EFFECTS OF CASHEW (*ANACARDIUMOCCIDENTALE*L) LEAF AS SOIL AMENDMENT ON THE GROWTH AND YIELD OF TOMATO (*SOLANUMLYCOPERSICUM)* INFECTED WITH *FUSARIUMOXYSPORUM*FSP*LYCOPERSICI*

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Abstract
Tomato is a vegetable crop that is affected by Fusarium wilt disease caused by Fusariumoxysporumfsplycopersici. The present study investigated the effects of cashew leaf as soil amendment on growth and yield of tomato infected with Fusariumoxysporumfsplycopersici. The pot plants were grown on soil mixed with dried cashew leaf powder and biochar produced from dried cashew powder at 10g and 30g respectively while the unamended soil serves as control. The growth performance was determined by plant height, stem girth and number of leaves while the yield was determined as total weight per treatment. The control plants had the lowest plant height, stem girth, number of leaves which was significantly different (p ≤ 0.05) *from plants grown on soil amended with dried cashew leaf powder and biochar. The study showed that biochar produced from cashew leaf powder as soil amendment promotes the growth and yield of Fusarium wilt of tomato plants than dried cashew leaf. Application of biochar produced from cashew leaf can be useful in Integrated Pest Management.*

Keywords: Fusarium wilt, Plant height, Stem girth and Yield

Introduction

Tomato (*Solanumlycopersicum)* is a vegetable crop grown in Nigeria. About 180 million tons of tomato have been produced on an area of 4.76milion hectares in more than 150 countries (FAOSTAT, 2020). The fruit is consumed fresh, processed into tomato puree, sauce, ketchup, juice and stews (Lenucci*et al.,* 2006). Tomato is a good source of Vitamin A, C and lycopene which reduces the incidence of cancer, heart and age related diseases (Asian Vegetable Research and Development Corporation, 2003). Among the constraints of tomato production, Fusarium wilt of tomato caused by *Fusariumoxysporum*fsp*lycopersici is* one of the most destructive diseases of tomato accounting for yield losses of up to 90% in severe epidemics (Singh and Kamal, 2012). It constitutes serious threat to food security in Sub-Saharan Africa, especially in the coastal regions (Popoola *et al.,* 2012).

Soil-borne pathogens like *F.oxysporum*fsp*lycopersici* cause a lot of diseases and infections on tomato (Babalola and Glick, 2012).This soil-inhabiting pathogen affects tomato production in the field and greenhouse grown tomato worldwide (Abel-Monaim, 2012). Symptoms often appear later in the growing season and are first noticed on the lower leaves which later progresses into the younger leaves and the plant may eventually die. In many cases, only one branch or side of the plant shows symptoms. Disease symptoms appear on the lower leaves as yellow blotches, wilting and eventually dropping off (Naika*et al.,* 2005).The management of Fusarium wilt of tomato involves many control measures such as chemical control which involves use of fungicides. The chemical fungicides are associated with severe damage to human, environment and development of new pathogenic races (Juliano and Bettiol, 2005).

Therefore, there is need to explore environment in managing Fusarium wilt. The alternative method of controlling plant diseases involves using novel compounds derived from plant sources (Alabouvette, 1999). Many plants and their products have pest control properties (Singha*et al.,* 2011).These are good alternatives to chemical pesticides, as they are readily biodegradable in nature. Soil amendment is a farm techniques explored by farmers in providing solutions to the problem of loss in soil fertility resulting from overcultivation, industrialization and urbanization (Aina*et al.,* 2018).The use of soil amendments to suppress or eliminate the inoculum of the pathogen from the soil is a promising approach of controlling soil-borne diseases. The soil amendment provides suitable environment for plant growth thereby reducing the activities and population of soil-borne pathogens. When plants and their products are used as amendment, it improves soil fertility and soil-borne disease control.

Cashew leaves contain phytochemicals such as flavonoids of quercetin-3-*O*-rhamnoside, myriceten, myriceten-3-*O*-rhamnoside and amentoflavone which contributes to its antimicrobial effect (Konan and Bacchi, 2007). The leaves of *A. occidentale* have been reported to inhibit the growth of *Brevibacillusbrevis, Micrococcus luteus, Staphylococcuscohnii, Escherichia coli and Pseudomonas aeruginosa* except *Salmonella enterica* (Tan and Chan, 2014). The leaf extract of *A. occidentale* inhibited more than the bark extract (Manasa *et al.,* 2013). Although biochar application induces systemic resistance of plants through its improvement of physical, chemical and biological attributes of the soil that leads to creating adequate environment for healthy plant development (De Medeiros *et al.,* 2021), the effectiveness of amendment from plant sources on growth and yield performance under Fusariumdisease condition will enhance tomato production. Therefore, the effects of cashew leaf as soil amendment on growth and yield of tomato infected with *Fusariumoxysporum*fsp*lycopersicii* was investigated.

Materials and Methods

Source of plant materials

Seeds of susceptible tomato plant (Roma) were surface disinfected with 0.5% sodium hypochlorite for two minutes and rinsed thrice with sterile distilled water before planting in the nursery. The leaves of cashew were collected from Oyo State College of Education, Lanlate, washed and air-dried at room temperature and grounded into powder. The biochar used was made from dried cashew leaves under zero or no oxygen condition.

Sterilization of water and soil

The distilled water was sterilized using autoclave at 15psi for 15 minutes while the topsoil was also autoclaved for 30minutes at 15psi for two consecutive days to destroy living microbes on the soil.

Preparation of Inoculum

Fusariumoxysporum inoculum was prepared by washing 14 days old *F. oxysporum* culture on Potato Dextrose Agar plates with sterile distilled water. The culture was filtered through a four layers of muslin cloth. The inoculum was adjusted to 1 x 10^6 spores per ml using haemocytometer.

Effects of cashew leaf as soil amendment on growth and yield of tomato infected with *Fusariumoxysporum*fsp*lycopersici.*

The dried cashew leaf powder and biochar were weighed into 10g and 30g respectively. Each pot was filled with 5kg of sterilized soil and the soils were mixed with 10 and 30 g dried cashew leaf powder and 10 and 30g of biochar produced from cashew leaf respectively. The control was unamended with dried cashew leaf orbiochar. The pots were watered regularly for one week before transplanting seedlings of *Solanumlycopersicon*of four weeks into the amended and unamended soil (1 plant/pot). The seedling was wounded at root before inoculating with 1 x 10^6 spores of *F. oxysporum.* The experiment was laid in completely randomized design and replicated three times. The growth rate was determined at three, six, nine and twelve weeks after transplanting. Plant height was measured by meter rules, stem girth by verniercallipers, number of leaves by visual counting and yield by weighing balance astotal weight per treatment. Analysis of variance was performed using the Newman-keuls multiple range test at probability of 0.05% on DSAASTAT ver.1.101.

Results and Discussion

Table 1: Effect of cashew leaf on plant height of tomato infected with *Fusariumoxysporum*

	Plant height (cm)			
Treatment (g)	3 WAT	6 WAT	9 WAT	12 WAT
B_{10}	13.72^{c}	35.60^{b}	48.80^{c}	56.40^{d}
B_{30}	9.20^{b}	27.00^{ab}	52.00^{c}	56.50^{d}
D_{10}	9.00^{b}	19.73^{ab}	25.10^{b}	31.80^{b}
D_{30}	10.50^{bc}	26.03^{ab}	31.00^{b}	36.20^{c}
Control	2.80^{a}	4.90^{a}	5.00^{a}	8.70^{a}

B = biochar D = Dried cashew leaf WAT = Weeks after transplanting
Means with the same letter (s) within the row are not significantly different at $p \leq 0.05$

Table 1 showed the effect of cashew leaf on plant height of tomato infected with *Fusariumoxysporum.* There was no significant difference ($p \leq 0.05$) in plant height of tomato treated with biochar at 30g, dried cashew leaves at 10 and 30g at three and six weeks after transplanting. Although tomato plants treated with 30 g of biochar height had highest plant height at nine and twelve weeks after transplanting control plants had lowest plant height of all the treated tomato plants which was significantly different ($p \leq 0.05$) from biochar and dried leaf at 10 and 30 g. The height of tomato plants treated with dried cashew leaves at 10g was significantly similar ($p \leq 0.05$) to 30g. Rapid growth rate in biochar amended soil than control and dried cashew leaves may be due to biochar potential of enhancing nutrient availability in the soil (Pandit*et al.,* 2018). It also helps to suppress fungal plant diseases (Elmer and Pignatello, 2011).

Table 2: Effect of cashew leaf on stem girth of tomato infected with *Fusariumoxysporum*

	Stem girth (mm)			
Treatment	**3 WAT**	**6 WAT**	**9 WAT**	**12 WAT**
B 10	1.25b	1.50bc	2.10b	2.18b
B 30	1.15b	2.03c	2.20b	2.06b
D 10	1.05b	1.40b	1.63b	1.70b
D 30	1.10b	1.45bc	1.70b	1.65b
Control	0.24a	0.30a	0.32a	0.35a

B = biochar D = Dried cashew leaf WAT = Weeks after transplanting
Means with the same letter (s) within the row are not significantly different at $p \leq 0.05$

The stem girth of tomato infected with *Fusariumoxysporum* treated with biochar and dried cashew leaves were not significantly different ($p \leq 0.05$) at three, nine and twelve weeks after transplanting (Table 2). The girth ranged from 0.24 to 0.35mm for twelve after transplanting. Tomato plants treated with biochar at 30g had highest stem girth which was significantly different ($p \leq 0.05$) from control. Reduced stem girth of the control may be due to the pathogen entry through the roots of the plant and proliferates in the vascular tissues leading to breakdown of the water economy of the infected plants (Agrios, 2005).

Table 3: Effect of cashew leaf on number of leaves of tomato infected *Fusariumoxysporum*

	Number of leaves			
Treatment	3 WAT	6 WAT	9 WAT	12 WAT
B10	34.25^{b}	75.75^{d}	91.50^{c}	39.25^{b}
B30	29.08^{b}	72.00^{d}	94.60^{c}	39.00^{b}
D10	25.00^{b}	55.66^{c}	63.30^{b}	32.33^{b}
D30	24.00^{b}	38.25^{b}	60.10^{b}	41.00^{b}
Control	5.25^{a}	6.25^{a}	10.50^{a}	11.75^{a}

B = biochar D = Dried cashew leaf WAT = Weeks after transplanting
Means with the same letter (s) within the row are not significantly different at $p \leq 0.05$

Effect of cashew leaf on number of leaves of tomato infected with *Fusariumoxypsorum* is presented in Table 3. The highest number of leaves was recorded at ninth week after transplanting on tomato plants treated with biochar at 30g/plant and the lowest in control at three weeks after transplanting. There was no significant difference in number of leaves of tomato plants treated with biochar and dried cashew leaves at three and twelve weeks but significantly different ($p \leq 0.05$) from the control plants. However, the number of leaves in biochar at 10g/plants is not significantly different from biochar at 30g/plant from three to twelve weeks after transplanting. Reduced number of leaves in control plants will affect the physiological activities of the plant such as phytosynthesis and transpiration.

Table 4: Effect of cashew leaf on yield of tomato infected *Fusariumoxysporum*

Treatment	Yield (g)
B10	34.75d
B30	40.33e
D10	7.50b
D30	13.75c
Control	0.00a

B = biochar D = Dried cashew leaf WAT = Weeks after transplanting
Means with the same letter (s) within the row are not significantly different at $p \leq 0.05$

The yield performance of tomato infected with *Fusariumoxysporum* was recorded by total weight of fruits per treatment is presented in Table 4. The highest mean yield was recorded for fruit harvested in the soil treated with 30g of biochar while the control had no yield. The pathogen affects the fruiting of the plant. Fusarium wilt of tomato is characterized with stunted growth and little or no fruit development (Bawa, 2016). Worku and Sahe (2018) revealed that the disease is apparent during flowering and fruiting stage of the plant. Lemaga*et al.* (2001) reported soil amendment consisting of organic materials with *Sesbaniasesbana*and *Leucaenadiversefolia*applied in the amount sufficient to supply 100kg N/ha either singly or combined with inorganic fertilizer was found to reduce disease incidence and increase tuber yield. Application of biochar enhances productivity and performance of crops (Jaiswat*et al.,* 2015; De Tender *et al.,* 2016).

Conclusion

From the study, it can be concluded that dried cashew leaf and biochar as an amendment improve plant height, stem girth, number of leaves and yield of tomato plants under Fusarium wilt condition. The biochar had higher fruit yield which is the optimal aim of farmers. Application of biochar produced from dried cashew leaf can be useful in Integrated Pest Management to promote sustainable agriculture.

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