**Article** AR2087 DOI: HTTPS://DOI.ORG/10.23910/IJBSM/2020.11.3.2087

*International Journal of Bio-resource and Stress Management*

June 2020

Crossref

Print ISSN 0976-3988

Online ISSN 0976-4038

*IJBSM* 2020, 11(3):214-218

**Research Article** *Stress Management*

# Cultural Parameters of *Xanthomonas cucurbitae* Causing Bacterial Leaf Spot of Bottle Gourd and Pumpkin

Sujata Kumari[1], Kumud Jarial[2*], R. S. Jarial[3] and Savita Jandaik[4]

[1-3]Dept. of Plant Pathology, College of Horticulture and Forestry, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Neri, Hamirpur, Himachal Pradesh (177 001), India

[4]Dept. of Plant Pathology, College of Horticulture, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh (173 230), India

Open Access

**Corresponding Author**

Kumud Jarial

*e-mail*: kumudvjarial@rediffmail.com

***Citation:*** Kumari et al., 2020. Cultural Parameters of Xanthomonas cucurbitae Causing Bacterial Leaf Spot of Bottle Gourd and Pumpkin. International Journal of Bio-resource and Stress Management 2020, 11(3), 214-218. HTTPS://DOI.ORG/10.23910/IJBSM/2020.11.3.2087.



***Data Availability Statement:*** Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

***Conflict of interests:*** The authors have declared that no conflict of interest exists.

## Abstract

Bacterial leaf spot caused by *Xanthomonas cucurbitae* is an important disease of cucurbits leading to huge crop losses especially to bottle gourd, pumpkin and squashes in sub tropical zone of Himachal Pradesh. Cultural parameters like effect of different temperatures, pH levels and nutrient media on the growth of two isolates of *X. cucurbitae* isolated from bottle gourd and pumpkin were studied under *in vitro* conditions.Among various temperature regimes (15–35 °C) tested for both the isolates, a temperature range of 25 to 30 °C was observed to be optimum, for bottle gourd ($5.35\times10^7$ cfu $ml^{-1}$at 25 °C) and pumpkin ($4.15\times10^7$ cfu $ml^{-1}$ at 30 °C) isolates. Out of six pH levels (4.0–9.0) tested to see the effect on bacterial growth, the optimum pH range for maximum growth of the bacteria was observed to be 6.0 to 7.0 for bottle gourd ($44.16\times10^7$ cfu $ml^{-1}$at pH 6.0 ) and pumpkin ($31.62\times10^7$ cfu $ml^{-1}$ at pH 7.0) isolates. However, no growth of the isolates was recorded at pH 4.0. The bacterium grew best in yeast extract calcium carbonate broth ($8.11\times10^7$ cfu $ml^{-1}$ and $10.63\times10^7$ cfu $ml^{-1}$; bottle gourd and pumpkin isolates, respectively), nutrient glucose broth (9.31×cfu $ml^{-1}$; bottle gourd isolate) and nutrient sodium chloride broth ($7.70\times10^7$ cfu $ml^{-1}$and $7.33\times10^7$ cfu $ml^{-1}$; bottle gourd and pumpkin isolates, respectively).

***Keywords:*** *Xanthomonas cucurbitae,* cultural characteristics, bacterial spot, cucurbits

## 1. Introduction

*Xanthomonas cucurbitae* (Bryan) Vauterin et al. (Syn. *X. campestris* pv. *cucurbitae*) causing bacterial spot is emerging as an important pathogen leading to huge crop losses especially to bottle gourd, pumpkin and squashes (Jarial et al., 2011; Babadoost, 2012; Babadoost, 2017). This disease was first reported as bacterial leaf spot on Hubbard squash in New York in 1925 by Bryan (Bryan, 1930). Since then, the disease has been reported to occur on various cucurbits (Gorlenko, 1979; Vlasov, 2005) like squash (Robbs et al., 1972; Alippi,1989; Kushima et al., 1994; Banchero et al., 1998; Liu et al., 2016 ), cucumber (Vincent-Sealy and Brathwaite, 1982; Maringoni et al., 1988; Sinha, 1989; Lia et al., 2018), pumpkin (Pruvost et al., 2009; Lamichhane et al., 2010;Babadoost and Ravanlou, 2012; Salamanca, 2014; Trueman et al., 2014; Ravanlou and Babadoost, 2015), watermelon (Pruvost et al., 2009; Duttaet al., 2013)

**Article History**

RECEIVED in 31st March 2020 RECEIVED in revised form 25th April 2020 ACCEPTED in final form 14th May 2020

and on bottle gourd (Jarial et al., 2011; Jarial et al., 2015; Sharma, 2016) from different countries of world.The disease has been reported to cause significant losses in different cucurbits. According to Larazev (2009), yield losses reach more than 20% in susceptible cultivars however, the disease severity reaches up to 50-60% at fruit storage in various cucurbits. Jarial et al. (2011) reported that yield losses in bottle gourd may reach up to 20 to 70%. However, in case of pumpkin, up to 90 %losses have been reported by Salamanca (2014).

Bryan (1930) described the cultural characters of the bacterium for the first time. According to him, *X. campestris* pv *cucurbitae* is a short, rod shaped bacterium, 0.5 to 1.3×0.45 to 0.6 µ in diameter with one polar flagellum occurring singly in pairs or in short chains. It is a Gram-negative, non acid-fast and non-spore producing bacterium. On beef agar, the colonies are round, yellow and opalescent. In general, Schaad and Stall (1988) have suggested a temperature range of 25 to 27 °C to be conducive for the growth of all the species of *Xanthomonas*. Many reports are not available in the literature regarding the cultural studies of *X. cucurbitae*. However, Zhang and Babadoost (2018) reported that the optimum temperature for colony development ranged from 24 °C to 30 °C and the maximum colony growth was observed at pH 6.5 to 7.0. Therefore, understanding of the nature of the pathogen with respect to cultural and physiological features is felt necessary and present studies were conducted with an objective to study the effect of different temperature regimes, pH levels and nutrient media on the cultural growth of *X. cucurbitae.*

## 2. Materials and Methods

All experiments on cultural studies were conducted in the laboratory, Department of Plant Pathology, College of Horticulture and Forestry, Neri, Hamirpur, Himachal Pradesh. The treatments were designed in completely randomized block design with three replications.The statistical analysis was done by using online software OPSTAT.

### *2.1. Isolation, purification and maintenance of the pathogen*

Infected leaves of bottle gourd and pumpkin exhibiting characteristics symptoms were brought to laboratory for isolation of the pathogen. The infected portions of the leaves were swabbed with rectified spirit followed by 1% sodium hypochlorite and washed repeatedly in sterile distilled water. Small pieces of diseased tissues were cut from the affected leaves with the help of sterilized blade.The bits were placed in sterile water drops in a sterilized Petri plate under aseptic conditions. In order to obtain the bacterial ooze, each bit was incised repeatedly with a sterile blade. Simultaneously, one drop of sterile water containing bacterial ooze was also examined under the microscope for the presence of bacterial cells. A loopful of bacterial suspension was streaked on sterilized nutrient sodium chloride agar (NSA) plates under aseptic conditions. These Petri plates were incubated at 30 °C for 72 h and observed for colony formation of the pathogen.

Typical colonies characteristic of the bacterium were picked from the Petri plates and transferred to Petri plates containing nutrient sodium chloride agar medium by streak plate method for the purification of culture. These cultures were further purified by streak plate method on NSA slants and maintained at 4-5 °C in refrigerator for further studies. The culture was periodically sub-cultured at an interval of two weeks regularly.

### *2.2. Effect of different temperature regimes on the growth of X. cucurbitae*

Erlenmeyer flasks of 150 ml capacity each containing 50 ml of nutrient sodium chloride broth were sterilized and inoculated with 1 ml of bacterial suspension (48 h old culture of both isolates in nutrient broth) and incubated at different temperatures *viz.,* 15, 20, 25, 30 and 35 °C for 48 h. Data were recorded in terms of colony forming units per millilitre ( cfu $ml^{-1}$) depicting bacterial growth. For this, the bacterial suspension thus obtained after incubation in each flask was diluted serially up to $10^{-7}$ and pour plated on nutrient sodium chloride agar medium with 1 ml bacterial suspension and incubated at 30°C for 72 h to record the colony forming units $ml^{-1}$ ( cfu $ml^{-1}$).

### *2.3. Effect of different pH levels on the growth of X. cucurbitae*

The effect of different pH levels viz*.,* 4.0, 5.0, 6.0, 7.0, 8.0 and 9.0 on the growth of the bacterium (both isolates i.e. bottle gourd and pumpkin) was evaluated so as to find the optimum pH for its growth. The desired pH levels were adjusted with the help of 1N HCl or NaOH. For this, 'Erlenmeyer flasks' (150 ml capacity) containing 50 ml nutrient sodium chloride broth adjusted with different pH levels were inoculated with 1 ml bacterial suspension (48 h old culture of both isolates in nutrient broth) and incubated at the best temperature obtained in previous experiment for 48 h. Data were recorded in terms of cfu $ml^{-1}$as mentioned under previous experiment.

### *2.4. Effect of different liquid media on the growth of X. cucurbitae*

Different nutrient liquid viz*.,* nutrient sodium chloride broth, nutrient glucose broth, yeast extract nutrient broth, yeast extract sucrose peptone broth, yeast extract dextrose calcium carbonate broth and nutrient yeast extract broth were evaluated *in vitro* by colony count to study their effect on the growth of both isolatesof *X. cucurbitae*. For this, 50 ml broth of each medium was taken in 150 ml capacity Erlenmeyer flasks and autoclaved at 15 lbs psi for 20 minutes and inoculated with 1 ml bacterial suspension taken from 48 h old culture in nutrient broth. After 72 h of incubation, the bacterial suspension thus obtained in each nutrient medium was serially diluted and pour plated as mentioned above to record the cfu $ml^{-1}$.

## 3. Results and Discussion

The colony characteristics of both pathogen isolates were observed on NSA medium. The colonies were mucoid, circular, smooth textured and yellow in colour having diameter of

about 2-4 mm.

*3.1. Effect of different temperature regimes on the growth of X. cucurbitae*

Among various temperature regimes ranging from 15-35 °C tested for both isolates (Table 1), maximum growth ($5.35\times10^7$ cfu $ml^{-1}$) of bottle gourd isolate was recorded at 25 °C which was significantly higher than the remaining temperature treatments followed by growth at 30 °C ($3.80\times10^7$ cfu $ml^{-1}$). The growth of bottle gourd isolate at temperatures 20 °C ($2.31\times10^7$ cfu $ml^{-1}$), 15 °C ($2.18\times10^7$ cfu/ml) and 35 °C ($1.63\times10^7$ cfu $ml^{-1}$) was found to be statistically at par with each other.

Table 1: Effect of different temperature regimes on the growth of *Xanthomonas cucurbitae*

| Temperature (°C) | Growth of bacterial isolates ($\times10^7$ cfu $ml^{-1}$) | |
|---|---|---|
| | Bottle gourd | Pumpkin |
| 15 | $2.18^c$ | $2.15^c$ |
| 20 | $2.31^c$ | $3.71^b$ |
| 25 | $5.35^a$ | $4.15^b$ |
| 30 | $3.80^b$ | $4.68^a$ |
| 35 | $1.63^c$ | $2.25^c$ |
| CD (*p*=0.05) | 0.85 | 0.51 |
| SEm± | 0.26 | 0.16 |

In case of pumpkin isolate, data indicate that significantly maximum growth of the bacterium was recorded at 30 °C ($4.68\times10^7$ cfu $ml^{-1}$) followed by growth at 25 °C ($4.15\times10^7$ cfu/ml) which was statistically at par with the growth at 20 °C ($3.71\times10^7$ cfu $ml^{-1}$). Minimum growth of the bacterium was recorded at 15°C ($2.15\times10^7$ cfu $ml^{-1}$) which was statistically at par with the growth recorded at 35 °C ($2.25\times10^7$ cfu $ml^{-1}$). Thus, temperatures of 25 and 30 °C were found to be optimum for the growth of bottle gourd and pumpkin isolates, respectively.

The results of temperature studies of *X. cucurbitae* obtained in present investigations were in accordance with Babadoost and Zitter (2009) and Zhang and Babadoost (2018) who reported that optimum temperature for the growth of *X. cucurbitae* ranged from 24 to 30 °C. The present investigations are further supported by Maji and Nath (2015) and Suresh et al. (2013) who reported that 30 °C is optimum temperature for the growth of *Xanthomonas* species.

*3.2. Effect of different pH levels on the growth of X. cucurbitae*

The pathogen grew to a variable extent at all pH levels tested except pH 4.0 at which no growth of the pathogen was observed. In case of bottle gourd isolate, maximum growth ($44.16\times10^7$ cfu $ml^{-1}$) of the pathogen was recorded at pH 6.0 which was significantly higher than the growth at remaining pH levels tested followed by growth at pH 7.0 ($36.15\times10^7$ cfu $ml^{-1}$), 5.0 ($25.33\times10^7$ cfu $ml^{-1}$), 8.0 ($6.80\times10^7$ cfu $ml^{-1}$) and 9.0 ($4.16\times10^7$ cfu $ml^{-1}$).

In case of pumpkin isolate, significantly maximum growth ($31.62\times10^7$ cfu $ml^{-1}$) of the pathogen was recorded at pH level 7.0 followed by pH 6.0 ($27.03\times10^7$ cfu/ml) and pH 5.0 ($19.40\times10^7$ cfu $ml^{-1}$). However, significantly minimum growth of the test pathogen was recorded at pH 9.0 ($2.50\times10^7$ cfu $ml^{-1}$) followed by that at pH 8.0 ($5.53\times10^7$ cfu $ml^{-1}$) (Table 2).

Table 2: Effect of different pH levels on the growth of *Xanthomonas cucurbitae*

| pH | Growth of bacterial isolates ($\times10^7$ cfu $ml^{-1}$) | |
|---|---|---|
| | Bottle gourd | Pumpkin |
| 4.0 | 0.00f (1.00) | 0.00f (1.00) |
| 5.0 | 25.33c (5.13) | 19.40c (4.51) |
| 6.0 | 44.16a (6.71) | 27.03b (5.29) |
| 7.0 | 36.15b (6.09) | 31.62a (5.70) |
| 8.0 | 6.80d (2.71) | 5.53d (2.55) |
| 9.0 | 4.16e (2.26) | 2.50e (1.86) |
| CD0.05 | 0.33 | 0.35 |
| SEm± | 0.10 | 0.11 |

Figures in parentheses are square root transformed values

During present studies, pH levels 6.0 and 7.0 were found to be best whereas nogrowth of the pathogen was recorded at pH 4.0.These results were in accordance with Zhang and Babadoost (2018) who reported that optimum pH level for the growth of *Xanthomonas cucurbitae* ranged from 6.5 to 7.0 whereas, no growth was recorded at pH below 4.5. During the course of study, it was also observed that with the increase in pH level above 7.0, there was a decrease in the bacterial growth. These findings are supported by the findings of Suresh et al. (2013) who obtained maximum growth of *X. oryzae* pv *oryzae* at pH 7.0 and observed a decrease in growth of the bacterium with the increase in pH level of the medium.

*3.3. Effect of different liquid mediaon the growth of X. cucurbitae*

Among the six liquid media studied (Table 3) for the growth of pathogen, maximum growth of bottle gourd isolate was supported by nutrient glucose broth ($9.31\times10^7$cfu $ml^{-1}$) followed by yeast extract dextrose $CaCO_3$ broth ($8.11\times10^7$ cfu $ml^{-1}$) and minimum growth of the bacterium was found in yeast extract nutrient broth ($3.65\times10^7$ cfu $ml^{-1}$). However in case of pumpkin isolate, maximum growth of the bacterium was supported by yeast extract dextrose $CaCO_3$ broth

Table 3: Effect of different liquid media on the growth of *Xanthomonas cucurbitae*

| Liquid media | Growth of bacterial isolates ($\times 10^7$ cfu $ml^{-1}$) | |
|---|---|---|
| | Bottle gourd | Pumpkin |
| Nutrient sodium chloride broth | 7.70b | 7.33cd |
| Nutrient glucose broth | 9.31a | 7.93bc |
| Yeast extract sucrose peptone broth | 5.30c | 8.71b |
| Nutrient yeast extract broth | 6.13c | 6.08d |
| Yeast extract dextrose $CaCO_3$ broth | 8.11ab | 10.63a |
| Yeast extract nutrient broth | 3.65d | 4.98e |
| CD ($p$=0.05) | 1.27 | 1.35 |
| SEm± | 0.40 | 0.43 |

($10.63\times10^7$cfu $ml^{-1}$) followed by nutrient sucrose peptone broth ($8.71\times10^7$cfu/ml) and nutrient glucose broth whereas, minimum growth was supported by yeast extract nutrient broth ($4.98\times10^7$ cfu/ml).

Growth of both the isolates was well supported by yeast extract dextrose $CaCO_3$ broth as well as nutrient glucose broth while, yeast extract nutrient broth was least supportive for the growth of both the isolates of *X. cucurbitae* under study. As there are no reports in the literature regarding the effect of different nutrient media on the growth of *X. cucurbitae*, so these results cannot be compared with. However, many of the workers have used yeast extract dextrose $CaCO_3$ agar medium for studying the cultural characteristics of *X. cucurbitae* (Lamichhaneet al., 2010; Babadoost and Ravanlou, 2012; Dutta et al., 2013 and Liu et al., 2016). Also, Jarial and Shyam (2004) while working on *X. campestris* pv *campestris* recorded a moderate growth of the bacterium on yeast extract dextrose calcium carbonate broth as well as nutrient glucose broth and minimum growth on yeast extract nutrient broth medium.

## 4. Conclusion

The colonies of isolates of *Xanthomonas cucurbitae* infecting bottle gourd and pumpkin were mucoid, circular, smooth textured and yellow in colour with 2-4 mm diameter. Temperatures of 25 and 30 °C and pH levels of 6.0 and 7.0were found to be optimum for the growth of bottle gourd and pumpkin isolates, respectively. Growth of both the isolates was well supported by yeast extract dextrose $CaCO_3$ broth as well as nutrient glucose broth.

## 5. References


Alippi, A.M., 1989. Characterization of *Xanthomonas campestris* pv. *cucurbitae* causal agent of bacterial leaf spot of squash. Rivista Argentina de Microbiologica 21(1), 15−19.

Babadoost, M., 2012. Report on plant disease. Department of Crop Sciences, University of Illinois at Urbana – Campaign.

Babadoost, M., 2017.Bacterial spot (*Xanthomonas cucurbitae*): An emerging disease of cucurbits. 2nd International Conference on Plant Science & Physiology w.e.f June 26-27, 2017 at Bangkok, Thailand. Journal of Plant Pathology and Microbiology 8, 5. DOI: 10.4172/2157-7471-C1-004

Babadoost, M., Ravanlou, A., 2012. Outbreak of Bacterial Spot (*Xanthomonas cucurbitae*) in Pumpkin Fields in Illinois. Plant Disease 96, 1222.

Babadoost, M., Zitter, T.A., 2009. Fruit rots of pumpkin: a serious threat to the pumpkin industry. Plant Disease 93(8), 772−782.

Banchero, M., Gonzalez P., Silvera, E., Mondino, P., Gepp, V., 1998. Leaf spot of squash (*Cucurbita* sp.) caused by *Xanthomonas campestris* pv. *cucurbitae* in Uruguay. Agrociencia (Montevideo) 2(1), 134−137.

Bryan, M.K., 1930. Bacterial leaf spot of squash. Journal of Agricultural Research 40(4), 385−391.

Dutta, B., Gitaitis R.D., Lewis, K.J., Langston, D.B., 2013. A new report of *Xanthomonas cucurbitae* causing bacterial leaf spot of watermelon in Georgia, USA. Plant Disease 97, 556.

Gorlenko, M.V., 1979. Bacterioses of cucurbits.In: Bacterial diseases of plants (VD Izrail.Skii (ed.). Moscow, Kolos. 161-171 (in Russian).

Jarial, K., Dogra, B.S., Mandradia, R.K., Kumar, S., Sharma, D., Gupta, A.K., 2011. Investigations on a new bacterial disease of bottle gourd in sub-tropical zone of Himachal Pradesh. Plant Disease Research 26(1), 68−75.

Jarial, K., Jarial, R.S., Sharma, D., Kumar, S., Dogra, B.S., 2015. Strategy for the management of bacterial spot of bottle gourd caused by *Xanthomonas cucurbitae* under low hill conditions of Himachal Pradesh. International Journal of Bio-resource and stress Management 6(6),744−748.

Jarial, K., Shyam, K.R., 2004. Black rot of cauliflower in relation to meteorological factors.Asian Journal of Microbiology, Biotechnology and Environmental Sciences 6, 113−117.

Kushima, Y., Tamura, I., Soubara, N., Tsuno, K., 1994. Bacterial leaf spot on fruit of squash in greenhouse. Proceedings of Association of Plant Protection of Kyushu 40, 62−64.

Lamichhane, J.R, Varvaro, L., Balestra, G.M., 2010. Bacterial leaf spot caused by *Xanthomonas cucurbitae* reported on pumpkin in Nepal. New Disease Reports 22, 20.

Larazev, A.M., 2009. Diseases: *Xanthomonas campestris* pv. *cucurbitae* (Bryan) Dye-bacterial leaf spot of cucurbits. In: 2003-2009 Project entitled Interactive agricultural ecological Atlas of Russia and neighbouring countries: economic plants and their diseases, pests and weeds. Available at http://www.agroatlas.ru.

Lia, R.S., Md. Ali, R., Md. Jahan, S., Akter, A., Mst. Sumi, S.E., Md. Hasan, F., Acharjee, U.K., Md. Islam, A., Sikdar,

B., 2018. Detection of *Xanthomonas campestris* pv. *cucurbitae* from Bacterial leaf spot disease of cucumber and evaluation of its biological control. Advances in Bioresearch 9, 41−46.

Liu, Q., Ravanlou, A., Babadoost, M., 2016. Occurrence of bacterial spot on pumpkin and squash fruit in North Central Region of United States and bacteria associated with the spots. Plant Disease 100 (12), 2377−2382. https://doi.org/10.1094/PDIS-01-16-0107-RE

Maringoni, A.C., Jr. Leite, R.P., Komori, N., 1988. A new disease of cucumber (*Cucumis sativus* L) caused by *Xanthomonas campestris* pv *cucurbitae* (Bryan) Dye in Brazil. Summa Phytopathologica 14, 225−230.

Maji, A.,Nath, R., 2015. A study on pathological aspects of *Xanthomonas campestris* pv *campestris* causing bacterial rot of cabbage under red lateritic zone of West Bengal.Journal of Applied and Natural Science 7(2), 780−785.

Pruvost, O., Robene-Soustrade, I., Ah-You, N., Jouen, E., Boyer, C., Wuster, G., Hostachy, B., Napoles, C.,Dogley, W., 2009.First report of *Xanthomonas cucurbitae* causing bacterial leaf spot of watermelon in the Seychelles.Plant Disease 93(6), 671.

Robbs, C.F., Kumura, D., Barbosa, G.A.A., 1972. Bacterial blight of squash, a disease new to Brazil.Arquivos do Universidade federal Rural do Rio de Janeiro 2(2), 105−106.

Salamanca, L.R., 2014. Bacterial Diseases of pumpkins: an old enemy and an emerging bacterial disease. Michigan State University Extension Bulletin. Available at http://msue.anr.msu.edu.

Sharma, R.R., 2016. Integrated Management of Bacterial Spot of Bottle Gourd caused by *Xanthomonas cucurbitae*. M.Sc. Thesis. Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu Main Campus, Chatha, Jammu-180009. 81.

Sinha, P.P., 1989. Preliminary studies on bacterial leaf spot of cucumber. Indian Phytopathology 42, 146−149.

Suresh, S.R., Yejenrappa, S.T.,Naik, M.K., Mallesh, S.B.,Kalibavi, C.M., 2013. Studies on cultural and physiological characters of *Xanthomonas oryzae* pv *oryzae* causing bacterial blight of rice. Karnataka Journal of Agricultural Sciences 26(2), 214−216.

Trueman, C.L., Roddy, E., Goodwin, P.H., 2014. First report of bacterial spot (*Xanthomonas cucurbitae*) of pumpkin in Ontario, Canada.New Disease Reports 30, 8.

Vincent-Sealy, L., Brathwaite, C.W.D., 1982. Bacterial leaf spot of cucumber in Trinidad. Tropical Agriculture 59(4), 287−288.

Vlasov, V.V., 2005. *Xanthomonas cucurbitae* - causal agent of bacteriosis on cucurbits in Pridnestrov.e. In: Collection of papers of participants of the International Scientific Conference, Phytopathogenic bacteria, Phytoncidology, Allelopathy by (VS Podgorskii (ed.), Kiev: Gosudarstvennyi argoekologicheskii universitet, 14−18 (in Russian).

Zhang, X., Babadoost, M., 2018. Characteristics of *Xanthomonas cucurbitae* isolates from pumpkins and survival of the bacterium in pumpkin seeds. Plant Disease 102(9), 1779−1784.