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Management of Cantaloupe Fruit-Rot

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Many fungal isolates were isolated from naturally rotted cantaloupe fruits. The obtained isolates were purified and identified as *Alternaria* sp., *Fusarium semitectum*, *F. solani*, *F. subglutinans*-1, *F. subglutinans*-2 and *Rhizopus stolonifer*. Pathogenicity test revealed that *F. semitectum* was the most pathogenic one followed by *F. solani* then *F. subglutinans*-1 and *F. subglutinans*-2. Under laboratory conditions, the efficacy of some bioagents as well as fungicides against the growth of isolated fungi was tested. Under *in vitro* conditions the antagonistic *Bacillus subtilis*-1 showed high reduction in the growth of *F. solani* followed and *F. subglutinans*-$_1$, meanwhile *B. subtilis*-2 showed similar effect against the growth of *F. subglutinans*-1 and *F. semitectum*, respectively. Moreover, the fungicides Combinex and Basten at concentration of 800 ppm completely inhibited the linear growth of the tested fungi compared with control treatment. Under field conditions, spraying the fungicide Combinex, salicylic acid and the bioagent *B. subtilis*, alone or in combinations, on cantaloupe plants resulted in significant reduction in natural fruit rot infection with considerable increase in fruit yield and their total soluble solids compared with untreated control.

Keywords: Antagonism, biocontrol, cantaloupe, fruit rot and fungicides.

Cantaloupe (*Cucumis melo* L. var. *reticulates* Ser.) become one of the most famous cucurbit crops in Egypt for local consumption and exportation. It is considered as an untraditional winter crop and became one of the most important exportation crops to the foreign markets. The demand production from cantaloupe fruits for local consumption and exportation are annually increased. Cantaloupes are the most important type of muskmelon grown in Egypt. Cantaloupes, and more specifically the winter type muskmelons, are better adapted to the drier south western areas of the state where foliage diseases are less prominent. Although hot, dry weather is favourable for cantaloupes, they can be grown successfully under plastic houses conditions if diseases can be managed. Cantaloupe is susceptible to several diseases that attack the roots, foliage, and fruit. However, cantaloupe plants are liable to infection by bacterial, fungal and viral diseases in addition to nematode infection and physiological disorders (Osman, 1966; Zitter *et al*., 1996; Agerter *et al*., 2000; Muhanna, 2006; Ashour, 2009 and Abada and Eid, 2013).

However, fruit-rots are among the most destructive constrained for its production (Seebold, 2010). Postharvest decay of cantaloupe fruits caused by *Fusarium* spp. is the most important factors affecting harvested lime fruits during handling, transportation, exportation and storage (Bruton *et al*., 1998; Zhang *et al*., 1999 and Seebold, 2010). Moreover, cantaloupe fruits contaminated with *Fusarium* spp. found to cause a great hazard to human health, where some of them produce mycotoxins (Rheeder *et al.*, 2002).

Disease control is essential in the production of high-quality cantaloupes. A preventive program that combines the use of cultural practices, genetic resistance, and chemical control as needed usually provides the best results. Cultural practices are useful for limiting the establishment, spread, and survival of pathogens that cause cantaloupe diseases. It is well known that chemical control of plant diseases mostly causes environmental pollution and increase the accumulated of toxic substances in human food chain. On the other hand, using other trials of disease management, *e.g*. biological control, plant extracts, antioxidants and agricultural practices, are not enough to obtain efficient results, when each of them used alone (Hilall, 2004; Muhanna, 2006; Abada *et al*., 2008 and Abada and Eid, 2013).

Therefore, the purpose of the present study was to evaluate the effect of some fungicides and bioagents on the *in vitro* growth of rot fungal pathogens. Moreover, their effects in addition to Salicylic acid (SA) against the rot incidence of cantaloupe fruits were also tested under *in vivo* conditions.

Materials and Methods

Isolation, purification and identification of the causal fungi:

Cantaloupe fruits showing fruit-rot symptoms were collected from different local markets at Giza Governorate, whereas red to brown lesions on the fruit tissues were developed. Small pieces of necrotic tissues appeared on the fruits were picked up and surface sterilized in 2% sodium hypochlorite for 2 min. followed by several rinses in sterilized water before being transferred onto sterilized Potato Dextrose Agar medium (PDA) plates. All inoculated plates were incubated at 25±2^{o}C and examined daily for the appearance of fungal colonies. Developed fungal cultures were purified by single spore method and/or hyphal tip technique. The purified cultures were maintained on PAD slants in a refrigerator at 5°C. Identification of the isolated fungi was carried out according to the cultural and microscopically characteristics using the manuals described by Gilman (1957); Booth (1971) and Barnett and Hunter (1998).

Pathogenicity test:

Pathogenicity test of six isolated fungi, *i.e. Alternari*a sp., *Fusarium semitectum*, *F. subglutinans*-1, *F. subglutinans*-2, *F. solani* and *Rhizopus stolonifer* was carried *in vitro* on cantaloupe fruits (cv. Galia). Apparently healthy cantaloupe fruits were obtained from a local orchard and used shortly after harvest or stored at an optimal storage temperature 11°C, until use.

Prior to inoculation, fruits were washed thoroughly with tap water and sterilized by drenching in a water solution of 2.0% hypochlorite for 2 min, and left to air dry under room temperature (18-22^{o}C). Three marked wounds were made up for all infested and non-infested fruits at its equator using sterilized head of an inoculated needle (Wilson and Chalutz, 1989). After wounding, 50µl of an aqueous fungal suspension (10^6 cfu/ml) were immediately pipetted into each wound site. The treated fruits with fungal suspension were left to air dry for 2 hr at ambient temperature (20-24°C). Control treatments included infested and non-infested fruits inoculated only with sterilized water. All cantaloupe fruits were placed into plastic boxes (three fruits per each) in relevant to each particular treatment and stored in a cold room at 18±2°C for two weeks and examined daily for rot incidence. Three boxes as replicates were used for each particular treatment as well as control. At the end of storage period average percentages of infected fruits were recorded.

In vitro evaluation of the antagonistic effect of Bacillus subtilis against the linear growth of pathogenic fungi:

Two isolates of *B. subtilis* which proved their high antagonistic effect against wide spectrum of pathogenic fungi were kindly provided by Plant Pathol. Dept., Fac. Agric., Cairo Univ. and used in this test. The interaction between bacterial isolates and rot pathogenic fungi was evaluated as fungal growth inhibition. Dual culture technique was followed according to Ferreira *et al*. (1991). Bacterial isolates (48-h-old) were streaked individually on one side of 9 cm Petri dishes containing PDA medium, while 5 mm disks of tested fungi were placed on the opposite side of bacterial inoculated plates. Both tested microorganisms were placed 2 cm from the plate edges. A set of only fungal inoculated plates were used for check treatment. All plates were incubated at 25±2°C until full fungal growth in check plates. Percentage of fungal growth reduction was calculated in bacterial treatments relative to the fungal growth in the check treatment after 7 days. The percentage of redaction in the mycelial growth of the pathogenic fungi to control was calculated according to Fokemma (1973).

Effect of the fungicides Basten and Combinex on the linear growth of the tested fungi:

The inhibitory effect of the fungicides Basten (carbindazim 80%) and Combinex (thiophanate-methyl) was evaluated on the linear growth of tested fungi *in vitro*. For each of the tested fungicide six concentrations were prepared by dissolving in sterilized distilled water. They were added individually to conical flasks containing sterilized PDA media before its solidification to obtain the proposed concentrations based on their active ingredient, *i.e.* 0.0, 10, 100, 200, 400 and 800 ppm. The supplemented media were poured into Petri-dishes (9 cm Ø) nearly 20 ml per each. A separate PDA plates free of fungicide was used as control treatment.

Mycelial discs (5mm Ø) were taken from the periphery of an actively growing PDA culture of each tested fungus and placed at the centre of the prepared Petri dishes. Three replicated dishes were used as replicates for each treatment. The plates were incubated at 25±1°C. The diameter of the fungal growth in different treatments was measured when that of the check control reached the edge of the dish.

Field experiment:

The fungicide Combinex, salicylic acid (as resistance inducers chemical, RIC) and the bioagent *B. subtilis* were evaluated as pre-harvest treatments against cantaloupe fruit rot under field conditions. Field experiment was carried out at Imbaba region, Giza Governorate, Egypt during two successive growing seasons 2012 and 2013. A field experiment consisted of plots 126 m^2 (2.5x42 m) each comprised of 3 rows and 86 hole/row which were conducted in completely randomized block design with three plots as replicates for each particular treatment as well as untreated control treatment. Cantaloupe transplants (cv. Galia) were planted in all treatments. All plots received the traditional agricultural practices as irrigation, fertilization and soil plunging. Transplants were grown under low tunnels during low temperature conditions and at the night until beginning of March and left to grow in the open air until end of the growing season (mid of June). The growing cantaloupe plants were left for natural infection with fruit rot caused by pathogenic fungi.

The pre-harvest treatments (Table 4) with fungicide Combinex at concentration of 150 g/l, Salicylic acid (RIC) at concentration of 50 mM/l and the bioagent *B. subtilis* at concentration of $1x10^7$ cfu/ml were applied as foliar spray twice with 15 days interval started two weeks after the first sign of fruit formation. Another set of cantaloupe plants sprayed only with water was used as control treatment. Unsprayed cantaloupe plants with the tested fungicide, RIC and the bioagent were left as control treatment. Cantaloupe fruits periodically harvested and their average weights were recorded. Total soluble solids (T.S.S.) of five fruits of each treatment were assessed using hand fractometer (Abada and Eid, 2013).

Disease assessment:

The rotted fruit area was examined and classified into the devised scale (0-5) using the modified formula suggested by Cohen *et al.* (1991) as follows:

0= No observable symptoms of fruit- rot,
1= Rotted portion ranged from 1-10% of fruit surface area,
2= Rotted portion ranged from more than 11-25%,
3= Rotted portion ranged from more than 26-50%,
4= Rotted portion ranged from more than 51-75% and
5= Rotted portion ranged from more than 75%.

Disease severity percentages were calculated using the following formula:

$$\text{Disease severity (\%)} = \frac{\sum (n \times v)}{5N} \times 100$$

Whereas, n = Number of fruits in each category.
v = Numerical values of symptoms of each category.
N= Total number of the examined fruits.
5 = Maximum number of numerical values of symptoms category.

Statistical analysis:

Data were statistically analyzed using the standard procedures for split designs as mentioned by Snedecor and Ghram (1967). The averages were compared at 5% level using least significant differences (L.S.D) according to Fisher (1948).

Results

Isolation, purification and identification of the causal fungi:

Isolation trials from naturally rotted fruits yielded many fungal isolates. Obtained isolates were purified using single spore method and/or hyphal tip technique. The purified fungi were identified as *Alternaria* sp., *Fusarium semitectum*, *F. subglutinans*-1, *F. subglutinans*-2, *F. solani* and *Rhizopus stolonifer*. These fungi were maintained as pure cultures on agar slants kept in refrigerator at 5±2°C until using.

Pathogenicity test:

Pathogenicity test of the isolated fungi (Table 1) reveal that all the isolated fungi were pathogenic to cantaloupe fruits cv. Galia, whereas all the inoculated fruits showed rot symptoms. In this respect, *F. semitectum* was the most pathogenic one, being 61.4 % of rot severity followed by *F. solani* then *F. subglutinans*-1 and *F. subglutinans*-2, being 56.3, 52.6 and 43.0%, respectively. Meanwhile, *R. stolonifer* caused the lowest disease severity followed by *Alternaria* sp., being 10.0 and 24.3%, respectively.

Since the pathogenic fungi *R. stolonifer* and *Alternaria* sp., showed the lowest rot severity (Table 1) therefore they were neglected from the following antagonistic and fungicides tests.

Table 1. Pathogenicity test of the isolated fungi on cantaloupe cv. Galia

Tested fungus	Fruit infection (%)	Rot severity (%)
Alternaria sp.	100	24.3
F. semitectum	100	61.4
F. subglutinans-1	100	52.6
F. solani	100	56.3
F.subglutinans-2	100	43.0
R. stolonifer	100	10.0
Control	0.0	0.0

Effect of B. subtilis isolates on the linear growth of pathogenic fungi:

The antagonistic effect of bacterial isolates against rot pathogenic fungi was evaluated as fungal growth inhibition *in vitro*. Data in Table (2) reveal that the two tested isolates of *B. subtilis* could inhibit the linear growth of tested fungi. The growth of *F. semitectum* followed by *F. subglutinans*-$_2$ showed the most growth reduction against *B.subtilis*-1, which recorded as 53.3 and 47.5%, followed by 43.3 and 42.5% for *F. subglutinans*-2 and *F. solani*, respectively. It is interesting to note that the bacterium *B. subtilis*-2 showed higher inhibitor effect against the growth of tested fungi. In this regard, the recorded reduction in the growth of *F. solani*, *F. subglutinans*-2, *F. semitectum* and *F. subglutinans*-1 were 58.3, 52.5, 51.3 and 45.0%, in respective order.

Table 2. Antagonistic effect of *B. subtilis* isolates on the linear growth of *Fusarium* spp.

Antagonistic bacteria	Reduction (%) in the linear growth of			
	F. subglutinans-1	*F. solani*	*F. Subglutinans*-2	*F. semitectum*
B. subtilis-1	43.3	42.5	47.5	53.3
B. subtilis-2	45.0	58.3	52.5	51.3
LSD at 5%	1.6	2.3	3.7	1.9

Effect of the fungicides Basten and Combinex on the linear growth of the tested fungi:

The inhibitory effect of the fungicides Basten and Combinex was *in vitro* evaluated on the linear growth of tested fungi. Results presented in Table (3) indicate that the two tested fungicides could highly inhibited the linear growth of *F. semitectum*, *F. subglutinans*-1, *F. solani* and *F. subglutinans*-2 compared with control treatment.

This inhibitory effect was gradually increased by increasing of the fungicide concentration. In addition, the fungicide Combinex showed superior higher inhibitory effect against fungal growth than Basten. In this concern, complete inhibition of fungal growth was observed at 400 ppm of the fungicide Basten, meanwhile the same effect was recorded at 800 ppm of the fungicide Combinex.

Table 3. Effect of fungicides at different concentrations on the linear growth of *Fusarium* spp.

Fungicide concentration (ppm)	Linear growth (mm)							
	F. Subglutinans-1		*F. solani*		*F. Subglutinans*-2		*F. semitectum*	
	Combinex	Basten	Combinex	Basten	Combinex	Basten	Combinex	Basten
50	51.0	70.3	72.0	77.3	59.3	65.3	61.0	78.0
100	16.7	30.0	30.0	38.3	20.0	27.3	23.3	38.3
200	6.3	16.3	15.0	21.7	18.3	21.7	10.0	21.0
400	0.0	8.0	0.0	7.9	0.0	9.3	0.0	6.7
800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
LSD at 5%	8.9	9.3	8.4	6.7	5.6	4.3	6.7	8.3

Field experiments:

Pre-harvest treatments by spraying the fungicide Combinex, the IRC salicylic acid and the bioagent *B. subtilis*, each alone or in different combinations, on cantaloupe plants were carried out under field conditions during two successive growing seasons 2012 and 2013. Data in Table (4) revealed that the applied treatments resulted in significant reduction in the incidence of natural infection with fruit-rot compared with untreated plants. Also, it was observed that no significant differences were observed for the obtained results at the two growing seasons.

Table 4. Effect of pre-harvest application with fungicide Combinex, the RIC salicylic acid and the bioagent *B. subtilis* at different combinations on the percentage of fruit-rot incidence, fruit yield and T.S.S. of cantaloupe (cv. Galia), during 2012 and 2013 growing seasons

Treatment	Fruit-rot infection (%) season 2012	Fruit-rot infection (%) season 2013	Mean	Average**** fruit yield (kg/plot) season 2012	Average**** fruit yield (kg/plot) season 2013	Mean	Average T.S.S. of the harvested fruits season 2012	Average T.S.S. of the harvested fruits season 2013	Mean
Combinex (C)*	2.5	2.4	2.5	234.5	231.0	232.7	15.4	15.2	15.3
Salicylic acid (S)	8.2	8.3	8.3	222.0	223.8	222.9	14.1	15.2	14.7
B. subtilis (BS)	10.9	10.2	10.6	220.7	221.5	221.1	14.0	13.8	13.9
C + S **	3.3	3.6	3.5	230.4	231.0	230.7	14.8	15.2	15.0
C + BS	5.0	5.4	5.2	228.0	227.7	227.8	13.8	13.9	13.9
S + BS	5.3	5.1	5.2	225.5	224.0	224.8	13.5	13.7	13.6
C + S + BS***	3.6	3.9	3.8	230.0	231.0	230.5	14.9	14.6	14.8
Control	18.4	20.0	18.7	134.3	132.6	133.5	11.8	11.9	11.9
Mean	7.2	7.4	-----	215.7	215.3	-----	14.0	14.2	-----
L.S.D. at 5% for:									
Treatment (T) =			3.5			2.1			2.3
Season (S) =			n.s			n.s			n.s
T x S =			3.4			3.3			2.9

* Plants received 6 sprays of each compound when sprayed alone.
** Plants received 3 sprays of each compound when sprayed in alternation.
*** Plants received 2 sprays of each compound when sprayed in alternation.
**** Each plot 3 rows of 42 m long.

Application of the fungicide Combinex alone revealed the highest reduction in fruit rot incidence, fruit yield and the percent of TSS in harvested fruits throughout the two seasons which recorded in means as 2.5%, 232.7 kg/plot and 15.3%, respectively. Combined treatments (Combinex + Salicylic acid), (Combinex + *B. subtilis*), (Salicylic acid + *B. subtilis*) and (Combinex + Salicylic acid + *B. subtilis*) showed superior effect on disease incidence as 3.5, 5.2, 5.2, 3.8% and fruit yield as 230.7, 227.8, 224.8, 230.5 kg/plot as well as the percent of fruit T.S.S. which recorded as 15.0, 13.9, 13.6, 14.8% than each of them alone comparing with untreated control plants which revealed 18.7%, 133.5 kg/plot and 11.9% T.S.S. for rot disease incidence, fruit yield and the percent of TSS in harvested fruits, in respective order.

Discussion

Fruit rot is one of the most important postharvest diseases affecting cantaloupe production. Isolation trial from the collected naturally rotted cantaloupe fruits yielded many fungal isolates.

The isolated fungi were purified and identified as *Alternaria* sp., *Fusarium semitectum* , *F. subglutinans*-1, *F. subglutinans*-2, *F. solani* and *Rhizopus stolonifer*. In this concern, many investigators isolated these fungi from cantaloupe fruits at different countries (Zhang *et al.*, 1999 and Latiffah *et al.*, 2013).

The isolated fungi from cantaloupe fruits revealed their pathogenic ability to cause fruit rot on cv. Galia under laboratory conditions. In this respect, the highest percentages of fruit-rot severity were recorded by the four species of genus *Fusarium*, *i.e. Fusarium semitectum*, *F. subglutinans*-1, *F. subglutinans*-2 and *F. solani*. These results confirmed those obtained by Bruton *et al.* (1998); Zhang *et al.* (1999); Seebold (2010) and Latiffah *et al.* (2013).

Under *in vitro* conditions, the antagonistic bacteria showed significant growth inhibitory effect among the tested fungal isolates. The highest inhibitory effect was recorded for *B. subtilis*-2, although no significant differences between the two tested *B. subtilis* isolates was observed. Similarly, Sunick *et al*. (1997) recorded that *Bacillus* sp. gave a highly antagonistic effect against some pathogenic fungi. Also, Kim *et al*. (1997) found that seed treatment with *Bacillus* spp. actively controlled three fungal root diseases of wheat. In addition, *Bacillus cereus* has proven to have beneficial effects on crop health including enhancement of soybean yield, suppression of damping-off of tomato (Smith *et al*., 1999) and alfalfa (Kazmar *et al*., 2000). Extensive laboratory testing demonstrated a powerful suppression of damping-off of alfalfa by diverse strains of *B. cereus*, which confirmed preliminary testing under field conditions (Handelsman *et al*., 1990 and Kazmar *et al*., 2000).

Laboratory tests revealed that that the tested fungicides significantly reduced the linear growth of all tested fungi. The fungal growth affected negatively with the increasing concentrations of the tested fungicides. Complete inhibition of fungal linear growth was observed at concentration of 400 ppm of Combinex as well as 800 ppm of Basten. Similar results concerning the response fungicides at different concentrations were also reported (Li *et al*., 1995; Sheler *et al*., 1997; Mahmood *et al*., 2002). Also, Banik *et al.* (1998) also found that carbendazim at 400 ppm completely inhibited the linear growth of *Botryodiplodia theobromae* followed by Thiophanate-methyl at 450 ppm.

Under field conditions, three foliar spray, *i.e.* inducer resistance (Salicylic acid), biological (*B. subtilis*) and chemical control (Combinex) were applied individually or in combinations to control the natural infection with fruit-rot of cantaloupe during two successive growing seasons. The obtained results in the present study showed that these treatments caused reduction in fruit-rot, increase in the harvested fruit yield and their percent of T.S.S. in comparison with control plants significantly. The combination among the tested fungicide, RIC and the bioagent resulted in superior effect on measured parameters compared with spraying any of them alone.

In spite of that, the harvested fruits are of low fungicides residue and become of more desirable as a safe production, due to the metabolic changes to the sprayed fungicide to be unpoisoned after the long period after the latter fungicide spray.

The role of fungicides in reducing the disease is well known (McGrath, 2001) and the role of RICs could be explained by many hypothesis, where induced acquired resistance was induced by restricted infection is not due to a specific component of the pathogen, but rather to gradual appearance and persistence of a level of metabolic perturbation leading to stress on the host. Doubrava *et al.* (1988) mentioned that induced acquired resistance is persistent and generally is pathogen nonspecific. Larcke (1981) found that unlike elicitors of phytoalexins accumulations, which are elicited at the application site, may be responsible for localized protection and induces systemic acquired resistance that sensitizes the plant response rapidly after infection. These responses induced phytoalexins accumulation and lignifications and induce enhance activities of chitinase and *β*-glucanase (Dean and Kuc, 1985 and Metranx and Boller, 1986). Furthermore, Kessmann *et al.* (1994) reported that the mechanism of systemic acquired resistance is apparently multifaceted, likely resulting in stable broad spectrum disease control.

Biological control has emerged as an alternative and most promising means of the management of plant pathogens. Bacillus strains effective as biocontrol agents are known to produce several antibiotics such as Zwittermycin A and kanosanine, which are significant in the control of Pythium and Phytophthora damping-off and root diseases (Stabb *et al.*, 1994). The degree of disease suppression confined by rhizobacteria depends on the sensitivity of the target pathogen to the antibiotics (Buchenauer, 1998).

Bacillus species, including *B. subtilis*, produce spores that are resistant to various physical and chemical treatments, such as desiccation, heat, UV irradiation, and organic solvents (Leelasuphakul *et al.,* 2008), and serve as excellent biological control agents against a wide range of plant pathogens by their production of antibiotics (iturin, surfactin, and fengycin), cell wall-degrading enzymes (chitinase and *B*-1,3 glucanase), and antifungal volatiles (Kim and Chung, 2004 and Leelasuphakul *et al*., 2008). At the same time, *B. subtilis* can occupy the same niche as many pathogens and play an antagonistic role (Bacon *et al.,* 2001 and Wang, *et al.,* 2010). Thus, *B. subtilis* has been recommended as a generally safe microorganism by the United States Food and Drug Administration (Denner and Gillanders, 1996), which promotes its use in the food industry.

Promising applicable pre-harvest technique could be suggested on the light of the results obtained in the present study. The usage of inducer resistance (Salicylic acid), biological (*B. subtilis*) and chemical control (Combinex) as integrated control measure might be considered as safe, cheep and easily applied method for controlling postharvest fruit decay taken in consideration the avoidance of environmental pollution.

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مكافحة عفن ثمار الكنتالوب

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** قسم سموم وملوثات الغذاء- المركز القومي للبحوث.

تم عزل عدد من الفطريات من ثمار كنتالوب مصابة طبيعياً بالعفن ثم تم تنقيتها وتعريفها بأنها:

Alternaria sp., *Fusarium semitectum* , *F. subglutinans* and *Rhizopus stolonifer.*

أثبتت تجربة المرضية أن الفطر *Fusarium semitectum* هو أكثر الفطريات مرضية تلاه الفطر *F. solani* ثم الفطر *F. subglutinans*-1 فالفطر *F. subglutinans*-2. كان الفطران *F. solani*, *F. subglutinans*-1 الأكثر تأثرا بتضاد العزلة الأولى من البكتريا *Bacillus subtilis* بينما كان الفطران *F. semitectum* ، *F. subglutinans*-1 هما الأكثر تأثرا بتضاد العزلة الثانية من البكتريا *B. subtilis*.

ثبط المبيدين كومباينكس وباستن بدرجة كبيرة الفطريات الأربعة المختبرة مقارنة بالمقارنة. وتم تثبيط جميع الفطريات المختبرة بكلا المبيدين عند تركيز ٨٠٠ جزء في المليون .

أدى رش نباتات الكنتالوب بالمبيد الفطري كومباينكس وحامض السالسيلك كمُستحث كيماوي للمقاومة والبكتريا *B. subtilis* كل على حدى أو باتحاداتهم المختلفة إلى حدوث انخفاض معنوي لشدة الإصابة الطبيعية بمرض عفن الثمار مع حدوث زيادة معنوية لمحصول الثمار الناتج وكذلك المواد الصلبة الذائبة لهذه الثمار مقارنة بمعاملة المقارنة .