MINAR International Journal of Applied Sciences and Technology
ISSN: 2717-8234
Article type: Research Article

Received: 02/06/2022 **Accepted:** 18/06/2022 **Published:** 01/09/2022

FIRST RECORD for WATERMELON NECROSIS DISEASE on WATERMELON CROP in IRAQ

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Abstract:

This research was carried out during a severe unknown disorder epidemic wave was spread out on watermelon crop over all Iraqi provinces that causing significant economic losses to the farmers of this crop. The research included conducting a field survey covering about 183 hectares of watermelon fields during the spring agricultural season in four Iraqi provinces; Baghdad, Kirkuk, Erbil, and Penguin/Sulaymaniyah. According to this survey, the disease occurrence percentage ranged from 70-100% in Baghdad, Kirkuk, and Erbil, while it was around 10-20% only in the Penguin/Sulaymaniyah area. It is also noted that plants growing under the shade of trees or long intercropped crops like sunflower, were escaped from the infection. Despite many watermelon varieties cultivated by farmers during the survey year, no resistant or tolerant varieties were observed, and minor differences in their susceptibility were noticed. The disease is diagnosed as Watermelon rind necrosis (WRN) depending on intensive field and laboratory investigations conducted for this purpose. Bacteria were isolated from necrosis spots in the watermelon rind, but the same was isolated also from the healthy tissues in the watermelon rind with less intensity. A high correlation was found between disease occurrence and the amount of difference between night and day temperature during the first month before the fruit ripening. This research finding is considered the first record of watermelon rind necrosis (WRN) disease on the watermelon crop in Iraq.

Keywords: Watermelon, Watermelon Rind Necrosis Disease, WRN.

http://dx.doi.org/10.47832/2717-8234.12.27

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Introduction:

The watermelon crop *Citrullus lanatus* (Thumb.) belongs to Cucurbitaceae and is considered one of the most important summer vegetable crops in Iraq. The total area cultivated with this crop in 2015 is estimated at 11728 hectares with a total production of 126433 tons (Production of field crops and vegetables in Iraq in 2015, Central Statistical Organization IRAQ). Watermelon is exposed to infection by many pathogens like; downy mildew, Powdery mildew, root rot, and wilt. The most dangerous and mysterious disorder which is infected the watermelon crop on large scale during the spring season of 2009 and 2016 in most of its cultivated areas in Iraq causing heavy economic losses is still unknown. Disease symptoms on the inner layer of fruit rind are similar to those described in the case of Watermelon rind necrosis disease (WRN). Internal browning of watermelon was first reported in Georgia/USA in 1925 and attributed that time to prolonged drought conditions during the fruit maturation period [3]. A relatively inconspicuous vascular browning of watermelon rind was observed in Hawaii/USA in 1960 and attributed to physiological causes [7]. Bacterial rind necrosis of watermelon was also reported in some areas of the USA like Hawaii [7] Texas [12] and California [9]. In California/Imperial valley the economic losses due to WRN are estimated at 100,000 USD [1]. WRN was first observed in Illinois/USA in 2000 [9]. A detailed description of disease symptoms includes a dry, brown, and hard rind necrosis that rarely extends into the flesh of watermelon fruits [10]. Disease syndromes could be described also as a corky appearance, and brownish discoloration of watermelon fruit rind [4]. Round shape-fruited cultivars of watermelon are tending to have a higher occurrence of WRN than long shape-fruited ones[6]. The disease is affecting fruits, particularly with no symptoms on plant root or vegetative systems. As the external symptoms; only the severely affected plants are given misshaped fruits. Although fruit surface roughening may occur in the area that is external to the diseased area, accurate identification of fruits as diseased is usually difficult unless getting it cut off [4]. Consequently, the consumer may purchase an otherwise acceptable fruit and find upon slicing it is an unattractive, very low sweetness with a diseased interior. Severely infected watermelon cultivars are unmarketable when sliced [6].

This study was aiming to:

1- Having an idea about the distribution of disease in Baghdad, Kirkuk, Erbil Provinces and Penjuain district, the percentage of occurrences of susceptible cultivars and economic losses estimated.

2- Determine whether this disorder is caused by an infectious pathogen (Biotic causal agent) or other environmental or physiological causes (abiotic causal agent).

Materials and methods:

1. Field survey: Twenty-six watermelon fields with a total area of 183 hectares in four Iraqi provinces were randomly chosen for carrying out the field survey from June 19 to August 6, 2016, with a special focus on northern provinces for security reasons. Watermelon growers of surveyed fields were interviewed to obtain needed information regarding field history, tillage irrigation type, crop varieties cultivated, pesticides used for this disease, other pests' treatment in this season, fertilization, previous occurrence of WRN disease in the field, and economic losses caused by this disease. For survey conduction, an imaginary tendon between two opposite ends had drawn in each field, and watermelon plants were sampled in each 50 M on this tendon for fruits and vegetative parts. Samples (roots, stems, leaves, and blossoms) were carefully examined for any external disorders and signs with the help of a magnifying lens while fruits were opened for tasting and internal symptoms observation. Both types of samples were transferred in closed nylon bags labeled with the necessary information in the cooling box to the laboratory for further examinations and inoculum preparation.

2. Pathogen diagnosis: Fruits were surface-disinfested by rubbing their surface with a paper towel moistened with 70% ethanol and then sliced. Isolation from watermelon rinds has done by peeling off the surface of the rind using a sterile scalpel and cutting off a small internal section around 10 mm3 from the necrotic spot and crashing in a drop of sterile deionized water. After 15 minutes, a loopful of the suspension was streaked onto nutrient yeast-dextrose agar (NYDA) and King's medium B agar (KMB). Plates were incubated at 28 °C for 3 days and checked daily for any bacterial growth.

A similar internal section of rind necrotic tissue from infected watermelon fruits was placed on potato dextrose agar (PDA) amended with 0.5 mg/ml chloramphenicol, and incubated for 7 days at 25 + 3 °C to check at 1,3,5 and 7 days for any fungal mycelial growth. Samples of roots and vegetation from some infected plants were prepared in the same methodology for the above bacterial and fungal tests. All tests were done in the diagnostic laboratory of the Ministry of Agriculture/ plant protection office/Baghdad-Abu-Graib and confirmed by the diagnosis facility belonging to the Ministry of Sciences & Technology/ Agriculture & biology office/Bagdad-Iraq.

3. Pathogenicity test:

Infected watermelon fruit was surface-disinfested by rubbing fruit with paper towel paper moistened with 70% ethanol and sliced by a sterile scalpel. The crude extract of 250 gm of necrotic rind tissues was crushed and mixed by a sterile blinder and then filtered by double layers of sterilized muslin. Filtered extract was injected by sterile syringe into 28-day-old seedlings of the Fairoz cultivar of watermelon planted in the field on three replicates, each replicate contained 12 plants. Plants were monitored at 1,3,7,14,21,28,35 till the fruit ripening stage for any abnormal signs or symptoms to develop. Ripe fruits were sliced and checked for disease symptoms examination.

4. Symptoms observation: watermelon plants with infected fruits were carefully observed in the field, 10 fruits for each Iraqi donum (1 hectare = 4 Iraqi donum) were sliced in all visited fields; disease syndromes on vegetation and infected fruits were described on external and internal levels.

5. Field trial: This trial is carried out in AMC experimental station located in Quashtapa district 25.1 km south of Erbil city. Watermelon crop (var. Fairoz) was directly sown in the field on August 15, 2016 (Autumn season) under spilt split Plot Design with three replicates. Each replicate contained 8 treatments as indicated in table (1). Each treatment except control was divided into two parts, the first part was inoculated with the extract of infected rind tissue of watermelon fruit while the second was left for the natural infection. The dimensions for each experimental plot were 3 X 2 m^2, and 1 m length was maintained between every two treatments as a buffer zone to avoid contamination among various treatments. Corn seeds (local variety) were sown 14 days earlier than the watermelon sowing date alternately with watermelon pre-planned sowing sites for intercropping treatment. A drip irrigation system was installed and maintained to ensure irrigation water as needed while all experiment treatments were duplicated in an adjacent location under a sprinkler irrigation system to ensure an integrated impact for daily water spraying during temperature peak time with all other treatments. Killpack, Dentamet, and Curenox have thrice applied 21 days post-emergence with an interval of 20 days using Jakto knapsack hand sprayer having a 16-liter capacity fitted with control flow valve (CFV), nozzle with a discharge rate of 0.8 L/min at 2.4 bar pressure. Bio-formulation of *Bacillus subtalis* (15) g dissolved in a little water was mixed thoroughly with watermelon seeds and left for two hours to get dried under natural conditions before sowing. All agronomic practices like irrigation, fertilization, pest control, and so on were kept uninformed throughout the experiment on all plots. All treatments kept monitored on weekly basis to assess disease incidence and development.

Table-1. Treatments applied in the field trial

Sq.	Treatment	Active ingredient	Manufacturer	Application rate
1	Kelpak	Seaweed extract	Agrichem/South	50 ml/ 5 liter of
2	Dentamet	Zinc, copper, citri	DiAgro/Italy	15 ml/ 5 liter of
3	Curenox	Copper	IQV/Spain	15 g/ 5 liter of water
4	Biotilis	*Bacillus*	AgriLife/India	15 g/ 10 g of
5	Intercropping with	-	-	-
6	Irrigation by	-	-	-
7	Inoculated	-	-	-
8	Non-inoculated control	-	-	-

Table 2. Watermelon necrosis disease (WRN) spreading on watermelon crop in four Iraqi provinces.

Province	Locations	Date of survey	No. of fields surveyed	Total areas	Cultivated varieties	Irrigation method	Fertilization	Disease Percent
Kirkuk	AltonKopry,Shwan, Zirdak, Chlor, Kariez, Hasar, Daraman, Klozy, Shaniz, Nabeaoah	July, 2016	13	84 ha	Topyield, Fairoz, Chrest, Miraj, Hamour Yaqoot	Drip	NPK Trace element, DAP, Rootex manure	70%-90%
Erbil	Quashtapa, Makhmor, Baharka	July, 2016	7	41 ha	Fairoz, Chrest, Miraj, Yaqoot, Basha	Drip	NPK, N,Trace elements, Humic	70%-100%
Baghdad	Abugraib, Ziadan, Ameriah	July, 2016	3	16 ha	Sakata, Chrest, Fairoz, Basha	Flood irrigation	NPK, DAP, N, Humic, Trace elements	80-100%
Penjuain	Penjuain, Kanimasi	August, 2016	3	42 ha	Chrimston sweet, Top yield,	Drip	NPK,Trace, Humic	10-20%

6. Meteorological data: As an attempt to correlate daily temperature trend with disease development, minimum and maximum temperatures were ensured for the targeted year 2016 and its prior and post years of 2015 and 2017 respectively with a special focusing on the two months before watermelon fruit development which were considered as April &May for Baghdad, Kirkuk, Erbil governorates and (May& June) for Penguain district. Unfortunately, temperatures for the Baghdad governorate could not be ensured due to administrative obstacles. Daily temperatures were treated to get daily differences between maximum and minimum temperature for above mentioned months, these differences were arranged on thermal categories starting from 4-6 to 34-36 °C with 2 °C interval among every two categories to allocate thermal difference among seasons on certain categories.

Results and discussion:

1. Field survey: Table (2) show the results of the field survey for watermelon cultivated areas in Baghdad, Kirkuk, and Erbil governorates which is indicated that disease is spreading in all the areas surveyed in high incidence percentages ranging from 70-100% causing heavy economic losses to farmers, while it was ranged from 10-20% in Penguain/ Sulaymaniyah Province, characterized by its low temperatures compared to other areas surveyed. This difference may refer to a possible link between the prevailing temperatures in the region and the outbreak of the disease. It is also noted that plants growing under the shade of trees or long intercropped crops like sunflower, were escaped from the infection, which indicates a possible relationship between temperature and disease development. Although the vast majority of the fields visited are provided with good agricultural practices as recommended, like drip irrigation, pest control, and frequent fertilization with good types of fertilizers as needed, all these good agricultural practices had no impact to protect or promote plant to escape from this disease. Hopkins and Elmstrom,1977 reported that supplemental mineral nutrition didn't eliminate WRN [6]. In spite of many watermelon varieties cultivated by farmers during the survey year, no resistant or tolerant varieties were observed, minor differences in their susceptibility were noticed. Researchers at Illinois University reported that watermelon varieties vary both in the incidence of disease and severity of symptoms [13]. Susceptibility to rind necrosis varies among watermelon cultivars [4,8]. Elmstrom and Hopkins reported in 1973 that round-fruited cultivars tend to have a higher incidence of WRN than long-fruited ones [1]. Somodi and Hopkins tested 36 watermelon cultivars against WRN and found all were susceptible to different degrees of susceptibility [11]. Also noticed that Plants infected with Watermelon Mosaic Virus WMV (Fig.1) are more likely to attack by this disease, leading farmers to believe that mosaic symptoms are the early-stage symptoms of watermelon rind necrosis (WRN) disease while the most likely reason behind this interaction between these two diseases that viral infection seems to predispose the plant condition to attack by WRN disease. This result agreed with Kontaxis who reported in 1976 that all cultivars infected with WRN are severely infected with WMV [8] while Hopkins and Elmstrom,1977 stated that the occurrence of WRN was not correlated with WMV incidence but this viral infection could act as a factor to trigger hypersensitivity reaction hypothesized to be responsible for WRN syndromes [6].

Fig 1. Watermelon plant infected with watermelon mosaic virus (WMV).

2. Pathogen diagnosis: Isolation from watermelon plants infected with WRN showed no fungal growth in all tested samples, only various bacterial growth could be seen in some sample cultures which are further varying from sample to sample. No single bacterium could

be found in all or most of the tested samples. Isolated bacteria were initially characterized on the genus level as non-pathogenic species belonging to *Pseudomonas* and *Eriwinia* which are commonly found on plant external surfaces as secondary invaders. Those bacteria were isolated from both infected and healthy watermelon fruit tissues but with higher density in infected tissues. Back inoculation with these bacteria on healthy seedlings didn't produce the disease or any abnormal syndromes. These results agreed with Hopkins and Elmstrom who stated that bacteria were consistently isolated from healthy watermelons and watermelon affected by WRN. No single bacterial species was isolated consistently from WRN-affected tissues [6]. The diversity of bacterial flora isolated from healthy and diseased fruit was similar except that enterobacteria were isolated more frequently from diseased than from healthy fruit. *Erwinia*, *Pseudomonas*, *Enterobacter*, and *Bacillus* isolated from symptomatic fruit caused rind necrosis at injection sites following inoculation [6]. The role of bacteria in WRN is either causing the disease or accelerating the disease as reported by (Kontakis and Kurupas,1975). The same researcher stated also that watermelon rind necrosis in the Imperial Valley is due to bacteria that cannot be made on our findings [9]. Hopkins and Elmstrom,1977 reported that a pre-disposing environmental condition may lead to non-pathogenic resident bacteria of normal watermelon tissue causing WRN [6].

3. Pathogenicity test: the result of the pathogenicity test showed that WRN absolutely couldn't be produced in the fruits of inoculated watermelon plants with extract of diseased plants and nothing of abnormal signs could be seen on plant morphology as well. These results came in confirming with laboratory tests stating that the WRN disease observed on watermelon in Iraq during the 2016 spring cultivation season is not caused by an infectious causal agent. Hopkins and Elmstrom, 1973 reported that Incidence and severity data of WRN did not correlate well indicating that this disease may be controlled by different factors including morphological and physical factors so they hypnotized that WRN disease syndrome is a hypersensitivity (HR) response, and several events that need to occur for HR; internal microflora, certain environmental conditions or stress like WMV or nutrient imbalance, etc. [5]. No single bacterial species was isolated consistently from WRN-affected tissues [6]. Results from several experiments to determine a causal agent of WRN were inconclusive [10].

4. Symptoms observation: Symptoms observed in infected watermelon fruits could be described as the formation of brown, dry, and hard necrotic spots appearing throughout the internal layer of watermelon rind, symptoms in severe infection extend into the fruit flesh with corky, white to pale red discoloration and loss of its sweet flavor. We note that losing of sweet flavor is highly correlated with the WRN occurrence even in symptomless cases in the fruit flesh. Although a large number of fruits have been opened for symptoms studying purposes, not even single fruit seen that shows necrosis symptoms in the pre-ripening stage. Necrosis symptoms start developing with the first stage of ripening by forming water-soaked spots in the rind layer then these spots turned gradually to necrosis symptoms near the edge of the rind which are further extended sideways to meet each other forming almost continuous necrosis symptoms around the entire fruit and internally to affect fruit flesh and gaining its pale corky appearance (Fig.2). Kontaxis,1976 reported that young fruits were free of necrosis disease, whereas ripe fruits had a high necrosis incidence [8]. No any abnormal symptoms have seen on the external fruit shape or color like misshaping, discoloration, etc. only the infected fruit seems to be much sold and rigid when pressed by hand compared with healthy fruit and even this point couldn't serve always as a good guide for diagnosis the infected fruits, for that, a considerable percent of Iraqi farmers prohibit selling their product of fruits which looks externally very normal in order to avoid cheat the consumers and its un legal profits from the religious point of view as they believe and consequently maximizing the economic losses caused by this disease.

5. Field trial: Unfortunately, we could get the infection on field level neither through natural infection nor by the artificial inoculation with rind necrosis extract, and that is another proof

that WRN couldn't produce naturally or artificially unless the presence of its suitable environmental condition.

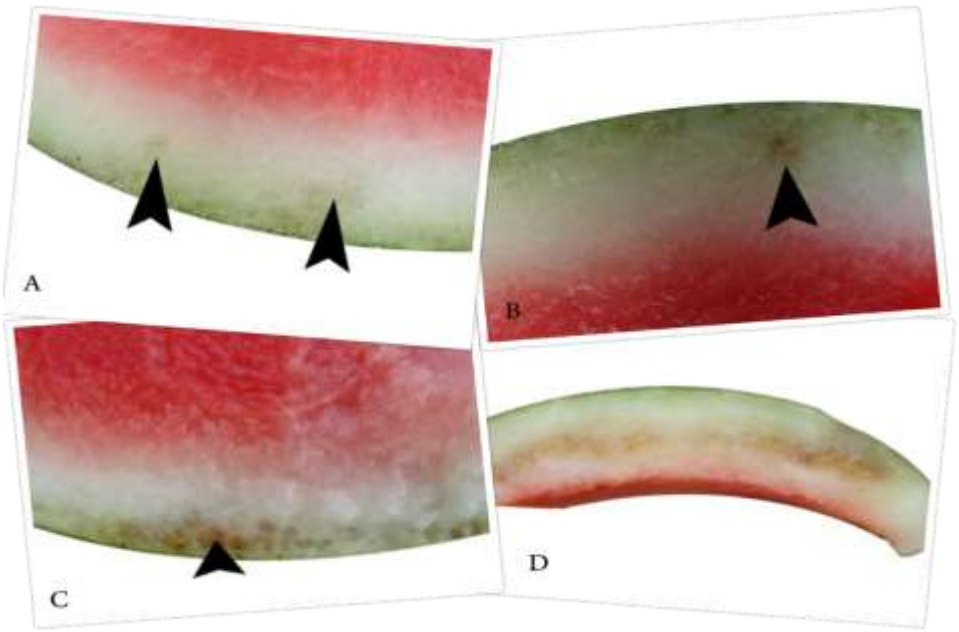

Fig.2: Stage of rind necrosis lesions in watermelon fruit.

6. Correlation with the meteorological data: By studying the environmental data for the two months prior to the fruit development process, namely April and May for the provinces of Baghdad, Kirkuk, Erbil; May and June of the Penguain region, it was found that there is a correlation between the incidence and development of the disease and the amount of difference between the temperature of night and day during the first month preceding the development of fruits, which is April in the provinces of Baghdad, Kirkuk, Erbil and May for the district of Penguain, where this month recorded the highest levels of difference in the target year of 2016 between day and night temperatures compared to the same month of the last and next years of 2015 and 2017, as Kirkuk province recorded a difference mean of (18.1 °C) compared to means recorded in the same month of 2015 and 2017 (16.4 °C, 16 °C) respectively while Erbil province and Penguain district recorded difference means of (27.1 °C,18.6 °C) compared to the difference means recorded (13 °C,14.5 °C),(16 °C,16.8 °C) during same month of 2015 and 2017 respectively. Also noted that the majority of these differences during 2016 were distributed within the following thermal ranges: (16-28 °C), (20-32 °C) for Kirkuk and Erbil respectively while it was within the range of (16-24 °C) for Penguin which further confirms that WRN severity is correlated with the amount of thermal difference among day and night temperature during the first month of fruit pre-ripening stage. It is clear from the mentioned figures that the difference recorded in Penguain district was relatively much less compared to those recorded in the provinces of Kirkuk and Erbil, which may interrupt the low incidence percentage of this disease in this region. The correlation between the development of this disease (WRN) and the amount of differences among day and night temperatures may lead directly to trigger the hypersensitivity reaction of the host plants causing the disease or indirect effect through predispose the conditions for the bacterial flora found in the fruits to multiply to a population high enough to cause the disease or starting the hypersensitivity reaction which may cause the deformation of the fruit and other pathological syndromes that significantly reduce its marketing value. This interruption is agreed with Hopkins and Elmstrom,1977 who stated that a pre-disposing environmental condition may lead to non-pathogenic resident bacteria of normal watermelon tissue to cause WRN [6].

Table-3: Temperature degrees of first month of watermelon pre-fruiting developing in 2016 compared with 2015 and 2017.

Temp.diff. Categories (°C)	Pre-fruiting developing period			Temp.diff. Categories (°C)	Pre-fruiting developing period			Temp.diff. Categories (°C)	Pre-fruiting developing period		
	1st month (2015)				1st month (2016)				1st month (2017)		
	Kirkuk	Erbil	Penguain		Kirkuk	Erbil	Penguain		Kirkuk	Erbil	Penguain
2-4	0	0	0	2-4	0	0	0	2-4	0	0	0
4-6	0	0	0	4-6	0	0	0	4-6	0	0	1
6-8	0	0	0	6-8	0	0	0	6-8	0	2	0
8-10	0	6	0	8-10	2	0	0	8-10	2	2	0
10-12	5	6	0	10-12	3	0	0	10-12	4	6	2
12-14	3	7	2	12-14	0	0	2	12-14	4	10	2
14-16	3	7	7	14-16	1	0	3	14-16	5	7	7
16-18	11	4	13	16-18	4	0	4	16-18	5	2	5
18-20	3	0	5	18-20	1	1	7	18-20	4	1	8
20-22	4	0	2	20-22	5	4	8	20-22	4	0	3
22-24	1	0	1	22-24	6	1	6	22-24	2	0	3
24-26	0	0	0	24-26	3	5	0	24-26	0	0	0
26-28	0	0	0	26-28	5	7	0	26-28	0	0	0
28-30	0	0	0	28-30	0	4	0	28-30	0	0	0
30-32	0	0	0	30-32	0	5	0	30-32	0	0	0
32-34	0	0	0	32-34	0	1	0	32-34	0	0	0
34-36	0	0	0	34-36	0	2	0	34-36	0	0	0
Mean of Max. temp.	29.1	26.4	24.5	Mean of Max. temp.	28.16	38.5	25.7	Mean of Max. temp.	28.2	25.1	25.5
Mean of Min. temp.	12.67	13.4	10.2	Mean of Min. temp.	10.0	11.5	9.9	Total of Min. temp.	12.2	12.3	9.7
Total of diff. Degrees	492.5	390.3	510.9	Total of diff. Degrees	543.5	811.5	575.5	Total of diff. Degrees	481	382.1	521.2
Mean of diff. Degrees	16.4	13.0	14.5	Mean of diff. Degrees	18.1	27.1	18.6	Mean of diff. Degrees	16.1	12.7	16.8

Table-4: Temperature degrees of second month of watermelon pre-fruiting developing in 2016 compared with 2015 and 2017.

Temp.diff. Categories (°C)	Pre-fruiting developing period			Temp.diff. Categories (°C)	Pre-fruiting developing period			Temp.diff. Categories (°C)	Pre-fruiting developing period		
	2nd month (2015)				2nd month (2016)				2nd month (2017)		
	Kirkuk	Erbil	Penguain		Kirkuk	Erbil	Penguain		Kirkuk	Erbil	Penguain
2-4	0	0	0	2-4	0	0	0	2-4	0	0	0
4-6	0	0	0	4-6	0	0	0	4-6	0	0	0
6-8	0	0	0	6-8	0	0	0	6-8	0	0	0
8-10	0	1	0	8-10	1	2	0	8-10	0	0	0
10-12	0	0	0	10-12	2	3	1	10-12	0	6	0
12-14	3	2	2	12-14	0	10	1	12-14	6	10	0
14-16	8	3	5	14-16	6	10	1	14-16	0	7	4
16-18	7	4	6	16-18	7	5	5	16-18	0	5	2
18-20	10	5	7	18-20	9	1	8	18-20	3	3	7
20-22	2	5	8	20-22	4	0	13	20-22	7	0	12
22-24	1	7	3	22-24	2	0	2	22-24	7	0	5
24-26	0	2	0	24-26	0	0	0	24-26	5	0	0
26-28	0	2	0	26-28	0	0	0	26-28	3	0	0
28-30	0	0	0	28-30	0	0	0	28-30	0	0	0
30-32	0	0	0	30-32	0	0	0	30-32	0	0	0
32-34	0	0	0	32-34	0	0	0	32-34	0	0	0
34-36	0	0	0	34-36	0	0	0	34-36	0	0	0
Mean of Max. temp.	36.6	38.4	33.2	Mean of Max. temp.	33.2	32	32.01	Mean of Max. temp.	34.95	32.9	30.0
Mean of Min. temp.	19.5	19	14.0	Mean of Min. temp.	14.7	18.1	15.1	Total of Min. temp.	14.21	18.6	13.6
Total of diff. Degrees	531.8	603.5	573.8	Total of diff. Degrees	607.3	430	591.1	Total of diff. Degrees	643	440.5	585.2
Mean of diff. Degrees	17.2	19.5	19.1	Mean of diff. Degrees	19.6	18.9	19.7	Mean of diff. Degrees	20.74	14.2	19.5

Conclusion:

Several fields and laboratory investigations were conducted to diagnose the severe mysterious disease that infected the watermelon crop overall Iraqi provinces in 2016 which was responsible for significant economic losses. On-field level; it was found that disease is spreading over all areas surveyed in high incidence percentages ranging from 70-100%, while it ranged from 10-20% in Penguin restrict characterized by its relatively low temperatures compared to other areas surveyed. Good agricultural practices had no impact to protect or promote plants to escape from this disease, minor differences in cultivar's susceptibility to the disease were observed. The disease couldn't be produced in watermelon fruits inoculated with extract of infected tissues. It was found also that losing fruit sweet flavor is highly correlated with disease occurrence even in the symptomless fruit flesh. Ripe fruits only were in the susceptible phase and no disease symptoms were observed in the fruit pre-ripening stage. As for laboratory investigations; no biotic causal agent could be isolated from infected tissues, Isolated bacteria *Erwinia* spp and *Pseudomonas* spp are commonly found on plant external surfaces. A high correlation was detected between disease incidence and severity with the amount of thermal difference between day and night temperatures during the first month of the fruit pre-ripening stage. Based on the above, we conclude that the targeted disease is watermelon rind necrosis (WRN) and the mechanism for its occurrence and development is hypothesized that the differences between day and night temperatures may lead directly to trigger the hypersensitivity reaction of the host plants causing the disease or indirect effect through predispose the conditions for the bacterial flora found in the fruits to multiply to a

population high enough to cause the disease or starting the hypersensitivity reaction which may cause the deformation of the fruit and other pathological syndromes that significantly reduce its marketing value. This finding is considered the first record for this disease in Iraq.

References:

Elmstrom, G W and Hopkins, D L 1973 Variable susceptibility to bacterial rind necrosis in watermelon *Hort*-Science**8**:32.

Seminis and DeRuiter 2015 Field guide for cucurbit diseases Page.110.

Gilbert, W W and Artschwager E 1925 Watermelon internal browning Phytopathology **15**:119-121.

Henderson, W R and Jenkins S F 1982 Bacterial rind necrosis of watermelon in North Carolina Cucurbit Genetics Cooperative Report 5:36-37.

Hopkins, D L and Elmstrom G W 1973 Severity of bacterial rind necrosis in watermelon cultivars in Florida Florida Agricultural Experiment stations Journal series No. 5643:184-187.

Hopkins, D L and Elmstrom G W 1977 Etiology of watermelon rind necrosis Phytopathology **67**:961-964.

Ishii, M and Aragaki M 1960 Bacterial rind necrosis of watermelon Plant Dis.Rep.**44**:761-763.

Kontaxis, D G 1976 Rind necrosis in watermelon cultivars Calf. Agr. (Feb):22.

Kontaxis, G K and Kurupas, T 1975 Watermelon rind necrosis in imperial valley California Agriculture series,9:14-15.

Maynard, D N and Hopkins, D L 1999 Watermelon fruit disorders HorTechnology**9**(2):155-161.

Somodi, G C, Hopkins, D L, Stall, R E Kucherek, T A Hoge, N C and Waterson, J C 1991 The occurrence of a bacterial watermelon fruit blotch in Florida Pl ant disease Vol. **75**(10):1053-1056.

Thomas, C E 1968 Bacterial rind necrosis of watermelon in south Texas Plant Dis. Rep. **52**:375-377.

University of Illinois-Extension Department 2002 Bacterial rind necrosis of watermelon Report on plant disease No.948:3-4.