JOURNAL OF SUSTAINABLE AGRICULTURE AND THE ENVIRONMENT

E-mail: jsae@mouau.edu.ng. Website: www.mouau.edu.ng.

Efficacy of Some Botanicals in the Control of Bacterial Soft Rot Disease of Cucumber (*Cucumis sativum* L.) Varieties in Umudike, Abia State.

***M. J. Ogbonna and E. U. Opara**

Department of Plant Health Management, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

**Corresponding author:maryjoyogbonna@gmail.com*

Abstract

A field experiment was conducted at the Eastern Research Farm of Michael Okpara University of Agriculture, Umudike (MOUAU) from June to August 2017 cropping season to assess the disease incidence and severity of the bacterial soft rot disease of cucumber (*Cucumis sativum* L.) and to determine the efficacy of leaf extracts of *Bryophyllum pinnatum, Ficus sur, and Jatropha curcas* in the control of bacterial soft rot disease of cucumber and on yield performance. The experimental design was RCBD replicated three times. The treatments were the leaf extracts of *Bryophyllum pinnatum, Ficus sur*,and *Jatropha curcas*. Streptomycin synthetic (antibiotics) served as a positive check while sterile water served as the control. Three varieties of cucumber used were Beta alpha, Marketer and Ngwa Local. Seeds were sown on a 6m ridge at Im x 0.75 m spacing. Diseased fruits were taken to the laboratory for examination, isolation and identification of micro-organisms, and the causal organism identified as *Pectobacterium carotovorum.* The result showed that fruit rot can initiate from the 6th week after planting increasing till harvest; and disease symptoms develop and become more pronounced after long period of rainfall (402.6mm) and high humidity (85%). Result showed that all the botanicals assessed significantly ($P \leq 0.05$) reduced the disease incidence and severity when compared to the control which recorded 62.20% and 3.76 respectively. Plants treated with leaf extract of *Ficus sur* had the best performance in yield (18.56t/ha), and compared favourably with Streptomycin which recorded 20% and 1.24 incidence and severity. It is therefore recommended that extracts of *Bryophyllum pinnatum, Ficus sur, and Jatropha curcas* be used as a better alternative biopesticides to synthetic pesticide in the management of bacterial soft rot of cucumber in Umudike, South Eastern Nigeria

Keywords: Cucumber, varieties, bacterial disease, botanicals

Introduction

Cucumis sativum L. commonly known as cucumber belongs to the botanical family Cucurbitaceae, other crops in this family include melons, squashes, pumpkins and gourds etc. It is a widely cultivated crop, comprising of many genera and species (Best, 2000; Nwofia *et*

al., 2015) that now grows in many continents.

It is believed to be of Indian origin (Dilip, 2016), a warm season, annual monoecious crop(Benzioni *et al.*, 1993). It produces both male and female flowers on the same plant. Cucumbers are naturally low in calories, fat, cholesterol, and sodium. Many modern hybrids are gynoecious—they produce only female flowers and are referred to as all female varieties (Michael *et al*., 2017).

In cucumber production, there are different varieties (Sebastine *et al*., 2010) but virtually all can be divided into three basic types: slicing, pickling and burpless (Abiola *et al*., 2017). It is greenish in colour, and is a major fruit vegetable that can be consumed raw, used as salad or cooked with other vegetables (Shetty and Wehner, 2002).

Global cucumber production in 2002 was estimated at about 2 million ha, with a total production of 36 million tones. Asia is the world leader, with China alone leading production, accounting for over 60%, followed by Turkey, Russia, Iran and the United States of America (Wehner, 2007).Cucumber is grown in all countries of tropical Africa, but with increasing population, currently there is a huge demand for the product locally, this account for its high cost in the market and a worthwhile Agribusiness with high degree of turnover over 200%.In spite of the numerous benefits and uses of cucumber in Nigeria, there are limitations confronting its production especially in the South-Eastern zone. These challenges include water flooding in the soil, nutrients and water deficiencies (Ayotamuno *et al*., 2007) and most importantly pre harvest and post-harvest losses (Opara and Ikoro, 2016) from insects and other pests, and disease outbreak. Another limitation is the Economic factor which includes transportation problems, storage cost, and lack of processed products, unstable demand and supplies, high marketing cost among others (Opara and Ikoro, 2016). Edaphic constraints like soil structure and texture, soil fertility, flooding, lack of improved cultivars and planting materials also limits cucumber production (Lerner and Dana, 2001).

Major insect pests of cucumber are aphids, whitefly, melon flies and thrips, mainly because they act as vectors for viruses or diseases. The pathogens infect the produce on farm or develop during storage (Shukla *et al*., 2012). The points of entry for these organisms remain the wounds and bruises which happen during harvesting and transportation. The use of synthetic pesticides as a control practice in disease management is strongly discouraged, due to its residual effects on the crops which makes it

unfit for consumption, harmful effects to the environment, eco-system and humans, also high cost of purchase by poor farmers (Amienyo and Ataga, 2007).

Due to the numerous dangers posed by the synthetic chemicals like toxic residues in crops which eventually lead to death, mammalian toxicity, accumulation in the ecosystem, eradication of beneficial non-target insects, high cost of purchase of synthetic chemicals etc., its use has been de-emphasized (Salako, 2002), and therefore there is a growing interest to search for phytochemicals of native and naturalized plants for plant disease management (Oktay, *et al*., 2003). Its advantages include the following; cost effectiveness, ease in preparation and application procedures, availability, little or no toxicity to humans and animals, eco-friendly (Amadioha, 2012).
Bacterial soft rot is one of the destructive diseases of vegetables and fruits that occur wherever fleshy storage tissues of vegetables and ornamentals are found (Agrios, 2006). It is among the top most important bacterial pathogens in agriculture which greatly limits crop production (Mansfield *et al*., 2012). In Nigeria, it causes greater total loss of produce than any other bacterial disease. In other to tackle this challenge, farmers use synthetic pesticides which cause toxic effects, which is a serious threat globally. There is a great need to research for possible control measures which are eco-friendly, cost effective and easily accessible to manage this ravaging disease. This study was therefore conducted to evaluate the incidence and severity of bacterial soft rot of cucumber fruits in the fields, and to determine the efficacy of some plant extracts to serve as alternatives to synthetic pesticides in the management of bacterial soft rot of cucumber fruits.

Materials and Methods

The study was carried out at the Eastern Farm of Michael Okpara University of Agriculture, Umudike. It is located on latitude 5^0 22^1 and longitude 7^0 33^1 , and an altitude of 122m above sea level, with annual rainfall of about 1916mm, 76% relative humidity and temperature range of 19-35^0C(NRCRI, 2018).

The field was manually cleared, mapped out and prepared into ridges. Cucumber seeds were sourced from National Horticultural Research Institute, Mbato Outstation Okigwe. Three different cucumber varieties: Beta Alpha, Marketer and the Ngwa local were used in this experiment.
The treatments consist of leaf extracts of *Bryophullum pinnatum, Ficus sur, Jatropha carcus,* Streptomycin (Standard bactericide) and sterile water as the control.

Cucumber seeds were sown on a 6m x 0.75m ridge at planting spacing of 1m x 0.75 m intra row-spacing, 3 seeds per hole and latter thinned down to two. The total area for the experiment was 33m x13.25m (437.25m^2) with a total of 45 ridges. Regular weedings were done manually.

Soil samples were randomly collected using a soil auger from the site at a depth of (0-20 cm) before planting, bulked into composite sample and taken to the Soil Science laboratory for analysis to determine the physico- chemical properties of the experimental site.

Preparation and application of the biopesticides:

Cold extraction method (Harborne, 1973) was used for the extraction of the plant leaves. The crude extracts were prepared by first of all sterilizing plant leaves in 1% Sodium hypochlorite (NaOCl) for 1 minute, washed 3 times in distilled water, and air dried. Thereafter, the fresh plant leaves were ground with a sterile manual grinder (Amadioha, 2004). 30 g of the ground plant leaves were soaked in 100ml of distilled water and vigorously agitated (Opara *et al*., 2013). The mixture was allowed to stand overnight then strained through double folds of sterile cheese cloth. This was used as the biopesticides in the experiment.

A hand-held sprayer was used to apply the different treatments; *Bryophullum pinnatum, Ficus sur*, and *Jatropha curcas,* antibiotic (streptomycin at 5g per litre), and sterile water (control), at 3, 5 and 7 weeks after planting.

Field Assessment of Disease Incidence and Severity:

Eighteen randomly tagged plants per plot were examined for disease symptoms weekly from 6 weeks after planting (WAP) and numbers of plants/fruits infected were recorded until 8 WAP. Assessment of the number of infected plants was done per plot, the total number of plants and number infected were counted and the percentage disease incidence assessed and severity determined using the formula:

Percent Disease Incidence (PDI) = $\frac{\text{Number of plants infected in the sampled area}}{\text{Total number of plants assessed in the sampled area}} \times 100$ 1

Assessments of disease severity were done on the fruits of the randomly tagged plants by a scale of 1-6 (a modified scale of Opara and Wokocha, 2008) where;

1= No symptom

2 = A few water soaked dark lesions about 5% or less on the fruit surface,

3 = About 10-20% of the fruit surface covered with lesions/spots,
4 = 25% portion but less than 50% of the fruit covered by lesions/spots,
5 = 50% of the fruit covered with lesions and the lesions coalesce to form large dead lesions
6 = 70% and above of the fruit surface covered by lesions/and may crack and fruits completely collapse.

Disease severity was expressed as the mean of the severity scores recorded on plants, this was calculated using the formula;

$$\text{Disease severity} = \frac{\text{Sum of individual ratings}}{\text{Total number of plants examined}}$$

Data were also collected on the following growth parameters:

(a) Total number of leaves (NOL) .This was obtained by counting the total number of leaves on each of the randomly tagged plants.
(b) Vine length (cm) (VL)
(c) Number of branches (NOB)
(d) Number of fruits
(e) Fruit weight at harvest (kg)

Laboratory Analyses

Sterilization of glass wares and inoculation chamber:

All glass wares used for the experiment were sterilized by autoclaving at 121^{o}C/15psi for 30 minutes prior to inoculation. The chamber and all non-glass items were sterilized by mopping with 70% absolute alcohol.

Preparation of the culture medium:

The culture medium was prepared according to the manufacturer's instructions. 28g of Nutrient Agar (NA) were dissolved in 1000ml of distilled water in a conical flask. This was properly shaken to obtain an even mixture. The mixture was autoclaved for 15 minutes at 121^{o}C, allowed to cool to about 45^{o}C and 15ml was dispensed into sterilized Petridishes. The agar plates were allowed to solidify and turned upside down for the evaporated moisture to dry before being used for bacteria culture.

Isolation of the pathogen:

Diseased cucumber fruits were washed under tap water, small sections of about 1-2mm taken from the advancing edge of the lesions of newly diseased tissue with a sterile scalpel. The cut section was rinsed in three changes of sterile distilled water to reduce surface contaminants and

macerated with a glass rod to form a suspension. This was allowed to stand for 15minutes in order for the bacterial cells to multiply. The suspension was streaked unto the solidified agar plates with the aid of a flamed red and cooled wire loop and plates were incubated at 37^{o}C for 24 hours, after which single colonies from the 24 hours old culture were picked with a sterile wire loop and streaked in a zig-zag fashion unto fresh prepared Nutrient agar Petridishes. Subsequent subculturing was done to obtain a pure culture

Preparation of inoculum:

Bacterial inoculum was prepared from 24 hours culture by washing bacterial colonies on agar plates with sterile distilled water into McCartney bottles and adjusting the density of the inoculum to 10^{8} CFU/ml using haemocytometer.

Identification of the pathogens:

Pathogenic organisms from diseased specimens (fruits of cucumber) were identified based on pathogenicity, morphological and Biochemical tests.
Their respective colony and structural characteristics were compared with those of known existing taxa with tests using Bergey's manual of determinative bacteriology (Buchaman and Gibbons, 2004) and those with corresponding characteristics were identified accordingly.

Morphological Identification of Bacteria Isolates:

The colonies in pure bacteria culture plate were examined to determine their colony features such as extent and mixture of growth, colony elevation, pigmentation, colour, edge and form of colony as well as consistency and observations recorded. (Okigbo, 2005). Following this, microscopic examinations were carried out in several tests which showed the reaction of the test organism to several dye (gram stain)to indicate the presence or absence of some features. The shape and arrangement were also noted. Final identification tests were conducted by some biochemcal reaction tests; carried out to confirm the ability of the enzymes like the catalase, indicated by production of bubbles showing either a positive (+ve) or a negative (-ve) reaction. Oxidase-reduction test, as well as H2S production tests were all conducted.

Pathogenicity test:

Healthy mature fruits of cucumber were surfaced sterilized by washing in 0.1% sodium hypochlorite solution, rinsed in three changes of sterile water and air dried on a laboratory bench. Inoculation was done by introducing the bacterial inoculum into a hole made on the fruit with a

flamed 2mm cork borer (Okigbo and Ikediegwu, 2000). The inoculated point was sealed up with a sterile gel. The inoculated fruits were placed in a humid chamber with moistened cotton wool for 48 hours to maintain high humidity; thereafter they were incubated at 30^{o}C room temperature and daily observed for development of soft rot symptoms such as wetting, softening, discoloration (darkening) and offensive odor. Re-isolation was made from symptomatic fruits.
A control experiment was set up by opening and closing the core in a healthy cucumber pod without introducing any organism in it except with 0.5ml sterile water.

From the third day after inoculation, the fruits were carefully examined by cutting open transversely along the line of inoculation to reveal the extent of the rot inside.

Statistical Analyses

Data were analysed using general linear procedure of Genstat 2008 model. The treatment means were separated and compared at 5% level of significance using Fishers Least Significant difference.

Results

Soil analysis and characterization of the experimental site

The physical and chemical properties of the soil of the experimental farms are presented in Table 1

The soil test shows that the soil in Umudike is a sand loamy, moderately acid pH of 5.5, sand, silt and clay particles of 561.0g/kg, 231.0g/kg, and 208.0g/kg respectively. It has low concentrations of total nitrogen of 0.1g/kg, available phosphorus 22.7mg/kg, and exchangeable calcium of 4.0cmol/kg.

Table 1: Soil properties of the experimental site in 2017.

Soil Properties	Umudike
Sand (g/kg)	561.0
Silt (g/kg)	231.0
Clay (g/kg)	208.0
Texture	**Sandy loam**
pH (H_2O)	5.5
Available phosphorus(mg/kg)	22.7
Total Nitrogen (mg/kg)	1.0
Organic Carbon (mg/kg)	11.1
Organic Matter (mg/kg)	19.1
Calcium (cmol/kg)	4.0
Magnesium (cmol/kg)	1.8
Potassium (cmol/kg)	1.3
Sodium (cmol/kg)	0.2
Exchangeable Acidity(cmol/kg)	3.9
Fixed Cation exchange capacity (cmol/kg)	7.0

Source: Soil science laboratory, National root crop research institute, Umudike (2017)

The Effect of Weather on the Growth Performance of the Test Crop

It was observed that the peak rainfall was at the month of July (402.6) with 25 days of rain, the mean minimum and maximum temperatures were 21.89-30.33 respectively and relative humidity were recorded as 50-80%
The relative humidity was highest in August with the value of 85%. (NRCRI, 2018)

Prevailing environmental factors like temperature, rainfall, relative humidity, sunlight etc. contributes generally in the plant's processes of growth.

Effect of the plants extracts and streptomycin on the growth characters of Cucumber at the 4, 6 and 8 weeks after planting in Umudike, Abia state.

The results of the experiments are shown in Table 2. All treatments were significantly different at 5% probability level for the number of leaves. The highest number of leaves at 4WAP were recorded by *F.sur* (30.29), followed by Streptomycin (30.28), *B. pinnatum* (29.03), and *J. curcas* (28.24). The untreated control had the least number (27.33). At the 6^{th} WAP, *F .sur* (58.33) had higher number but not significantly different ($P \geq 0.05$) compared to the antibiotics (Streptomycin) (58.29), J. *curcas* recorded 55.62, and the least was the control (51.38), streptomycin (88.53), and *Ficus sur* (86.69) performed better than the others at

8 WAP *B. pinnatum* had 82.20 and *J. curcas* had 80.29, the control was the least (77.91)

For the vine Length, *F.sur* gave the highest vine length of 105.32, and streptomycin had 104.93, the control recorded the least vine length of 93.64, followed by *B. pinnatum* which had 93.73.At 6 WAP, *F. sur* the highest vine length of 171.00, followed by streptomycin (168.80), *J. curcas* had 161.18, and the least was the control (147.91) and *B. pinnatum* (156.93); while Streptomycin had 198.2, *F. sur* had 188.4, closely followed by *B. pinnatum* (187.2), and the least was the control (171.1)for 8 WAP.

It was observed that *F. sur* recorded the highest number of branches (3.49), Streptomycin had 3.47, followed by *B. pinnatum* (3.42), *J. curcas* (3.20) and the least was the control (3.04). *B. pinnatum* at 6 WAP recorded the highest number of branches (4.20), closely followed by Streptomycin (4.20), *F.sur* had 3.98; the untreated control was the least (3.82) at 6WAP. At 8 WAP aside the antibiotics (Streptomycin) which recorded 6.98, *Ficus sur* had the highest number of branches (6.64), closely followed by *B. pinnatum* (6.44), the least was recorded by the untreated control (5.80).

Table 2: Effect of the plant extracts and Streptomycin on growth characters of Cucumber at the 4, 6 and 8 weeks after planting in Umudike, Abia state.

	4WAP			6WAP			8WAP	
Treatments	**NoL**	**VL (cm)**	**NoB**	**NoL**	**VL (cm)**	**NoB**	**NoL**	**VL (cm)**
B.pinnatum	29.03	93.73	3.42	53.62	156.93	4.20	82.20	187.2
F.sur	30.29	105.32	3.49	58.33	171.00	3.98	86.64	188.4
J.curcas	28.24	91.84	3.20	55.62	161.18	3.71	80.29	181.3
Streptomycin	30.28	104.93	3.47	58.29	168.80	4.42	88.53	198.2
Control	27.33	93.64	3.04	51.38	147.91	3.82	77.91	171.1
LSD (P≤0.05)	**0.89**	**4.65**	**0.18**	**1.59**	**4.80**	**0.37**	**3.11**	**8.64**

Effect of the Varieties on the growth characters of cucumber at the 4, 6 and 8 weeks after planting in Umudike, Abia State.

The result presented in Table 3 shows that Ngwa Local had the highest number of leaves (29.61), followed by Marketer (29.14) and the least was Beta alpha (28.35) at

the 4thWAP, then at the 6th, Marketer had highest (59.25) while Beta alpha had 53.31 which did not significantly vary from the Ngwa Local that had 53.79. Marketer had the highest number of leaves (85.64) at the 8 WAP, followed by the Ngwa local (82.31), and the least was Beta alpha with 81.40 number of leaves**.**

There was no significance difference among the varieties on the vine Length at the 4th WAP, but at the 6th WAP, Marketer had the longest vine of 166.12, followed by Beta alpha (159.15), Ngwa Local was the least (158.23). Marketer recorded the longest vine length of 191.5, followed by the Ngwa Local (185.6) and Beta alpha (178.7) at the 8th WAP. There was no significant difference in the number of branches among the varieties at 5% probability level at all the weeks after planting.

Table3: Effects of the varieties on growth characters of cucumber at 4, 6 and 8 Weeks after planting at Umudike

	4WAP			6WAP			8WAP	
Varieties	**NoL**	**VL (cm)**	**NoB**	**NoL**	**VL (cm)**	**NoB**	**NoL**	**VL (cm)**
Beta alpha	28.35	95.92	3.32	53.31	159.15	3.97	81.40	178.7
Ngwa Local	29.61	98.35	3.33	53.79	158.23	4.16	82.31	185.6
Marketer	29.14	99.42	3.32	59.25	166.12	3.95	85.64	191.5
LSD (P≤0.05)	**0.68**	**NS**	**NS**	**1.24**	**3.72**	**NS**	**2.41**	**6.69**

Effects of the treatments on the yield of cucumber at Umudike, Abia State.

The results of the Table 3 study showed that all plant extracts and the synthetic antibiotic were significantly different (P≤0.05) from the control. They increased the yield of cucumber. *F. sur* produced the best results in all the yield parameters in terms of number of fruits (11.76), weight per fruit (0.35kg) and fruit yield (18.56t/ha), followed by Streptomycin with 11.76 number of fruits, 0.35kg weight per fruit, 18.56 t/ha fruit yield, *B. pinnatum* with 9.50 number of fruits, weight per fruit (0.31kg), fruit yield (13.10t/ha) and *J. curcas* had 9.61 number of fruits, 0.29kg weight per fruit and fruit yield of 12.31t/ha. All these were significantly different from the untreated control, which had the least number of fruits (6.93), weight per

fruits (0.25kg), and fruit yield (7.54t/ha)

Table 4: Effects of the treatments on the yield of cucumber at Umudike, Abia state.

Treatments	Number of fruits	Weight per fruit (kg)	Fruit Yield (t/ha)
Byophyllum pinnatum	9.50	0.31	13.10
Ficus sur	11.76	0.35	18.56
Jathropha curacs	9.61	0.29	12.31
Streptomycin	11.74	0.35	18.26
Sterile water	6.93	0.25	7.54
LSD	**0.79**	**0.01**	**1.64**

Effects of the Varieties on the Yield of Cucumber at Umudike, Abia State

There was no significant difference among the varieties observed

Table 5:Effects of the varieties on the yield of cucumber at Umudike, Abia state

Varieties	Number of fruits	Weight per fruit (kg)	Fruit Yield (t/ha)
Beta alpha	9.77	0.31	13.69
Ngwa Local	10.12	0.31	14.34
Marketer	9.84	0.31	13.82
LSD	**NS**	**NS**	**NS**

Effects of the Plant Extracts and Streptomycin on the Incidence and Severity of Bacteria Soft Rot Disease of Cucumber at Umudike, Abia State.

The results presented in table 6 shows that at 6th week after planting, the treatments significantly reduced the disease severity and incidence of the soft rot disease of cucumber fruit. The least fruit disease severity and incidences were recorded by *Ficus sur* which had 1.09, 13.3% and Streptomycin1.06, 8.9% respectively, followed by *B. pinnatum* with severity of 1.22 and incidence of 20.0%. The untreated control recorded the highest disease severity of 1.67 and incidence of 35.6%.

At the 7th week, Streptomycin had the lowest disease severity (1.20) and incidence (13.3%), followed closely by *F.sur* severity (1.33), and incidence (28.9%). *B. pinnatum* recorded severity of 1.49 and 37.8% incidence. The least was the untreated control with 2.58 severity and 62.2%. At the 8th week, *F.sur* recorded 1.47 severity and 26.2% incidence, followed by *B. pinnatum* which recorded severity of 1.71 and 42.2% incidence, *J. curcas* with severity of 1.73 and 46.7% incidence. The highest was the untreated control with severity of 3.76 and 62.2% incidence.

Effects of the Varieties on the Incidence and Severity of Bacteria Soft Rot Disease of Cucumber at Umudike, Abia State.

Among the varieties, the result of the disease severities and incidences are shown in table 7. These parameters were generally not affected by varieties planted. However, at 8WAP severity score for Marketer was significantly different from Ngwa local and Beta alpha.

Table 6: Effects of treatments on the incidence and severity of bacteria soft rot disease of cucumber at Umudike, Abia state

	6WAP		7WAP		8 WAP	
Treatments	**Dis Sev.**	**Dis. Inc (%)**	**Dis. Sev.**	**Dis. Inc (%)**	**Dis. Sev.**	**Dis.Inc (%)**
B.pinnatum	1.22	20.00	1.49	37.80	1.71	42.20
F.sur	1.09	13.30	1.33	28.90	1.49	26.70
J.curcas	1.27	22.20	1.64	46.70	1.73	46.70
Streptomycin	1.06	8.90	1.20	13.30	1.27	20.00
Sterile water	1.67	35.60	2.58	62.20	3.76	62.20
LSD (P≤0.05)	**0.21**	**14.10**	**0.27**	**12.97**	**0.30**	**12.12**

Table 7: Incidence and severity of bacteria soft rot disease on different cucumber varieties at Umudike, Abia state

Varieties	6WAP Dis Sev	Dis Inc (%)	7WAP Dis Sev.	Dis Inc (%)	8WAP Dis Sev.	Dis Inc (%)
Beta alpha	1.16	13.30	1.57	33.30	1.64	33.30
Ngwa local	1.36	25.30	1.7	40.00	1.73	41.30
Marketer	1.27	21.30	1.67	40.00	2.00	44.00
LSD(P≤0.05)	**NS**	**NS**	**NS**	**NS**	**0.24**	**NS**

Morphological Characterization of Soft Rot of Cucumber Fruit in the Laboratory

The Identification, preliminary confirmatory tests for the bacteria isolates based on the description of Bergey's Manual of Determinative Bacteriology (Buchaman and Gibbons, 2004), are results of the laboratory experiment. It showed that the bacterium isolated from the rotting cucumber fruit was *Pectobacterium carotovorum.* It was found to be rod shaped, creamy white colonies on nutrient agar (Gupta and Thind, 2006), slightly raised and glistening colonies, a Gram negative rod after staining. Smear culture with a drop of hydrogen peroxide (H_20_2) produced bubbles indicating positive for catalase tests, oxidase test was negative with motile several flagella (peritrichous). With all these observed features, the organism was identified as *Pectobacterium carotovorum.*

Pathogenicity Test

A confirmatory test based on the results of the pathogenicity tests conducted in which the bacteria isolate was inoculated into healthy cucumber fruit was done. The results of the pathogenicity test carried out on healthy cucumber fruit showed that the organism induced bacteria soft rot on the inoculated healthy cucumber fruits after 7 days, according to Koch's postulate, hence it is confirmed to be *P. carotovorum.*

Table 8: Morphological and Biochemical characteristics of the fruit rot pathogen of cucumber

Tests	Fruit rot pathogen
Morphological characteristics	
Colony colour	Creamy white
Motility/Flagellation	Motile/peritrichous
Gram reaction	–
Biochemical characteristics	
Oxidase test	–
Catalase test	+
Acid production from:	
Glucose	+
Lactose	+

Legends - = Negative, + = Positive

Discussion

Results obtained from the physico-chemical properties of the soil of the experimental site shows deficiencies in some nutrient requirements of cucumber. The low nutrient status of phosphorus (22.7mg/kg) and calcium (4.0Cmol/kg) may have contributed to the poor resistance of the test crop to *P. carotovorum*, thereby resulting in the high incidence and severity of the soft rot disease on the untreated cucumber fruit recorded in the study. This finding is in consonance with the works of Owolade *et al*., (2006).They noted that deficiency in calcium and phosphorus contributes to poor development of disease resistance mechanisms in crops. Cucumber requires a well drained sandy loam rich in organic matter, as it rarely grows luxuriantly on infertile soil hence its susceptibility to disease. From 6 WAP, there was an increase in both disease severity and incidence in the control test crop and increased continuously up till 8 WAP.

The high severity and incidence of soft rot diseases were recorded on the untreated control. This increased disease occurrence could be due to the climatic conditions of the study area, as a result of high temperature (30-29^{0}C), heavy rainfall (368.0-402.6mm) and high relative humidity (50-80%) lasting up to 22-25 days in the study months.

The observation made in this study is in agreement with Mohammed (2013). He noted that high relative humidity, rainfall and ambient temperature encourage the

initiation, development and spread of common bean anthracnose disease caused by *Colletotrichum lindemuthianum* (Sacc. & Magn.) in Ethiopia.

The prolonged rainfall may have resulted in availability of moisture that led to the spread of the pathogen by the rain splash which consequently caused the increase in the disease incidence and severity. The work of Manbre and Burlot (1994) validate these observations that both bacterial multiplications and pathogenicity are temperature and moisture dependent.

In this study, results of the effects of the application of these plant extracts against *Pectobacterium carotovorum* in cucumber fruits indicated that all the extracts reduced disease incidences and severity of the pathogen, as they were significantly different from the untreated control. There was also significant increase in the yield of cucumber, when compared to the untreated control. This observation is in agreement with the work done by Shaiesta *et al*., (2011) whose results showed reduced disease incidence and increased yield of Mushroom using some plant extracts.

The varieties were not significantly different from each other in performances. The treatments therefore were effective in suppressing the disease and in increasing yield irrespective of the type of variety used.

Ficus sur leaf extracts demonstrated greater antibactericidal effects than the other plant extracts, and was not significantly different ($P \leq 0.05$) from the synthetic antibiotics used as control. This therefore, implies it could also be used as prophylactics against *P. carotovorum*, since they minimized the development and expression of the disease in the field. Oyelana *et al*., (2011) observed that the extracts from four *Ficus* species at 75-100% concentrations exhibited significant difference against the growth of bacteria and Fungi species of *Discorea rotundata.* Solomon *et al*., (2011) also reported that both the leaf and stem bark extract of *Ficus sur* had inhibitory effect against six human pathogenic micro-organisms and observed that *F.sur* significantly inhibited bacterial growth.

One characteristic symptom of the soft rot disease of bacteria caused by *P. carotovorum* which was observed in the study was that severely infected plant parts may rot and collapse inside but sometimes the outer skin remains intact. Soft rots are known for a strong, offensive odour that accompanies decaying tissues.

The confirmatory tests to ascertain true identity of the pathogen also revealed that the pathogen was *P. carotovorum*.

Conclusion

There has not been much documentation on the incidence and severity of bacteria soft rot of cucumber fruits in Umudike, South Eastern Nigeria, therefore reports of these findings now provided a basis for further research on this disease. In this study, the disease incidence and severity indexes are high in the research farm. Subsequently, this explains the challenges that hinder the cultivation of this crop on a wide scale and its disease management in the study area.

This study therefore showed that plants extracts especially the leaf extract of *Ficus sur* could be effective in the management of bacteria soft rot of cucumber, considering challenges of chemical control. These plant materials could be used as a good alternative for disease control and increased yield of the cucumber crop in this area.

References

Abiola, I.O. and Isola, J.O (2017) Comparative Effect of Organic, Inorganic and Organo-Mineral Fertilizers on Growth and Yield performance of (Cucumber) *Cucumis sativus* L. in Ibadan. Proceedings of the 35th Annual conference of the Horticultural Society of Nigeria. Pp. 13-15

Agrios, G.N(2006) Plant pathology. Fifth Edition, Academic Press, San Diego, California. Pp 126-135.

Amadioha, A.C (2000) Controlling rice blast in vitro and in vivo with extracts of *Azadirachta indica. Crop Protection*. 19:287-290.

Amadioha, A.C (2004) Control of black rot of potato caused by *Rhizoctonia bataticola* using some plant leaf extracts. *Archives of Phytopathology and Plant Protection*. 37:111-117

Amadioha, A.C (2012) Reducing food losses through sustainable methods of plant disease management: an imperative for actualization of food security in Nigeria. A paper presented at the 13th inaugural lecture of MOUAU, June 2012.

Amienyo, C.A and Ataga, A.E, (2007) Use of indigenous plant extracts for the protection of mechanically injured sweet potato (*Ipomea batatas* (L.) Lam) tubers. *Scientific Research and Essay*. Vol 2 No 5

Ayotamuno J., Zouga K., Ofori S.A. and Kogbara R.B. (2007). Response of Maize and cucumber intercrop to soil

moisture control through irrigation and mulching during the dry season in Nigeria. *African Journal of Biotechnology*. 6(5):509

Belay, A. A., Classens, S., Wehner, F.C and De Beer, J. M. (2010) Influence of residual manure on selected nutrient elements and microbial composition of Soil under long term crop rotation. South *African Journal of Plant and Soil*. 18:1-6

Best, K. (2000). Adaptation of cabbage varieties. ARP Training Reports. AVRDC-AFRICA. Regional Programme, Arusha, Tanzania. 10 pp.

Benzioni A., Mendlinger V.M. and Huyskens S. (1993). Germination, pods development, yield and post-harvest characteristics of *C. metuliferus*. In: Janick J. Simon JE (eds) New crops. Wiley, NewYork. pp. 553-557

Buchaman R.E and N.E Gibbons. (2004). Bergy's Manual for Determinative bacteriology, 8th Edition, Williams and Watkins Ltd, UK

Dilip Kumar Sharma (2016) Seed-Borne and Post-Harvest Diseases of Cucumber (*Cucumis sativus* L.) And Their Management. *Indian Journal of Plant Sciences*. Vol 5 (2)Pp 35-40

Enujeke E. C (2013) Growth and yield responses of cucumber to five different rates of poultry manure in Asaba area of Delta state, Nigeria. *International Research Journal of Agricultural Science and Soil Science.* Vol. 3(11) pp. 369-375.

Gupta, S.K and Thind (2006) Diseases of cruciferous Vegetables. Scientific Publishers, India. Pp 135

Lerner B.P and Dana M.N (2001) Growing cucumbers, Melons, Squash, Pumpkins and Gourds. Purdue University Cooperative. Pp 1-5

Michael D. Orzolek, Lynn F. Kime, Steven M. Bogash, Jayson K. Harper. (2017) Cucumber production. Available online at http://extension.psu.edu. Retrieved on the 25th of April, 2017

Manbre, J.M and Burlot (1994) Effects of Temperature, p H and NaCl on growth and pectolytic activity of *Pseudomonas marginalis*. *Applied and Environmental microbiology* 60:2017-2022

Mossler, M.A and Nesheim, O.N. (2005) Florida crop/pest management profile: Squash. Electronic Data Information Source of UF/IFAS Extension (EIDS) CIR 1265. Available online at http/edis.ifas.ufl.edu/.

Mohammed (2013) An overview of distribution, biology and

management of common bean (*Phaseolus vulga*ris L.) anthracnose. *Journal of plant pathology Microbiology*. 4(8): 193-200.

Nwofia G. E., Amajuoyi A. N., Mbah E. U (2015) Response of Three Cucumber Varieties (*Cucumis sativus* L.) to Planting Season and NPK Fertilizer Rates in Lowland Humid Tropics: Sex Expression, Yield and Inter-Relationships between Yield and Associated Traits. *International Journal of Agriculture and Forestry*. 5(1): 30-37

NRCRI (2018) National Root Crops Research Institute, Umudike Meteorological Station Data.

Oyelana, O. A., E.U. Durugbo, O.D. Olukanni, E.A. Ayodele, Z.O. Aikulola and A.I. Adewole, (2011). Antimicrobial Activity of *Ficus* Leaf Extracts on Some Fungal and Bacterial Pathogens of *Dioscorea rotundata* from Southwest Nigeria. *Journal of Biological Sciences, 11: 359-366*

Okigbo, R.N (2005) Biological control of the postharvest fungal rot of yams (*Discorea spp*.) with *Bacillus subtilis*. *Mycopathologica*, 159:307-314

Okigbo, R.N and Ikediegwu F.E.O (2000) Study on biological control of post-harvest rot of yam (*Discorea spp*) with *Trichodermaviridae*. *Journal of Phytopathology*; 148:351-353

Oktay, M., Gülçin, I., Küfrevioglu, O. I., (2003): Determination of in vitro antioxidant activity of fennel (*Foeniculum vulgare*) seed extracts. LWT., 36: 263 - 271.

Opara, E.U and Wokocha, R.C (2008) Efficacy of some plant extracts on the *In Vitro* and *Invivo* control of *Xanthomona scampestris Pv. Vesicatoria. Agricultural Journal*, 3:163-170.

Opara Emma, Njoku Theresa and Ogbonna Ucheoma (2013) Control of Post Harvest Bacterial Diseases of Tomato in Abia State, South Eastern Nigeria. *Journal of Biology, Agriculture and Healthcare. Vol.3, No.19.*

Opara, E.U and Agugo B.A.C. (2014) Control of Post-harvest rot of Sweetpotato (*Ipomea batatas Lam*) Tuber *in Vitro* and *in Vivo*. *Journal of Agriculture and Sustainability*. Vol 6 (1) pp 50-68

Opara, E.U and Ikoro A,I (2016) Influence of organic wastes on bacterial soft rot disease of Cucumber(*cucumis*

sativus) in humid tropical Nigeria. *Global Science Research Journal*. Vol 4 (1), pp 176-181

Plant village (2017) Cucumber. Available online from https://www.plantvillage.org. Retrieved on the 20th of April, 2017.

Salako, E.A (2002) Plant protection for the Resource poor farmers. Paper presented at the 30th annual conference of Nigeria Society of Plant Protection, UNAAB Abeokuta. Pp 1-4.

Sebestian P, Schaefer H, Telford IR (2010) Cucumber (*Cucumis sativus*) and melon (*C. melo*) have numerous wild relatives in Asia and Australia, and the sister species of melon is from Australia. Proceedings of National Academy of Science;107(32):14269-73. E-pub Jul 23

Shukla, A.M., Yadav, R.S., Shashi, S.K.,Dikshit, A., (2012). Use of plant metabolites as an effective source for the management of postharvest fungal pest: A review. *International Journal of Curriculum Discoveries Innovations*. Vol. 1(1): Pg 33-45.

Solomon, G.O., Shittu G.A., Agboola Y.A (2011) Antimicrobial and Phytochemical Screening of *Ficus sur* (Forssk). *New York Science Journal* 4(11):15-18.

Shaiesta Shah, Sahera Nasreen and Munshi, N.A (2011) Evaluation of some botanicals in controlling green mold (*Trichoderma harzanum)* disease in Oyster Mushroom cultivation. *International Journal of Botany*. 7:209-215.

Shetty, N.V and Wehner, T.C. (2002). Estimation of fruit grade weights based on fruit number and total fruit weight in cucumber. *Horticultural Science*, 37: 1117-1121.

Tatlioglu T (1997). Cucumber (*Cucumis sativus* L.) In: Kailov, G and Bo Bergn,(eds.). Genetic improvement of vegetable crops. Oxford Pergamon Press. pp. 197-227.

Wasihun, Y. W and Flagote, A.B (2016) Assessment of diseases on rice (*Oryza sativa* L.) in major rice growing fields of Pawe district, North western Ethiopia. *World Scientific News* 42:13-23

Wehner, T.C (2007) Cucumbers. Watermelon Squash and other cucurbits, In: Encyclopaedia of food culture Pp 474-479.