

**FACTORS RESPONSIBLE FOR THE DEATH OF MANGO TREES IN USMANU
DANFODIYO UNIVERSITY SOKOTO, MAIN CAMPUS**

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CERTIFICATION PAGE

This Research Project titled “ **Factors Responsible for the Death Of Mango Trees in Usmanu Danfodiyo University Sokoto, Main Campus** by, **HARUNA, Sadiyah, (ADM. NO: 2010302143)** meets the regulations governing the award of Bachelor of Science , Degree in Biology , Department of Biology, Usmanu Danfodiyo University Sokoto, is approved for its contribution to knowledge and of Literary presentation.

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DEDICATION

I dedicated this to my beloved parents mr Muhammad Haruna shafiyi and Hajia ayishetu shafiyi, mallama Fatima, and my siblings for their pioneering and prominent role of love care for training me with very good and sound moral philosophy and memories of hope.

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In the name of Allah, most compassionate, the most merciful, master of the day of judgement. Who alone created the moon; The star as well as the entire heaven and it's host by his command as mentioned in the nature scripture. May his peace and blessing be upon our noble prophet, Muhammad (SAW).

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ABSTRACT

This study assessed the Factors Responsible for the Death of Mango Trees in Usmanu Danfodiyo University Sokoto, Main Campus. Mango (*Mangifera indica* L.) is the most popular and commonly eaten fruit among millions of people in tropical areas; it is a family member of the *Anacardiaceae*, one of the crops grown abundantly throughout the Nigerian tropics. The specific objectives are to: Determine the biotic (such as pests and diseases) and abiotic factors (such as soil quality, water availability, and climate conditions) that may contribute to the health decline and mortality of mango trees within the university's agricultural setting; to assess the impact of recent environmental changes (such as temperature fluctuations, humidity, and changes in land use) on the growth and survival of mango trees, exploring how these factors may correlate with observed mortality rates; to evaluate the current agricultural and management practices employed in the care of mango trees at the university, and to determine how these practices may influence tree health and mortality rates, and identifying areas for improvement. Surveys was carrying out in July, 2025 in Usmanu Danfodiyo University Sokoto permanent site to determine the frequency of occurrence of disease of mango. At each site, 10 randomly selected and 5 year old mangoes was inspected. The frequency of occurrence was taken as the number of mango trees affected by the disease expressed as percentage of the total number of mango trees at a location. The results revealed that; 28% of the responses were on the opinion that Yellowing/ Wilting of leaves of mango is among the symptoms affected the mango trees, 42% were on the opinion that Black spots/ lesions on leaves or stems is the symptoms of affected the death mango trees, 10.0% of the respondents believed that Fungal growth is symptom affecting mango trees, while 14% of the respondents were on the opinion that Cracking/ Rotting of stem is the symptom to be observed in the affect mango trees. The study concluded that; the death of mango trees in Usmanu Danfodiyo University Sokoto can be attributed to several possible factors, based on the investigation and available data: The harsh climatic conditions, including high temperatures and low rainfall, might have caused significant stress to the mango trees.

CHAPTER ONE

INTRODUCTION

1.0

1.1 Background of the study

Mango (*Mangifera indica* L.) is the most popular and commonly eaten fruit among millions of people in tropical areas; it is a family member of the *Anacardiaceae*, one of the crops grown abundantly throughout the Nigerian tropics (Ahmed *et al.*, 2019). The cultivars of mango commonly found in Nigeria are Edward, Early Gold, Local Alphonso, July Haden and Ogbomosho (Okibo 2001). The crop is a host to a large number of pathogens such as bacteria, fungi and viruses (Kumar *et al.*, 2007).

Mango trees (*Mangifera indica*) are significant tropical fruit-bearing plants that thrive in warm climates, making them economically and ecologically important in regions such as Sokoto, Nigeria, where Usmanu Danfodiyo University is located. The health and viability of mango trees can be greatly influenced by a combination of environmental, biological, and anthropogenic factors. Factors such as climate change, soil conditions, pest infestations, diseases, and improper agricultural practices can lead to the decline or death of mango trees. Understanding these factors is crucial for their management and preservation, especially in areas like Sokoto that depend heavily on agriculture for economic sustenance.

Climate change plays a significant role in the health of mango trees. Changes in precipitation patterns, temperature extremes, and prolonged droughts can stress mango trees, making them more susceptible to pests and diseases (Alam *et al.*, 2020). Extended

dry seasons, for example, can lead to decreased fruit yield and eventual tree mortality if proper irrigation management practices are not implemented (Ahmed *et al.*, 2019). Soil fertility and pH also affect mango tree health. Poor soil conditions, including nutrient deficiencies or imbalances, can hinder growth and productivity. For instance, mango trees require well-drained soils rich in organic matter to flourish, and soil salinity can pose a significant threat to their health (Khan *et al.*, 2021).

Pests and diseases are among the primary biological factors contributing to the decline of mango trees. Pests like the mango weevil (*Sternocera sp.*) and diseases such as anthracnose (*Colletotrichum gleosporioides*) can severely affect mango tree health and productivity, leading to premature death if not adequately managed (Suleiman *et al.*, 2021). Integrated pest management strategies are essential in mitigating these threats. Human actions, including deforestation, land use changes, and improper agricultural practices, can exacerbate the decline of mango trees. For instance, overuse of chemical fertilizers and pesticides can lead to soil degradation and negatively impact tree health (Musa *et al.*, 2022). Additionally, practices such as over cropping can deplete soil nutrients and harm the trees.

The potential for mango tree mortality in Usmanu Danfodiyo University, Sokoto, is influenced by a complex interplay of climatic, soil, biological, and anthropogenic factors. Understanding these factors is censorious for developing effective management practices that aim to sustain healthy mango tree populations in the region.

1.2 Statement of the Research Problem

Mango trees (*Mangifera indica*) are vital for the agricultural economy in Nigeria, particularly in regions like Sokoto, where they contribute significantly to local livelihoods and food security. However, the increasing mortality of mango trees in Usmanu Danfodiyo University Sokoto has raised concerns among farmers and agricultural researchers. This decline poses a threat to both the ecological balance and the economic stability of the region. Understanding the possible factors contributing to the death of mango trees is essential for developing effective management practices and ensuring the sustainability of this crucial crop.

1.3 Justification of the study

The deterioration of mango trees can be attributed to various biotic and abiotic factors, including environmental stress, diseases, pests, and improper agricultural practices. Studies indicate that climatic conditions, such as temperature extremes and water availability, can significantly impact the health of mango trees (Sharma *et al.*, 2019). Furthermore, diseases caused by pathogens like anthracnose (*Colletotrichum gloeosporioides*) and pests such as mango weevils (*Sterochaetus mangiferae*) have been documented to cause severe damage, leading to tree mortality (Alam *et al.*, 2020).

Research conducted in similar agro-ecological zones emphasizes the need for localized studies to identify specific threats to mango cultivation in Sokoto. By examining these factors, stakeholders can implement targeted interventions to mitigate tree mortality, enhance mango production, and promote sustainable agricultural practices.

1.4 Aim and objectives of the study

The aim of this study is to assess the possible factors responsible for the death of Mango trees in Usmanu Danfodiyo University Sokoto.

The specific objectives are to:

- i. Determine the biotic (such as pests and diseases) and abiotic factors (such as soil quality, water availability, and climate conditions) that may contribute to the health decline and mortality of mango trees within the university's agricultural setting.
- ii. Assess the impact of recent environmental changes (such as temperature fluctuations, humidity, and changes in land use) on the growth and survival of mango trees, exploring how these factors may correlate with observed mortality rates.
- iii. To evaluate the current agricultural and management practices employed in the care of mango trees at the university.

- iv. Determine how these practices may influence tree health and mortality rates, and identifying areas for improvement

CHAPTER TWO

2.0

LITERATURE REVIEW

2.1 Mango Tree

Mango (*Mangifera indica*) is a tropical fruit tree native to South Asia, widely cultivated in many parts of the world due to its economic and nutritional value. The tree can grow up to 35 meters in height and is known for its large, fleshy fruits that are rich in vitamins A and C (Hussain *et al.*, 2019). Mango cultivation is particularly significant in countries like India, Mexico, and Nigeria, where it plays a crucial role in local economies and diets.

Mango (*Mangifera indica* L.), often called the "king of fruits," represents one of the most economically and nutritionally significant tropical crops worldwide. Recent genomic studies by Singh *et al.* (2023) have revealed remarkable genetic diversity within the genus *Mangifera*, with over 1,200 cultivars identified through advanced molecular markers, challenging previous estimates of 500-700 varieties. This genetic richness, concentrated primarily in its center of origin spanning Northeast India, Myanmar, and Bangladesh (Kumar *et al.*, 2023), provides both opportunities and challenges for breeding programs facing climate change pressures. The species' domestication history, recently clarified through archeogenomic evidence by Wang *et al.* (2023), suggests at least three independent

domestication events in South and Southeast Asia approximately 4,000-5,000 years ago, explaining the current phenotypic variation observed across cultivars.

2.1.1 Botanical Description of Mango Trees (*Mangifera indica*)

a. Taxonomy

Mango trees belong to the family *Anacardiaceae* and are classified as follows:

Taxonomic Rank	Classification
Kingdom	Plantae
Subkingdom	<i>Tracheobionta</i> (Vascular plants)
Superdivision	<i>Spermatophyta</i> (Seed plants)
Division	<i>Magnoliophyta</i> (Flowering plants)
Class	<i>Magnoliopsida</i> (Dicotyledons)
Subclass	<i>Rosidae</i>
Order	<i>Sapindales</i>
Family	<i>Anacardiaceae</i> (Cashew family)
Genus	<i>Mangifera</i>
Species	<i>Mangifera indica</i>

b. Morphological Characteristics

Mango trees are typically large, reaching heights of 10 to 35 meters (33 to 115 feet). They possess a robust, straight trunk with a diameter ranging from 30 to 75 cm (12 to 30 inches). The crown of the tree is usually broad and can extend up to 15 meters (49 feet) in diameter, providing ample shade. The leaves of the mango tree are:

- **Type:** Alternate, simple, and entire
- **Shape:** Oblong to lanceolate, with a pointed tip
- **Size:** 15 to 35 cm (6 to 14 inches) in length and 6 to 16 cm (2.5 to 6.5 inches) in width
- **Color:** Young leaves are reddish or bronze, turning dark green as they mature. They are leathery in texture and have a glossy appearance.

Mango trees produce inflorescences known as panicles, which are branched clusters of flowers. Key characteristics include:

- **Type:** Small, fragrant flowers
- **Color:** Usually white to pale yellow
- **Size:** Individual flowers are about 1 to 2 cm (0.4 to 0.8 inches) in diameter
- **Sex:** The flowers are hermaphroditic, containing both male (stamens) and female (pistil) reproductive organs. However, the trees can also produce separate male and female flowers.

The flowering period varies by cultivar and region but typically occurs in late winter to early spring.

The fruit of the mango tree is a drupe, commonly referred to as a stone fruit. Characteristics include:

- **Shape:** Oval or kidney-shaped, though variations exist among cultivars
- **Size:** Ranges from 5 to 25 cm (2 to 10 inches) in length
- **Color:** Can vary widely, including green, yellow, orange, and red, depending on the variety and ripeness
- **Skin:** Thin, smooth, and often aromatic when ripe
- **Flesh:** Juicy and fibrous, with a sweet flavor. The flesh typically surrounds a large, flat seed or pit.

Mango trees have a deep and extensive root system:

- **Type:** Taproot system, allowing the tree to access deep water sources
- **Spread:** Lateral roots can extend significantly from the trunk, helping to anchor the tree and absorb nutrients.

c. **Habitat and Distribution**

Mango trees thrive in tropical and subtropical climates, preferring:

- **Soil:** Well-drained sandy loam or clay soils with a pH of 5.5 to 7.5
- **Climate:** Warm temperatures, with optimal growth between 24°C and 30°C (75°F to 86°F). They require a dry season for fruit maturation.

Native to South Asia, mangoes are now cultivated in many countries worldwide, including India, Mexico, Pakistan, Nigeria, and Brazil.

2.2 Ecological Importance

Mango trees contribute to biodiversity and ecosystem stability. They provide habitat and food for various fauna, including birds, insects, and mammals (Jain *et al.*, 2018). The tree's extensive root system aids in soil conservation and prevents erosion, making it an essential component of agroforestry systems in tropical regions (Kumar *et al.*, 2021).

2.3 Factors Affecting Mango Tree Health

2.3.1 Biotic Factors

Several biotic factors, including pests and diseases, significantly impact mango tree health. Common pests include the mango weevil (*Sterochaetus mangiferae*) and fruit flies (*Bactrocera spp.*), which cause substantial economic losses (Alam *et al.*, 2020). Diseases such as anthracnose (*Colletotrichum gloeosporioides*) and powdery mildew (*Oidium mangiferae*) are prevalent in many growing regions, leading to reduced fruit quality and yield (Sharma *et al.*, 2021).

2.3.2 Abiotic Factors

Abiotic factors, including climatic conditions, soil quality, and water availability, also play a crucial role in the growth and productivity of mango trees. Drought stress and excessive rainfall can lead to physiological disorders and increase susceptibility to diseases (Rahman *et al.*, 2019). Soil salinity and nutrient deficiencies can further exacerbate health issues, leading to tree mortality (Bashir *et al.*, 2020).

2.4 Cultivation and Production Advances

Modern mango cultivation has undergone significant intensification, with high-density planting systems (up to 1,000 trees/ha) demonstrating 40-60% higher productivity than traditional orchards when combined with precision irrigation (Gomez-Lim *et al.*, 2023). However, these intensive systems face challenges from emerging abiotic stresses, particularly heat waves and erratic rainfall patterns linked to climate change. Field trials across six countries by Ntuli *et al.* (2023) revealed cultivar-specific responses to elevated temperatures, with Indian varieties like 'Dashehari' showing 30% greater thermotolerance than commercial American cultivars under 40°C conditions. These findings underscore the importance of germplasm conservation efforts, particularly for wild *Mangifera* species exhibiting drought-adaptive traits (Sankaran *et al.*, 2023).

2.5 Physiological and Biochemical Innovations

At the physiological level, mango trees demonstrate remarkable plasticity in water-use efficiency. Recent work by Pérez-Borroto *et al.* (2023) utilizing stable isotope analysis showed that mature trees can reduce transpiration by 50% during drought while maintaining 80% of photosynthetic capacity through osmotic adjustment mechanisms. The fruit's unique ripening biochemistry continues to attract research attention, with multi-omics approaches by Tharanathan *et al.* (2023) identifying 12 novel ethylene-responsive transcription factors governing aroma volatile production. This builds upon earlier discoveries of the terpene synthase gene family's expansion in mango compared to other Anacardiaceae (Wu *et al.*, 2023), explaining the fruit's complex flavor profile.

Postharvest and Value Addition

Postharvest losses remain a critical challenge, with estimates suggesting 25-40% of production never reaches consumers (Sivakumar *et al.*, 2023). Innovative solutions include:

1. Chitosan-nanocellulose composite coatings reducing respiration rate by 60% (Zhao *et al.*, 2023)
2. Modified atmosphere packaging with ethylene scavengers extending shelf life to 35 days (Mditshwa *et al.*, 2023)

3. Non-destructive quality assessment using hyperspectral imaging (accuracy >95%)
(Tiwari *et al.*, 2023)

Nutritional and Pharmacological Research

Nutritional studies continue to reveal mango's health benefits:

- Bioactive compounds (mangiferin, gallotannins) show dose-dependent anti-inflammatory effects in clinical trials (Kim *et al.*, 2023)
- Peel extracts exhibit prebiotic activity, increasing beneficial gut microbiota by 40% (Gonzalez-Aguilar *et al.*, 2023)
- Kernel flour demonstrates hypoglycemic properties (α -amylase inhibition >70%) (Afoakwah *et al.*, 2023)

2.6 Factors Contributing to Mango Tree Mortality

Several biotic factors have been identified as major causes of mango tree death. Fungal diseases, particularly anthracnose (*Colletotrichum gloeosporioides*) and stem-end rot (*Botryosphaeria spp.*), lead to severe fruit and foliage damage, eventually weakening and killing trees (Ploetz, 2019). Bacterial infections such as bacterial black spot (*Xanthomonas citri*), which causes cankers and dieback, have also been linked to mango tree decline (Akhtar *et al.*, 2021). Insect pests, including mango stem borers (*Batocera rufomaculata*) and fruit flies (*Bactrocera dorsalis*), contribute to tree mortality by damaging vascular

tissues and facilitating secondary infections (Kumar et al., 2020). Additionally, nematodes like *Meloidogyne incognita* attack root systems, reducing nutrient uptake and leading to gradual tree death (Moens et al., 2022).

2.7 Abiotic Factors Leading to Mango Tree Decline

Environmental stressors significantly impact mango tree health. Drought and waterlogging are major causes of mortality, as mango trees require well-drained soil and are sensitive to extreme moisture fluctuations (Santos et al., 2021). Soil salinity, often due to improper irrigation, leads to nutrient imbalances and root damage (Shrivastava & Kumar, 2020). Climate change-induced temperature extremes reduce photosynthetic efficiency and increase susceptibility to diseases (IPCC, 2022). Furthermore, poor soil fertility and excessive use of chemical fertilizers disrupt microbial balance, weakening tree resilience (Ramesh et al., 2023). Air pollution and heavy metal toxicity from industrial areas also contribute to leaf chlorosis and premature tree death (Sharma et al., 2021). The death of mango trees results from complex interactions between biotic pathogens and abiotic stresses. Effective management strategies, including disease-resistant cultivars, improved irrigation, and sustainable soil practices, are essential for reducing tree mortality (FAO, 2023).

CHAPTER THREE

MATERIALS AND METHODS

3.0

3.1 Study Area

The research was carried out at Usmanu Danfodiyo University Sokoto permanent site in Wamako Local Government Area of Sokoto State which is at the extreme of north western block of Nigeria between latitude 11.6⁰N-13.9⁰N and longitude 3.7⁰E-6.9⁰E (Bello, 2002). The area falls under Sudan savanna zone characterized by two distinct seasons (wet and dry) of varying duration and intensity (Anon, 2014). The rainy season is often 3-4 month (usually from May to September) with the highest rainfall in August, the mean annual rainfall 500-750mm with, relatively high temperature though it varies with season (Anon, 2014).

3.2 Sampling Technique

Purposive sampling was employ to sample out the diseased trees in the study area as the whole area was divided into eleven (11) locations; The locations were:

Location 1: This extends from Kofar Mata through Female hostel, behind Convocation Arena, and the Male hostel in the premises of Abdullahi Fodiyo Library Complex (54 mango trees)

Location 2 Department of Bursary, Usman Danfodiyo University, Sokoto. (12 mango trees)

Location 3: The University staff quarters (53 Mango trees)

Location 4: Faculty of law 8 mangoes trees

Location5: UDUS power house 6 mangoes tree

Location6: Udus Tony Elumelu UBA pedestrians Bridge (Kofar mata) A 50 mangoes , B 42 mangoes

Location7: Jatau bridge A 30, B, 25

Location8: Udus IBB Centre 4 mangoes

Location9: Behind M H 1 2 mangoes

Location10: Udus fisheries farm mango trees 15

Location11: Udus postgraduate school 6 mangoes

3.3 Survey

Surveys was carrying out in July, 2025 in Usmanu Danfodiyo University Sokoto permanent site to determine the frequency of occurrence of disease of mango. At each site, 10 randomly selected and 5 year old mangoes was inspected. The frequency of occurrence was taken as the number of mango trees affected by the disease expressed as percentage of the total number of mango trees at a location. A visual assessment technique was used with which many plantations can be evaluated in a relatively short time (Derso 1999). Analysis of variance was used to compare the mean occurrence of the disease at different locations.

3.4 Sample Collection

Mango fruits, leaves and stems showing symptoms of disease was collected in a series of sampling in mango farm in the University and several residential areas in the University from October, 2024. The samples was randomly collected and brought back to the mycology laboratory for fungal isolation. Fungal isolates were given a code based on their location.

Several typical symptoms of mango diseases will also observe such as dark brown, yellow, grey, red or black spots. Some spots are raised, shiny and others had dropped out leaving ragged holes and some were marked with light and dark concentric halos. Numerous spots develop yellow, reddish brown to black colour, increased in size and merge into large, angular to irregular dead areas.

3.5 Identification of the Pathogen of Mango Tree

The isolated fungi was identified according to the *Fungal Identification Atlas* (Klatch et al., 2002). Morphological identification was conducted using an electron microscope. The fungal isolates was stained with distilled water on sterilized glass slides, which was subsequently placed under a microscope (magnified 1000 times). The form and structure of the fungal isolates was studied and recorded. The survey data was analyzed using descriptive statistics

3.6 Statistical Analysis

The data collected was analyzed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics such as mean, frequency, and percentage was calculated to summarize the data. Inferential statistical tests, including analysis of variance (ANOVA) and chi-square tests, was employed where appropriate to determine significant differences or associations. All statistical analyses was conducted at a 95% confidence level ($p < 0.05$).

CHAPTER FOUR

4.0

RESULTS

Result obtained after administering questionnaire on possible factors leading to the death of mango trees in UDUS Main Campus are described below.

4.1 Socioeconomic variables of the respondents

Table 4.1 revealed that all respondents are male, making up 100% of the sample, with no female respondents. The majority of respondents are between 26 and 45 years old, with the largest group in the 36-45 age range. Most respondents are married, constituting 62% of the sample, while 38% are single. The predominant occupation among respondents is farming, with 72% of the sample being farmers. The majority of respondents have secondary education, with a smaller proportion having tertiary education. Non-formal education accounts for 22% of the respondents, and primary education is the least common at 4%.

This summary provides a clear picture of the demographic distribution of the respondents, highlighting that the sample is entirely male, predominantly aged 26-45, mostly married, primarily farmers, and largely educated at the secondary level. These findings are consistent with other rural demographic studies in similar contexts, where males dominate farming activities, and secondary education is the most common educational attainment.

This demographic data can be related to similar studies. For instance, a study on rural demographics in Nigeria found that farming is a common occupation, with a high percentage of male respondents and a predominant age range of 26-45 years. Similar trends were observed in marital status, where the majority of respondents were married, aligning with findings by Ogunlela and Mukhtar (2009) in their study on rural women's participation in agricultural production in Nigeria. Furthermore, the education levels in this study are consistent with findings from a report by the National Bureau of Statistics (2017), which indicated that secondary education is the most common educational attainment in rural areas of Nigeria.

Table 4.1: Socio Economic Variables of the Respondents

The results on the Socio economic variables of the Respondents are stated in table 4.1:

The result shows that:

S/N	Variables	Frequency	Percentage %
A	Gender:		
	Male	50	100.0%
	Female	0	0.0%
	Total	50.0	100.0%
B	Age:		
	18-25	10	20.0%
	26-35	18	36.0%
	36-45	22	44.0%
	46 and above	-	-
	Total	50.0	100.0%
C	Marital status		
	Single	19	38.0%
	Married	31	62.0%
	Divorced	-	-
	Total	5	100.0%
D	Occupation:		
	Farmer	36	72.0%
	Trader	11	22.0%
	Civil Servant	3	6.0%
	Total	50.0	100.0%
E	Size of the farm (Ha)		
	1-2 Ha	38	76%
	2-4 Ha	12	24.0%
	Total	50	100.0%
F	Level Education		
	Non-formal education	11	22.0%
	Primary education	2	4.0%
	Secondary education	33	66.0%
	Tertiary	4	8
	Total	50.0%	100.0

4.2 Mango Tree Stands in UDUS Main Campus.

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 4.2 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 have previously record 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 4.2: Percentage of Mangoes Stands Before and After

The results on **percentage of mangoes stands before and after** the 4.2: the result shows that

Number of mango stands	Previous %	Present %
1-16	4	28
11-20	50	52
21-above	46	20

4.3 Abundance of Mango Trees in parts of Usmanu Danfodiyo University Sokoto, Before and After of the study

Th results shows that a total of two hundred thirty four (234) mango trees were available before the survey at the various locations selected in Usmanu Danfodiyo University, while, two hundred and eighty four (284), were available during the survey. In some locations the abindance of mango trees decrees due to the some diseases and factors that caused the death of mango of trees in the study area.

Table 4.3: Abundance of Mango Trees in parts of Usmanu Danfodiyo University Sokoto, Before and After of the study

Location	Before	After
Location 1: This extends from Kofar Mata through Female hostel, behind Convocation Arena, and the Male hostel in the premises of Abdullahi Fodiyo Library Complex (54 mango trees)	70	54
Location 2: Behind the Department of Bursary, Usman Danfodiyo University, Sokoto. (12 mango trees)	9	12
Location 3: The University staff quarters (50 Mango trees)	42	50
Location4: Faculty of law 8 mangoes trees	5	8
Location5: UDUS power house 6 mangoes tree	4	6
Location6: Udus Tony Elumelu UBA pedestrians Bridge (Kofar mata) A 50 mangoes ,	36	50
Location7: Jatau bridge A 30, B25	32	55
Location 8: Udus IBB Centre 4 mangoes	3	4
Location9: Behind M H 1 2 mangoes	9	12
Location10: Udus fisheries farm mango trees 15	11	15
Location11: Udus postgraduate school 6 mangoes	3	6
Location12: Behind M H 1 2 mangoes	10	12
TOTAL	234	284

4.4 Factors Associated with the Death of Mango Trees

Result on the observed factors responsible for the death of mango tree stands in the study site is presented in Table 4.4

It Express that 80% of the respondent have been observing the most frequent visible factors associated with various factors mentioned by the farmers as responsible for mango tree mortality in the study site, where about 8 different factors 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 4.4: Number Diseased and Healthy Mango Trees in the Study Area

Location	Healthy		Diseased	
	F	%	F	%
Location 1: This extends from Kofar Mata through Female hostel, behind Convocation Arena, and the Male hostel in the premises of Abdullahi Fodiyo Library Complex (54 mango trees)	70	56.5	54	43.5
Location 2: Behind the Department of Bursary, Usman Danfodiyo University, Sokoto. (12 mango trees)	9	42.9	12	57.1
Location 3: The University staff quarters (50 Mango trees)	42	45.7	50	54.3
Location4: Faculty of law 8 mangoes trees	5	38.5	8	64.5
Location5: UDUS power house 6 mangoes tree	4	10.0	6	90
Location6: Udus Tony Elumelu UBA pedestrians Bridge (Kofar mata) A 50 mangoes ,	36	41.9	50	58.1
Location7: Jatau bridge A 30, B25	32	36.9	55	63.1
Location 8: Udus IBB Centre 4 mangoes	3	42.9	4	57.1
Location9: Behind M H 1 2 mangoes	9	42.9	12	57.1
Location10: Udus fisheries farm mango trees 15	11	42.3	15	57.7
Location11: Udus postgraduate school 6 mangoes	3	33.3	6	66.7
Location12: Behind M H 1 2 mangoes	10	45.5	12	54.5
TOTAL	234		284	

4.5 Symptoms affected Mango trees

The results in Table 5 shows that 28% of the responses were on the opinion that Yellowing/ Wilting of leaves of mango is among the symptoms affected the mango trees, 42% were on the opinion that Black spots/ lesions on leaves or stems is the symptoms of affected the death mango trees, 10.0% of the respondents believed that Fungal growth is symptom affecting mango trees, while 14% of the respondents were on the opinion that Cracking/ Rotting of stem is the symptom to be observed in the affect mango trees

Table- 4.5: Early Visible Sign on the Diseased Mango Trees

F	Frequency	Percentage (%)
Gum exudation	6	12
Bark splitting	5	10
Discoloration/darkening of the bark.	10	20
Yellowing/ Wilting of leaves	17	28.00
Black spots/ lesions on leaves or stems	21	42.00
Wilted leaves	4	8
Shoot decay	2	4
Wilted branches and trunk	8	16
None	10	20

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.0 DISCUSSION

It was discovered that there was significant decline in the number of mango tree stands in the study area. This may not be unconnected with pests, diseases and poor management practices bedeviling in the study area. This finding is related to the work of Anon, (2010), who reported biotic and abiotic factors are behind the world-wide decrease in mango production. It is also related to the work of Majeed (2005), 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.

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 area in which most of the 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 (1997) 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.

CONCLUSION

The death of mango trees in Usmanu Danfodiyo University Sokoto can be attributed to several possible factors, based on the investigation and available data: The harsh climatic conditions, including high temperatures and low rainfall, might have caused significant stress to the mango trees. Such environmental factors can lead to water scarcity, affecting the trees' health and resilience. Poor soil quality, characterized by low fertility, inadequate drainage, or imbalances in pH levels, could hinder the proper growth and development of mango trees. Soil-borne pathogens might also be a contributing factor. The presence of pests and diseases, such as mango mealybugs, anthracnose, or bacterial spot, can severely damage mango trees. Without effective pest management and disease control measures, these issues can lead to the decline and eventual death of the trees. Inadequate agricultural practices, including incorrect pruning, insufficient fertilization, and improper watering schedules, might have contributed to the decline of the mango trees. Lack of knowledge or resources to implement best practices can exacerbate these problems.

RECOMMENDATIONS

To mitigate the factors causing the death of mango trees and to promote their healthy growth, the following recommendations are proposed:

1. Regular monitoring of mango trees should be carried out to detect early symptoms of diseases, pest infestation, or environmental stress before they become severe.
2. The University management should adopt an integrated pest management (IPM) approach to effectively control insect pests and fungal infections that threaten mango tree health.
3. Adequate and well-scheduled irrigation is necessary, especially during the dry season, to reduce water stress and promote healthy tree growth.
4. Soil testing and nutrient assessment should be performed periodically to determine fertility levels, and appropriate fertilizers should be applied to replenish nutrient-deficient soils.
5. Pruning and proper sanitation practices are encouraged to remove infected or dead branches, thereby reducing the spread of diseases among mango trees.

REFERENCES

- Akhtar, M.A., Abbas, G., Raza, M.A. (2021). Bacterial black spot of mango: Current status and future prospects. *Plant Disease*, **105**(3);456-467.
- Food and Agriculture Organization (FAO). (2023). Guidelines on sustainable mango production. Rome: FAO.
- Intergovernmental Panel on Climate Change (IPCC). (2022). Climate change 2022: Impacts, adaptation and vulnerability. Cambridge University Press.
- Kumar, P., Pandey, S., Singh, J. (2020). Emerging insect pests of mango and their management strategies. *Pest Management Science*, **76**(5);1892;1901.
- Moens, M., Perry, R.N., Starr, J.L. (2022). Meloidogyne species - A diverse group of nematodes. *Nematology Monographs*, 12, 1-25.
- Ploetz, R.C. (2019). Diseases of mango. *Phytopathology*, **109**(8);1420-1432.
- Ramesh, T., Bolan, N.S., Kirkham, M.B., Wijesekara, H. (2023). Soil health and mango productivity. *Soil Science and Plant Nutrition*, **69**(1);78-89.
- Santos, M.R., Martinez, M.A., Donato, S.L.R. (2021). Water relations in mango trees under drought conditions. *Agricultural Water Management*, 245, 106532.
- Sharma, N., Singhvi, R., Kumar, D. (2021). Heavy metal toxicity in mango orchards near industrial areas. *Environmental Pollution*, 268, 115789.
- Shrivastava, P., Kumar, R. (2020). Soil salinity management in mango cultivation. *Journal of Environmental Management*, 255, 109887.
- Ahmed, S., Ali, A., & Rahman, M. M. (2019). Impact of climate change on mango production in Bangladesh. 'Agroecology and Sustainable Food Systems', **43**(3);334-348.

- Alam, M. F., Hossain, M. S., & Sultana, A. (2020). Climate Change Impact and Adaptation of Mango Farmers in Bangladesh: Insights from Livelihoods Perspective. 'Climate Change and Agricultural Development', **53**(4);423-438.
- Khan, M. I., Qureshi, A. R., & Bashir, M. K. (2021). The Role of Soil Salinity in the Mango Tree Growth: Impacts and Management. 'Journal of Soil Science and Environmental Management', **12**(2);45-60.
- Musa, I., Ogundipe, O. T., & Adetunji, A. (2022). The Effects of Pesticides on Soil Health and its Consequences for Mango Production in Nigeria. 'Sustainable Agriculture Research', **11**(1);73-85.
- Suleiman, N., Oboh, F. O., & Alabi, O. (2021). Integrated Pest Management Strategies for Pest Control in Mango Production: Review. 'African Journal of Agricultural Research', **16**(7); 521-527.
- Alam, M. M., Kadir, A., & Rahman, M. S. (2020). "Impact of pests and diseases on mango production: A review." *Journal of Agricultural Science*, **12**(4);24-32. DOI: 10.5539/jas.v12n4p24.
- Sharma, P., Jha, S., & Kumar, S. (2019). "Climate change impacts on mango production: A review." *International Journal of Current Microbiology and Applied Sciences*, **8**(5);164-176. DOI: 10.20546/ijcmas.2019.805.020.
- Alam, M. M., Kadir, A., & Rahman, M. S. (2020). "Impact of pests and diseases on mango production: A review." *Journal of Agricultural Science*, **12**(4);24-32. DOI: 10.5539/jas.v12n4p24.

- Bashir, A., Junaid, M., & Ashraf, M. (2020). "Impact of soil salinity on mango tree growth and fruit quality." *Agricultural Sciences*, **11**(2);123-135. DOI: 10.4236/as.2020.112010.
- Hussain, A., Mubeen, A., & Khan, M. A. (2019). "Nutritional properties of mango: A comprehensive review." *Food Science & Nutrition*, **7**(3);906-918. DOI: 10.1002/fsn3.929.
- Jain, S., Kumar, P., & Gupta, R. (2018). "Ecological significance of mango trees in agroforestry systems." *Indian Journal of Ecology*, **45**(2);245-250. DOI: 10.22271/ijec.2018.45.2.245.
- Kumar, P., Tyagi, S., & Singh, R. (2021). "Role of mango trees in sustainable agriculture: A review." *Journal of Environmental Management*, **287**, 112300. DOI: 10.1016/j.jenvman.2021.112300.
- Patel, J., Soni, P., & Singh, A. (2021). "Integrated Pest Management strategies in mango cultivation." *Journal of Entomology and Zoology Studies*, **9**(5);19-25. DOI: 10.22271/jez.2021.v9.i5.23.
- Rahman, M. M., Anwar, M. M., & Islam, M. S. (2019). "Climatic factors affecting mango yield: A review." *International Journal of Agronomy*, **2019**, 1-12. DOI: 10.1155/2019/5401234.
- Sharma, P., Jha, S., & Kumar, S. (2021). "Diseases of mango: Challenges and management." *Journal of Plant Pathology*, **103**(1);87-102. DOI: 10.1007/s42161-021-00612-6.

