

Study of the Causes of Death of Mango Stands in Some Fadama Lands of Sokoto Metropolis, Nigeria

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Abstract: Study on the Etiology of mango (*Mangifera indica*) tree mortality was conducted in some Fadama (Lowland) Areas of Sokoto metropolis, with the aim of determining; early visible symptoms associated with the diseases that lead to the death of mango trees and identify the pathogens responsible for the diseases. Mango owners were selected from four different locations; besides Kwakwalawa, Tori farm, Western Bye pass and Tashar Illela Bridge. Random sampling was used to identify 50 respondents who were interviewed using a semi structured questionnaire. The data was analyzed using descriptive statistics. Farmers knowledge and perception on most frequent early visible symptom that often leads to the death of mango trees were determined, the result showed significant variation on farmers perception on the possible cause of mango tree mortality as there were various factors such as insect, pathogens and abiotic stress. Based on the information obtained, samples were collected using purposive sampling procedure and the pathogen was isolated and identified as *Fusarium solanii*. It was concluded that farmer's choice to take certain management practices such as pruning and irrigation on the farms not solely for the management of mango trees on the farms, but primarily for the benefit of their intercrops. Also, there are about eight different symptoms associated with the diseases responsible for the sudden death of mango trees in the study site. These include; gum exudation, bark splitting, discoloration and darkening of the bark, wilting of leaves, root decay, whitish substance on and around the root surfaces and wilting of branches. The study recommends awareness creation on good orchard management practices, regular monitoring of the orchards by the farmers and establishing link with expert by the farmers for advice.

Keywords: *Mangifera indica*, Lowland, Farmers knowledge, *Fusarium solanii* and Management practices.

INTRODUCTION

Mango (*Mangifera indica*) is among the fruit plant rich in vitamin C that is grown throughout Nigeria [1]. The fruit though eaten as desert fruit in Nigeria, rank first among other tropical fruits like citrus and pineapple. It is important fruit crop in most tropical regions of the world and mostly eaten in the developed countries [2]. The dietary contributions of mango fruit in the diet of most people in the tropic ran above that of citrus fruit. It has been reported that the fruit can be processed into dry mango, mango pickle, mango jellies and can also be eaten cooked [3 and 4], while the fat contained in the seeds can be processed into flour or as a substitute to cocoa butter, when unripe, the fruit is tart, crispy and somewhat dry just like the green apples [3].

Mango production in many countries has been decreased due to numerous biotic and abiotic factors

[5]. Mango production is hampered by the attack of number of significant diseases [6]. During all stages of their life cycle, mango can be attacked by over 1400 different species of plant pathogens, inciting diverse number of diseases [7]. Some of these diseases have become a limiting factor to mango production [8]. According to Rajan [9] more than 17 species of mites, 492 species of insect and 26 species of nematode have been reported to be infesting mango trees, about 45% of which are reported from India, a considerable number of these pest are causing severe loses to the mango growers [10].

Apart from pest and pathogens, environmental factors (abiotic factors) such as; humidity, high temperature, sun scold, water stress and draught, unskilled cultural practices and less attention by the farmers or growers contribute to the development of sudden death of mango tree [11].

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The economic importance of mango as food, source of income, foreign exchange earnings and employment opportunities could not be overemphasized; in fact mango orchard cultivation is a profitable activity that could bring huge return to the growers [12]. It is therefore of immense importance to broaden research on some of the common diseases affecting mango yield and productivity and where possible device measures of control. Furthermore, despite the continuous decline of mango tree stands in the study area, recent studies conducted were mainly focused on the assessment of mango tree diseases. There is therefore the need for more research not only on diseases assessment but also on the identification of the pathogens responsible. So this study aimed at to determine the early visible symptoms of the disease that often leads to the death of mango tree and identify the pathogens responsible for the death of mango tree in the study area.

MATERIALS AND METHODS

The Study Area

The research was conducted at various mango orchards in Sokoto metropolis. Sokoto state is located on latitude 13⁰04N; longitude 5⁰14E and altitude of 350m above sea level in the Sudan savannah agro-ecological zone of Nigeria [13]. The area has an average temperature of 30.60⁰C and receives an average annual rainfall of 655.85 mm and a relative humidity of 48.54 between January and October [14]. The rainfall establishes between mid May to early June and reaches peak in august. Dry season starts in mid October and ends in late April. The hottest months are March and April, while the coolest months are November and January which are characterized by dry harmattan wind [14].

Sampling Procedure

Purposive sampling procedure was employed in this study. The study area was divided into four different sampling areas;

1. AREA A: Kwalkwalawa farms
2. AREA B: Alhaji Tori Farm
3. AREA C Western Bye pass Orchards
4. AREA D: Tashar Illela Bridge

Diseased samples were collected from samples sites. Because though the disease symptoms observed are almost uniformly distributed throughout the study area, this sampling area was observed to be highly concentrated with severely diseased trees. Thus samples were purposely and intentionally collected based on experience of the sites.

Questionnaire Administration

Questionnaire was designed and distributed to 50 respondents to obtained information from orchards owners on what they thought to be responsible for the death of their mango tree stands and management effort if any. The information procured were analyzed and

used to determined key research priority problem to work upon, along with the most frequent early visible symptoms associated with the problems.

Sample Collection

A small piece of bark from the margin of the lesion on the main trunk of the diseased tree were surface-sterilized with 70% Concentration Ethanol for 30seconds, a small piece from this were suddenly cut off with a chisel (0.5inch). The collected tissues were cautiously sealed into a Polythene bag and taken to the mycology laboratory for isolation and identification of the pathogen.

Isolation and Identification of the Pathogen

All the glassware used were washed with detergent, rinsed with distilled water and air-dried. Petri dishes and glass slide were ovum-dried at 160⁰C for 1hr, whereas inoculating needles and spatulas were flamed with a burner.

The media used for this study was potato dextrose ager (PDA), 39g of which was dissolved into 1litre of distilled water. This was followed by adding 1g of streptomycin into the mixture to inhibit bacterial growth. The mixture was subsequently boiled with frequent shaking to ensure homogeneity until the mixture became translucent. The prepared media was finally sterilized in an autoclave.

Direct plating technique described by Pitt and Hokking [15] was used. the affected tissue were sterilized with 0.5% hypochlorite solution for 3min and subsequently small portion from this was directly inoculated into labeled (A,B,C,&D) plates of PDA media. The plates were incubated at room temperature for 4-7 days interval. The resultant fungal growth comprises of more than one colony which were sub cultured to obtain pure isolates.

Identification of the Pathogen

The isolated fungi were discovered according to the fungal identification Atlas [16]. Morphological identification was made through the use of electronic microscope. The fungal isolates were stained with distilled water on sterilized glass slides, which was subsequently placed on a microscope (magnified 1000 times). The form and structure of the fungal isolates were studied and noted.

The survey data were analyzed using descriptive statistics.

RESULTS

Visible Symptoms Leading to the Death of Mango Trees in the Study Area

Result obtained after administering questionnaire on early visible symptoms leading to the death of mango trees in the study area are described below.

Mango Tree Stands in the Study Area.

Distributions of the respondents, based on whether they have mango tree stands in their farm or not, the number of stands previously and presently in existence on the farm is presented in Table 1.

It shows that all the farmers encountered during the survey possess mango tree stands in their farms with distinct number of stands per farm enumerated. Majority of the respondent which are about

50% of the entire farmers were previously had about 11-20 stands of mango tree on their farms followed by others which are 46% and 4% of the total encountered farmers with previously in existence 21 stands and above and 1- 10 stands of mango trees on farms respectively. It further express that presently, majority of the respondent which about 52% of the farmers have in existence have 11-20 stands of mango tree stands on their farms followed by those with 28 and 20 percent from the entire farmers reported to have 1-10 and 21 stands and above stands of mango trees respectively.

Table-1: Mango Tree stands in the Study area

Variables	Response of the respondent	Frequency	Percentage (%)
Own a mango tree stand	YES	50	100
	NO	None	-
Number of mango tree stands on the farm previously	1-10 stands	2	4
	11-20 stands	25	50
	21 stand and above	23	46
Number of stands on the farm presently	1-10 stands	14	28
	11-20 stands	26	52
	21 stand and above	10	20

Source: Field Survey, 2020.

Mango Management Practices

Distribution of the respondent based on the adopted practice for the management of mango tree stands, reason for chosen the adopted practice as well as the challenges often encountered from the adopted practice is presented in Table 2.

It shows that 100% of the farmers have deliberately employed varying degree of measures in the management of their mango tree stands, where majority of the farmers which are 86% of the entire respondent reported pruning as their adopted practice, 14% reported irrigation and none have reported manuring. It also express the various reasons for chosen the practices by each farmer where majority which are 60% of the responded farmers mentioned better result yielded by the selected practice as their main reason for

chosen it, whereas 16% and 4% of the farmers have reportedly mentioned provision of light for the intercrops and feasibility of each practice as the bases for chosen the appropriate practices respectively.

Furthermore, it provide explicit vivid details of the most frequent challenges encountered from the selection of each practice mentioned, where majority of the farmers which are 80% of the entire responded farmers reported the resultant physical injury with particular reference to pruning as the major threat to mango trees followed by 16% of the farmers who reported severe drying of the trees as (wilting) as the main challenges, whereas 4% of the farmers mentioned root decay as a limiting factor resulted from the practice employed.

Table-2: Mango Management Practice

Variables	Response of the respondent	Frequency	Percentage (%)
Practice adopted	Pruning	43	86
	manuring	0	0
	irrigation	7	14
	other	0	0
Reason for chosen the adopted practice.	Easy to practice	7	14
	Yield better result	30	60
	Provide light for intercrops	13	26
Challenges from the chosen practice	Root decay	2	4
	Injure the trees	40	80
	Drying of the tree	1	1

Source: Field Survey, 2020

Awareness of the Respondent on Possible Cause of Mango Tree Mortality

Result on the awareness of the Possible Cause of Mango Tree Mortality is presented in Table 3.

It express that only 80% out of the entire farmers enumerated are aware of the sudden and continuous death of mango tree stands bedeviling the study site, with divergent of opinion on the perceived factor responsible for the prevailing menace; 32% of the

which are leading majority of the farmers have mentioned pathogens as the most common factor causing mango tree mortality in the study area followed by 24% of the farmers whose suggested abiotic stress with main emphases to lack of water as responsible factor causing drying and eventually death of the trees, 16% and 8% of the farmers have reported insect and nematodes respectively.

Table-3: Awareness of the Respondent on Possible Cause of Mango Tree Mortality

Variables	Response of the respondent	Frequency	Percentage (%)
Awareness of the death mango tree stands	YES	40	80
	NO	10	20
Factor perceived to be responsible	Insect	8	16
	Nematodes	4	8
	Pathogens	16	32
	Abiotic stress	12	24
	None	10	20

Source: Field Survey 2020.

Early Visible Symptoms Associated with the Death of Mango Trees

Result on the observed symptoms responsible for the death of mango tree stands in the study site is presented in Table 4.

It Express that 80% of the respondent have been observing the most frequent visible symptoms associated with various factors mentioned by the farmers as responsible for mango tree mortality in the

study site, where about 8 different symptoms are reported with varying degree of occurrence; discoloration and darkening of the bark were the most common mentioned symptom with 20%, followed by wilting of the branches and gum-exudation with 8% and 6% mentioned respectively. Bark splitting, wilting of the leaves and root as well as appearance white powdery substance on and around the root surfaces were consecutively mentioned by 5%, 4%, 3% and 2% respectively.

Table-4: Early Visible Symptoms Associated with the Death of Mango Trees

Symptoms	Frequency	Percentage (%)
Gum exudation	6	12
Bark splitting	5	10
Discoloration/darkening of the bark.	10	20
Wilted leaves	4	8
Root decay	2	4
Whitish substance on the root.	2	4
Wilted root	3	6
Wilted branches and trunk	8	16
None	10	20

Source: field survey, 2020.

Morphological and Physical Features of the Fungal Pathogen (*Fusarium solanii*)

The fungal pathogen was identified as (*Fusarium solanii*) based on its structural features. It is thread like in structure, branches into thin-elongated parts, with thickened basal cells and tapered, rounded apical cell. They are also abundant and have rough wall. The fungal isolate was visually observed to be; grayish-white, cream-buff. Ager surface sometimes green to bluish- brown as shown in Figure 1 and 2 below.



Fig-1: Isolate of (*Fusarium solanii*) after 5 days of plating



Fig-2: Isolates of (*Fusarium solanii*) after 10 days of plating

DISCUSSION

It was discovered that there was significant decline in the number of mango tree stands in the study sites. This is because previously there were about twenty three farmers with largest number of mango tree stands i.e 21 stands and above, while presently, only ten farmers were reported to have 11 stands and above mango tree stands on their farms. This may not be unconnected with pests, diseases and poor management practices bedeviling the site. This finding is related to the work of Anon [17] who reported biotic and abiotic factors are behind the world-wide decrease in mango production. It is also related to the work of Majeed [11] who reported environmental factors in concert with unskilled management practice and less attention by the farmers contribute significantly to the sudden death of mango trees.

Pruning was discovered to be the most common practice adopted by the farmers in the study area with about 86% mentioned. This practice was aimed at providing light for the intercrops and it was probably done haphazardly which may consequently injure the trees, thereby predisposing the trees to diseases. This finding is related to the work of Boddy and Watkinson [18] who reported that diverse set of microbes are associated with the injured portion of the branches that are exposed to the atmosphere.

Irrigation was also discovered to be practiced by few farmers in the study area with 14% mentioned. This is because most mango farmers in the area depend on rainfall, with irrigation either too expensive or not available. The farmers also believed that the area received enough rainfall that meet the water requirement of mangoes. Besides, mangoes were perceived as hard crops that can withstand long dry season. Such kind of believes made farmers not to provide additional water for mango trees during dry season, but often do so to their intercrops if present. This finding is in support with the work of Singh [19] who reported that mango is draught tolerant and can withstand occasional flooding.

Although farmers employed some level of orchard management practice on their field, they did not do it the right way, as such; most mango farmers interviewed lack the basic skills on good orchard management practice. This finding is in consistent with the work of Majeed [11] who reported unskilled management practices employed during orchard management are one of the factors contributing to the death of mango trees.

Although some level of organic amendment was discovered to be practiced mainly for the intercrops, nothing is done purposely for the benefit of mango trees on this aspect, because none of the respondent mentioned manuring as one of the mango management practice adopted in the site. This may be a clear indication of the farmers' low level of knowledge on skilled orchard management practices and their preference to mere intercrop management, with mangoes either too cost to manage or does not produce any meaningful return. This may likely to predispose the trees to diseases and this finding goes along with the work of Minnatullah and Jah [20] who reported that deficiencies in certain amount of nutrient may predispose mango trees to diseases infection by fungal pathogens which may attack shoot or by root feeding nematode.

It was discovered that the main reason or factor influencing the farmers to the adoption of a particular orchard management practice, is the better result yielded by the appropriate practice which was mentioned for about 60%. This is possibly because pruning was the most common practice adopted in the study area and additionally mango tree are usually scattered with mostly narrow spacing in the area, neglected in terms of management and became important only during harvesting season. This may result to high humidity which may consequently cause rapid buildup of pest and diseases in the study area. Hence, pruning adopted for whatever reason may possibly reduce the relative humidity of the site by ensuring open crown thereby promoting growth of the trees and decreasing the menace of pest and pathogen. This finding is in consistent with the work of [17] who asserted those neglected orchards are more prone to pest and diseases attack and consequently high yield losses.

The research also discovered that majority of the farmers are aware of the sudden and continuous decline in the number of mango tree stands in the study site as 80% of the respondent were reported to be aware of the prevailing menace with little or no knowledge on the possible cause. The farmers have limited knowledge on the diseases as they described most of the diseases by the type of symptoms and various part of the plant affected. Most of the symptoms described by the farmers appeared to be fungal pathogenic in nature. This finding is related to the work of Conolly and Jellison [21] that reported fungi as the most common

pathogens in forest ecosystems and identify root rot basidiomycetes as the most important because of their capability in degrading all plant cell wall components, thereby causing decay and deterioration.

The research also discovered the early visible symptom associated with the sudden death of mango tree stand on the study area where discoloration and darkening of the bark was the most prevalent symptom with 20% mentioned followed by bark splitting and gum exudation with 12% and 10% mentioned respectively. This is because these symptoms are outwardly manifested, thus visually recognized. The presence of observable symptoms depends on the presence of sufficient number of pathogens. Gum formation represents the food materials secreted due to the blockage of phloem vessels by the fungal hyphae, whereas bark splitting may also be due to the severe drying of the infected portion of the branch which may result from the blockage of water conducting vessels as fungal hyphae penetrate through them. This is related to the work of [22] who reported that fungal mycelia gradually invade the xylem tissue from the top of the branch and spread pet ally, ultimately causing death of the infected branch. Similarly this finding is in agreement with the work of [23] who reported bark discoloration and deterioration increases the susceptibility of the plant to further infection by fungal pathogens.

Moreover, white powdery substance was discovered on and around the root surfaces of mango trees in the study area as mentioned by the farmers for about 4%. This may be because, during dry season the canal water often highly became deficit and irregular, that made the farmers apply irrigation for their intercrops. The underground water used for this practice is naturally harder than rain water, thus promotes buildup of salinity which may be often seen on the surface and described by the respondent as whitish substance. Salinity may interfere with the water absorption capacity of the plant, thereby predisposing the trees to diseases. This finding is related to the work of Majeed [11] who reported unskilled management practices including improper irrigation as one of the many factors affecting mango production.

Conclusively, the research also discovered the pathogen responsible for the sudden death of mango tree stands in the study site. *Fusarium solani* was the most purely isolated pathogen discovered as responsible for the sudden death of mango tree stands in the study site. This is because *Fusarium solanii* belongs to the class of fungi Ascomycetes which together with Basidiomycetes form the most prevalent microbes in forest ecosystems. Additionally, this species of fungi (*Fusarium solanii*) has been known to be responsible for sudden death syndrome of some arable crops like soya bean. This finding is related to the work of many researchers such as Kore and Mare [24] who reported

that *Fusarium solanii* infect mango trees and the diseases increases with decrease in soil moisture with maximum of 22% soil moisture. While in the same year Narasinhudu and Reddy [25] found that mangoes were severely affected by gummosis *Botryodiplodia theobromae* was isolated from the diseased tree and pathogenicity was confirmed.

CONCLUSION

The research revealed that; gum exudation, bark splitting, discoloration and darkening of the bark, wilting of leaves, branches and root, root decay and presence of whitish substance on and around the root surface are the most common symptoms associated with the factor that leads to the sudden death of mango trees in the study area. This research also concluded that *Fusarium solanii* is the pathogen responsible for the sudden death of mango trees in the study site. Therefore all possible measures should be put in place to ameliorate the situation of so as to enhance productivity of these mango tree stands in the study area.

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