The Effects of *Calotropis Procera, Adansonia Digitata* and *Manihot Esculenta* in the Remediation of Soil-Borne Fungal Diseases of Tomato

Peter M. Etaware
Department of Botany, Faculty of Science, University of Ibadan, Ibadan, Nigeria

Corresponding author: peterparkers007@gmail.com

Received on: 29/05/2019 Accepted on: 17/06/2019 Published on: 29/06/2019

ABSTRACT

Aim: The main objective of the study was to evaluate efficacy *Calotropis procera, Adansonia digitata,* and *Manihot esculenta* in the remediation of soil-borne fungal diseases of Tomato.

Method and Materials: A biological screening for antifungal activities was conducted on 4 species of pathogenic fungi isolated from diseased tomato. Three plants (*Calotropis procera, Adansonia digitata,* and *Manihot esculenta)* were used for the treatment of soil-borne fungal diseases of Tomato.

Results: The Laboratory analysis showed that the plants extracts totally inhibited the growth of the pathogens (100%). In the field, *C. procera* was effective in inhibiting disease symptoms caused by *Aspergillus glaucus, A. fumigatus and A. sclerotirium* with a significant increase in some agronomic parameters of the tomato plants compared to the control set up ($P<0.05$). Other extracts had significant effects in the control of the induced disease too suggesting their usefulness in plant disease management.

Conclusion: The findings from this research concluded that bio-pesticides are as effective as chemicals to safeguard life and the environment, manufacturers of pesticide should be considered natural alternatives.

Keywords: Antifungal activities; biological screening; bio-pesticides; pathogenic fungi; soil borne contaminants.

Introduction

The Food and Agricultural Organization of the United States of America reported that majority of the diagnosed cases of disease outbreak on both stored and cultivated Tomato were in actual fact products of microbial activities of some Fungi, few bacteria and some tomato fruit worms. The possible mode of infection are through bruises, soil borne or airborne [1] and some of these pathogens over-winter on harvested fruits, invading and ramifying the fruit contents for survival, an effect that later translated in store houses as postharvest losses. The fungal "genera" responsible for field infection of tomato plants and Postharvest losses of vegetables are *Alternaria, Aspergillus, Botrytis, Cladosporium, Colletotrichum, Fusarium, Geotrichum,* M*ucor,* P*enicillium,* P*hytophthora, Rhizopus* and *Stemphylium* [2].

Initially, the devastating effects of these microbes on tomato were effectively managed by the use of chemicals. These chemicals tend to produce residues that are harmful to consumers of such products, hence, the need for a revolutionized approach in disease management strategy. Past researches conducted to show the potency of natural antimicrobial products has demonstrated the effectiveness of some medicinal plants against the growth of plant pathogenic bacteria. These plants were found to be highly effective in the control of soil borne pathogen(s) of tomato [3]. The efficacy of "thymol" from thymus plant and "palmorosa" from *Cymbopogon martinii* in the control of bacterial wilt of tomato was determined [4]. Therefore, a scientific probe of the therapeutic properties of these plants might turn out to be the much anticipated breakthrough in the world of research, culminating in the commercial production of medicinal extracts that can prolong the shelf life of perishable vegetables and at the same time serve as Bio-pesticides and Bio-fertilizers. Research have shown that plant based extracts are good curative alternative for some human ailments and they confer no health risk on the consumers of plant products treated with these medicinal extracts.

Citation as: Etaware PM (2019). The effects of Calotropis procera, Adansonia digitata and Manihot esculenta in the remediation of soil-borne fungal diseases of tomato. J. Agri. Res. Adv. 01(02): 28-37.

Materials and Methods

Preparation of inoculation fluid

Tomato pathogens were isolated from infected tomato leaves, stem, roots and soil samples (around the root rhizosphere). Pure cultures of each isolate were grown on a full strength (39g/L) potato dextrose agar (PDA) in a 20ml capacity Petri-dish for each pathogen. The culture medium for each pathogen was flooded with 15ml sterile distilled water, swirled and decanted into a sterile Duran ® 100ml capacity Erlenmeyer narrow neck flask. The spore extrapolation was repeated for all the pathogens and 1ml of the spore suspension was calibrated using a spore counter (Central Laboratory, University of Ibadan). The inoculum size for each sample was maintained at 3.2 x 10^6 spores per ml to ensure uniformity.

Treatment Conc. (Botanicals)

- 5% Conc.: 5g of plant powder + 20ml of Ethanol (soaked for 24hrs) + 80ml sterile dH_20
- 10% Conc.: 10g of plant powder + 20ml of Ethanol (oaked for 24hrs) + 80ml sterile dH_20
- 15% Conc.:15g of plant powder + 20ml of Ethanol (soaked for 24hrs) + 80ml sterile dH_20

Laboratory Analysis

Procedure

- Fresh botanicals were prepared and labeled according to their type and concentrations.
- Freshly prepared PDA (full strength) was allowed to stand in a regulated water bath to maintain the temperature of the molten medium at 37°C.
- 1ml of each botanical was aseptically introduced into 9ml of the molten PDA in a Petri dish
- The mixture was rocked gently and allowed to stand in a lamina airflow chamber till it solidified
- A sterile 5mm cork borer was used to aseptically introduce each pathogen(s) unto the core of the treated medium.
- The inoculated cultures were labeled accordingly and incubated at room temperature for 7days.
- Radial mycelia growth measurements were taken daily for 7days.
- Percentage mean mycelia inhibition was recorded and calculated using the formula below:

Mathematically,

Percentage mean mycelia inhibition = $\frac{N_1}{N_0} x\ 100$

Where

N_0= Mycelia diameter of each untreated pathogens

N_1= Mycelia diameter of each treated pathogens

Dry weight determination

The treated and control cultures were harvested separately at day 7 into boiling tubes, carefully labeled, heated at 80°C in a regulated water bath to liquefy the medium. The liquefied mixture was filtered using Whatman's filter paper No. 1, wrapped in an aluminum foil, labeled appropriately and oven-dried in the central laboratory of the University of Ibadan. The weight of each sample was determined using a Digital Milligram Pocket Scale and the percentage dry mycelia weight was calculated thus:

Mathematically,

Dry mycelia weight (%) = $\frac{M_1}{M_0} x\ 100$

Where;

M_1= Dry mycelia weight of each treated isolate

M_o= Dry mycelia weight of each untreated isolates

Field Experiment

Source of Tomato Seeds

Three varieties of tomato seeds were used for this experiment. They are *Lycopersicon esculentum var. esculentum* (V_1), Cherry Tomato (*L. esculentum var. cerasiforme*) (V_2), Currant Tomato (*L. pimpinellifolium*) (V_3). The seeds were obtained from the National Center for Genetic Resources and Biotechnology (NACGRAB).

Soil Sterilization

Top-soil was collected from the nursery in the Department of Botany, University of Ibadan. The soil was measured and loaded into troughs, watered and heated. The temperature of the heated soil was maintained at 85° C for one hour using a thermometer. The soil was allowed to cool before loading into different vessels.

Soil Analysis

Analysis of soil samples were carried out to determine the difference in microbial load of the soil samples. A total of 1g of both sterilized and unsterilized soil sample were collected and labeled appropriately. The collected samples were aseptically introduced into test tubes and serial dilution of the suspension were made; 1ml dilution factor of 10^{-3} and 10^{-6} was aseptically inoculated using pour plate method, into freshly

prepared potato dextrose agar (for fungal growth) and nutrient agar (for Bacteria growth). The soil flora was thereafter identified using standard laboratory procedures.

Planting of Sterile Tomato Seeds

Sterile tomato seeds were evenly broadcast on a nursery bed containing sterilized soil samples. The seeds were allowed to germinate (between 2-3 days) with consistent watering using sterile distilled water. The germinated seedlings were nurtured in a controlled microcosm for three weeks before transplanting into the planting vessels for the field experiment. They were allowed to adapt to their new environment for 48hrs.

Procedure for field analysis

- The inoculation fluid (50ml of 3.2 x 10^6 spores per ml) was aseptically introduced to the root of the healthy tomato seedlings [5].
- The tomato seedlings were then allowed to stabilize for 24hrs before the introduction of the plant extracts.
- 50ml of the plant extract (at various conc.) were aseptically introduced to the root of the already inoculated tomato seedlings and the plants were left to stabilize for another 24hrs.
- The experiment was allowed to run for a period of 3months, during which agronomic parameters were measured for each plant weekly.

- The disease incidence and severity of the induced infection on the tomato plants were measured [6]. This was modified to better suit the research aim (Table 1).

Table 1: The method for determination of disease severity

Score	Infected plant part	Severity (%)	Inference
0	None	00	Healthy
1	($^1/_5$)	20	Not Severe
2	($^2/_5$)	40	Mildly Severe
3	($^3/_5$)	60	Averagely Severe
4	($^4/_5$)	80	Severe
5	All	100	Extremely Severe

Data Analysis

Data generated from this research were pooled over runs for final analysis and data presentation, after which they were subjected to analysis of variance using Minitab 16 statistical software to test for the homogeneity of variance. Statistically significant means ($P<0.05$) were identified by the Least Significant Difference (LSD) and Duncan Multiple Range Test (DMRT).

Results

Radial mycelia growth measurement (Laboratory Analysis)

At 5-10% concentration of the administered treatments, *Aspergillus fumigatus* and *A. sclerotirium* were effectively controlled by aqueous extracts of *Manihot esculenta* (0.9±0.00 and 1.2±0.15 cm, respectively), *Calotropis procera* (1.0±0.16 and 1.2±0.22 cm, respectively) and *Adansonia digitata* (0.9±0.08 and 1.5±0.29cm, respectively) from day 1. At 15% concentration of the applied treatment, the growth on culture media of *A. terreus* and *A. sclerotirium* were effectively inhibited by *Adansonia digitata* (0.9±0.00 and 1.0±0.10 cm, respectively), while *A. fumigatus, A. terreus* and *A. sclerotirium* was inhibited by *Manihot exculenta* (1.0±0.10, 1.0±0.10 and 1.5±0.33cm, respectively) from day 1 when compared to the control set up for this experiment i.e. *A. fumigatus* (1.9±0.40cm), *A. terreus* (1.8±0.53cm) and *A. sclerotirium* (2.6±1.68cm)($P<0.05$) as shown in Table 2.

Percentage dry mycelia weight (Laboratory Analysis)

Aspergillus glaucus had the highest percentage loss in dry mycelia weight (71.3%), *A. sclerotirium* had 33.3% weight loss after treatment and *A. fumigatus* was reduced by 2.20% compared to the control set up. However, the mycelia weight of *A. terreus* was significantly increase (47.5%) at the end of the treatment (Table 3).

Tomato disease assessment (Field Analysis)

After 7 days of treatment administration on the tomato plants, the plots treated with 5% *C. procera* + *A. sclerotirium* and *A. digitata* + *A. glaucus*, 10% *C. procera* + *A. sclerotirium, A. digitata* + *A. sclerotirium* and *A. digitata* + *A. terreus*, and 15% *C. procera* + *A. fumigatus*,*C. procera* + *A. sclerotirium*, *C. procera* + *A. glaucus* and *M. esculenta* +*A. glaucus* showed no disease symptoms or signs of infection after inoculation with the pathogens (Table 4). Disease assessment conducted after 14 days of treatment administration showed that all the plots treated with 10% conc. of *A. digitata* and 15% conc. of *C. procera* had absolute control of the

Table 2:Radial mycelia growth measurement

		5% Conc.				10% Conc.				15% Conc.			
Treatment	**Pathogen**	**Day 1**	**Day 3**	**Day 5**	**Day 7**	**Day 1**	**Day 3**	**Day 5**	**Day 7**	**Day 1**	**Day 3**	**Day 5**	**Day 7**
Calotropis procera	*A.fumigatus*	1.5±0.31	4.5±1.01	5.6±2.40	3.3±1.59	1.0±0.16*	4.1±1.09	4.6±1.85	2.8±1.16	1.3±0.25	4.4±0.96	6.5±1.63	4.9±1.86
	A.terreus	1.9±0.77	4.1±1.51	3.3±1.02	3.1±0.97	1.3±0.21	4.7±1.43	2.7±0.42	3.1±0.82	1.3±0.13	5.7±3.26	3.0±1.71	3.5±2.55
	A.glaucus	1.7±0.32	7.3±1.70	3.4±2.01**	2.4±0.66*	1.4±0.41	5.2±2.56*	2.5±0.42***	1.9±0.75**	1.1±0.13	8.5±0.00	1.8±0.42***	1.7±0.47**
	A.sclerotirium	1.9±0.33	4.4±0.61	4.5±1.81	2.7±1.02*	1.2±0.22*	4.3±1.90	4.0±1.56	3.4±1.86*	2.0±0.10	5.0±1.71	4.6±1.12	4.5±1.64
Adansonia digitata	*A.fumigatus*	1.4±0.13	3.7±0.85	4.3±1.39	2.8±1.39*	0.9±0.08*	2.7±1.12	2.1±0.60*	2.0±0.66	1.4±0.24	6.9±2.18*	3.3±1.13	2.3±0.32
	A.terreus	1.8±0.33	3.7±0.77	5.0±2.03	4.3±1.16	1±0.15	3.3±1.56	3.6±1.44	2.7±0.50	0.9±0.00*	2.3±0.22	2.5±0.36	2.2±0.56*
	A.glaucus	1.3±0.06	8.5±0.00	2.0±0.27***	1.7±0.29	1.2±0.37	2.4±0.10***	2.2±0.42***	2.2±0.39**	0.9±0.05	5.2±3.81*	1.6±0.21***	1.6±0.19**
	A.sclerotirium	2.0±0.52	6.3±1.62	6.7±2.34	2.6±1.77	1.5±0.29*	4.2±2.71	5.3±2.56	2.3±0.40**	1.0±0.10*	6.0±2.33	3.1±1.69*	2.1±1.02*
Manihot esculenta	*A.fumigatus*	0.9±0.00*	3.4±0.77	4.0±1.13	3.9±1.74	1.1±0.22	4.0±0.97	2.2±0.34*	2.1±0.44	1.0±0.10*	4.0±0.90	3.7±1.01	3.4±0.88
	A.terreus	1.2±0.13	3.0±0.61	2.6±0.39	2.4±0.58	2.0±0.71	4.5±1.29	3.7±1.55	3.0±0.72	1.0±0.10*	3.7±0.56	4.9±1.14	4.3±0.70
	A.glaucus	1.1±0.33	8.5±0.00	2.7±1.15***	2.0±0.24*	1.1±0.13	6.2±2.91	2.2±0.80***	1.7±0.40**	0.9±0.24	8.5±0.00	5.6±3.42*	2.1±0.59**
	A.sclerotirium	1.2±0.15*	3.5±1.28	2.9±0.75*	2.7±0.43*	1.3±0.13*	4.6±0.68	4.1±1.90	4.2±2.04	1.5±0.33*	4.8±1.18	5.3±0.49	3.9±1.48*
Control	*A.fumigatus*	1.9±0.40	3.8±0.95	4.7±2.54	3.9±1.23	1.9±0.40	3.8±0.95	4.7±2.54	3.9±1.23	1.9±0.40	3.8±0.95	4.7±2.54	3.9±1.23
	A.terreus	1.8±0.53	3.6±0.93	4.9±1.40	4.8±1.93	1.8±0.53	3.6±0.93	4.9±1.40	4.8±1.93	1.8±0.53	3.6±0.93	4.9±1.40	4.8±1.93
	A.glaucus	1.2±0.22	8.5±0.00	8.5±0.00	5.9±3.10	1.2±0.22	8.5±0.00	8.5±0.00	5.9±3.10	1.2±0.22	8.5±0.00	8.5±0.00	5.9±3.10
	A.sclerotirium	2.6±1.68	5.1±1.41	5.9±0.61	6.3±0.54	2.6±1.68	5.1±1.41	5.9±0.61	6.3±0.54	2.6±1.68	5.1±1.41	5.9±0.61	6.3±0.54

The level of inhibition of mycelia growth of each pathogen on the culture medium is indicated by the number of (*) sign present.

Table 3: Percentage Dry Mycelia Weight (DMW)

Conc.	Treatment	Weight Loss/Gained (%)			
		A. fumigatus	*A. terreus*	*A. glaucus*	*A. sclerotirium*
5%	*Calotropis procera*	+42.2	+55.0	-66.7	-33.3
	Adansonia digitata	+17.8	+47.5	-52.7	-11.1
	Manihot esculenta	-2.20	+17.5	-71.3	-13.3
10%	*Calotropis procera*	+31.1	+40.0	-45.7	+40.0
	Adansonia digitata	+240.0	+210	-60.5	+66.7
	Manihot esculenta	+40.0	+32.5	-24.0	+144.4
15%	*Calotropis procera*	+48.9	+95.0	-55.0	+66.7
	Adansonia digitata	+13.3	+170	-76.0	+28.8
	Manihot esculenta	+35.6	+15.0	-62.8	-4.50
Control	*Sterile Distilled Water*	±0.0	±0.0	±0.0	±0.0

Note: *Negative sign (-) indicates weight loss, while positive sign (+) signifies weight gain*

Table 4: Tomato disease assessment after 7 days of treatment

	Tomato Pathogen	*C. procera*		*A. digitata*		*M. esculenta*			*C. procera*		*A. digitata*		*M. esculenta*			*C. procera*		*A. digitata*		*M. esculenta*	
		Inci.	Sev.	Inci.	Sev.	Inci.	Sev.		Inci.	Sev.	Inci.	Sev.	Inci.	Sev.		Inci.	Sev.	Inci.	Sev.	Inci.	Sev.
5% Conc.	*A. fumigatus*	Yes	+	Yes	+	Yes	+	10% Conc.	Yes	+	Yes	+	Yes	+	15% Conc.	No		Yes	+	Yes	+
	A. terreus	Yes	+	Yes	+	Yes	++		Yes	+	No		Yes	++		Yes	+	Yes	++	Yes	++
	A. sclerotirium	No		Yes	+	Yes	++		No		No		Yes	+		No		Yes	+	Yes	+
	A. glaucus	Yes	+	No		Yes	+		Yes	+	Yes	+	Yes	+		No		Yes	+	No	

Table 5: Tomato disease assessment after 14 days of treatment

	Tomato Pathogen	*C. procera*		*A. digitata*		*M. esculenta*			*C. procera*		*A. digitata*		*M. esculenta*			*C. procera*		*A. digitata*		*M. esculenta*	
		Inci.	Sev.	Inci.	Sev.	Inci.	Sev.		Inci.	Sev.	Inci.	Sev.	Inci.	Sev.		Inci.	Sev.	Inci.	Sev.	Inci.	Sev.
5% Conc.	*A. fumigatus*	No		No		Yes	+	10% Conc.	No		No		Yes	+	15% Conc.	No		No		Yes	+
	A. terreus	Yes	+	No		Yes	++		No		No		Yes	+		No		Yes	+	Yes	+
	A. sclerotirium	No		Yes	+	Yes	++		Yes	+	No		Yes	+		No		No		Yes	+
	A. glaucus	No		No		Yes	+		No		No		Yes	++		No		No		No	

disease so induced by the pathogens as there were no visible symptoms or signs of infection on the tomato plants (Table 5).

Assessment of agronomic parameters of the tomato plants (Field Analysis)

An evaluation of the effects of application of 5% conc. of the treatment showed that there was no significant difference in the number of leaflets and branches produced by the treated tomato plants, but the Leaf Area (4.0±0.80 cm^2), Leaf Length (3.2±0.32 cm) and Plant Height (15.2±2.06 cm) of the treated tomato plants were significantly improved when compared to the control plants (Table 6). At 10% treatment level, the leaf area of the treated tomato plants showed significant improvement compared to the plants in the control plots (Table 7). At 15% treatment level, there was no appreciable improvement in any of the agronomic parameters in the treatment plots (Table 8) after 7 days of treatment administration. A significant improvement in agronomic properties was observed after 14 days of treatment administration. The number of leaflets and branches, Leaf Area, Leaf Length, Stem Girth and Plant Height were each significantly improved by the application of 5% (Table 9), 10% (Table 10) and 15% (Table 11) concentration of the treatment used ($P<0.05$).

Table 6: Assessment of agronomic parameters after 7 days of 5% treatment administration

Treatment	Tomato pathogen	No of leaflets	No of Branches	Leaf Area (cm^2)	Leaf Length (cm)	Stem Girth (cm)	Plant Height (cm)
Calotropis procera	*A. fumigatus*	20.0±6.56^{a}	7.0±1.00^{a}	4.0±0.80^{a}*	3.2±0.32^{a}*	1.0±0.18^{a}	15.2±2.06^{a}*
	A. terreus	17.0±5.03^{a}	7.0±1.15^{a}	2.1±1.24^{a-c}	2.2±0.61^{a-c}	0.8±0.18^{a}	11.4±2.97^{b}
	A. glaucus	19.0±0.58^{a}	7.0±0.58^{a}	2.8±0.72^{ab}	2.7±0.30^{ab}	0.9±0.00^{a}	11.8±0.69^{b}
	A.sclerotirium	16.0±2.00^{a}	6,0±0.58^{a}	1.8±0.21^{bc}	2.2±0.20^{a-c}	0.9±0.09^{a}	11.1±2.25^{b}
Adansonia digitata	*A. fumigatus*	15.0±4.62^{a}	7.0±1.53^{a}	1.5±1.10^{bc}	1.9±0.74^{bc}	0.8±0.09^{a}	10.1±3.36^{b}
	A. terreus	19.0±8.50^{a}	6.0±1.00^{a}	1.9±1.04^{bc}	2.1±0.82^{a-c}	0.8±0.18^{a}	10.2±3.40^{b}
	A. glaucus	13.0±2.52^{a}	6.0±0.00^{a}	1.0±0.21^{c}*	1.6±0.20^{c}	0.7±0.24^{a}	8.3±2.97^{b}
	A.sclerotirium	14.0±2.65^{a}	6.0±0.58^{a}	1.9±0.72^{bc}	2.1±0.46^{a-c}	1.0±0.09^{a}	11.2±3.57^{b}
Manihot esculenta	*A.fumigatus*	15.0±4.58^{a}	7.0±0.58^{a}	1.2±0.49^{c}*	1.7±0.47^{c}*	0.7±0.18^{a}	9.1±1.97^{b}
	A.terreus	11.0±3.61^{a}	5.0±1.53^{a}	1.3±0.56^{bc}	1.8±0.42^{bc}	0.7±0.09^{a}	8.4±0.98^{b}
	A.glaucus	13.0±1.73^{a}	6.0±0.58^{a}	1.2±0.38^{c}*	1.7±0.36^{c}	0.8±0.00^{a}	9.2±1.35^{b}
	A.sclerotirium	11.0±3.06^{a}	6.0±2.31^{a}	1.5±0.81^{bc}	2.0±0.46^{bc}	0.9±0.09^{a}	8.9±1.05^{b}
Control	*A.fumigatus*	23.0±14.84^{a}	8.0±3.06^{a}	2.1±0.47^{a-c}	2.2±0.25^{a-c}	0.7±0.33^{a}	10.3±2.27^{b}
	A. terreus	13.0±3.21^{a}	7.0±1.00^{a}	2.1±1.60^{a-c}	2.3±0.92^{a-c}	0.6±0.16^{a}	10.2±2.75^{b}
	A. glaucus	15.0±3.00^{a}	7.0±1.15^{a}	2.1±0.78^{a-c}	2.3±0.57^{a-c}	0.7±0.24^{a}	11.3±2.25^{b}
	A.sclerotirium	17.0±2.08^{a}	7.0±0.00^{a}	2.6±0.45^{ab}	2.5±0.31^{ab}	0.7±0.09^{a}	11.0±1.69^{b}

Means with the same letters within a column are not significantly different at $P<0.05$ using LSD. Values carrying (*) are significantly different from their control experiment

Table 7: Assessment of agronomic parameters after 7 days of 10% treatment administration

Treatment	Pathogen	No of leaflets	No of Branches	Leaf Area (cm)	Leaf Length (cm)	Stem Girth (cm)	Plant Height (cm)
Calotropis procera	*A.fumigatus*	18.0±3.21^{a}	7.0±1.15^{a}	3.4±1.16^{a}	2.8±0.47^{a}	0.9±0.00^{a}	12.9±0.61^{a}
	A.terreus	16.0±4.93^{a}	7.0±0.58^{a}	2.6±0.75^{a-c}	2.7±0.74^{a-c}	0.9±0.18^{a}	12.1±2.89^{a}
	A.glaucus	15.0±2.65^{a}	7.0±1.00^{a}	3.1±1.33^{ab}	2.7±0.60^{a-c}	0.9±0.00^{a}	12.9±2.45^{a}
	A.sclerotirium	15.0±3.21^{a}	7.0±0.58^{a}	2.1±0.25^{a-c}	2.2±0.17^{a-c}	0.8±0.07^{ab}	11.0±0.32^{a}
Adansonia digitata	*A.fumigatus*	19.0±7.64^{a}	7.0±1.00^{a}	2.5±0.67^{a-c}	2.5±0.44^{a-c}	0.8±0.16^{ab}	12.4±3.79^{a}
	A.terreus	15.0±2.08^{a}	7.0±0.58^{a}	3.3±0.40^{a}	2.8±0.30^{a}	0.9±0.00^{a}	13.1±0.72^{a}
	A.glaucus	16.0±2.31^{a}	7.0±0.00^{a}	3.2±0.47^{a}	2.7±0.21^{a-c}	0.9±0.00^{a}	12.9±1.00^{a}
	A.sclerotirium	14.0±4.16^{a}	6.0±1.00^{a}	2.6±1.30^{a-c}	2.5±0.60^{a-c}	0.8±0.09^{ab}	10.8±1.91^{a}
Manihot esculenta	*A.fumigatus*	13.0±5.57^{a}	6.0±1.15^{a}	1.4±0.90^{c}	1.9±0.60^{c}	0.7±0.24^{a-c}	10.3±3.66^{a}
	A.terreus	12.0±1.00^{a}	6.0±0.00^{a}	1.6±0.59^{c}	2.0±0.40^{c}	0.5±0.09^{c}	9.3±0.97^{a}
	A.glaucus	9.0±6.51^{a}	5.0±2.65^{a}	1.1±0.17^{c*}	1.6±0.17^{c}	0.5±0.00^{c}	8.2±1.44^{a}
	A.sclerotirium	14.0±2.65^{a}	6.0±0.58^{a}	1.8±0.44^{bc}	2.1±0.15^{bc}	0.7±0.09^{a-c}	10.5±1.68^{a}
Control	*A.fumigatus*	23.0±14.84^{a}	8.0±3.06^{a}	2.0±0.35^{a-c}	2.2±0.25^{a-c}	0.7±0.33^{a-c}	10.3±2.27^{a}
	A.terreus	13.0±3.21^{a}	7.0±1.00^{a}	2.2±1.60^{a-c}	2.3±0.92^{a-c}	0.6±0.16^{bc}	10.2±2.75^{a}
	A.glaucus	15.0±3.00^{a}	7.0±1.15^{a}	2.1±0.78^{a-c}	2.3±0.57^{a-c}	0.7±0.24^{a-c}	11.3±2.25^{a}
	A.sclerotirium	17.0±2.08^{a}	7.0±0.00^{a}	2.6±0.45^{a-c}	2.5±0.31^{a-c}	0.7±0.09^{a-c}	11.0±1.69^{a}

Means with the same letters within a column are not significantly different at P<0.05 using LSD. Values carrying (*) are significantly different from their control experiment

Table 8: Assessment of agronomic parameters after 7 days of 15% treatment administration

Treatment	Pathogen	No. of leaflets	No. of Branches	Leaf Area (cm)	Leaf Length (cm)	Stem Girth (cm)	Plant Height (cm)
Calotropis procera	*A.fumigatus*	16.0±4.62^{a}	6.0±1.15^{a}	2.8±1.59^{bc}	2.4±0.75^{bc}	0.9±0.00^{a}	11.8±2.62^{a-c}
	A.terreus	17.0±3.79^{a}	7.0±0.58^{a}	2.0±1.31^{b-d}	2.3±0.82^{b-d}	0.8±0.09^{ab}	11.1±1.06^{a-c}
	A.glaucus	20.0±3.46^{a}	8.0±0.58^{a}	3.8±0.72^{a}	3.4±0.36^{a}	0.9±0.00^{a}	13.9±1.50^{a}
	A.sclerotirium	15.0±3.79^{a}	8.0±0.58^{a}	2.0±0.38^{b-d}	2.2±0.42^{b-d}	0.9±0.00^{a}	12.2±0.12^{ab}
Adansonia digitata	*A.fumigatus*	13.0±1.00^{a}	6.0±0.00^{a}	1.7±0.36^{b-d}	2.0±0.15^{b-d}	0.6±0.09^{bc}	9.9±2.14^{a-c}
	A.terreus	15.0±5.57^{a}	7.0±0.58^{a}	1.8±0.06^{b-d}	2.0±0.06^{b-d}	0.6±0.16^{bc}	11.2±2.55^{a-c}
	A.glaucus	15.0±3.06^{a}	7.0±1.00^{a}	2.0±0.59^{b-d}	2.0±0.38^{b-d}	0.7±0.24^{a-c}	9.0±2.46^{a-c}
	A.sclerotirium	16.0±1.15^{a}	7.0±0.58^{a}	2.0±0.61^{b-d}	2.1±0.26^{b-d}	0.7±0.18^{a-c}	10.8±2.62^{a-c}
Manihot esculenta	*A.fumigatus*	13.0±2.31^{a}	7.0±0.58^{a}	1.6±0.25^{b-d}	1.9±0.21^{b-d}	0.5±0.08^{c}	8.8±1.55^{bc}
	A.terreus	13.0±2.08^{a}	6.0±0.58^{a}	1.5±0.42^{cd}	1.8±0.32^{cd}	0.7±0.24^{a-c}	9.1±0.56^{b}
	A.glaucus	15.0±3.06^{a}	7.0±1.15^{a}	1.0±0.25^{d*}	1.7±0.15^{d}	0.5±0.09^{c}	8.4±0.95^{c}
	A.sclerotirium	19.0±3.61^{a}	6.0±1.53^{a}	2.3±1.05^{bc}	2.6±0.60^{bc}	0.8±0.18^{ab}	12.2±3.70^{ab}
Control	*A.fumigatus*	23.0±14.84^{a}	8.0±3.06^{a}	2.0±0.35^{b-d}	2.2±0.25^{b-d}	0.7±0.33^{a-c}	10.3±2.27^{a-c}
	A.terreus	13.0±3.21^{a}	7.0±1.00^{a}	2.2±1.60^{bc}	2.3±0.92^{b-d}	0.6±0.16^{bc}	10.2±2.75^{a-c}
	A.glaucus	15.0±3.00^{a}	7.0±1.15^{a}	2.1±0.78^{b-d}	2.3±0.57^{b-d}	0.7±0.24^{a-c}	11.3±2.25^{a-c}
	A.sclerotirium	17.0±2.08^{a}	7.0±0.00^{a}	2.6±0.45^{bc}	2.5±0.31^{bc}	0.7±0.09^{a-c}	11.0±1.69^{a-c}

Means with the same letters within a column are not significantly different at P<0.05 using LSD. Values carrying (*) are significantly different from their control experiment.

Table 9: Assessment of agronomic parameters after 14 days of 5% treatment administration

Treatment	Pathogen	No. of leaflets	No. of Branches	Leaf Area (cm)	Leaf Length (cm)	Stem Girth (cm)	Plant Height (cm)
Calotropis procera	*A.fumigatus*	39.0±11.14^{a}	10.0±2.52^{a}	7.3±1.06^{a-d*}	4.8±0.53^{a}	1.5±0.18^{a*}	28.8±4.62^{a}
	A.terreus	34.0±12.50^{ab}	10.0±2.08^{a*}	6.4±1.02^{b-e*}	4.2±0.49^{b-e}	1.4±0.27^{ab}	23.5±6.74^{a-c}
	A.glaucus	39.0±7.77^{a}	11.0±0.58^{a*}	8.2±1.12^{ab}	4.4±0.25^{ab}	1.4±0.16^{ab}	27.9±0.95^{a}
	A.sclerotirium	34.0±5.29^{ab}	10.0±1.15^{a*}	6.6±0.15^{b-d}	4.4±0.32^{ab}	1.3±0.00^{bc}	27.0±1.38^{a}
Adansonia digitata	*A.fumigatus*	29.0±6.66^{a-c}	7.0±1.73^{b}	5.9±1.74^{c-e}	3.7±0.59^{c-e}	1.3±0.09^{bc}	21.3±4.53^{b-d}
	A.terreus	30.0±9.87^{a-c}	7.0±2.65^{b}	7.7±1.25^{a-c}	4.2±0.55^{b-e}	1.5±0.18^{a*}	22.5±4.83^{bc}
	A.glaucus	21.0±3.79^{bc}	5.0±1.15^{b}	5.7±1.47^{c-e*}	3.7±0.75^{c-e}	1.2±0.09^{b-d}	19.3±4.63^{cd}
	A.sclerotirium	26.0±0.58^{bc}	6.0±0.58^{b}	7.7±0.79^{ab}	4.4±0.25^{ab}	1.3±0.09^{bc}	24.3±4.08^{a-c}
Manihot esculenta	*A.fumigatus*	20.0±16.80^{c*}	7.0±1.00^{b}	5.5±0.61^{de}	3.7±0.26^{c-e}	1.2±0.14^{b-d}	19.2±3.25^{cd}
	A.terreus	21.0±5.86^{bc}	5.0±1.53^{b}	6.1±2.28^{c-e*}	3.7±0.81^{c-e}	1.0±0.08^{d}	17.6±2.72^{d*}
	A.glaucus	26.0±3.21^{bc}	6.0±0.58^{b}	7.3±0.35^{b-d}	4.3±0.25^{b-d}	1.2±0.07^{b-d}	22.2±1.69^{b-d}
	A.sclerotirium	25.0±3.46^{bc}	7.0±0.58^{b}	6.0±2.32^{c-e*}	3.7±0.70^{c-e}	1.1±0.19^{cd}	19.8±4.15^{cd}
Control	*A.fumigatus*	40.0±15.89^{a}	11.0±2.89^{a}	4.9±1.70^{e}	3.6±0.81^{e}	1.2±0.38^{b-d}	18.6±4.36^{cd}
	A.terreus	28.0±8.66^{a-c}	6.0±1.53^{b}	9.3±2.30^{a}	4.8±0.76^{a}	1.2±0.35^{b-d}	23.3±6.74^{a-d}
	A.glaucus	26.0±5.57^{bc}	7.0±1.53^{b}	8.4±1.12^{ab}	4.4±0.38^{ab}	1.2±0.18^{b-d}	22.3±4.69^{bc}
	A.sclerotirium	29.0±2.08^{a-c}	7.0±0.00^{b}	8.5±0.64^{ab}	4.5±0.00^{ab}	1.2±0.08^{b-d}	24.1±0.90^{a-c}

Means with the same letters within a column are not significantly different at P<0.05 using LSD. Values carrying (*) are significantly different from their control experiment

Table 10: Assessment of agronomic parameters after 14 days of 10% treatment administration

Treatment	Pathogen	No. of Leaflets	No. of Branches	Leaf Area (cm)	Leaf Length (cm)	Stem Girth (cm)	Plant Height (cm)
Calotropis procera	*A.fumigatus*	42.0±10.21^{a}	11.0±0.58^{a}	9.9±1.62^{a*}	5.1±0.40^{a}	1.6±0.00^{a*}	29.1±3.10^{a*}
	A.terreus	38.0±10.41^{a}	11.0±1.00^{a**}	9.3±3.11^{ab}	4.9±0.82^{ab}	1.4±0.18^{ab}	29.1±5.75^{a}
	A.glaucus	29.0±8.96^{ab}	7.0±3.21^{bc}	7.1±0.15^{a-c}	4.1±0.10^{a-c}	1.3±0.31^{ab}	27.8±4.31^{a}
	A.sclerotirium	33.0±1.15^{ab}	7.0±0.58^{bc}	8.2±2.03^{ab}	4.3±0.64^{ab}	1.5±0.09^{ab}	25.7±2.82^{a}
Adansonia digitata	*A.fumigatus*	35.0±9.07^{ab}	8.0±1.15^{b}	6.6±0.55^{b-d}	4.1±0.38^{a-c}	1.3±0.00^{ab}	22.9±2.71^{ab}
	A.terreus	28.0±0.58^{ab}	6.0±0.00^{b-d}	9.9±0.35^{a}	4.7±0.10^{a}	1.4±0.18^{ab}	26.0±2.39^{a}
	A.glaucus	30.0±0.58^{ab}	8.0±0.58^{b}	10.2±0.99^{a}	4.8±0.30^{a}	1.6±0.00^{a*}	27.6±2.40^{a}
	A.sclerotirium	26.0±6.03^{b-d}	6.0±0.58^{b-d}	9.0±1.63^{ab}	4.6±0.26^{ab}	1.3±0.00^{ab}	23.6±2.94^{ab}
Manihot esculenta	*A.fumigatus*	26.0±10.54^{b-d}	5.0±1.53^{cd}	6.3±1.93^{b-d}	2.7±0.44^{b-d}	1.2±0.18^{bc}	21.1±4.47^{a-c}
	A.terreus	14.0±7.23^{d}	4.0±2.08^{d}	4.6(±2.87^{cd*}	2.2±0.82^{cd}	0.9±0.23^{cd}	15.5±5.81^{c}
	A.glaucus	19.0±8.00^{cd}	5.0±1.00^{cd}	3.9±3.00)^{d*}	2.0±0.86^{d}	0.8±0.27^{d*}	15.3±6.26^{c}
	A.sclerotirium	24.0±2.08^{cd}	6.0±0.00^{b-d}	8.1±1.97^{ab}	3.0±0.50^{ab}	1.2±0.15^{cd}	22.3±2.21^{ab}
Control	*A.fumigatus*	40.0±15.89^{a}	11.0±2.89^{a}	4.9±1.70^{cd}	3.6±0.81^{ab}	1.2±0.38^{cd}	18.6±4.36^{bc}
	A.terreus	28.0±8.66^{ab}	6.0±1.53^{b-d}	9.3±2.30^{ab}	4.8±0.76^{a}	1.2±0.35^{cd}	23.3±6.74^{ab}
	A.glaucus	26.0±5.57^{b-d}	7.0±1.53^{bc}	8.4±1.12^{ab}	4.4±0.38^{ab}	1.2±0.18^{cd}	22.3±4.69^{ab}
	A.sclerotirium	29.0±2.08^{ab}	7.0±0.00^{bc}	8.5±0.64^{ab}	4.5±0.00^{ab}	1.2±0.08^{cd}	24.1±0.90^{ab}

Means with the same letters within a column are not significantly different at P<0.05 using LSD. Values carrying (*) are significantly different from their control experiment

Table 11: Assessment of agronomic parameters after 14 days of 15% treatment administration

Treatment	Pathogen	No. of leaflets	No. of Branches	Leaf Area (cm)	Leaf Length(cm)	Stem Girth (cm)	Plant Height (cm)
Calotropis procera	*A.fumigatus*	28±7.94^{a}	7±1.00^{bcd}*	9.2±3.40^{a}*	4.6±0.87^{a}	1.6±0.16^{a}*	28.6±5.91^{ab}*
	A.terreus	30±8.08^{a}	8±2.52^{bc}	7.7±1.47^{abc}	4.3±0.38^{abc}	1.4±0.00^{ab}	25.0±2.17^{bc}
	A.glaucus	35±7.02^{a}	9±2.00^{ab}	9.8±1.55^{a}	4.9±0.29^{a}	1.6±0.02^{a}*	32.0±3.17^{a}*
	A.sclerotirium	29±2.89^{a}	7±1.53^{bcd}	9.0±1.14^{a}	4.6±0.06^{a}	1.4±0.00^{ab}	29.1±0.15^{ab}*
Adansonia digitata	*A.fumigatus*	26±4.62^{a}	6±1.00^{cd}**	7.0±0.76^{bc}	4.0±0.40^{bc}	1.3±0.00^{bc}	21.0±2.04^{cd}
	A.terreus	27±5.03^{a}	6±1.15^{cd}	6.9±0.97^{bc}	4.0±0.36^{bc}	1.3±0.16^{bc}	20.4±3.42^{cd}
	A.glaucus	27±5.51^{a}	7±1.00^{bcd}	7.6±0.59^{abc}	4.2±0.10^{abc}	1.3±0.09^{bc}	21.7±3.50^{cd}
	A.sclerotirium	32±1.00^{a}	7±0.58^{bcd}	6.9±1.31^{bc}	3.9±0.32^{bc}	1.2±0.21^{bc}	23.5±2.84^{cd}
Manihot esculenta	*A.fumigatus*	24±4.36^{a}	6±1.15^{cd}**	6.7±0.85^{bc}	4.0±0.50^{bc}	1.1±0.14^{c}	19.5±2.30^{d}
	A.terreus	25±5.29^{a}	6±1.00^{cd}	6.5±1.20^{bc}	3.9±0.53^{bc}	1.1±0.12^{c}	20.6±2.20^{cd}
	A.glaucus	28±6.66^{a}	7±2.52^{bcd}	5.8±0.46^{c}*	3.6±0.23^{c}	1.1±0.13^{c}	18.6±2.31^{d}
	A.sclerotirium	25±5.57^{a}	7±1.00^{bcd}	7.6±1.60^{ab}	4.3±0.26^{ab}	1.1±0.17^{c}	23.1±5.71^{cd}
Control	*A.fumigatus*	40±15.89^{a}	11±2.89^{a}	4.9±1.70^{c}	3.6±0.81^{c}	1.2±0.38^{bc}	18.6±4.36^{d}
	A.terreus	28±8.66^{a}	6±1.53^{cd}	9.3±1.00^{a}	4.8±0.76^{a}	1.2±0.35^{bc}	23.3±6.74^{cd}
	A.glaucus	26±5.57^{a}	7±1.53^{bcd}	8.4±1.12^{ab}	4.4±0.38^{ab}	1.2±0.18^{bc}	22.3±4.69^{cd}
	A.sclerotirium	29±2.08^{a}	7±0.00^{bcd}	8.5±0.64^{ab}	4.5±0.00^{ab}	1.2±0.08^{bc}	24.1±0.90^{bc}

Means with the same letters within a column are not significantly different at P<0.05 using LSD. Values carrying (*) are significantly different from their control experiment

Discussion

The radial mycelia growth of the tomato pathogens was negatively affected by the botanical treatment applied. This was in agreement with the researches which determined the efficacy of various plant extracts against an array of microbes causing infections in tomato [5] [7]. The plant extracts was able to cause reduction in the dry mycelia weight of the pathogens due to interference in the pathogens' metabolic functioning. This was in accordance with the report which was carried out for a similar experiment on some micro-flora of tomato plants [8]. The botanical treatment was able to eradicate the effects of the pathogens on the treated tomato plants as there were no visible signs of infections or symptoms of the disease after treatment. This corroborated with the research findings which were carried out to evaluate the antifungal effects of some selected plants in the suppression of disease expression in tomato plants [2][4]. There was improvement in the agronomic parameters of the treated tomato plants; this could be as a result of the ability of the plant extracts to act as fertilizers or nutrient augmenters. This can help alleviate the problem associated with food poisoning or other health related issues due to bioaccumulation of toxic chemical residues from inorganic fertilizers. These findings were in line with the research which was conducted using biological agents in improving tomato seedling growth [9].

Conclusion

Plant extracts have been proven to possess a high level of antimicrobial and antifungal ingredients that can be administered at safe levels. Research conducted in Nigeria have proven the efficacy of these plants extract in the management of several diseases associated with cowpea, banana, yam, cocoyam, sweet potato, maize etc. Plant extracts are potential substitute for the more systemic and hazardous chemicals with added benefits and zero percent risk to life.

Acknowledgements

Author would like to acknowledge the efforts of Chief John O. Etaware and Mrs. Esther Etaware for their moral and financial support towards the completion of this research. Your benevolence and benignity will never go unrewarded, God bless you both.

References

[1] Food and Agricultural Research Organization of the United Nation (FAO) (2000). Tomato integrated pests management (an ecological guide), FAO Rome, pp204.

[2] Michael M, Steven SA and Bartz JA (2002). Guide to identifying and controlling postharvest tomato diseases in Florida, Institute of Agricultural Science, University of Florida, Gainesville, pp9.

[3] Owolade OF, Osikanlu YOK and Fadare TA (2003). Control of brown blotch of cowpea using botanicals, *Journal ofCrop Research*, 25 (3): 561-566.

[4] Momol MT, Momol EA, Dankers WA, Olson SM, Simmons JA and Rich JR (1999). Evaluation of selected plant essential oils for suppression of *Ralstonia solanacearum* and *Melodogyne arenaria* on tomato, *Journal of Phytopathology,* 89:54.

[5] Ijato JY, Oyeyemi SD, Ijadunola JA and Ademuyiwa JA (2010). Alleopathic effects of leaf extract of *Azadirachta indica and Chromolaena odorata* against postharvest and transit rot of tomato (*Lycopersicon esculentum L.), Journal of American Science*, 6(12): 1595-1599.

[6] Akrofi AY (2015). *Phytophthora megakarya*: A review on its status as a pathogen on cacao in West Africa. *African Crop Science Journal* 23(1):67-87.

[7] Dong C, Zhang X and Lin Q (1999). Biological control of tomato bacterial wilt with avirulent bacteriocinogenic strain of *Ralstonia solanacearum*. *Journal of Science* 20: 1-4.

[8] Mohamed AR (2008). Phytotoxic effect of *Calotropis procera* extracts on seedling development and rhizosphere micro-flora of tomato plants grown in soil infested with *Fusarium oxysporum f.sp Lycopersici*. *World Applied Sciences Journal*, 3(3): 391-397.

[9] Silveria EB, Da RJ, De Mariano LR and Micherett SJ (1995). Antagonism of *Bacillussp* against *Pseudomonas solanacearum* and effects on tomato seedling growth. *Fitopathological Brasil* 20: 605-612.

****