

EFFECT OF COOLING TREATMENTS ON THE DEVELOPMENT OF THE IMMATURE STAGES OF MEDITERRANEAN FRUIT FLY *Ceratitis capitata* (Wiedemann) (DIPTERA:TEPHRITIDAE)

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ABSTRACT

Two citrus varieties, Navel orange and Valencia were subjected to be infested by mature flies of Mediterranean fruit fly *Ceratitis capitata*(Wiedemann) for 24 hours. The infested fruits were exposed to three different cooling temperatures 1,2,and 4°C for 14 days. It was noticed that eggs, first and second larval instars were highly affected by cooling treatments . A delay of development was noticed in the third larval instar but not death when infested fruits were stored in 4°C and it may need longer exposure period to cause death.

INTRODUCTION

Mediterranean fruit fly, *Ceratitis capitata*(Wied.) is derived as one of the most important and economic fruit pests (Awadallah *et al.*,1974, Saafan,1986 and saafan *et al.*,1987). It is infesting more than 200 different varieties of fruits around the world (Hafez *et al.*,1973, Liquido *et al.*,1991 and Hashem *et al.*, 2001). Fruit exportation usually affected by the infestation of fruit flies, where immature stages complete their development during the period of shipping,which takes about two weeks to reach the destination country. Cold temperatures usually affect the development of different stages of Mediterranean fruit fly *Ceratitis capitata* in apple and citrus (Sproul 1976), *Dacus tryoni* in kiwi fruit (Rippon and Smith 1979) and Caribbean fruit fly *Anastrepha suspensa* (Loew), in oranges (Benschotre 1984 and Hill *et al.*, 1988).

In the present work, different cooling temperatures were used to stop the development of the immature stages of Mediterranean fruit fly inside the fruits of two different varieties of citrus.

MATERIALS AND METHODS

Orange fruits (Navel and Valencia) were derived from local orchards immediately after harvesting to the laboratory. The fruits were not treated with any kind of wax or protecting shell. All of the fruits were marked with a permanent marker and then exposed to the mature flies of Mediterranean fruit fly *Ceratitis capitata* (Wied.) inside the breeding cage (80 x 40 x 30 cm) and removed after 24 hours of exposure. The fruits were kept under laboratory conditions 25 ± 2°C and 70 % RH for 1,3,5, and 7 days before using cooling temperatures. Fruits were stored in incubators which adjusted on 1, 2, and 4 °C and 85 % RH. Control treatments were kept in the natural room temperatures in plastic trays (20 x 20x 20 cm) and covered with pieces of muslin cloth and held in position by rubber bands.

Treated fruits were examined on the 5th, 10th, and 15th days after storage in the incubators. Each treatment was replicated three times. Numbers of eggs, larvae and pupae were counted and mortality of each stage was observed. Also, the quality and the appearance of the fruits were kept in consideration as an important factor for exportation of the fruits.

RESULTS AND DISCUSSION

I. Fruits incubated 1 day after infestation

A.1. Fruits examined on the 5th day

A.1.1. Fruit Status

All fruits of both varieties Navel orange and Valencia which stored in 1,2,and 4°C and control treatments were fresh and had healthy appearance.

A.1.2. Immature stages inside the fruits

As shown in table (1) after examination of the fruits of both Navel orange and Valencia, which stored in 1,2,and 4°C, it was observed that the fruits contained eggs only and no larval stages were found. The eggs appeared vital and fresh. Mean numbers of eggs in Navel orange was 13.82, 15.04, and 12.41 for 1, 2, and 4°C, respectively. Mean numbers of eggs found in Valencia fruits were 16.67, 18.81, and 16.46 for 1,2, and 4°C, respectively. Mean numbers of 1st instar larvae in control treatments were 18.68 and 18.56 for Navel and Valencia fruits, respectively.

A.2. Fruits examined on the 10th day

A.2.1. Fruit status

All the fruits stored in 1, 2, and 4°C were fresh and had healthy appearance except some decay was noticed on the control treatment fruits due to infection by fungi which entered the fruits through the punctures made by flies.

A.2.2. Immature stages inside the fruits

After examination of the fruits of both navel orange and Valencia, which stored in 1,2, and 4°C, it was observed that the fruits contained eggs only and no larval stages were found. The eggs appeared dead and collapsed. Mean number of eggs found in Navel orange fruits were 13.82, 15.04,and 12.41, respectively. Mean number of eggs, which found in Valencia fruits were 16.67, 18.81, and 16.46 for 1,2, and 4°C. Third instars larvae were found inside the control treatment fruits. Mean numbers of 3rd instar larvae were 18.68 and 18.56 for both Navel and Valencia fruits, respectively. Table (1).

A.3. Fruits examined on 15th day

A.3.1. Fruit status

All fruits of both varieties Navel orange and Valencia which stored in 1,2,and 4°C were still fresh and healthy but the control treatment fruits were completely decayed and covered by fungi.

A.3.2. Immature stages inside the fruits

After examination of the fruits of both Navel orange and Valencia, which stored in 1,2, and 4°C, it was observed that the fruits contained eggs only and no larval stages were found. The eggs appeared collapsed and almost ruptured and decayed. Mean number of eggs found in Navel orange fruits were 8.50, 6.04 , and 9.41, respectively. Mean number of eggs, which found in Valencia fruits were 7.01, 9.22, and 9.46 for 1, 2, and 4°C, respectively. Pupae were found at the bottom of the control treatments trays. Mean numbers of pupae were 18.68 and 18.56, respectively. Table (1).

Table (1): Effect of different cooling treatments on the development of immature stages of Mediterranean fruit fly *Ceratitis capitata* (Wied.) in Navel orange and Valencia fruits stored one day after infestation.

Cooling period	Temp.	Navel orange			Valencia		
		Mean no. of eggs	Mean no. of larvae	Mean no. of pupae	Mean no. Of eggs	Mean no. of larvae	Mean no. of pupae
5 days	1°C	13.82	0.0	0.0	16.67	0.0	0.0
	2°C	15.04	0.0	0.0	18.81	0.0	0.0
	4°C	12.41	0.0	0.0	16.46	0.0	0.0
	Cont.	0.0	18.68	0.0	0.0	18.56	0.0
10 days	1°C	13.82*	0.0	0.0	16.67*	0.0	0.0
	2°C	15.04*	0.0	0.0	18.81*	0.0	0.0
	4°C	12.41*	0.0	0.0	16.46*	0.0	0.0
	Cont.	0.0	18.68	0.0	0.0	18.56	0.0
15 days	1°C	8.50*	0.0	0.0	7.01*	0.0	0.0
	2°C	6.04*	0.0	0.0	9.22*	0.0	0.0
	4°C	9.41*	0.0	0.0	9.46*	0.0	0.0
	Cont.	0.0	0.0	18.68	0.0	0.0	18.56

Means followed by * are dead individuals.

Control treatments are not followed by any sign.

B. Fruits incubated 3 days after infestation

B.1. Fruits examined on the 5th day

B.1.1. Fruit Status

All fruits of both Navel orange and Valencia stored in 1,2,4°C, and control treatments fruits were fresh and had healthy appearance.

B.1.2. Immature stages inside the fruits

As shown in table (2), first larval instars were found dead inside both of Navel orange and Valencia fruits stored in 1,2, and 4°C. Mean numbers of dead larvae were 13.25, 12.04, and 13.87 and 17.89, 16.54, and 14.47 in Navel orange and Valencia fruits stored in 1,2, and 4°C, respectively. Second larval instars were found inside the control treatment fruits. Mean numbers of 2nd instar larvae in the control treatments fruits of both Navel and Valencia were 17.15 and 18.56, respectively.

B.2. Fruits examined on the 10th day

B.2.1. Fruit status

All fruits of both Navel orange and Valencia stored in 1, 2, and 4°C were fresh and healthy but some decay appeared on the surfaces of the control treatment fruits due to the infection of fungi via the punctures which were made by the flies.

Table (2): Effect of different cooling treatments on the development of immature stages of Mediterranean fruit fly *Ceratitidis capitata* (Wied.) in Navel orange and Valencia fruits stored three days after infestation.

Cooling period	Temp.	Navel orange			Valencia		
		Mean no. of eggs	Mean no. of larvae	Mean no. of pupae	Mean no. of eggs	Mean no. of larvae	Mean no. of pupae
5 days	1°C	13.25*	0.0	0.0	0.0	17.89*	0.0
	2°C	12.04*	0.0	0.0	0.0	16.54*	0.0
	4°C	13.87*	0.0	0.0	0.0	14.47*	0.0
	Cont.	17.15*	0.0	0.0	0.0	18.56	0.0
10 days	1°C	13.25*	0.0	0.0	0.0	17.89*	0.0
	2°C	12.04*	0.0	0.0	0.0	16.54*	0.0
	4°C	13.87*	0.0	0.0	0.0	14.47*	0.0
	Cont.	0.0	0.0	0.0	0.0	18.56	0.0
15 days	1°C	0.0	0.0	0.0	0.0	0.0	0.0
	2°C	0.0	0.0	0.0	0.0	0.0	0.0
	4°C	0.0	0.0	0.0	0.0	0.0	0.0
	Cont.	0.0	17.15	18.68	0.0	0.0	18.56

Means followed by * are dead individuals.

Control treatments are not followed by any sign.

B.2.2. Immature stages inside the fruits

On examination of the fruits, first larval instars were found dead inside both of Navel orange and Valencia fruits stored in 1, 2, and 4°C but no development to the second larval instars was noticed. Mean numbers of larvae were 13.25, 12.04, and 13.87 and 17.89, 16.54, and 14.47 in Navel orange and Valencia fruits stored in 1, 2, and 4°C, respectively. The third larval instars were found inside the control treatment fruits. Mean numbers of 3rd instar larvae in the control treatments fruits for both Navel and Valencia were 17.15 and 18.56, respectively. Table (2).

B.3. Fruits examined on the 15th day

B.3.1. Fruit Status

All fruits of both Navel orange and Valencia stored in 1, 2, and 4°C, were fresh and had healthy appearance. The control treatment fruits became rotten and completely covered by fungi.

B.3.2. Immature stages inside the fruits

No larvae or eggs were found inside the Navel orange and Valencia fruits and it is thought that larvae and eggs were decayed. Pupae were found

at the bottom of trays. Mean numbers of pupae were 17.15 and 18.56 for Navel and Valencia fruits, respectively. Table (2).

C. Fruits incubated 5 days after infestation

C.1. Fruits examined on the 5th day

C.1.1. Fruit Status

All fruits of both Navel orange and Valencia stored in 1,2,4°C, and control treatments fruits were fresh and had healthy appearance .

C.1.2. Immature stages inside the fruits

As shown in table (3), first larval instars were found dead inside Navel and Valencia fruits stored in 1,2,and 4°C. Mean numbers of 1st larval instars were 13.83,13.55,and 15.81 in Navel orange fruits stored in 1,2,and 4°C, respectively. Mean number of dead larvae were 16.37,14.74, and 15.84 in Valencia fruits stored in 1,2,and 4°C, respectively. Third larval instars were found alive inside the control treatment fruits. Mean numbers of 3rd larval instars were 15.68 and 17.83 for Navel orange and Valencia fruits, respectively.

Table (3): Effect of different cooling treatments on the development of immature stages of Mediterranean fruit fly *Ceratitis capitata* (Wied.) in Navel orange and Valencia fruits stored five days after infestation.

Cooling Period	Temp.	Navel orange			Valencia		
		Mean no. of eggs	Mean no. of larvae	Mean no. of pupae	Mean no. of eggs	Mean no. of larvae	Mean no. of pupae
5 days	1°C	0.0	13.83	0.0	0.0	16.37*	0.0
	2°C	0.0	13.55	0.0	0.0	14.74*	0.0
	4°C	0.0	15.81	0.0	0.0	15.84*	0.0
	Cont.	0.0	18.68	0.0	0.0	17.83	0.0
10 days	1°C	0.0	13.83*	0.0	0.0	16.37*	0.0
	2°C	10.0	13.55*	0.0	0.0	14.74*	0.0
	4°C	0.0	15.81*	0.0	0.0	15.84*	0.0
	Cont.	0.0	0.0	15.68	0.0	17.83	17.83
15 days	1°C	0.0	0.0	0.0	0.0	0.0	0.0
	2°C	0.0	0.0	0.0	0.0	0.0	0.0
	4°C	0.0	0.0	0.0	0.0	0.0	0.0
	Cont.	0.0	0.0	15.68	0.0	0.0	17.83

Means followed by * are dead individuals.

Control treatments are not followed by any sign.

C.2. Fruits examined on 10th day

C.2.1. Fruit Status

All fruits of both Navel orange and Valencia stored in 1, 2,and 4°C were fresh and healthy but some decay appeared on the surfaces of the control treatment fruits due to the infection of fungi via the punctures which made by the flies.

C.2.2. Immature stages inside the fruits

First larval instars were found dead inside Navel orange and Valencia fruits stored in 1,2,and 4°C. Mean numbers of dead larvae were 13.83,13.55 and 15.81 in Navel orange and 16.37,14.74,and 15.84 in Valencia fruits stored in 1, 2,and 4°C,

respectively. No larvae were found inside control treatment fruits but pupae were observed at the bottom of trays. Mean number of pupae was 15.68 and 17.83 for Navel and Valencia fruits, respectively. Table (3)

C.3. Fruits examined on the 15th day

C.3.1. Fruit Status

Fruits of both Navel orange and Valencia stored in 1 and 2°C were fresh and had healthy appearance but fruits of both Navel and Valencia stored in 4°C seemed a little bit shrink and hard.

C.3.2. Immature stages inside the fruits

No larvae were found inside the Navel orange and Valencia fruits and it is thought that larvae were decayed. Pupae were observed at the bottom of the trays of control treatments. Mean numbers of pupae were 15.68 and 17.83 for Navel orange and Valencia fruits, respectively. Table (3).

D. Fruits incubated 7 days after infestation

D.1. Fruit examined on the 5th day

D.1.1. Fruit Status

All fruits of both Navel orange and Valencia fruits stored in 1,2, and 4°C were fresh and had a healthy appearance but control treatments fruits showed some decay as a result of fungi infection via the punctures made by the flies.

D.1.2. Immature stages inside the fruits

As shown in table (4), both second and third larval instars were found alive in the treatments of both Navel orange and Valencia fruits stored in 1,2, and 4°C. Mean numbers of 2nd instar larvae were 10.12, 11.35, and 11.05 while mean number of the 3rd instar larvae were 4.01, 3.39, and 3.10 in Navel fruits stored in 1,2, and 4°C, respectively. Mean numbers of 2nd instar larvae were 10.14, 10.03, and 9.89 while mean numbers of 3rd instar larvae were 5.00, 3.60, and 3.82 in Valencia fruits stored in 1,2, and 4°C, respectively. Pupae were noticed at the bottom of the trays of the control treatments. Mean numbers of pupae were 15.03 and 14.13 for Navel and Valencia fruits, respectively.

Table (4): Effect of different cooling treatments on the development of immature stages of Mediterranean fruit fly *Ceratitidis capitata* (Wied.) in Navel orange and Valencia fruits stored seven days after infestation.

E	Temp.	Navel orange			Valencia		
		Mean no. of eggs	Mean no. of larvae	Mean no. of pupae	Mean no. of eggs	Mean no. of larvae	Mean no. of pupae
5 days	1°C	0.0	14.13	0.0	0.0	15.14	0.0
	2°C	0.0	14.74	0.0	0.0	14.63	0.0
	4°C	0.0	14.15	0.0	0.0	13.71	0.0
	Cont.	0.0	0.0	15.03	0.0	0.0	14.13
	1°C	0.0	14.13*	0.0	0.0	15.14*	0.0

10 days	2°C	0.0	14.74*	0.0	0.0	14.63*	0.0
	4°C	0.0	14.15*	0.0	0.0	13.71*	0.0
	Cont.	0.0	0.0	15.03	0.0	0.0	14.13
15 days	1°C	0.0	0.0	0.0	0.0	0.0	0.0
	2°C	0.0	0.0	0.0	0.0	0.0	0.0
	4°C	0.0	3.10*	0.0	0.0	3.82*	0.0
	Cont.	0.0	0.0	15.03	0.0	0.0	14.13

Means followed by * are dead individuals.

Control treatments are not followed by any sign.

D.2. Fruits examined on the 10th day

D.2.1. Fruit Status

All fruits stored in 1 and 2°C were fresh and had healthy appearance for both of Navel orange and Valencia while fruits stored in 4°C had hardening and shrink. Some control treatment fruits had decayed and some fungi appeared on their surfaces.

D.2.2. Immature stages inside the fruits

Both Navel orange and Valencia fruits which were stored in 1 and 2°C contained dead 2nd and 3rd larval instars. Mean numbers of dead 2nd instar larvae were 10.12 and 11.35 while mean numbers of dead 3rd instar larvae were 4.01, 3.39 in Navel orange. In case of Valencia fruits, mean numbers of dead 2nd instar larvae were 10.14 and 11.03 and these of 3rd instar larvae were 5.00 and 3.60, respectively. On examination of Navel orange and Valencia fruits stored in 4°C; 2nd instar larvae were found dead but 3rd instar larvae were found alive but moving very slowly. Mean number of dead 2nd instar larvae was 11.05 but mean number of alive 3rd instar larvae was 3.01 in Navel orange fruits stored in 4°C. In Valencia fruits stored in 4°C, mean number of dead 2nd instar larvae was 9.89 while mean number of alive 3rd instar larvae was 3.82. Pupae were observed at the bottom of the trays of control treatments. Mean numbers of pupae were 15.03 and 14.13 for Navel and Valencia fruits, respectively. Table (4).

D.3. Fruits examined on 15th day

D.3.1. Fruit Status

Both Navel orange and Valencia fruits stored in 1 and 2°C were fresh and had healthy appearance while fruits stored in 4°C seemed hard and shrink. Control treatment fruits were completely rotten and covered by fungi.

D.3.2. Immature stages inside the fruits

On examination of fruits of Navel orange and Valencia stored in 1 and 2°C, no larvae were found and it is thought that they were decayed while 3rd larval instars were found alive but moving very slowly in fruits stored in 4°C. Mean numbers of 3rd instar larvae in Navel orange fruits stored in 4°C were 3.10 while 3.82 in Valencia fruits. Pupae were observed at the bottom of

the trays of control treatments. Mean numbers of pupae were 15.03 and 14.13 for Navel orange and Valencia fruits, respectively. Table (4).

The data obtained showed that cooling treatments had an effect on the development of immature stages of Mediterranean fruit fly *Ceratitis capitata* (Wied.). The two temperatures 1 and 2°C were highly affecting the development of different stages. These low temperatures killed the immature stages, eggs, 1st, 2nd, and 3rd larval instars. Burditt and Balock (1985) infested the fruits mangoes, papayas, and guava by the fruit flies *Dacus dorsalis* and *D.cucurbitae* and stored them at 2.8°C or below for 12 days. They found that none of the larvae of both species were able to form puparia following the storage period. Also, Hill *et al.* (1988) exposed freshly harvested Valencia and Navel orange fruits to mature flies of both Queensland fruit fly *Dacus tryoni* and Mediterranean fruit fly *C. capitata* and stored them at 1.0±0.5°C for 16 days, resulted in 100% mortality of the immature stages inside the fruits. Heather *et al.* (1996) found that storage of mandarine fruits infested by *D.troyni* at 1.0±0.5°C for 14 to 16 days achieved any survivors.

On the other hand, Jessup *et al.* (1993) infested lemon fruits artificially with immature stages of both Queensland fruit fly *Bactrocera tryoni* and Mediterranean fruit fly *C.capitata* and stored them at 1±0.2°C for 14 days showed that 1st larval instar of *B.tryoni* and 2nd larval instar of *C.capitata* were the life stages tolerant to cold.

The cooling treatments used (4°C) had no effect on the 2nd larval instars through the first few days but its effect started one week later. The 3rd larval instars were highly tolerating for cooling treatment (4°C). This cooling temperature (4°C) did not kill the 3rd larval instars but it lengthened the period of its development. It may need longer exposure period to kill the 3rd larval instars.

By comparing the effect of cooling treatments on the development of the immature stages in Navel orange variety and Valencia variety, there were no much differences between both of them. Some fruits of both Navel and Valencia varieties dried at the end of the two weeks when 4°C was applied as a cooling treatment. These results are in agreement with those obtained by Benschoter (1984), who infested Valencia orange fruits by the Caribbean fruit fly *Anastrepha suspensa* (Loew) and stored them at 1.7°C for 12 to 19 days and found that Valencia fruits tolerated lower storage temperatures.

According to the data obtained in the present work, the treatments used 1 and 2°C can be regarded as quarantine methods to kill Mediterranean fruit fly *C.capitata* in oranges without a significant change in the appearance of the fruit.

REFERENCES

- Awadallah, A.M.; A.G.Hashem and S.M. Foda (1974). A trial for testing the sterile male technique as a mean of controlling the medfly, *Ceratitis capitata* (Wied.). Egypt. Agric. Res. Rev. Egypt, 52: 41-49.

- Benschoter, C.A. (1984). Low-temperature storage as a quarantine treatment for the caribbean fruit fly (Diptera:Tephritidae) in Florida citrus. *J.Econ.Entomol.*, 77: 1233-1235.
- Burditt, A.K.J.R. and J.W. Balcock (1985). Refrigeration as a quarantine treatment for fruits and vegetables infested with eggs and larvae of *Dacus dosalis* and *Dacus cucurbitae* (Diptera:Tephritidae). *J.Econ.Entomol.*, 78: 885 - 887.
- Hashem, A.G.; S.M. Ahmad and M.F. El-Wakkad (2001). Diversity and abundance of Mediterranean and Peach fruit flies (Diptera:Tephritidae) in different Horticultural orchards. *Egypt.J.Appl.Sci.*, 16 (1): 303-314.
- Heather, N.W.; L. Whitfort; R.L. McLaufen and Kopittke (1996). Cold disinfestations of Australian mandarins against Queensland fruit fly. *Postharvest Biology and Technology*, 8: 307-315.
- Hill, A.R.; C.J. Rigney and A.N. Sproul (1988). Cold storage of oranges as a disinfestation treatment against the fruit flies *Dacus tryoni* (Forggatt) and *Ceratitidis capitata* (Wiedemann) (Diptera:Tephritidae). *J.Econ.Entomol.*, 81(1): 257-260.
- Jessup, A.J.; C.P.F. DE Lima; C.W. Hood; R.F. Sloggett; A.M. Harris and M. Beckingham (1993). Quarantine disinfestations of lemons against *Bactrocera tryoni* and *Ceratitidis capitata* (Diptera:Tephritidae) using cold storage. *J.Econ.Entomol.*, 86 (3): 798-802.
- Liquido, N.J.; L.A. Shinoda and R.T. Cunningham (1991). Host plants of the Mediterranean fruit fly *Ceratitidis capitata* (Wied.). (Diptera:Tephritidae). An annotated world review. Miscellaneous publication. 77, Entomol, Soc. Amer. Lanham, MD.
- Rippon, L.E. and R.J. Smith (1979). Postharvest treatment of Chinese gooseberries (kiwifruit) for the control of Queensland fruit fly. *Rural Newsl.*, 73: 34-35.
- Saafan, M.H. (1986). Studies on Mediterranean fruit fly *Ceratitidis capitata* (Wiedemann) (Diptera:Tephritidae) with emphasis on the sterile-male technique (SIT). Ph.D. Thesis, Fac. Agric. Cairo Univ., Egypt.
- Saafan, M.H.; A.G. Hashem and S.I. El-Sherif (1987). The practical use of the sterile insect technique (SIT) for the control of Mediterranean fruit fly, *Ceratitidis capitata* (Wied.) in Egypt. The 2nd Nat. Conf. of pest and diseases of Veg. and Fruit Crops. 20-22 October pp.312-321.
- Sproul, A.N. (1976). Disinfestation of Western Australian Granny Smith apples by cold treatment against the eggs and larval stages of the Mediterranean fruit fly *Ceratitidis capitata* (Wied.). *Aust.J.Exp.Agric.Anim.Husb.*, 16: 280-285.

تأثير معاملات التبريد على نمو الأطوار الغير كاملة لذبابة فاكهة البحر المتوسط

سيراتينيس كابيتاتا

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هدف هذا البحث إلى دراسة تأثير معاملات التبريد باستخدام درجات الحرارة 1, 2, 4°م على الأطوار الغير كاملة للحشرة (البويض و اليرقات), وذلك بتعريض الثمار بعد الحصاد مباشرة للذباب داخل قفص التربية بالمعمل لمدة 24 ساعة ,

ثم تخزين الثمار فى حضانات قد تم ضبطها على درجات الحرارة السابق ذكرها بعد الفترات يوم ,ثلاثة أيام, خمسة أيام و سبعة أيام من التعريض للذباب مع مراعاة درجة الرطوبة النسبية داخل الحضانات(85 %) و قد تم فحص الثمار فى اليوم الخامس والعاشر و الخامس عشر من تاريخ التخزين بالحضانات.

أوضحت الدراسة أن معاملتى التبريد على درجتى 1, 2°م كان لها تأثيراً مميّزاً على طور البيض و الطور اليرقى الأول و الثانى و الثالث مع عدم ظهور أى تغيير فى شكل الثمرة و جودتها ولكن معاملة التبريد على درجة 4°م لم يكن لها التأثير المميّز على الطور اليرقى الثالث و لكن يمكن إستنتاج أن زيادة مدة التخزين على ذات الدرجة قد تتسبب فى موت الطور اليرقى الثالث و باستخدام معاملة التبريد 4°م ظهرت بعض التغييرات على شكل الثمرة مما يقلل من جودتها و بالتالى على التصدير .