Biological Forum – An International Journal **14(2): 389-395(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Incidence of Major Acid Lime Diseases in Tamil Nadu and Ecofriendly Management of Bacterial Canker caused by *Xanthomonas axonopodis* pv. *citri* in var. PKM 1

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(Received 30 January 2022, Accepted 07 April, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Roving and fixed plot surveys were conducted for three consecutive years from 2011 – 2014 to study the incidence and intensity of major diseases in acid lime grown in Tamil Nadu. The diseases *viz.*, canker, twig blight, stem end rot, gummosis, citrus greening and citrus yellow mosaic virus were recorded through roving survey in the acid lime orchards of Coimbatore, Dindigul, Madurai, Tirunelveli, Virudhunagar and Theni districts of Tamil Nadu. It was observed that the incidence of canker was high in the orchards where the canopy management was poor with interlocking of branches and dense growth of foliage. In the old and uncared orchards with dense canopy, twig blight, gummosis and drying of the entire tree were also recorded. Citrus Yellow Mosaic Virus was recorded as a new incidence in Palakkanuthu village of Dindigul district in variety Balaji. The fixed plot survey conducted at Horticultural College and Research Institute, Periyakulam in twenty acid lime trees of PKM1 variety revealed the incidence of twig blight, gummosis, bacterial canker and citrus greening. It was also observed that the diseases occurring throughout the year in the fixed plot were twig blight, bacterial canker and citrus greening with the expression of greening being high during January to March. Gummosis was recorded from November to March with severe oozing during February and March.

Management trial conducted for bacterial canker (*Xanthomonas auxonopodis* p.v. *citri*) for three consecutive years revealed that, pruning followed by five consecutive foliar sprays starting with streptocycline (100ppm) + copper oxychloride (0.3%) as the first spray followed by NSKE (5%) as the second spray at thirty days interval was highly significant in reducing the intensity of bacterial canker (6.97 PDI) and yielded 24.61 kg/ tree/year when compared with the control. As an alternative to chemical, biological management consisting of pruning followed by five consecutive foliar sprays starting with talc based formulations of *Pseudomonas fluorescens* (Pf1) (0.5%) + *Burkholderia gladioli* TNAU1 (0.5%) as the first spray followed by NSKE (5%) as the second spray at thirty days interval was effective in reducing the intensity of canker to 10.00 PDI and recorded a yield of 21.02 kg/tree/year and was the second best.

Keywords: Acid lime diseases, survey, bacterial canker, *Burkholderia gladioli* TNAU1, *Pseudomonas fluorescens* (Pf1), NSKE.

INTRODUCTION

Acid lime is an important commercial fruit crop in India which is cultivated in 2.96 lakh hectares with an annual production of 33.97 lakh tonnes during 2018-19 (Anon, 2020). In the Citrus group next to mandarin and sweet orange, it is widely grown in India contributing to its economy. The area under acid lime in Tamil Nadu is 11,069 hectares with an annual production of 15,657 tonnes during 2019-20 (Anon., 2022). The crop is gaining momentum in its large scale cultivation throughout Tamil Nadu other than the traditionally cultivated areas. However, there are many constraints which contribute to the low performance of the crop inspite of its importance, fetching very low price to the farmers/stakeholders. Diseases caused by fungi, bacteria, phytoplasma and virus pose the major constraint and cause considerable loss. Since the acreage of acid lime is expanding in Tamil Nadu, the need to keep a record of the diseases and the trend of occurrence of the major and minor diseases becomes obligatory.

Bacterial canker caused by *Xanthomonas axonopodis* p.v. *citri* (Hasse) Vauterin (*Xac*) is one of the major diseases in which the canker affected fruits lose their market value due to the cankerous growth on the fruit surface. The causal organism is a Gram- negative rod shaped bacterium, measuring 1.5 – 2.0 × 0.5 – 0.75 mm with a single polar flagellum and is an obligatory aerobic at temperature range from 28°C to 30°C. The climatic fluctuations prevailing in the last few decades keep exerting drastic effects on crop growth and these altered environmental conditions have the potential to elevate the incidence, intensity and disease epidemics pressure on the crop. There is no cure for the disease and resistance cannot be genetically introgressed by breeding. This is especially the case where tropical storms are prevalent (Das, 2003; Raza *et al*., 2014). Pria *et al*. (2006) has registered that the disease is greatly influenced by environmental factors. Since the disease occurs severely in acid lime, timely prediction is essential to manage the disease without much loss in the yield. In Brazil, the major diseases affecting Citriculture were canker, variegated chlorosis, and Huanglongbing (HLB), caused by *Xanthomonas citri*, *Xylella fastidiosa* and *Candidatus* Liberibacter respectively and due to the inefficacy of the current eradication program Citrus canker has re-emerged as the major disease (Mendonca *et al*., 2017).

Pruning of affected twigs before the onset of monsoon and spraying with 1% Bordeaux mixture can effectively control the disease (Ramakrishnan, 1954). Rangasamy *et al*., (1959) reported that spraying streptomycin sulphate 1000 ppm thrice at fortnightly intervals during rainy season effectively controls the disease. Antagonistic activity of selected Pseudomonads bacterial strains against *X. axonopodis pv. citri* carried out in the laboratory and greenhouse conditions showed that all bacterial strains were inhibitory to the pathogen through their various antagonistic activities (Khodakaramian *et al*., 2008). Decline in the canker incidence was recorded at 20 days after a single spray of the aqueous suspension (2.7 × 109 cells/ml) of *Bacillus subtilis* (S-12) during the peak season for the disease especially in July indicating that the spore forming bacteria might have taken over on the leaf surfaces of the plants reducing the disease (Das *et al*., 2014).

This study was undertaken to record the major diseases occurring in Tamil Nadu through roving survey and to correlation the weather parameters with the incidence of diseases through fixed plot survey. Since bacterial canker is a major problem in the acid lime cultivation which is very severe after the windy rains, this investigation also aims to develop an effective ecofriendly management strategy using chemicals and bioagents.

MATERIALS AND METHODS

Roving survey. The major acid lime cultivated areas in Tamil Nadu were surveyed for the incidence and intensity of different diseases. The districts, namely Madurai, Coimbatore, Theni, Tirunelveli and Virudhunagar were surveyed extensively. In each district five fields were selected for evaluation of the disease incidence. The diseases were recorded based on the symptoms on leaves, twigs, branches and fruits in each field by walking across starting from Southwest corner to Northeast corner. The grading scale of (0 – 9) was adopted for twig blight and bacterial canker. Based on the grade the severity or Percent Disease Index (PDI) was calculated using Mckinney, (1923) infection index.

$$\text{PDI} = \frac{\text{Sum of numerical ratings}}{\text{Total number of fruits/leaves observed}} \times \frac{100}{\text{Maximum grade}}$$

For the diseases *viz*., stem end rot, gummosis, greening, CYMV the per cent incidence (PI) was calculated as follows

$$\text{PI} = \frac{\text{No. of plants affected by the disease}}{\text{Total number of plants observed}} \times 100$$

Fixed plot survey. Twenty acid lime trees of PKM1 variety were selected in Horticultural College and Research Institute, Periyakulam. The major economically important diseases of the locality were studied by recording the incidence and intensity of the diseases at 15 days interval. The incidence (%) and severity (PDI) for the diseases were calculated as mention in the roving survey. The weather conditions preceding the observations were recorded. The incidence and severity of various diseases was correlated with weather parameters using multiple regression analysis.

Management of bacterial canker. Field trial was conducted in the orchard at Horticultural College and Research Institute, Periyakulam under natural disease condition in the cultivar PKM1 for three successive years (2011 – 12, 2012 – 13 and 2013 – 14). Pruning followed by five consecutive spraying after the onset of monsoon at 30 days interval was followed for all the treatments. The design followed was randomised block design with seven treatments and three replications. The observations were recorded on four plants per replication (20 leaves/plant selected randomly) based on the grading system (0-9 scale) and the PDI was assessed for the treatments after the last spray. The following treatments were imposed in the trial.

T_1: Foliar application of neem seed kernel extract (NSKE) 5%

T_2: Foliar application of copper oxychloride (COC) (0.3%) + streptocycline (100 ppm)

T_3: Foliar application of COC (0.3%) + streptocycline (100 ppm) + NSKE 5%

T_4: Foliar application of talc based formulation of *Pseudomonas fluorescens* (Pf1) (0.5%) + NSKE 5%

T_5: Foliar application of talc based formulation of *Burkholderia gladioli* TNAU1 (0.5%) + NSKE 5%

T_6: Foliar application of talc based formulation of *P. fluorescens* (Pf1) (0.5%) + *B. gladioli* TNAU1 (0.5%) + NSKE 5%

T_7: Control (Untreated check)

The cultures of *Pseudomonas* (Pf1) and *B. gladioli* TNAU1 was obtained from the culture collection of the Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore and used in this study. The antagonistic bacteria, *P. fluorescens* (Pf1) and *B. gladioli* TNAU1 exhibited antagonism against *Xac* when tested *in vitro* through dual plate technique. Hence, they were used in the experiment to evolve an ecofriendly measure alternative to the chemical methods used.

RESULTS AND DISCUSSION

A. Roving survey

Roving survey conducted for three consecutive years from 2011 – 2014 in acid lime growing areas of Tamil Nadu revealed the occurrence of canker, twig blight, stem end rot, gummosis, citrus greening and citrus yellow mosaic virus. It was observed that the incidence of canker was high in the orchards where the canopy management was poor with interlocking of branches and dense growth of foliage in the surveyed areas. Goto, (1992) has recorded severe foliage infection and defoliation leading to bare twigs resulting in almost complete loss. The disease caused heavy losses when the infection occurred at early stages of plant growth (Gupta and Sharma, 2008). Bock *et al*., (2005) observed that once the disease was established the most important ways of dispersal were rain splash and wind. In the studies conducted by Singh *et al*., (2014), the canker incidence in nurseries varied from 17.0 to 63.0 per cent and in orchard from 13.0 to 42.0 per cent in the citrus growing areas of Hoshiarpur, Faridkot, Ludhiana and Fazilka districts of Punjab.

Incidence of gummosis caused by *Phytophthora nicotinanae* was recorded at Periyakulam of Theni district during the survey conducted. In other areas gummosis infection accompanied with dieback, bark and wood splitting was caused due to *Botryodiplodia theobromae*. In both the cases, the affected tree exhibited slow decline after one or two years if left without proper management. In India, gummosis has been reported in every citrus growing area. Ramakrishnan, (1954) reported the susceptibility of Sathugudi, Jamberi, grapefruit, mandarin and acid lime to *Phytophthora* under South Indian conditions. Chengu Reddy *et al*., (1999) has stated that one of the causal organisms of acid lime root rot in Andra Pradesh was *Phytophthora* spp. Slow decline in acid lime due to bark and wood splitting disease caused by *Botryodiplodia theobromae* was observed (3.5 – 10 %) in old gardens effecting the longevity and yield of the tree (Gopal *et al*., 2005). A survey conducted at Oman showed prevalence of dieback symptoms in 8.8% of acid limes and in 15.9% of sweet limes. It was also observed that some of the acid limes (3.0%) and sweet limes (3.5%) suffered from gummosis at the trunk base.

Isolations from bark and root samples obtained from diseased acid lime and sweet lime trees showed association of 19 fungal species with these plants, with *Lasiodiplodia hormozganensis*, *L. theobromae* and *Fusarium solani* being the most common (Al-Sadi *et al*., 2014). Singh *et al*., (2014) has reported that twig blight, gummosis and drying of the entire tree were observed in old and uncared orchards with dense canopy.

In the present study, Citrus Yellow Mosaic Virus (CYMV) was recorded as a new incidence in Palakkanuthu village of Dindigul district in the variety Balaji where the planting material was procured from nurseries at Andhra Pradesh. The survey conducted by Gosh *et al.,* (2007) in Central India revealed the incidence of yellow mosaic disease in three commercial citrus cultivars *viz.*, Nagpur mandarin, mosambi sweet orange and acid lime in which 5.88 per cent incidence was recorded in acid lime. In the CYMV affected plants, leaves showed green areas with the severely infected leaves expressing green areas throughout the lamina. Moreover, the tree produced significantly less fruits which contained less juice and ascorbic acid content (Ahlawat *et al*., 1996).

The disease of concern to the acid lime farmers was greening during the investigation conducted which was recorded from various places and the highest occurrence was in Puliyangudi of Tirunelveli district. Schneider (1968) has reported that the infection being systemic causes small and upright leaves showing a variety of chlorotic patterns resembling those induced by zinc and iron deficiencies which are mostly secondary symptoms. Root systems are poorly developed with relatively few fibrous roots (Salibe and Cortez, 1966). In India, greening is widely distributed in all citrus growing states including North-eastern region, Bihar, West Bengal, Orissa, Maharashtra, Punjab, Andhra Pradesh, Kerala and several other areas where citrus is grown (Nariani *et al.*, 1967; Raychaudhari *et al.*, 1972). Survey conducted in the acid lime growing districts of Andhra Pradesh to study the incidence of diseases revealed the presence of bacterial canker (100 %), bark eruption (10.67 – 20.86 %), citrus greening (13.7 21.18 %), root rot (6.13 – 18.18%), twig blight (10.25 21.88 PDI) and longitudinal bark and wood disease (3.8 – 6.88%) (Nagalakshmi *et al*., 2014). On an average in the present study, the incidence of stem end rot, gummosis, greening and CYMV was 7.45 %, 11.32 %, 21.46 %, 0.1 % whereas the intensity of bacterial canker and twig blight was 22.50 PDI, 21.06 % respectively in the acid lime orchards of Coimbatore, Dindigul, Madurai, Tirunelveli, Virudhunagar and Theni districts of Tamil Nadu surveyed.

Table 1: Incidence and occurrence of diseases of acid lime - Roving survey (2011 – 2014) - pooled mean of 2011 – 12, 2012 – 13 and 2013 – 14.

Sr. No.	Place	Variety	Twig blight (PDI)	Stem end rot (%)	Bacterial canker (PDI)	Gummosis %	Greening %	CYMV %
1.	Andipatti	PKM 1	16.81	7.21	27.49	15.30	33.83	-
2.	Ayyampalayam	Rangpur lime	9.79	8.0	9.12	35.33	35.33	-
3.	Ayakudi	Local	13.63	10.12	27.31	14.64	-	-
4.	Chithayankottai	PKM1	13.02	16.05	9.80	8.75	-	-
5.	Coimbatore	Local	6.45	-	26.24	-	-	-
6.	Dindigul	Jenabi & Local	31.24	19.66	33.60	26.17	-	-
7.	Jadikoundanpatti	PKM1	20.67	16.00	27.73	-	-	-
8.	Kamblinayakanpatti	Local	7.00	-	36.75	5.67	-	2.00
9.	Messalur	Local	33.73	-	-	38	35.00	-
10.	Moolachathiram	Local	23.43	13.46	36.62	4.12	41.36	-
11.	Periyakulam	PKM1	19.88	-	10.37	6.67	58.33	-
12.	Puliyangudi	Local	13.70	-	12.44	-	75.00	-
13.	Reddiarchatram	Local	35.02	10.41	33.53	26.78	60.83	-
14.	Srivilliputhur	Local	26.27	-	24.56	16.89	-	-
15.	Theni	Tenali & Local	6.69	2.50	5.72	2.0	13.00	-
16.	Thenkasi	Local	25.91	16.84	23.75	-	13.33	-
17.	Thirupathur	Local	50.55	-	29.92	-	-	-
18.	Thirumangalam	Local	18.29	7.9	6.35	2.4	-	-
19.	Vadipatti	Local	27.98	13.33	23.70	12.33	41.66	-
	Mean		21.06	7.45	22.50	11.32	21.46	0.1

Table 2: Incidence and occurrence of diseases of acid lime – Fixed plot survey (2011 – 2014) - pooled mean of 2011 – 12, 2012 – 13 and 2013 – 14.

Sr. No.	Month and year	Twig blight (PDI)	Bacterial canker (PDI)	Gummosis %	Cirtus greening (%)
1.	January	8.15	7.63	11.67	93.33
2.	February	8.96	6.68	28.33	93.33
3.	March	10.15	2.46	28.33	93.33
4.	April	7.35	4.26	0.00	90.00
5.	May	6.12	3.51	0.00	90.00
6.	June	9.92	5.50	0.00	86.67
7.	July	11.74	6.45	0.00	86.67
8.	August	12.97	6.10	0.00	86.67
9.	September	9.50	5.19	0.00	86.67
10.	October	9.37	6.02	0.00	86.67
11.	November	6.72	8.49	1.67	86.67
12.	December	7.38	6.50	6.67	90.00

B. Fixed plot survey

The diseases *viz*., twig blight, gummosis, bacterial canker and citrus greening were recorded in the fixed plot survey conducted at Horticultural College and Research Institute, Periyakulam in the var PKM 1. The incidence of twig blight, bacterial canker and citrus greening diseases was recorded throughout the year. Though greening was present throughout the year due to its systemic nature, the symptom expression was high from January to March. Gummosis was recorded from January to March. The incidence ranged from 6.12 to 12.97 for twig blight, 2.46 to 8.49 for canker, 0.00 to 28.33 for gummosis and 86.67 to 93.33 for greening. The correlation coefficient analysis among the weather parameters and the incidence of the diseases is presented in Table 4. The regression analysis for the pooled data from 2011 – 2014 shows that total impact of weather parameters (maximum temperature, minimum temperature, relative humidity, rainfall and wind velocity) on the development of twig blight, canker and gummosis was 43 %, 83 % and 75 % respectively. During the disease rating period, significant negative correlation existed between maximum temperature and the occurrence of canker which was best explained by the linear regression in Table 5. The influence of minimum temperature, relative humidity, rainfall and wind velocity on the occurrence of canker was non significant. The occurrence of gummosis was significantly influenced by the minimum temperature. The weather factors taken

into consideration did not influence the occurrence of twig blight. Studies conducted by Raza *et al*., (2014) depicted that compared to relative humidity, rainfall and wind speed, air temperature (maximum and minimum) are biologically more important for the survival of *Xac* in citrus nurseries as well as orchards which is in accordance with the present study. The quantitative study of disease development through correlation coefficient and linear regression analysis helps to predict the occurrence and progress of the diseases with the existing scenario of climate change, as timely prediction of the disease becomes a prime component of management by imposing prophylactic measures thereby reducing the cost of cultivation for the farmer.

Table 3: Correlation of acid lime diseases with weather factors (2011 - 2014) - pooled mean of 2011 – 12, 2012 – 13 and 2013 – 14.

Diseases	Correlation co- efficient (r)				
	Temperature (°C)		Rainfall (mm)	Relative Humidity (%)	Wind velocity
	Maximum	Minimum			
Twig blight	-0.020 NS	0.299 NS	-0.400 NS	-0.110 NS	0.470 NS
Bacterial canker	-0.889**	-0.523 NS	0.549 NS	-0.010 NS	-0.190 NS
Gummosis	0.045 NS	-0.601*	0.378 NS	-0.173 NS	-0.200 NS

Table 4: Multiple regression equations based on fornightly environmental conditions and predicted canker incidence in acid lime.

Sr. No.	Multiple regression equations*	R^2
1.	**Twig blight:** Y = 94.81 - 0.75 × X1 - 0.80 × X2 - 0.62 × X3 + 0.01 × X4 + 0.21 × X5	0.43
2.	**Canker:** Y = 68.67 - 1.15 × X1 - 0.08 × X2 - 0.21 × X3 - 0.01 × X4 - 1.30 × X5	0.84
3.	**Gummosis:** Y = 14.71+5.26 × X1 – 7.54 × X2 - 0.02 × X3 + 0.04 × X4 + 6.33 × X5	0.75

*$Y=b_o+b_1x_1+ b_2x_2+\ldots\ldots+ b_nx_n$

Where Y= Dependent variable

b_o= Intercept (Constant)

$b_{1.....}$ b_n=Regression coefficients for the independent variables

$x_{1.....}$ x_n= Independent variable

Table 5: Management of acid lime canker caused by *Xanthomonas axonopodis p.v. citri.*

Sr. No.	Treatment	Canker (PDI)*	PROC*	Yield (kg/tree/ year) *	CB ratio
1.	Pruning followed by foliar application of NSKE 5%	12.34 c (26.60)	46.02	19.90	1:3.09
2.	Pruning followed by foliar application of COC (0.3%) + Streptocycline (100 ppm)	12.07 c (26.51)	42.64	20.92	1:3.15
3.	Pruning followed by foliar application of COC (0.3%) + Streptocycline (100 ppm) + NSKE 5%	6.97 a (22.53)	71.13	24.61	1:3.58
4.	Pruning followed by foliar application of *Pseudomonas* (Pf1) (0.5%) + NSKE 5%	16.30 d (29.03)	22.25	18.94	1:2.92
5.	Pruning followed by foliar application of *Burkholderia gladioli* TNAU1 (0.5%) + NSKE 5%	14.55 d (28.06)	31.57	18.61	1:2.89
6.	Pruning followed by foliar application of *Pseudomonas* (Pf1) (0.5%) + *Burkholderia gladioli* TNAU1 (0.5%) + NSKE 5%	10.00 b (24.88)	59.25	21.02	1:3.26
7.	Control (Untreated check)	21.00 e (31.30)	-	16.65	1:2.66
	SEd	0.61			
	CD(0.05)	1.24			
* pooled mean of 2011 – 12, 2012 – 13 and 2013 - 14					

PROC – Percent reduction over control

Values in parentheses are arcsine – transformed values.

In a column, means followed by same letter do not differ significantly ($P < 0.05$) according to DMRT

C. Management of bacterial canker

The results of the management trial conducted during the consecutive years from 2011 – 14 revealed that pruning followed by five consecutive foliar sprays starting with streptocycline (100ppm) + COC (0.3%) as the first spray followed by NSKE (5%) as the second spray at thirty days interval was highly significant in reducing the intensity of bacterial canker (6.97 PDI) with the yield being 24.61 kg/tree/year. As an alternative to chemicals, biological management consisting of pruning followed by five consecutive foliar sprays starting with talc based formulations of *P. fluorescens* (Pf1) (0.5%) + *B. gladioli* TNAU1 (0.5%) as the first spray followed by NSKE (5%) as the second spray at thirty days interval was effective in reducing the intensity of canker (10.00 PDI) and

recorded an yield of 21.02 kg / tree / year when compared with the untreated control recording 21.00 PDI canker intensity and yield of 16.65 kg / tree / year. Investigation conducted by Behlau, 2008 in a commercial citrus orchard in Southern Brazil on the effect of copper application against bacterial canker revealed that copper application significantly reduced canker damage to foliage and fruit thereby increased the fruit yield. He also explained that incidence and severity on the leaves were inversely related to the number of fruits harvested per tree and directly related to the number of fruits abscised per tree. Cultural practices in combination with the recommended chemical or biological control measures are needed for canker free cultivation. Foliar application of streptomycin sulphate + copper oxychloride given three times a year before the onset of monsoon was suggested by Jadeja *et al*., (2000) against canker infection. However, Bal and Dhiman, (2006) have reported that integrated management of canker (caused by *X. axonopodis pv. citri*) - scab (incited by *Elsinoe fawcetii*) complex involving the cultural control practices including covering the nursery with nylon net, providing shelterbelt with Hessian cloth and removing the diseased foliage were effective in reducing the development of these diseases. Further, Savitha, *et al*., (2016) have recorded that, sanitation and pruning followed by spraying of streptomycin sulphate (500 ppm) + COC (3g L−1) were effective with 30 PDI canker intensity and were on par with crop sanitation followed by Bordeaux mixture (1%) spray followed by bacterinashak (0.5g per l) and *P. fluorescens* (5g per l) spray with 32.17 PDI canker intensity.

The application of NSKE 5% for canker control can also control the leaf minor damage thereby indirectly reducing the canker incidence. When plant tissues are disrupted by wounds or by the feeding galleries of the Asian leaf miner (*Phyllocnistis citrella*) internal leaf tissues are exposed which makes all cultivars and most citrus relatives that express some level of field resistance, also to become infected (Sharma and Sharma, 2008) and thus exacerbating the incidence of Citrus canker (Hall *et al*., 2010). Reddy and Paparao, (1960) observed that fortnightly spraying of 1 kg of neem cake in 20 litres of water in the rainy season increased the shoot and leaf growth and indirectly reduced the canker infection. Similarly, Negi *et al*., (2015) have reported that the neem and garlic were most effective plant extracts tested against bacterial canker. In addition, have also recorded that among the antibiotics the most effective were chloramphanicol, streptocyclin and tetracyclin.

Acid lime is one of the important fruit crops of Tamil Nadu. The area under this crop is gradually increasing in recent years. However, the production is constrained by many factors. One such factor is the incidence of diseases causing severe losses not only in yield but also in the quality of fruits. Many fungi, bacteria and viruses are reported to infect acid lime. Through surverys, the newly emerging disease which will be of concern in the future can be monitored. Among the diseases causing economical loss in acid lime, bacterial canker is considered as a serious and fast spreading disease. The use of chemicals for the management of canker appears to be very effective in acid lime. However, minimizing the application of synthetic chemicals by replacing it with biological methods will leave the environment unharmed. Hence, the results of the study will promote the use of organic practices in the management of bacterial canker.

Acknowledgements. The authors whole heartedly thank and acknowledge ICAR - AICRP (Fruits) for funding the research programme to make it successful.
Conflict of Interest. None.

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How to cite this article: Vijayasamundeeswari A., M. Prabhu and B. Rex (2022). Incidence of Major Acid Lime Diseases in Tamil Nadu and Ecofriendly Management of Bacterial Canker caused by *Xanthomonas axonopodis* pv. *citri* in var. PKM 1. *Biological Forum – An International Journal*, *14*(2): 389-395.