externally)

The inoculums of pathogens were used as spray on the tested insects i. e. *A. mellifera* and *E. squalida* at rate 10 ml. pathogen(s) / 10 insects, using atomizer.

2.5.2.2. Feeding treatment (internally)

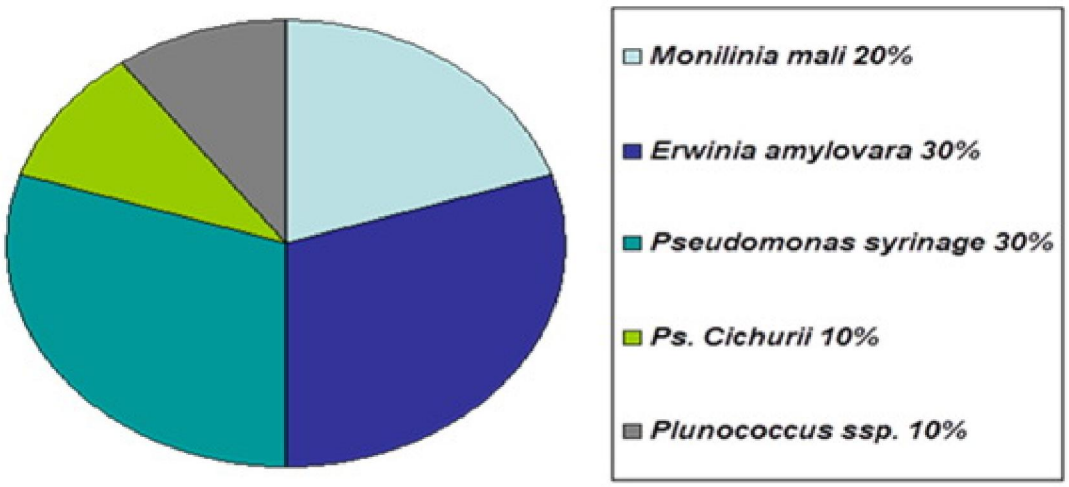
E. squalida beetles were feeding for 2 days on pieces of banana mixed with the inoculums of pathogen(s), while *A. mellifera* were feeding on nutrient solution (SDW+ glycerol + glucose, 100m +Zn 1g) mixed with the inoculum for the same period time. Inoculated insects were transferred to cage containing apple flowers. Two cages were used as replicates per treatment. Each cage contained four replicates and each replicate consisted of two clusters of flowers, where flower cluster contained 12 flowers. Inoculated insects were left for three days into the cage. Each pathogen was used as spray treatment (Stahl and Luepschen, 1977). Efficacy of insect was determined according to Percentage of infected flowers = T.N.I.F. / T.T.F X100.
Whereas: T.N.I.F = Total Number of Infected Flowers.
T.T.F = Total of Treated Flowers.

The data were statistically analyzed using the (F) test and the value of L.S.D (P=0.05) according to (Sndecor and Cochran, 1967).

3. Results

3.1. Isolation and identification the causal agent of diseased apple trees

Isolation from diseased samples of apple trees showing blight symptoms in blossoms, twigs, leaves and small fruits as fire blight and or cankers which were collected from EL-Nobaria location, Behira Governorate, Egypt resulted that 200 isolates belong to 40 isolates of fungi (equal 20 %) and 160 isolates of bacteria (equal 80 %). All fungal isolates were identified as *Monilinia mali*. Bacterial isolates were identified and classified into two groups based on Gram stain. The first group which are rod shaped and Gram negative (G-), it may belong to Erwinia and Pseudomonas genera. The second group which are Gram positive (G+) these isolates were identified as Planococcus genus. Data were tabulated in Fig (3). Data show that, *Monilinia mali* fungus was moderate frequency which gave 20 %. *Erwinia amylovora* and *Pseudomonas syringae* were the most frequency than other microorganisms, each recorded 30 %. Both *Plonococcus* spp. and *Pseudomonad cichurii* were less frequency and each recorded 10 %.



I. Fungal Frequency 20 % **II. Bacterial Frequency 80%**

Figure 3. Frequency percent of fungal and bacterial isolates which isolated from diseased apple tree samples.

3.2. Efficacy of tested insects as vector of fungal and bacterial pathogens

Apis mellifera and *E. squalida* insects were more effective to borne all tested pathogens i.e. *Monilinia mali* fungus and either bacteria *Erwinia amylovora* and *Pseudomonas syringae* as externally borne than internally. Examined insects were the most efficacy to transmit the pathogens during February and March, where percentage of infested insects were tabulated in Table (2) as 17.3, 17.7, 27.2, 27.8 and 28.6, 28.9% for *A. mellifera* and 21.1,21.9, 8.3, 8.9 and 9.0, 9.3% for *E. squalida*, respectively. The lowest percentages of tested insects as vectors of pathogenic diseases were recorded during April. The percentages of infested insects were 6.4, 10.7 and 11.3% for *A. melliffera* and 9.8, 3.2 and 3.7% for *E. squalida*, respectively. Meanwhile, *A. mellifera* was more effective than. *E. squalida* to transmit pathogenic bacteria i.e. *E. amylovora* or *P. syringae* and the percentages of infested insects recorded as 10.7, 27.8 or 11.3, 28.9% respectively. But *E. squalida* was more efficacy than *A. mellifera* to transmit *M. mali* fungus, where percentage of infested insects were 9.8, 21.9 and 6.4, 17.7% respectively. However, similarly results were obtained with population of pathogens transmitted by tested insects (Table3).

3.3. Efficacy of insects to transmit pathogens

The efficacy % of *A. mellifera* to transmit *M. mali*, *E. amylovora* and *P. syringae* externally were 45%, 54% and 56%, respectively. *There were highly significant differences between tested insects in %* of infested apple flowers externally. Efficacy of tested insects in transmitting pathogens whether externally (spraying treatment) or internally (feeding treatment) was tabulated in (Table 4). Both *A. mellifera* and *E. squalida*) were more efficacy to transfer all tested pathogens i.e. *M. mali*, *E. amylovora* and *P. syringae* with spray treatment than feed treatment (externally than internally), where efficacy of insects were 29-56% for spray treatment and 1-3% for feed treatment..

The efficacy % of *A. mellifera* to transmit *M. mali, E. amylovora* and *P. syringae* externally were 45%, 54% and 56%, respectively. There were highly significant differences between tested insects in % of infested apple flowers externally. *Apis mellifera* was more effective than *E. squalida* to transfer the pathogens, where efficacy of insect was 45-56% with spray treatment or 2-3% with feed treatment and was 29-32% with spray treatment or 1-2% with feed treatment respectively. *Pseudomonas syringae* and *E. amylovora* were the most effective to transfer by examined insects, where efficacy of insects were 32-56 and 30-54% for spray treatment or 2-3 and 1-2% for feeding treatment, respectively. Meanwhile, *M. mali* was moderately effective to transfer by examined insects, where efficacy of insects were 29-45% for spray treatment or 1-2% for feeding treatment.

Table 2. Efficacy of tested insects as vector of fungal and bacterial pathogens which attack apple trees during (February – April 2010)period.

Insect	**Period time**	**Pathogens contaminated insects (%)**					
		M. mali		***E. amylovora***		***P. syringae***	
		Externally	**Internally**	**Externally**	**Internally**	**Externally**	**Internally**
A.mellifera	February	17.3	0.0	27.2	0.0	28.6	0.0
	March	17.7	0.0	27.8	0.0	28.9	0.0
	April	6.4	0.0	10.7	0.0	11.3	0.0
E. squalidia	February	21.5	0.0	8.6	0.0	9.0	0.0
	March	21.9	0.0	8.9	0.0	9.3	0.0
	April	9.8	0.0	3.2	0.0	3.7	0.0
LSD 5%	Insects	3.7					
	Sample	2.4					
	Pathogen	3.0					
	Borne	1.8					
	Interaction	3.9					

Table 3. Mean numbers of spores or cells of pathogens counts internal or external of tested insects of apple orchard during (February – April 2010) period.

Insect	**Period time**	**Mean numbers of spores or cells of pathogens**					
		***M. mali*(10^7)**		***E. amylovora* (10^8)**		***P. syringae*(10^8)**	
		Externally	**Internally**	**Externally**	**Internally**	**Externally**	**Internally**
A. mellifera	February	1.4	0.0	1.8	0.0	2.0	0.0
	March	1.5	0.0	1.9	0.0	2.1	0.0
	April	1.0	0.0	1.3	0.0	1.5	0.0
E. squalidia	February	1.5	0.0	1.0	0.0	1.2	0.0
	March	1.7	0.0	1.2	0.0	1.4	0.0
	April	1.0	0.0	0.7	0.0	0.8	0.0
LSD 5%	Insects	3.7					
	Sample	2.4					
	Pathogen	3.0					
	Borne	1.8					
	Interaction	3.9					

Table 4. Efficacy of tested insects to transmit certain fungal and bacterial pathogens externally or internally, under artificial inoculation treatment

Pathogen	Insect	Externally		Internally	
		% Infected flowers of apple	% Efficacy of insect	% Infected flowers of apple	% Efficacy of insect
M. mali	*A. mellifera*	15.1	45	0.6	2
	E. squalida	9.8	29	0.9	1
	Check	33.7	100	33.7	100
E. amylovora	*A. mellifera*	18.3	54	0.7	2
	E. squalida	10.3	30	0.4	1
	Check	34.0	100	34.0	100
P. syringe	*A. mellifera*	19.0	56	0.9	3
	*E. squalid*a	10.9	32	0.6	2
	Check	33.9	100	33.9	100
LSD 5%	Pathogen	3.4			
	Insect	2.6			
	Treatment	4.3			
	Interaction	5.5			

4. Discussions

Many plant diseases in the field or in harvested plant produce become much more serious and damaging in the presence of specific or non-specific insect vectors that spread the pathogen to new hosts (Agrios, 1997). Isolation from diseased apple tree samples showing blight symptoms in blossoms, twigs, leaves and small fruits as fire blight and or cankers which were collected from EL-Nobaria location, Behira Governorate, Egypt yielded 200 isolates belong to 40 isolates of fungi (equal 20 %) and 160 isolates of bacteria (equal 80 %). These isolates were identified as *M. mali* fungus which was moderate frequency and gave 20 %. *E. amylovora* and *P. syringae* were the most frequency than other microorganisms, each recorded 30 %. Both *Plonococcus* spp. and *Pseudomonad cichurii* were less frequency and each recorded 10 %. Fire blight, blossom blight and twig blight, stem and branch canker a description is provided for *Erwinia amylovora* disease. Other records probably involve confusion with *Pseudomonas syringae* (Hayward & Waterston, 1965). *Erwinia amylovora*, the causal agent of pomes fruit fire blight, it is a minor problem on apples. Other names formerly used are twig blight, blossom blight, fruit blight and spur blight. The leaves, green shoots, fruits, mature branches, and roots are attacked (Ogawa and English, 1991). Also, they reported that, three pathovars of *Pseudomonas syringae* are involved in the blast, canker and fruit spot syndrome of poems fruit. Pollination is a predisposing factor in blossom blast.

Monilia blast caused by *M. mali* is an important diseases of apple and pear of wild species of Malus (Jones and Aldwinckle, 1990).

Meanwhile, *A. mellifera* was more effective than *E. squalida* to transmit pathogenic bacteria i.e. *E. amylovora* or *P. syringae.* While *E. squalida* was more efficacy than *A. mellifera* to transmit *M. mali* fungus. However, similarly results were obtained with population of pathogens previous on insects which previously mentioned. Bees and other pollinating insects may disseminate the epiphytic bacterium to other blossoms and leading to widespread distribution through the orchard (Stahle and Luepschen, 1977; Zwet and Keil,1979 and Zwet, 1994).

Apis mellifera and *E. squalida* insects were more effective to borne all tested pathogens i.e. *Monilinia mali* fungus and either bacteria *Erwinia amylovora* and *Pseudomonas syringae* as externally borne than internally. The highest activity of both *A. mellifera* and *E. squalida* in pathogens transmitting was recorded during February and March and then decreased during April. Insects are considered to play an important role in the spread of inoculum especially pollinating insects, as well as sucking, chewing and boring insects are claimed to be active in infection, and even a certain level of specificity between some insects and their role disseminating the

bacteria is supposed (Jean, 1997). The disease effects essentially the transportation of honey bee (*A. mellifera*) colonies. Bees are recognized as very successful short-distance disseminators of bacteria in the spring time. They may also act as vectors of the disease over large distances, when bee colonies are moved from infected to clear areas in April, May and June (Sasuclark *et al* 2008). There was a direct relationship between insects with the blight pathogens and incidence of bacterial blight of pear (*E. amylovora* and *P. syringae*) and concentration of *P. syringae* cells was less than cells of *E. amylovora*. *Apis mellifera* was the main disseminator of the blight pathogens, but Zeuzera pyrina and *Musca domestica* were had a moderate effect in transmission and *Anacridium aegyptium* was less effective (Abd El-Ghafar, 1998, Hildebrand, *et. al*., 2000 and Abo Al-Maatty, 2001).

A. mellifera and *E. squalida* were more efficacy to transmit all tested pathogens i.e. *M. mali*, *E. amylovora* and *P. syringae* externally (29-56%) than internally(1-3%). *A. mellifera* was more effective than *E. squalida* to transmit the pathogens, where efficacy of *A. mellifera* was 45-56% externally or 2-3% internally and was 29-32% externally or 1-2% internally, respectively. *Pseudomonas syringae* and *E. amylovora* were the most effective to transfer by examined insects, where efficacy of insects were 32-56 and 30-54% externally or 2-3 and 1-2% internally , respectively. Meanwhile, *M. mali* was moderately effective to transmit by examined insects, where efficacy of insects were 29-45% externally or 1-2% internally. Honey bees have sharp tarsal claws and stiff bristle could cause microscopic injuries, while foraging for nectar or pollen, thus allowing the pathogen entry into the tissues (Thomson, 1992, Zwet and Beer, 1995 and McLeod *et al*. 2005). Feeding behaviour of *E. squalida* destroy roses apple blossoms, especially (anther), which is part stamens pollen content, as well as, the feminization of pistil. Also, adults congregate in groups on the flower, causing injuries in parts of the flower and thus transmit pathogens to blossoms (Nel and Schotz 1990; Browne and Schttz 1999 and Abd El-Aziz *et al*., 2006).

5. Conclusion

A. mellifera and *E. squalida* insects transmit all tested pathogens mechanically. *A. mellifera* was more efficacy than *E. squalida* to transmit bacterial pathogens compared with pathogenic fungus. Meanwhile, *E. squalida* was more efficacy than *A. mellifera* to transmit pathogenic fungus than bacteria. *A. mellifera* was more effective than *E. squalida* to transmit all tested pathogens.

Corresponding Author:
Dr. E.M.Embaby
Plant Pathology Department
National Research Centre, Egypt.
E-mail: embaby.elsayed@yahoo.com

References

1. Abd El Ghafar, NY. (1998): Studies on bacterial blight disease of pear in Egypt. M.Sc. Thesis, Faculty of Agriculture, Ain shams university, Cairo, Egypt, 151 pp.
2. Abd El-Aziz, SE., Salem, H.A., Fahim SF. (2006): Effeciveness of certain nutrition, visual and olfaction cues in laboratory and field on the behaviour of *Epicometic* (*Tropinota*) *squalida* (Scop.) (Coleoptera : Scarabaeidae : Cetoniinae) Annals Agric.Sci. 51, 283 – 293.
3. Abo Al-Maatty, SM. (2001): Forecasting of fire blight of pear under Egyptian environmental conditions. MSc. Thesis, Faculty of Agriculture, Ain Shams Univ. p. 86.
4. Agrios, GN. (1997): Plant pathology (4th ed.). Academic Press, San Diego, California. Anonymous. Compendium of Diseases of… A series of books on diseases of individual crops published periodically by APS Press, St. Paul, Minnesota.
5. Barnett, HL., Hunter, B. (1972): Illustrated genera of imperfect fungi. *Burgess publishing company, U. S. A.* 241p.
6. Browne, J., Scholtz ,CH.(1999): A phylogeny of the families of Scarabaeoidea (Coleoptera) . Inver. System., 24,51 – 84.
7. Dhingra, OD., Sinclair, JB.(1995): Basic Plant Pathology methods. Lewis Publisher, London, 434pp. diseases of plants. Methods in plant pathology volume 2. First published. *Blackwell* Encyclopedia of Plant and Crop Science, 1-5.
8. Fahy PC. , Persly, G J. (1983): Plant bacterial disease: A Diagnostic guide. Academic Press, N. Y. 393 pp.
9. Gilman, CJ. (1957): "A manual of soil fungi ".2nd ed, Iowa State College Press, USA, 450p.
10. Granett, J., Walker, MA. Kocsis, L., Omer, AD. (2001): Biology and management of grape phylloxera. Annu. Rev. Entomol. 46, 387–412.
11. Hayward AC., Waterston JM .(1965): *Erwinia amylovora* .Description of fungi and bacteria. IMI, 5: sheet44.
12. Hildebrand M., Dickler,E. , Geider, K. (2000): Occurrence of *Erwinia amylovora* on insects in a fire blight orchards. Journal of Phytopathology 148, 251-265.
13. Jean-Pieere, Paulin (1997): Fire Blight: Epidemiology and control (1921-1996).

Nachichtenbl. Deut. Pflanzenschutzd., 49 (5), 116-125.
14. Johnson, K.B. , Stockwell, V.O. (1998): Management of fire blight : A case study in microbial ecology. Annual Review of Phytopathology 36, 227-248.
15. Jones, A.L. , Aldwinckle, H.S. (1990): Compendium of apple and pear diseases. APS Press, The American Phytopathological Society 1-100pp.
16. Kado, C. I., Heskett, M. G. (1970): Selective media for isolation of Agrobacterium, Corynebacterium, Erwinia, Pseudomonas and Xanthomonas. Phytopathology 60, 969-679.
17. Kluth, S., Kruess, A., Scharntke, T. (2002): Insects as vectors of plant pathogens: mutualistic and antagonistic interactions. Oecologia, 133 (2), 193-199.
18. Lelliott, M. R. A., Stead, D. E. (1987): Methods for the diagnosis of bacterial
19. McLeod, G. , Gries R. , von Reuß S.H. , Rahe J.E. , McIntosh R. , Ko¨nig W.A., Gries G.(2005): The pathogen causing Dutch elm disease makes host trees attract insect vectors. Proc. R. Soc. B, 272, 2499–2503.
20. Nel, A. , Scholtz, C.H. (1990): Comparative morphology of the mouthparts of adult Scarabaeoidea (Coleoptera). Entomology Memoir 80, 1–84.
21. OEPP EPPO (1990a): Quarantine procedure no. 25 general export inspection procedure for glass- house and nursery enterprises. Bulletin OEPP EPPO Bulletin 20,277-282.
22. Ogawa,J.M. ,English,H. (1991): Diseases of temperate zone, tree fruit and nut crops. University of California, 6701 San Pablo Avenue, pp.16.
23. Purcell, A.H. , Almeida R.P.P. (2005): Insects as Vectors of Disease Agents.
24. Ronald,M.(1995): Hand Book of Media for Environmental Microbiology". University of Louisville, CRC Press.
25. Sasuclark M., Seidl-Adans I., Winsor J., Stephenson, A. (2008): Inter relationships on inbreeding, Herbivory and Pathogen Transmission in *Cucurbita pepo* ssp. *texana*: Bacterial Wilt disease as a Sexually Transmitted disease. 25th Anniversary ISCE Meeting. State College, Pennsylvania, USA. Aug., 17-22, pp. 199.
26. Schaad, N. W. (1980): Laboratory Giud for identification of plant pathogenic bacteria. *Copyright by the American Phytopathological Society. 3340 Pilot Knob Road, St. Paul, Minnesota 55121. Scientific publication London.*
27. Snedecor, G. W., Cochran, W. G. (1967): Statistical Methods (2nd, ed.). Iowa State Univ., Press, Ames, Iowa, USA.
28. Stahl,F.J. , Luepschen, N.S. (1977): Transmission of *Erwinia amylovora* to pear fruit by *Lygus spp.* .Plant Disease Rept., 61, 936-939.
29. Thomson, S.V. (1992): Fire blight of apple and pear. In: Plant disease of international importance. Vol. 111. Disease fruit crops (Kumar, J., H.S. Chaube; U.S. Singh and E.C. Mukhpadhyay, eds), Prectice Hall, New Jersey, pp. 32-65.
30. Vanneste, J.L., (2000): Fire blight: The disease and its causative agent, *Erwinia amylovora*. CAB Publishing, 370pp.
31. Zwet, T. (1994): Present distribution of fire blight and its mode of dissemination-a review. Acta -Horticulture 367: 391- 401.
32. Zwet, T. , Beer, S.V.(1995): Fire Blight – its Nature, Prevention and Control. A practical guide to integrated disease management. *USDA. Agriculture Information Bulletin No. 631*. 97 pp.
33. Zwet, T. and H.L.Keil. (1979): Firelight, a bacterial disease of rosaceous plants. USDA Agric. Handbook 510, 200pp.

2/27/2011