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Comparative Efficacy of Chemical Salts and Fungicides for Controlling Date Fruit Rots

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Abstract: Different chemical salts were used to study the inhibitory activities under orchard and cold storage conditions. Date revealed that the increasing salt concentrations from 1g to 3g/l.w significantly decreased the decay caused with the tested fungi during 2019 and 2020 growing seasons. The tested salts when sprayed on date bunch at the rate 3g/l.w strongly reduced the fungal infection during storage. Calcium chloride with the highest concentrations was the most effective salt in reducing decay, followed by calcium carbonate and ammonium sulphate when used at 3g/l.w during 2019 and 2020 seasons. At the same time, using chemical salts as a dipping treatments revealed that calcium carbonate, followed by calcium chloride each at 3g/l.water were the most effective salts in minimizing disease severity caused with the tested fungi during 2019 and 2020 seasons if compared with control treatment. Also, ammonium sulphate at the rate 3g/l.w gave higher effect in reducing disease severity. Different concentrations of five fungicides were tested to study their efficacy in prevention and/or minimizing mycelial growth of *A.alternata*, *C.herbarum* and *Th.paradoxa*. Switch, Bellis and Rovral were the most effective fungicides in inhibition mycelial growth of *A.alternata*, when used with all concentrations. Mycelial growth of *C.herbarum* was entirely inhibited with Bellis and Rovral fungicides. The same data revealed that Switch, Bellis and Rovral completely prevented mycelial growth of *Th.paradoxa*. Different concentrations of Switch, Bellis, Rovral and Maystic fungicides were used as foliar spray on date bunches under orchar conditions.

Keywords: Date palm, Chemical salts, Fruit rots, Fungicides, pre and postharvest

INTRODUCTION

Date palm (*phoenix dactylifera* L.), is a tropical and subtropical tree, belonging to the family Palmae (Arecaceae) is one among man- kind's oldest cultivated plants, and in the Arabian Peninsula it has played an important role in the day-to-day life of the people for last 7000 years [1]. World production of dates has increased significantly and steadily over the last 30 years. Arab countries produce about 74.5% of the world's total production. Egypt is the largest world's top ten producers of dates [2]. Egypt produces 1.710.601 tons of date fruits. Only 16.5% of total date fruit production was directed for food processing [3]. Generally, whole dates are harvested and marketed at three stages of development: mature firm (Bisir or Khalal), full ripe (Rutab) and dry (Tamr). The decision for harvesting at one or other stage depends on cultivar characteristics, especially soluble tannins levels, climatic conditions and market demand [4]. Moreover, the largest post-harvest losses in fruit and vegetable crops are due to deterioration caused by microorganisms after harvest and during cold storage. Fruits, due to their low pH, higher moisture content and nutrient composition are very susceptible to the attack of fungi, while vegetables are generally less acidic, and their spoilage is usually by bacteria

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[5].A number of postharvest diseases attack date fruits during harvesting, packing, handling, marketing and storage. Date fruits are attacked by several diseases such as *A.alternata, C.herbarum* and *Th.paradoxa, Aspergillus niger, Penicillium spp.* and *Rhizopus stolonifer* [6]. *Alternaria, Aspergillus, Fusarium* and *Penicillium,* have been reported to cause fruit rots of date palm [7]. *Penicillium, Cladosporium, Aspergillus* and *Alternaria* fungi were the most genera in both part of date fruits [8]**.** The effect of different concentrations of sodium metabisulphite, sodium carbonate and borax on postharvest diseases of date fruits minimizwd remarkably the disease severity. In this regards, sodium metabisulphite at 200ppm was the most effect in reducing the fungal infection caused by *A.alternata, C.herbarum* and *Th.paradoxa* [9]. Some postharvest fungicides such as Imazalil, Rovral, Tecto and Topsin-M70 were evaluated at different concentrations against *A.alternata, C.herbarum* and *Th.paradoxa*. It was found that Imazalil fungicide completely prevented date fruit rots [9]. [10] Studied the efficacy of some safe substances such as sodium carbonate at different rate on storability and microbial load of Hyani date fruits under cold storage at 2°C and 90-95% RH. It was found that sodium carbonate with all tested concentrations significantly decreased the microbial load and decay percentage compared with the control treatment. The efficacy of two fungicides score and pentanol under Lab. and field conditions against *Alternaria sp.* and *Fusarium sp.* was investigated. The fungicides proved a significant increase in mycelial growth inhibition. As means, spraying date palm fruits with any fungicide effectively controlled *Alternaria sp.* In this study, the effect of pre-harvest and postharvest fungicides and chemical salts on major Bartamoda date fruits was studied.

MATERIALS AND METHODS

1. Effect of chemical salts on development of date fruit rots:

1.1. Under orchard conditions:

Inorganic chemical salts were tested under orchard conditions at Al-Adowa province, Edfou, Aswan Governorate. Calcium carbonate, calcium chloride and ammonium sulphate were used as foliar spray at the rate 1, 2 and 3g/L.water. These salts were sprayed three times, 15days between each of them. Three bunches of Bartamoda date cv. were served for each salt. Unsprayed bunches with any chemical salts served as control treatment. After 45 days from spraying, date bunches were harvested to study the effect of salts on postharvest decay of date fruits. Bartamoda date fruits were washed with tap water, surface sterilized in 3% sodium hypochlorite for 2minutes and rewashed with sterile distilled water, left to air dry under Lab. conditions. Fruits were inoculated with spore suspensions of the tested fungi (5×10^5 spores/ml). After 24hours from inoculation, treatment of each concentration was replicated three times, each replicate contained 30dates. Similar number of date fruits previously sprayed with sterile water, but inoculated with the same fungi, served as a control treatment. Each treatment was packed in perforated plastic box. All these boxes were stored at 5c° and 90 %RH in refrigerator for one month. Disease severity was estimated and calculated according to [11].

2. Under storage conditions:

Mature Bartamoda date fruits were harvested and collected from Al-Adowa, Edfou, Aswan. Bartamoda date fruits were

apparently healthy washed and disinfested by dipping in 3% sodium hypochlorite for 3min., rewashed with sterilized water and left to air dry under Lab. conditions. Bartamoda fruits were inoculated as mentioned before with the tested fungi, and then incubated for 24 hours at 5c°. After that the inoculated fruits were immersed for 5minutes in different solution of tested salts, i.e. ammonium sulphate, calcium chloride and calcium carbonate at the rates of 1, 2and 3g/L.W. Inoculated fruits were dipped in sterilized water served as control treatment. Three replicates were used for each treatment, each replicate contained 30dates. All treatments were packed in perforated plastic boxes, stored at 5c° and 90%RH for one month. During storage period, the number of decayed fruits was assessed periodically every 10days. The efficacy of salts was determined and recorded as mentioned before.

3. Chemical control:

3.1. Effect of different fungicides on the fungal growth *in vitro:*

Five fungicides were tested to study their effectiveness on the rate of fungal growth of *A.alternata, C.herbarum* and *Th.paradoxa.* Each fungicide was applied at 5, 10, 25, 50, 100 and 200ppm, based on their active ingredient. Each fungicide was added to PDA medium before solidification the stock medium for each concentration was poured into for Petri dishes, inoculated with equal mycelial disc (6mm in diameter). Petri dishes were incubated at 25c°and daily radial growth was checked till the uper surface in control treatment was fully covered with mycelial growth of the fungus. Then, the diameter of fungal growth were measured and calculated. The experimental data were recorded as linear growth.

3.2. Preharvest fungicides application and its effect on postharvest diseases:

Experiment was initiated during 2019 and 2020 seasons to protect Shamya date fruits against major postharvest fruit rots. Date palm trees were sprayed with four fungicides i.e. Switch 62.5% WDG, Bellis 38% WDG, Mystic 20% WP and Rovral 50% WP at 125, 250 and 500ppm, beginning on July 15, three spray at 3weeks intervals between each spray. Trees were divided into four replicate per each treatment. Four replicates were kept away from spray as a check. At harvest, 120 date fruits were collected from the check and sixteen treatments were used against fruit rots under storage conditions. Shamya date fruits were inoculated as described fore mentioned. Fruits were packed and stored at 5c°and 90%RH for 15days. After which, fruits were examined for disease severity as mentioned before.

2.2. Postharvest fungicides application and decay assessment:

Four fungicides were previously mentioned with the same dose were tested to control date fruit rot diseases caused by *A.alternata, C.herbarum* and *Th.paradoxa* during 2020 and 2021 seasons. Any bruised, wounded or unrepresentable fruits were discarded. Bartamoda date fruits were washed, sterilized, rewashed with sterilized water and left to air dry under Lab. conditions. Fruits were misted with a spore suspension containing 5×10^5 spores/ml of the tested fungi. Then, fruits were kept for 24hours at 5°C following incubation period, fruits were dipped for 5minutes in concentrations of the tested fungicides. Similarly fruits were inoculated but immersed in sterile water were served as a control treatment. Three replicates were used for each treatment and each replicate contained 30date fruits, both treated and untreated fruits were stored at 5° C and 90%RH for 15day. Fruits were examined for disease severity as described before.

RESULTS and DISCUSSION

1. Effect of chemical salts on development of date fruit rots:

1.1. Under orchard conditions:

Different chemical salts (Inorganic salts) namely: calcium carbonate, calcium chloride and ammonium sulphate were sprayed on date palm trees, Bartamoda cv. with three concentrations to study the inhibitory activities against date fruit rots caused by *A.alternata*, *C.herbarum* and *Th.paradoxa* under cold storage. Date presented in Table (1) revealed that increasing salt concentrations from 1g to 3g/L.water significantly decreased the decay caused with the tested fungi during 2019and 2020 growing seasons. Different tested salts at the rate 3g/L.W strongly reduced the fungal infection. In this regard, calcium chloride with the highest concentration 3g/l.water was the most effective salt in reducing decay caused with *A.alternata* , as recorded 2.5% disease severity during 2019growing season. Ammonium sulphate, followed by calcium carbonate, when applied at the same rate gave good control, whatever gave higher effect in limiting disease severity caused with *A.alternata,* as recorded 4.6 and 5.4%, respectively if compared with the control treatment. Also, calcium chloride, followed by calcium carbonate and ammonium sulphate with the rate 3g/l.w gave the best results in decreasing the decay caused by *C.herbarum,* as reached 3.8, 5.1and 6.7%, relatively. Meanwhile, calcium carbonate, followed by ammonium sulphate and calcium chloride each at 3g/l.w gave lower disease severity caused by *Th.paradoxa,* as recorded 4.2, 5.3and 5.4%, relatively during 2019 growing season. In general calcium chloride was more effective than calcium carbonate and ammonium sulphate in reducing fungal decay caused with the tested fungi during 2019 growing season. It was clear from data in the same Table (1) that calcium chloride at 3g/l.water gave the best control of disease incidence caused with the three tested fungi during 2020 growing season, whereas disease severity, reached it 2.65, 2.80 and 1.60%, respectively for all tested fungi. Meanwhile, calcium carbonate at the same rate 3g/l.water caused greater effect in reducing disease severity caused by the tested fungi during the same season, as recorded 3.5, 5.5and 3.5%, relatively. Whatever, ammonium sulphate was less effective in reducing the decay caused by the tested fungi during 2020growing season, as reached 4.75, 6.45and 3.5%disease severity. The previous results showed that application of calcium chloride and/or calcium carbonate at 3g/l.water controlled major fruit rot of Bartamoda dates, while ammonium sulphate gave lower effect in reducing disease severity during 2019and 2020season. The strong effective action of calcium chloride may be attributed to sufficient chemical residues on fruit surface to its ability to penetrate through the scale and into the flesh of the fruit. These results are in agreement with [12] which mentioned that some organic and inorganic salts are active antimicrobial agents and have been widely used in the food industry. Most of these salts have low mammalian toxicity and therefore have potential for postharvest disease control. Salt treatments can inhibit plant pathogens or suppress mycotoxin production.

Table (1): Evaluation of preharvest spraying on Bartamouda dates bunches with different chemical salts on developing postharvest rots after 30 days of storage.

Chemical salts	Conc. With g/L	Severity of infection %					
		2019			2020 seasons		
		A.alternata	*C.herbarum*	*Th.paradoxa*	*A.alternata*	*C.herbarum*	*Th.paradoxa*
Calcium carbonate	**1g**	26.8	17.8	14.8	23.5	17.8	13.8
	2g	16.6	11.0	13.2	11.0	8.75	6.8
	3g	5.4	5.1	4.2	3.5	5.5	3.5
Calcium chloride	**1g**	25.5	15.9	18.5	16.8	14.5	12.8
	2g	11.0	10.3	12.6	9.4	6.35	7.8
	3g	2.5	3.8	5.4	2.65	2.8	1.6
Ammonium sulphate	**1g**	22.8	19.6	14.6	17.9	17.5	11.6
	2g	7.8	13.8	9.8	9.8	10.3	8.33
	3g	4.6	6.7	5.35	4.75	6.45	3.5
Uninoculated fruits	**---**	100.0	98.0	93.0	100.0	96.0	96.0
L.S.D. at 5%	**S**	1.57	0.90	1.24	1.70	1.74	0.75
	C	1.49	1.25	1.45	1.85	1.67	1.35
	S x C	2.65	2.45	2.20	2.96	2.85	2.65

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2. Effect of dipping date fruits in some solution on postharvest date fruit rots under storage conditions:

Efficiency of chemical salts applied as postharvest treatment for controlling major postharvest date fruit rots caused by *A.alternata*, *C.herbarum* and *Th.paradoxa* was tested to study their efficacy one month after treatments. Data presented in Table (2) cleared that the chemical salts differed in their effects against the tested pathogens. This effect depended upon the rates of the application. Date also revealed that chemical salts reduced the disease incidence. The reduction of disease severity increased by increasing the salt concentrations from 1% to 3%g/l.w. Calcium carbonate, followed by calcium chloride each at 3g/l.water were the most effective salts in minimizing disease severity caused by the tested fungi during 2019 and 2020 seasons if compared with the control treatment As means, ammonium sulphate at the rate 3g/l.water gave higher effect in reducing disease severity caused by *A.alternata.* In this respect, calcium carbonate and calcium chloride were effective in reducing disease severity after harvesting, while ammonium sulphate was in the third rank after calcium carbonate and calcium chloride during 2019 and 2020 growing seasons. These results exhibited that calcium carbonate and calcium chloride application as postharvest dipping singnificantly reduced disease severity of date fruit rots. A proposed mechanism of fungal prevention with calcium treated fruit suggests some impediment of fungal pectolytic by Ca^{++} ions (calcium ions) associated with intercellular pectin substances in fruits. Also, it is possible that disease severity was reduced via the beneficial effects of calcium on reducing the incidence of calcium-related fruit disorders that serve as infection courts for the fungi. These results are in agreement with [13-14-15-16].

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Table (2): Effect of dipping Bartamoda dates in some salt solution on postharvest diseases after 30 days of storage at 5°C

Chemical salts	conc. with g/w	Severity of infection %					
		2019			2020 seasons		
		A.alternata	*C.herbarum*	*Th.paradoxa*	*A.alternata*	*C.herbarum*	*Th.paradoxa*
Ammonium sulphate	**1g**	24.9	65.	44.4	28.90	24.30	22.50
	2g	16.66	41.6	16.66	22.50	21.40	17.20
	3g	8.33	11.20	13.8	20.30	13.20	9.60
Calcium chloride	**1g**	25.2	28.10	22.35	32.4	20.3	18.85
	2g	16.4	13.6	19.60	16.80	14.42	12.60
	3g	10.25	9.8	11.0	12.40	10.15	9.40
Calcium carbonate	**1g**	20.0	21.20	16.90	14.25	11.15	12.40
	2g	10.2	10.25	10.95	7.80	7.90	8.60
	3g	6.8	4.45	6.90	5.0	6.6	4.2
Check	**---**	95.5	98.40	100.0	92.0	94.0	88.5
L.S.D. at 5%	**c.s**	0.48	0.58	1.58	0.45	0.80	0.38
	C	0.76	1.02	1.74	0.67	0.67	0.78
	c.s x C	1.18	2.35	2.30	1.15	1.55	0.94

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2. Chemical control:

2.1. Effect of different fungicides on the fungal growth *in vitro*:

Different concentrations of five fungicides namely; Switch 62.5%WDG, Bellis 38%WG, Rovral50%WP, Maysteic20%WP and Captan ultra 80% WP. Were tested to study their efficacy in prevention and/or minimizing mycelial growth of *A.alternata* , *C.herbarum* and *Th.paradoxa*. Data presented in Table (3) exhibited clearly that the increase in fungicides concentrations gave high significant reduction on mycelial growth of the tested fungi. Switch, Bellis and Rovral were the most effective fungicides in inhibition mycelial growth of *A.alternata* , when used with all concentrations. Maystic and Captan with all tested concentrations were effective in decreasing mycelial growth of *A.alternata*, whereas minimized growth for a large degree, as well as completely suppressed the fungal growth at 200ppm. Mycelial growth of *C.herbarum* was entirely inhibited with Bellis and Rovral fungicides with all tested concentrations. Captan ultra was effective in reducing mycelial growth of the same fungus, as well as prevented it by using 100 and 200ppm. In this respect, Maystic and Switch were less effect in reducing mycelial growth of *C.herbarum,* but these fungicides caused complete inhibition of mycelial growth at 200ppm. Whatever Captan showed complete suppression, when used at 100 and 200ppm. The same data revealed that Switch, Bellis and Rovral with all tested concentrations completely prevented mycelial growth of *Th.paradoxa*. while, considerable reduction of mycelial growth of this fungus took place with Maystic at 5, 10, 25, 50 and 100ppm, as well as the concentration 200ppm entirely prevented mycelial growth. The converse effect was obtained by using Captan with 5, 10, 25 and 50ppm, As regards Captan at 100ppm minimized mycelial growth and prevented it at 200ppm. Accordingly, the results indicated that the most of fungicides inhibited mycelia growth of the tested fungi. This result was also confirmed by measuring the mycelium growth inhibition. These results are in agreement with the findings of [17] who tested 7fungicides at 50, 100 and 150ppm concentrations and found Bavistin the most effective in inhibiting radial growth of the tested pathogen. Also, [9] found that Imazalil fungicide at 200ppm gave the best results against *A.alternata*, *C.herbarum* and *Th.paradoxa* if comared with Rovral, Tecto and Topsin-M fungicides.

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Table (3): Effect of different concentrations of five fungicides on linear growth of *A.alternata*, *C.herbarum* and *Th.paradoxa.*

Fungicides Conc. (ppm)	Cont.	Colony diameter in (cm.)																	
		A.alternata						*C.herbarum*						*Th.paradoxa*					
		5	10	25	50	100	200	5	10	25	50	100	200	5	10	25	50	100	200
Switch 62.5% WDG	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	9.0	9.0	9.0	0.86	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bellis 38% WG	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rovral 50% WP	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maysteic 20% WP	9.0	4.8	3.4	2.5	0.6	0.2	0.0	9.0	9.0	8.0	6.2	2.0	0.0	1.9	1.9	1.6	1.3	0.7	0.0
Captan 80% WP	9.0	6.8	3.7	2.2	1.4	1.0	0.0	2.4	2.2	2.0	1.5	0.0	0.0	9.0	7.8	6.3	4.5	2.4	0.0
	F	**0.03**						**0.21**						**0.12**					
L.S.D. at 5%	**C**	**0.09**						**0.14**						**0.20**					
	F x C	**0.19**						**0.28**						**0.35**					

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2.2. Preharvest fungicides application and its effect on postharvest diseases:

Preharvest treatments were conduct to tested the effect of different fungicides on the development of date fruit rots caused by *A.alternata* , *C.herbarum* and *Th.paradoxa*. It was clear from data presented in Table (4) that Bellis at all concentrations tested was effective fungicide in controlling decay caused with *A.alternata* during 2019 season. As recorded 28.20, 17.79 and 8.85%, relatively if compared with other fungicides and the control treatment, which reached 51.50% disease severity. At the same time, Rovral followed by Switch with all tested concentrations gave the same effect in controlling the decay of fruit, when applied as preharvest treatments. The same trend was observed in controlling *C.herbarum*, wherever, Bellis, followed by Switch and Rovral each at 500ppm gave higher effect in minimizing date fruit rots more than Maystic, which showed the less effect. On the other hand, Switch was very effective in limiting the decay caused by *Th.paradoxa*. Also, Bellis at 500ppm followed by Rovral gave slight disease severity caused with the same fungus during 2019 season. While, Maystic with all concentrations tested was the least effective ones. Also, data in the same Table (4) demonstrated that foliar spray with Bellis, followed by Switch and Rovral with the tested concentrations were effective fungicides in controlling date fruit rot caused by *A.alternata*, while Maystic with the same concentrations was less effective fungicide in limiting disease severity during 2020 season. As regard, Switch at 250 and 500ppm gave the best results in controlling the decay incited by *C.herbarum,* followed by Rovral at 500ppm. Also, Bellis and Maystic each at 500ppm gave the same effect in controlling the same fungus. In this respect, Bellis, followed by Rovral, Maystic and Switch each at 500ppm were very effective in reducing disease severity caused by *Th.paradoxa*, as recorded 1.11, 4.10, 5.45 and 5.80% , respectively if compared with the control treatment, which reached 41.15% disease severity. The lowest effect was obtained by using concentrations 125and 250ppm. Meanwhile, these fungicides affected on decay caused by *Th.paradoxa* during 2020 growing season.

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Table (4): Comparative effectiveness of certain fungicides as preharvest treatments on Shamya dates during 2019 and 2020 growing seasons.

Fungicides	Conc. (ppm)	Severity of infection %					
		2019			2020 seasons		
		A.alternata	*C.herbarum*	*Th.paradoxa*	*A.alternata*	*C.herbarum*	*Th.paradoxa*
Switch62.5WDG	**125**	31.16	29.61	24.02	29.44	21.87	20.84
	250	27.33	22.77	13.33	19.80	8.67	15.76
	500	10.75	7.85	2.77	5.03	2.42	5.80
Bellis38%WG	**125**	28.20	25.20	23.33	22.10	18.88	17.88
	250	17.79	15.73	12.88	11.55	14.92	13.36
	500	8.85	6.75	6.75	5.80	8.27	1.11
Maystic 20%WP	**125**	38.33	31.10	32.66	29.37	25.35	24.39
	250	27.22	27.21	22.77	12.35	16.10	10.76
	500	11.11	10.33	12.97	7.99	8.33	5.45
Rovral50%WP	**125**	31.11	30.10	29.44	25.55	19.54	18.90
	250	16.80	24.80	22.50	13.35	16.48	13.25
	500	12.25	8.25	6.55	4.85	2.77	4.10
Control	**---**	51.50	40.25	39.0	55.0	42.25	41.15
L.S.D. at 5%	**F**	2.05	1.75	1.07	1.69	2.08	1.49
	C	1.35	2.15	1.65	1.85	1.69	2.41
	F x C	3.10	4.25	3.25	3.78	3.35	3.85

Under field conditions for two successive seasons, the effect of fungicidal spraying on date bunches (pre-harvest) to protect date fruits during harvesting and storage revealed that disease severity decreased as fungicidal concentrations increased. Bellis and/or Switch with the highest concentration were the best fungicides for protecting date fruits during two seasons, followed Rovral, while Maystic at the same concentration was less effective in controlling the decay incited by the tested fungi. Similar trend was found by [6- 9 -18-19] who revealed that the active ingredient could be responsible for their higher antifungal activity against fungal pathogens

2.3. Postharvest fungicides application and decay assessment.

The efficacy of four different fungicides was used against *A.alternata* , *C.herbarum* and *Th.paradoxa* the causative pathogens of date fruit diseases under storage conditions during 2020and 2021seasons. Data presented in Table (5) indicated that all tested fungicides significantly inhibited and decreased the decay of Bartamouda date fruits. Bellis at 500 ppm entirely prevented date fruit rot caused by *A.alternata.* Rovral and Maystic each at 500ppm gave the highest effect in controlling *A.alternata,* as recorded 3.21% disease severity if compared with the control treatment, which reached it 54.80% infection. Switch at the same dose was less effective in controlling the decay caused by *A.alternata* during 2020season. At the same time, Switch and Bellis each at 500ppm completely suppressed the fungal infection caused by *C.herbarum* and *Th.paradoxa*. The reduction of disease severity increased by increasing the fungicidal concentrations. Meanwhile, Rovral followed by Maystic each at 500ppm gave higher effect in controlling Bartamoda fruit rots caused by *C.herbarum* and *Th.paradoxa,* as reached 2.22, 1.96, 2.22 and 2.88%, respectively. While, the fungal infection in control treatment reached it 42.35 and 41.25% disease severity. The same experiment was carried out next season 2021 for confirmation of the obtained result. It was shown from data in the same Table (5) that Switch at 500ppm was the most effective fungicide, which completely prevented the infection caused with *A.alternata* , *C.herbarum* and *Th.paradoxa*. Bellis fungicide at the highest concentration 500ppm entirley prevented the fungal infection caused with the tested fungi, except the infection caused by *A.alternata,* which reached 1.33% disease severity as compared with the control treatment.

In this respect, disease severity decreased with increasing the fungicidal concentration. All the tested fungicides significantly decreased the infection. However, Maystic followed by Rovral each at 500ppm gave higher effect in control disease severity caused by *C.herbarum* and *Th.paradoxa* during 2021season. Generally, all the tested fungicides with the highest concentrations gave the best effect in controlling the disease severity caused by *A.alternata*, *C.herbarum* and *Th.paradoxa*.

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Table (5): Evaluation of postharvest fungicidal treatments on fungal infection of Bartamoda dates during storage.

Fungicides	Conc. (ppm)	Severity of infection %					
		2020			2021 seasons		
		A.alternata	*C.herbarum*	*Th.paradoxa*	*A.alternata*	*C.herbarum*	*Th.paradoxa*
Switch62.5WDG	125	21.08	19.31	18.75	21.04	14.77	12.54
	250	14.41	11.01	9.57	8.06	6.86	7.82
	500	4.25	0.0	0.0	0.0	0.0	0.0
Bellis38%WG	125	14.25	13.03	11.65	11.03	18.94	11.57
	250	7.93	9.26	6.65	5.77	8.93	8.66
	500	0.0	0.0	0.0	1.33	0.0	0.0
Maystic 20%WP	125	24.12	20.47	17.70	21.44	15.12	14.51
	250	13.34	13.55	10.41	12.20	11.06	10.28
	500	3.21	2.22	2.88	4.66	3.22	1.65
Rovral50%Wp	125	17.34	14.81	16.82	21.14	19.40	17.35
	250	11.53	11.06	8.72	13.55	10.70	12.11
	500	3.21	2.22	1.96	5.53	3.21	2.27
Control	---	54.80	42.35	41.25	56.53	41.85	35.71
L.S.D. at 5%	F	2.32	1.36	1.47	3.11	1.91	2.10
	C	1.85	1.75	1.68	2.72	2.21	2.57
	F x C	3.55	3.78	4.1	N.S	4.63	5.03

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For protecting date fruits against some postharvest pathogens such as *A.alternata*, *C.herbarum* and *Th.paradoxa*, which cause fruit rotting during fruit harvesting, handling and marketing. Several fungicides were also tested for two successive seasons after harvesting. Bellis and Switch at 500ppm exceeded all the tested fungicides for controlling date fruit rots. These findings were in agreement with those previously obtained by [6-20].

CONCLUSION

This study was carried out under Lab., orchard and storage conditions. Chemical salts (inorganic salts) and certain fungicides were tested for its efficacy against *A.alternata, C.herbarum* and *Th.paradoxa* the major postharvest diseases of date fruits. These treatments were very effective in reducing important postharvest diseases of date fruits. Data obtained from *in vitro* and *in vivo* experiments revealed that all tested treatments had a good inhibitory effect on fungal infection caused with *A.alternata, C.herbarum* and *Th.paradoxa*, when tested on date fruits. Also, results showed that fungicide treatments exhibited the most pronounced antifungal activities against the tested fungi. All experiments exhibited that the reduction of disease severity increased by increasing all salts and fungicides concentrations. These results exhibited that calcium carbonate and calcium chloride application as preharvest or postharvest spraying and/or dipping significantly reduced disease severity of date fruit rots. The same trend was observed by using different fungicides as pre or postharvest treatments, which gave higher efficacy in controlling date fruit rots. Thus, it could be recommended that using of preharvest spraying and/or dipping with salts and fungicides with high concentration gave an obvious protection of date fruits during harvesting and storage.

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