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FUNGI ASSOCIATED WITH FRUIT-ROTS OF FRESH STRAWBERRY PLANTATIONS AND SOME TRIALS OF THEIR CONTROL

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ABSTRACT

Isolation trials from naturally rotted strawberry fruits of fresh plantations collected from Behera, Kalubiya, Giza, Ismailia, and Menofiya locations yielded 543 fungal isolates belonging to ten genera. The isolated fungi were purified and identified as: *Aspergillus niger*, *Alternaria tunissima*, *Botrytis cinerea*, *Cladosporium* spp., *Mucor* spp., *Penicillium* spp., *Phomopsis obscurans*, *Phytophthora cactorum* ,*Rhizopus stolonifer and Trichoderma harzianum*. Spraying of spore suspension of these fungi on strawberry plants (at the beginning of flowering stage and two weeks later) proved their pathogenicity. Moreover, both *B. cinerea* and *P. cactorum* were the most pathogenic ones.

Mulching strawberry beds with plastic sheets recorded significant decrease in the natural infection with fruit-rots compared with un-mulched beds. In addition, perforated mulch was more efficient in this respect compared with non-perforated mulch. Also, weight of the marketable fruits of the grown plants on pored mulch was higher than that grown on non-perforated mulch and on un-mulched beds.

No significant differences in the average percentages of naturally rotted fruits were detected due to the cultivar tested. However, cv. Camarosa, followed by cvs. Rosa Linda and Capitola were the least affected. Meanwhile, cv. Sweet Charlie followed by cv.

Oso Grande then Chandler were the most affected. Moreover, cv. Camaros., followed by cv. Sweet Charlie gave the highest values of T.S.S. and fruit yield .

In vitro examination indicated that all the bioagents tested, *i.e.* *Bacillus subtilis, Pseudomonas fluorescens* and *Trichoderma harzianum* caused different degrees of antagonistic action either by inhibition (*B. subtilis* and *P. fluorescens*) or hyperparasitism (*T. harzianum*), to the growth of the most pathogenic fungi, *i.e. B. cinerea* and *P. cactorum.*

In vivo experiment under field conditions, spraying of culture filtrate of the bioagents tested, each alone or in different combinations, on the growing strawberry plants at the beginning of flowering stage and two weeks interval resulted in significant reduction in fruit-rots with significant increase in the marketable fruits in comparison with control treatment.

Key words: *beds , bioagents , fresh plantation , fruit-rots , strawberry , total soluble solids and marketable yield.*

1. INTRODUCTION

Strawberry (*Fragaria* X anannas Duch) is one of the most important favorite and delicious fruits of which the demand has been increased in Egypt for local consumption and exportation. Under Egyptian conditions and allover the world, strawberry fruits are vulnerable to infection by many destructive pathogens that cause fruit-rots (Morris *et al.*, 1980 ;Khafagi, 1982; Pepin and Mac Pherson, 1982; Olcott- Reid and Moore, 1995; Bhardwaj *et al.*, 1998; Ellis *et al.*, 2000 and Helbig, 2001), in addition to physiological disorder (Ulrich *et al.*, 1980) which are responsible for causing rots either in the field or after harvesting. The cultivated area with fresh strawberry plantation during 1998/1999 growing season reached about 450 feddan, then increased to about 760 feddan during 1999/2000 growing season and to about 900 feddan during 2000/2001 growing season with an average of 18-24 ton/feddan during the three seasons. In addition, the exported amount resembled about 25-60 % from the total production in the aforementioned seasons, and the remained percentage of fruit production for local market, but with high price compared with Frigo (frozen) plantations (Higher Committee of

Strawberry, Min. of Agric., 2001). In this concern, nowadays strawberry plantation comprises the highest cash crop either for the growers or the national income.

Because strawberry fruits are exported directly from the growing fields, therefore using of fungicides in management of fruit-rots is not desirable and of great hazard.

Also, the world is suffering from pollution with agricultural chemicals which make great disturbance to the human health. Hence, the best solution for this problem is using some agricultural practices in addition to biological control.

The present investigation was planned to throw some light on the dominant fungi, in fresh strawberry plantations, responsible for strawberry fruit-rots and the possibility of controlling them with some agriculture practices as well as some bioagents.

2. MATERIALS AND METHODS

2.1. Isolation, purification and identification of the associated fungi

Strawberry fruits were collected from fresh plantation in Behera, Giza, Kalubiya, Menofiya, Ismailia and Sharkiya Governorates. The collected fruits were thoroughly washed with tap water, cut into small portions (0.5x 0.5 cm), immersed in 2 % sodium hypochlorite for one minute, dried between folds of sterilized filter paper and put in aseptic conditions in Petri-dishes containing sterilized PDA medium. The dishes were incubated at 20°C for 7 days. The emerged fungi were noticed daily and picked up on another PDA medium. The isolated fungi were purified using the hyphal tip method and/or single spore technique, then identified according to their morphological features using the description of (Gilman, 1957; Sutton , 1965; Newhook, *et al.*, 1978 and Barnett & Hunter 1986).

2.2. Pathogenicity tests of the isolated fungi

Two apparently healthy strawberry plants (cv. Sweet Charlie) were transplanted in each pot (25 cm in diameter) containing autoclaved Nile silt soil and left to grow. At the beginning of the flowering stage and two weeks later, the spore suspension of the isolated fungi (1 $x10^6$ spore/ml Water + 1 ml super film as sticker/L. spore suspension) was sprayed on the growing plants . Control plants were sprayed with water plus super film only at the same rate. The infected fruits were counted at maturity stage and the yield was also weighed for each treatment. Five replicate pots were used for each treatment.

2.3. Field preparation for fresh strawberry planting

A piece of land located at El-Tahady, El-Sadat County, Menofiya Governorate was prepared for strawberry planting by fresh transplants using the recommendation of Agricultural Technology Utilization and Transfer Organization (strawberry group) Ministry of Agriculture. In this respect, the land was divided into beds of 120 cm width and 40 m long with 40 cm between each two beds, and irrigated with enough water. Apparent healthy fresh strawberry transplants (previously grown in fumigated nursery and irrigated with under ground water) were dipped in the spore suspension of *T. harzianum* (3 x 10^6 spore/ml.) for 20 minutes just before transplanting. Four rows of plants were transplanted on each bed (30 cm interval) and 25 cm were left between each two transplants. The transplants were sprayed, just after transplanting, with water using sprinkler system when it was necessary for three weeks until forming new leaves. Also, drip irrigation was used after the establishment of the transplants. One month after transplanting, soil mulch was applied using clear plastic sheets to cover the soil surface and allowing the plants to grow through holes. On the other hand, another beds in the same location were transplanted by the same manner but without using plastic sheets. Field experiments were carried out during 1998/1999 and 1999/2000 growing seasons and transplants were planted during mid of September in each season. Low tunnels were used to warm up the plants from mid October to the end of February using plastic sheets of 80 microns in thickness. Low tunnels were opened during the day time when it was warm or for areation and harvest. The growning fruits were left to natural infection with the causal fruit-rots. Also, strawberry plants received all the agricultural practices as recommended by Min. of Agric.

2.3.1. Effect of soil mulch with perforated or non-perforated plastic sheets on the natural infection with fruit-rots and fruit yield

Strawberry transplants (cv. Sweet Charlie) were left to grow on perforated plastic sheets (40 pores per one cm in diameter/m^2) and non-perforated ones as soil mulch. Transplants of the same cultivar were left to grow without mulching.

2.3.2. Susceptibility of the fruits of some cultivars to fruit-rots

Six strawberry cvs., *i.e.* Camarosa, Capitola, Carles Pad, Chandler, Rosa Linda and Sweet Charlie were used for this purpose. The plants were grown on perforated plastic sheets and under low tunnels as mentioned before. The growing cultivars were left to the natural infection by the causal fruit-rots.

2.3.3. Biological control

The two bacteria tested, *i.e. Bacillus subtilis* and *Pseudomonas fluorescens*, kindly provided from Plant Pathol. Dept., Fac. of Agric., Cairo Univ., were grown on liquid nutrient agar medium. Meanwhile, *T. harzianum* (isolated from strawberry rotted-fruits) was grown on liquid gliotoxin fermentation medium consisted of : 25 g dextrose, 2 g. ammonium tartarate, 2g KH_2PO_4, 1 g Mg SO_4 and 0.01 g Fe SO_4 per one liter medium. Bacteria were grown for 2 days at 28° C and the fungus for two weeks at 25°C. The growth of the bioagents was filtered through centered glass apparatus (G5) .The obtained culture filtrate of each bioagent was used , each alone or in different combinations, for spraying strawberry plants (at the beginning of flowering stage and two week interval)at the rate of 1%.

2.4. Disease assessment

Rotted fruits were counted for each cultivar in each harvest. Also, the obtained marketable fruit yield (un-rotted fruits) was weighed in each harvest and the average of final weight was recorded for each treatment. In addition, total soluble solids were estimated using a hand refractometer in the experiment of pathogenicity tests.

2.5. Statistical analysis

Data obtained were statistically analyzed using the completely randomized and split plot design (Snedecor and Cochran, 1967). The averages were compared at 5% level of probability using L.S.D. (Fisher, 1948).

3. RESULTS

3.1. Occurrence and frequency of fungi associated with strawberry fruit-rots

Isolation trails from rotted strawberry fruits collected from different locations of fresh strawberry plantations (Table 1) yielded 543 fungal isolates belonging to 10 genera. The isolated fungi were purified and identified as: *Aspergillus niger*, *Alternaria tinussima*, *Botrytis cinerea*, *Cladosporium* spp., *Mucor* spp., *Penicillium* spp., *Phomopsis obscurans*, *Phytophthora cactorum*, *Rhizopus stolonifer* and *Trichoderma harzianum*.

All the fungi were isolated from the inspected locations, but with different frequencies. Also, rotted fruits collected from the different governorates did not yield the same number of isolates. In this respect, samples of Ismailia Governorate recorded the highest frequency followed by those of Menofiya, Giza and Behera Governorates, being 147,135, 123 and 117 fungal isolates, respectively.

The isolated fungi also recorded different frequencies, *B.cinerea* recorded the highest frequency followed by *P. cactorum* then *R. stolonifer* and *Mucor* spp., being 238, 88, 66 and 63 fungal isolates, respectively. Meanwhile, the fungus *P. obscurans* recorded the lowest frequency followed by *Cladosporium* spp., then *T. harzianum* and *A. tunissima*, being 7, 8, 11 and 15 isolates, respectively. In addition, both *A. niger* and *Penicillium* spp. recorded 31 and 21 isolates, respectively.

3.2. Pathogenicity tests of the isolated fungi

Data presented in Table (2) indicate that all the tested fungi were able to cause fruit-rot infection, with the exception of *T. harzianum*. Moreover, the fungus *B. cinerea* followed by *P. cactorum* caused the highest infection, being 64.0 and 43.2 %, respectively. Both

A. tunissima and *P. obscuras* caused moderate infection, being 18.6 and 16.4 %, respectively. Low percentages of fruit-rot were observed on fruits inoculated with *A. niger*, *Cladosporium* spp., *Mucor* spp., *Penicillium* spp. and *R. stolonifer*, being 1.8, 2.2, 1.6, 2.6 and 1.2 %, respectively.

Table (1): Occurrence and frequency of fungi associated with strawberry fruit-rots* of fresh plantations in different governorates during February 1998.

Tested fungi	Occurrence and frequency of fungi at				Total
	Ismailia	Giza	Menofiya	Behera	
A. niger	5	8	10	8	31
A. tunissima	3	6	2	4	15
B. cinerea	48	60	57	58	238
Cladosporium	3	2	1	2	8
Penicillium spp.	3	6	5	7	21
P. obscurans	2	2	1	2	7
P. cactorum	20	31	19	1 8	88
R.stolonifer	15	15	19	17	66
T.harzianum	2	3	3	3	11
Mucor spp.	16	14	17	16	63
Total	117	147	123	135	543

* Each sample was represented by 50 rotted fruits.

The effect of the infection by the fungi tested on reducing total soluble solids (T.S.S.) was obviously noticed in the case of fruits inoculated with *B. cinerea,* followed by *P. cactorum* ,being 6.4 and 7.3 %, respectively. On the other hand, fruits inoculated with the other fungi caused low decrease, with the exception of *T. harzianum* which gave the same figures of the control.

The average of marketable fruits/plant was also affected by the tested fungi. In this respect, *B. cinerea* followed by *P. catorum* caused the highest reduction, being 141.0 and 161.6 g/plant, respectively. The other fungi did not cause great reduction in the fruit yield. Moreover, plants inoculated with *T. harzianum* yielded more than the control plants, being 372.2 and 370.0 g/plant, respectively.

Table (2): Pathogenicity test of the isolated fungi on cv. Sweet Charlie, pot experiment.

Tested fungi	%, Rotted fruits	Total soluble solids of the marketable fruits	Average of marketable fruits (g)/Plant
A. niger	1.8	9.8	368.8
A. tunissima	18.6	9.0	358.4
B. cinerea	64.0	6.4	141.0
Cladosporium spp	2.0	9.4	369.0
Mucor spp.	1.6	9.6	369.2
Penicillium spp.	6.4	9.0	362.0
P.obscurans	16.4	9.0	360.0
P. cactorum	43.2	7.3	161.6
R.stolonifer	1.2	9.2	368.4
T. harzianum	0.0	10.0	373.2
Control	0.0	10.0	370.0
L.S.D. at 5%.	2.3	1.9	6.7

3.3. Effect of soil mulch with perforated or non-perforated plastic sheets on the natural infection with fruit-rots and fruit yield

Table (3) shows that growing strawberry plants on beds covered with perforated mulch (plastic sheets) caused significant reduction in the rotted fruits compared with those growning on beds covered with non-perforated mulch and on un-mulched beds. The respective averages of fruit-rot were 13.7, 19.3 and 35.2 %, respectively with significant differences among the three values.

The reduction in fruit-rots was reflected on the increase of the marketable fruit/plot, being 192.0, 185.8 and 135.4 Kg/plot (48 m^2, respectively). In addition, no significant differences were detected due to the effect of the growing season on the incidence of the disease and the obtained marketable fruit yield.

3.4. Reaction of some strawberry cultivars to natural infection with the causal fruit-rots

It is evident (Table 4) that all the tested strawberry cultivars were liable to the natural infection with the causal fruit-rots. However, there were significant differences among the values of the tested cvs. In this respect, fruits of cv. Camarosa were the least affected being 8.0

% followed by cv. Rosa Linda (9.8 %). On the other hand, fruits of cv. Sweet Charlie were the most affected, being 13.7 % followed by cv. Capitola, being 11.4%. Both cvs. Chandler and Oso Grande recorded 10.9 and 10.7% fruit-rots, respectively.

Table(3): Effect of mulching strawberry beds with perforated or non-perforated plastic sheets on the natural infection with fruit rots and fruit yield (cv. Sweet Charlie) during 1998/1999 and 1999/2000 (field experiments at Menofiya Governorate).

Treatments	%, Rotted fruits during		Mean	Average marketable yield (kg)/plot ($48m^2$) during		Mean
	1998/1999	1999/2000		1998/1999	1999/2000	
Perforated mulching	13.8	13.6	13.7	191.0	193.0	192.0
Non-perforated mulching	19.2	19.4	19.3	185.2	186.4	185.8
Un-mulched	34.2	36.2	35.2	134.8	136.0	135.4
Mean	22.4	23.1	---	170.3	171.8	-----

L.S.D. at 5 % for: Treatments (T) = 3.2 3.5
Season (S) = n.s. n.s.
T x S = 2.8 5.1

There were significant differences in the averages of the marketable fruit yield due to the tested cultivars. In this respect, cv. Camarosa gave the highest yield ,being 205 Kg/plot ($48m^2$) followed by cv. Sweet Charlie (192.0 Kg/plot (48 m^2) and cv. Oso Grande (190.6Kg/plot (48 m^2). Meanwhile, cv. Chandler gave the lowest marketable fruit yield, being 179.9 Kg/plot (48 m^2) followed by cv. Capitola, being 181.8 Kg/plot (48 m^2).

No significant differences were detected due to the effect of the growing season on the incidence of the disease and the obtained marketable fruit yield.

3.5. Biological control

Preliminary examination *in vitro* revealed that all the bioagents tested, *i.e. B. subtilis*, *P. fluorescens* and *T. harzianum* caused different degrees of antagonistic action either by inhibition (*B.subtilis* and *P.flourescens*) or hyperparasitism (*T. harzianum*), to the growth of

B .cinerea and *P. cactorum* grown on PDA medium.

Data presented in Table (5) show that spraying of any of the culture filtrate of the tested bioagents, *i.e* *B. subtilis* (BS), *P. fluorescens* (PF) and *T. harzianum* (TH), each alone or in different combinations, caused significant reduction in the average percentages of the rotted fruits and significant increase in the marketable fruits compared with control treatment. In general, spraying of the mixture of the culture filtrate of BS + PF + TH gave the best results in controlling the disease and the marketable fruits, being 2.6 % and 202.0 kg/plot (48 m^2), respectively followed by the mixture of PF + TH, being 3.2 % and 199.0 kg/plot (48 m^2) then by the mixture of BS + PF, being 3.3 % and 199.0 kg/plot (48 m^2), respectively and by the mixture of BS + TH, being 3.6 % and 197.7 kg/plot (48 m^2), respectively. On thē other hand, using any of the culture filtrate of the bioagents tested, *i.e.* BS, PF and TH was of low effect in controlling fruit-rots, being 6.3, 5.7 and 7.8 % fruit-rots, respectively, compared with the other treatments. Also, these treatments gave low marketable fruits, being 1951.8, 196.7 and 194.5 kg/plot (48m^2), respectively compared with the other treatment. In addition, unsprayed plants recorded the highest infection (13.7 %) and the lowest marketable fruits (192.0 kg/plot (48 m^2).

4. DISCUSSION

Isolation trials from rotted strawberry fruits collected from different locations of fresh plantations, yielded many fungal isolates. Fungal isolates were purified and identified as: *Aspergillus niger, Alternaria tunissima, Botrytis cinerea, Cladosporium* spp., *Mucor* spp., *Penicillium* spp., *Phomopsis obscuras, Phytophthora cactorum* and *Rhizopus stolonifer*. All the isolated fungi proved their pathogenicity. In addition, both *B. cinerea* and *P. cactorum* were the most pathogenic fungi. The estimated T.S.S. and marketable fruits were greatly affected only by *B. cinerea* and *P. cactorum*. The isolated fungi were previously isolated by many investigators (Khafagi, 1982; Bahardwaj, *et al.,* 1998; Berrie, 1998; Ellis *et al.*,2000; Legard *et al.*, 2000; and Helbig, 2001) and found that they are responsible for causing fruit-rots and reduction in fruit yield .

Nowadays, the world is suffering from great pollution with many chemical residuals including agrochemicals. Therefore, many attempts are made to reduce these pollutants. In this respect, three safety trials of controlling strawberry fruit-rots were employed, *i.e.* perforated mulching sheets and resistant cultivars as agricultural practices in addition to using culture filtrate of some bioagents.

Table (4): Reaction of strawberry cultivars to the natural infection by the causal fruit rots and fruit yield during 1998/1999 and 1999/2000 (field experiments at Menofiya Governorate).

Cultivars	%, Rotted fruits during		Mean	Average marketable yield (kg)/plot (48 m^2) During		Mean
	1998/1999	1999/2000		1998/1999	1999/2000	
Camarosa	7.2	8.8	8.0	207.4	202.6	205.0
Capitola	11.0	11.8	11.4	181.0	182.6	181.8
Chandler	10.8	11.0	10.9	178.8	181.0	179.9
Oso Grande	10.9	10.5	10.7	188.0	193.2	190.6
Rosa Linda	9.2	10.4	9.8	189.5	190.7	190.1
Sweet Charlie	13.8	13.6	13.7	191.0	193.0	192.0
Mean	10.5	11.0	-----	189.3	190.5	------

L.S.D. at 5 % for: Treatments (T) = 0.9   4.5
Season (S) = n.s.   n.s.
T x S = 2.5   7.1

Mulching strawberry beds with perforated plastic sheets caused significant reduction in the natural infection of fruit-rots with significant increase in the marketable fruits compared, even, with mulched beds with non-perforated plastic sheets and un-mulched ones. This reduction, might be due to the pored mulch that did not keep any free water, for a long duration (wetness duration), on the plastic sheets which is responsible for fruit-rot infection by fungal pathogens, especially those which need high moisture such as *B. cinerea* and *P.*

cactorum. Jarvis, 1962 mentioned that under favorable conditions of wetness and temperature during flowering and harvest, yield loss could exceed 50 %. The same author (1964) and Bulger *et al.* (1987) found that fruit-rot incidence was highly correlated with pre-harvest duration of relative humidity more than 80 % and the amount of pre-harvest rainfall. Thus, environmental variables such as wetness duration are likely to play a critical role in the development of latent infection, especially with *B. cinerea* and subsequent rot of ripe fruits. On the other hand, strawberry fruits grown on un-mulched beds recorded the highest infection and the lowest marketable fruits. This result is expected, where the attachment of the fruits with the humid soil of the beds increases this infection due to the fact that soil, mostly is infested with many kinds of the pathogens including those causing fruit-rots. In addition, fruits grown on un-mulched beds are of low marketable degree and they mostly bear sand and/or soil particles which make them unsuitable for exportation.

Table (5): Effect of spraying strawberry plants with culture filtrate of some bioagents on the natural infection with the causal of fruit-rots and fruit yield (cv. Sweet Charlie) during 1998/1999 and 1999/2000 (field experiments at Menofiya Governorate).

Treatments	%, Rotted fruits during 1998/1999 1999/2000		Mean	Average of marketable fruit yield (kg)/plot ($48m^2$) during 1998/1999 1999/2000		Mean
***B. subtilis* (BS)**	6.2	6.4	6.3	196.4	195.2	195.8
***P. fluorescens* (PF)**	5.8	5.6	5.7	195.0	196.4	195.7
***T. harzianum* (TH)**	7.8	7.8	7.8	195.0	194.0	194.5
BS +PF	3.4	3.2	3.3	197.0	201.0	199.0
BS+TH	3.4	3.8	3.6	196.4	199.0	197.7
PF +TH	3.6	2.8	3.2	198.2	200.0	199.0
B S+ PF +TH	2.4	2.8	2.6	200.0	204.0	202.0
Control	13.8	13.6	13.7	191.0	193.0	192.0
Mean	5.4	5.8	-----	196.1	197.8	------

L.S.D. at 5% for: Treatments (T)	=	1.6	2.7
Season (S)	=	n. s.	n. s.
T x S	=	0.9	3.7

The strawberry cvs. tested did not exert any significant differences in their reaction to natural infection with fruit-rots. However, cv. Camarosa was the lowest affected one and gave the highest marketable yield viz. cv. Sweet Charlie. Although the latter cv. was the most susceptible one, at least under Egyptian conditions, but it gave an early yield by 2-3 weeks than cv. Camarosa, has high T.S.S. (sweet) and the beak of its production is during December and the beginning of January. This early and abundant yield is of high exportation price. Therefore, it is favorable for Egyptian growers. The susceptibility of strawberry cvs. to fruit-rot was previously reported by many investigators (Khafagi,1982; Ballington *et al.*, 1993; Albergts and Chandler, 1995 and Olcott-Reid and Moore, 1995). In addition, the fluctuation in the marketable fruits may be due the differences in susceptibility of these cvs. to the causal of fruit-rots and/or to the genetic variations among these cultivars.

In vitro examination revealed that the three tested bioagents, *i.e. B. subtilis, P. fluorescens* (Bacteria) and *T. harzianum* (fungus) caused antagonistic and/or hyperparasitism to the two more pathogenic fungi, *i.e. B. cinerea* and *P. cactorum.* These actions were previously reported by many investigators. (Dennis and Webster, 1971; Hutchinson and Crown, 1972; Baker and Cook, 1974; Chet, 1984; Campbell, 1989, Peng and Sutton, 1990 and Legard *et al.,* 2000). In this respect, Chet (1984) reported that the action of *Trichoderma* sp. as a biocontrol agent may act as a mycoparasite, which detects its host from some distances, binds itself to the pathogenic fungus by sugarlectin linkage and begins to excrete extra-cellular lytic enzymes such as B-1,3 glucanse, chitinase, protease and/or lipase. Loeffer *et al.* (1986) mentioned that the antagonistic effects of *B. subtilis* towards wide spectrum of pathogenic soil-borne fungi are due to dipeptide compounds namely bacilysin and fengymycin. On the other hand, Voisard *et al.* (1989) declared that *P. fluorescens* excretes several metabolites with antifungal properties and the most important is hydrogen cyanide. In addition, Fiddaman and Rossal (1993) mentioned that *T. hazianum* and *B. subtilis* may secrete, during their growth, some antagonistic substances and/or lytic enzymes, which probably suppress the growth of many soil-borne pathogenic fungi.

In vivo experiments indicated that when the mixture of the culture filtrate of the bioagents tested was used, low infection by fruit-rots was recorded. This reduction may be due to the effect of the different kinds of secreted antifungal substances by the three bioagents. Moreover, there are some agricultural or sanitary methods responsible for increasing the efficiency of the used methods of controlling strawberry fruit-rots such as harvesting the rotted fruits with workers (sweeping) before gathering the marketable fruits with another workers and collecting all the dead strawberry plant debris and burn them to reduce the suitable medium for growing the causal fruit-rots, especially *B. cinerea.* Also, harvesting the fruits without free wetness (after evaporation the dew)is very important.

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الفطريات المصاحبة لعفن ثمار زراعات الفراولة الطازجة وبعض طرق مقاومتها

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ملخص

أسفرت عمليات العزل من ثمار فراولة مجموعة من زراعات طازجة ومصابة طبيعيا بأمراض عفن الثمار والتي تم جمعها من مناطق القليوبية ، الجيزة ، الإسماعيلية ، الشرقية ، جنوب التحرير عن الحصول على ٥٤٣ عزلة فطرية تنتمي إلى ١٠ أجناس . تم تنقية هذه الفطريات وعرفت على أنها :

Aspergillus niger, Alternaria tunissima, Botrytis cinerea, Cladosporium spp., *Mucor* spp., *Penicillium* spp., *Phomopsis obscurans, Phytophthora cactorum* , *Rhizopus stolonifer and Trichoderma harzianum.*

تم إثبات مرضية هذه الفطريات وذلك برش معلق جراثيم هذه الفطريات على نباتات الفراولة (عند بداية الإزهار ثم بعد ذلك بأسبوعين) ، وقد وجد أن كلا من الفطرين : *B . cinerea* و *P. cactorum* هما الأكثر مرضية.

أدت تغطية المصاطب النامي عليها نباتات الفراولة بشرائح بلاستيك شفاف إلى انخفاض معنوي في نسبة الإصابة الطبيعية بعفن الثمار مقارنة بالمصاطب غير المغطاة بشرائح البلاستيك ، بالإضافة إلى ذلك فإن تغطية المصاطب بشرائح البلاستيك المثقبة كانت أكثر فعالية في خفض الإصابة مقارنة باستخدام البلاستيك غير المثقب. كانت كمية الثمار القابلة للتسويق (الخالية من العفن) أعلى في الحالة الأولى عن الثانية.

لم تسجل فروق معنوية في النسبة المئوية للثمار المصابة بالعفن للأصناف المختبرة، ورغم ذلك ، كان الصنف كماروزا تلاه الصنفين روزالندا ، كابيتولا

هم الأقل قابلية للإصابة الطبيعية بهذا العفن ، أما الصنف سويت شارلى فقد كان أكثرها قابلية للإصابة تلاه الصنفين أوزو جراندى و شاندلر . هذا ، وقد أعطى الصنف كماروزا تلاه الصنف سويت شارلي أعلى كمية مواد صلبة ذائبة وكذلك المحصول القابل للتسويق.

أوضح الفحص المعملي ، أن الكائنات الثلاثة المضادة المختبرة قد أعطت درجات مختلفة من التأثير التضادي ، حيث أحدثت البكتريا *B. subtilis*, *P.flurescens* تثبيطا بدرجات متباينة لنمو الفطرين الممرضين ، أما الفطر *T. harzianum* فقد أحدث علاقة فوق تطفلية.

في تجربة الحقل وذلك تحت ظروف العدوى الطبيعية ، أدى رش معلق الكائنات المضادة المختبرة (عند بداية الإزهار ثم كل أسبوعين) إلى تقليل نسبة الإصابة الطبيعية بعفن الثمار (سواء تم رش كل كائن مضاد على حده أو متحدا مع الكائنين الآخرين) مع إحداث زيادة معنوية في محصول الثمار القابل للتسويق مقارنة بالنباتات غير المعاملة.

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