PLANT HEALTH AND HUMAN SURVIVAL

"A PLACE FOR PHYTOPATHOLOGIST"

INAUGURAL LECTURE

DELIVERED

BY

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B.Sc.(BUK); M.Sc. (UI) Ph.D. PGDE (UDUS)

PROFESSOR OF BOTANY

Thursday, 30th day of September, 2021

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بِسم الله الرَّحْمَن الرَّحِيم

COURTESIES

In the Name of Allah, the Beneficient, the Merciful. The creature, Sustainer and the Lord of the spectacular biological World. All praise are due to him (SWT) alone. Maythe peace and salutations of Allah be upon noble Prophet Muhammad (SAW), His household and comanions

The Vice chancellor,

Deputy Vice chancellors

Registrar

Librarian

Bursar,

Other Principal Officers of the University

Dean of the postgraduate School , provost college of Health Sciences and Deans of other faculties here present.

Directors of Academic and Non-Academic Departments

Professors and members of the senate

Head of Departments

Academic and Non-Teaching staff

Members of my family

Invited Guest

Postgraduate and undergraduate students

Gentlemen of the press

Ladies and Gentlemen

Assalamu-Alaikum Warahmatullah

Felicitations and Preamble!!

It gives me pleasure and satisfaction to be given this opportunity to deliver my inaugural lecture which I had for long wanted to do. I was appointed Professor of Botany on 1st October 2008 and since then engaged in several University activities both within and outside the country and in both Governmental and Non-Governmental organizations

Inaugural Lecture is a way of letting people know what academic/research activities a Professor has carried out over the years and what his/her future research interests are.

Now I am ready to share with you my experiences as a Professor of Botany, so that you can appreciate what I have been professing. I am happy and excited but before I go further, I must express my gratitude to the Vice Chancellor, Professor Lawali Suleiman Bilbis and his entire administration for sustaining this essential aspect of academic life and also for providing Inaugural Lectures and Seminar Committee the finance and other support needed to organize this inaugural lecture. I thank the Chairman of Inaugural Lecture and Seminar Committee Professor Ahmed Bako and his colleagues for organizing this great event.

My choice of topic for this inaugural lecture was influenced by the prevalent food shortage as a result of plant diseases epidemics in present day Nigeria (About 34% of the crop produce is lost annually due to diseases, insect-pests and weeds on the global basis FAO 2012). It is glaringly clear that food supply is on a steady decline. The consistent rise in food prices attests to this assertion. Food is the most basic human need and access to it is a basic human right. The domestication and cultivation of plants, which began almost ten thousand (10,000) years ago, were aimed at ensuring that this need was met. While food production is not a problem for the developed countries, the need to increase crop yield is an urgent issue in Nigeria and many other African countries. Today, most Africans cannot feed well. There is no pretence about this. Africa has more countries with food insecurity problems than any other region (FAO, 2004).

An inaugural lecture is a major milestone in the life of an academic who is a Professor. It is a celebration of upliftment to the exalted rank of Professor. Trust me, it is not easy to become a Professor. But by Allah's Grace I, for one, was determined from the onset, to get to that height and I worked for it step by step.

There would be no great ones if there were no little ones

---George Herbert

The great and thme little have need of one another

----thomas Fuller

INTRODUCTION

An inaugural lecture is an occasion of significance in an academic staff member's career at the University. Inaugural lectures provide newly appointed professors with the opportunity to inform colleagues, the campus community and the general public of their work to date, including current research and future plans. Inaugural lecture also introduce a professor to the academic and non-academic community of the University, and provide opportunity for engagement with the greater community.

This lecture is one of a kind, over the past 30 years of my career, I have lectured and taught students in the different cadres ranging from the Senior Secondary School Certificate (SSCE) (I participated in WAEC marking for 9-year), Interim Joint Matriculation Board (IJMB), Predegree/Matriculation programme, Undergraduate, and postgraduate (postgraduate diplomas Masters and Doctoral degrees) and in the process carried them through the pedagogical process to earn their certificates.

It is my honour and privilege to stand before you today, Thursday 30th day of September 2021 to present my inaugural lecture as a professor of Botany. Im happy and delighted that today's inaugural lecture is the series number 27th and today Im exactly 13 years on professorial (27, and 13) are odd numbers, most loved by Allah, Thursday is a special day as reported from our noble prophet Muhammad (SAW). This lecture is special for me in many respects; the first from my Unit Botany (now Department of Plant Science) and of course the first Botany Inaugural lecture from Usmanu Danfodiyo University, Sokoto. I am here as a Professor of Botany to tell you a little of what I have been professing in the last 13 years

Mr. Vice Chancellor Sir, Inaugural Lectures is done in a simplified manner that individuals who do not belong to the same field with the scholar will understand what the lecturer has come to say. For this reason, In this lecture, I will take you through the meaning of Botany, Botany as a discipline, areas of study in Botany, my chosen area of specialization in Botany (Phytopathology); my contributions to the plant heath for well being of Mankind/contributions to other areas of Botany and Biological Sciences in general; My future Research plans; My rough ride through life, UDUS My Alma mater and finally Conclusions/Recommendations

1.0 BOTANY

1.1 Meanig of Botany

Botany is the scientific study of plants. "Plants," to most people, means a wide range of living organisms from the smallest bacteria to the largest living things - the giant sequoia trees. By this definition plants include: algae, fungi, lichens, mosses, ferns, conifers and flowering plants. Today scientists believe bacteria, algae and fungi are in their own distinct kingdoms,.

Describes the observable phenomena that distinguish living matter from non-living matter and dead. All such information that is pertaining to plants is known as **botany.**

1.2 Botany as a discipline

Botany is one of the branches of life sciences (Biology), which is concerned with all aspects of the study of plants, from the study of all aspects of a single plant to the complex interactions of all the different members of a complicated botanical community of plants with their environment and their importance to the humanity. Plants are now defined as multicellular organisms that carry out photosynthesis. Organisms that had previously been called plants, however, such as bacteria, algae, and fungi, are continually placed in the province of botany, due to their historical connection with the discipline and their similarities to true plants, and because of the practicability of not fragmenting the study of organisms into too many separate fields.

1.3. **Areas of study in Botany**,

Research in botany has progressed by breaking down the complex subject into its component part so that there are numerous branches and fields to study plants and their importance. With the study of plants in botany, the following are the well known disciplines which one can get involved in:

1. Plant morphology
2. Plant Anatomy.
3. Plant Cytology.
4. Plant Taxonomy
5. Plant Physiology.
6. Plant Evolution.
7. Plant Reproduction.
8. Plant Genetics.
9. Plant breeding.
10. Plant Ecology
11. Phytopathology (Plant Pathology)

In collaboration with other fields of science that is, applied science there are many more disciplines which are of vital importance to the world population, these include: -

1. Agricultural science
2. Horticulture
3. Agronomy
4. Pharmaceutical sciences

5. Medical sciences
6. Biochemistry
7. Microbiology
8. Applied genetic engineering etc

.Historical Development

Civilization depends in part on knowledge of plants and their cultivation, botany was belief to have originated with the first cultivation of crops, which was probably dated from 9000-7000 BC. However, man become interested in plants for their own sake some 2300 years ago. Thus, botany as a pure science began in the 4th century BC with the Greek philosopher Theophrastus, whose treatises on the classification, morphology, and reproduction of plants heavily influenced the discipline until the 17th century. Indeed, the development modern botany actually began to develop about the 16th century, due to the invention of the microscope (1590) and of printing with movable type (1440).

In the 18th century the English chemist Joseph Priestley demonstrated that growing plants "restore" air from which the oxygen has been removed (by the burning of candles or the breathing of animals), and the Dutch physiologist Jan Ingenhousz (1730-99) extended this observation by showing that light is required for plants to restore air. These and other discoveries formed the basis for modern plant physiology, that branch of botany dealing with basic plant functions.

That water moves upward through the wood and that solutes move downward through the stems of plants was discovered independently in the 17th century by Marcello Malpighi in Italy and Nehemiah Grew in England. The cellular nature of plants was first pointed out by the English scientist Robert Hooke in the 17th century, when he observed that cork bark consists of cells. In 1838 the German botanist Matthias Schleiden proposed that all plant tissues consist of cells; this implied a basic sameness of living things and laid the foundation for the development of cytology, the study of the structure and function of cells as individual units rather than as aggregate tissue. The German pathologist Rudolf Virchow showed in 1858 that cells are derived from pre-existing cells, and thus that a continuity exists between past and present living things.

In the 19th century the Austrian botanist Gregor Mendel worked out the basic principles of genetics, using varieties of garden peas and observing variations in their floral and vegetative features. His hybridization experiments required knowledge of the function of the various parts of the flower in reproduction, and this knowledge was derived from the experiments of the Dutch botanist Rudolph Jacob Camerarius, who established the nature of sexual reproduction in plants. Mendel's experiments went unnoticed until the early 1900s; in the meantime, Charles Darwin founded the theory of evolution (which in modern form depends on the principles of genetics) without knowledge of Mendel's work. The source of differences and changes was not known, however, until the Dutch botanist Hugo Marie de Vries observed the spontaneous appearance of

new traits in otherwise predictable crosses of evening primroses and suggested that these were the result of changes, or mutations, in the genes.

Knowledge of anatomy, genetics, and evolution has greatly advanced plant classification by providing a rational basis for this subdivision of botany. The 17th-century British naturalist John Ray divided plants into non-flowering and flowering types, and flowering plants into dicots and monocots. The 18th-century Swedish botanist Carolus Linnaeus, however, provided the framework on which modern classifications are based and, just as important, a simplified system of nomenclature in which each plant is given two names binomial or binary system: the first, the name of the genus and the second, the name of the species.

Modern Botany

Botany is a pure science concerned with investigating the basic nature of plants. Many aspects of botany, however, have direct importance to human welfare and advancement, and applied botany is an important field. Such fields as forestry and horticulture are closely tied to basic botanical studies, whereas those such as pharmacology and agronomy are not as closely related but still depend on basic botanical knowledge.

Hence botanists now occupy themselves with a broad range of activities. Many botanists are in academics teaching and researching into plants.

This include any member of the plant kingdom, comprising about 260,000 known species of mosses, liverworts, ferns, herbaceous and woody plants, shrubs, vines, trees, and various other forms that inhabit the Earth and are also found in its waters. Plants also range in size and complexity from small, nonvascular ones eg mosses, which only survive when in direct contact with surface water, to giant sequoia trees, which has the capacity to draw water and minerals through their vascular systems to elevations of more than 100 m (330 ft).

Out of several members of the plant kingdom, only very small percentages of plant species are directly used by humans for food, shelter, fiber, and drugs. Some of the commonly used species are rice, wheat, corn, legumes, tuber root crops, cotton, conifers, mahogany and tobacco, on which whole economies and nations depend. One of the activities of plant is carrying out photosynthesis and thereby supplying sufficient oxygen to the atmosphere to support the survival of higher animals Dead plants also contribute to the fossil fuels that provide power for industrial society.

Characteristics of Plants as Living things

Plants differ from other eukaryotes because their cells are enclosed by more or less rigid cell walls composed primarily of cellulose. However, the most important characteristic of plants is their ability to photosynthesize. During photosynthesis, plants make their own food by converting light energy into chemical energy. A few plants have lost their chlorophyll and have become saprophytes or parasites−that is, they absorb their food

from dead organic matter or living organic matter, respectively−but details of their structure show that they are evolved plant forms.

Beside the above-mentioned features plants also perform all the characteristics of living things to survive. Such life characteristics includes

1. Nutrition. This is simply referring to feeding. Food is the source of energy, which flows in the living world and makes an organism vital and active. Plants are capable of converting solar energy into organic compounds; hence, they show a superior trophic level among the living organisms. Plants with the green pigments are called **Autotrophs**, while others, which lack it, are called **heterotrophs**.

2. Respiration. This is simply the process by which the energy stored in foods is released so that it can be used by the body activities. The chemical equation for the process is as follows: -

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + Energy$$

Plants show aerobic and anaerobic respiration. Certain plants like anaerobic bacteria live only in the absence of oxygen. They also release energy but not as much as in aerobic respiration.

3. Excretion. This is simply the removal of waste products of metabolism from the body. Plants carry out the process of excretion in order to get rid of the metabolic wastes which other wise may be toxic to the plants.

4. Growth. Like all living organisms plants do grow. The growth is a quantitative change in the body as result of anabolic and catabolic reactions.

5. Movement. Movement in plants may be of the whole body as in taxis (tactic movement) or a part as in tropism or may be special types as nastic movement. The movement may be automatic but mostly induced by external factors such as light, water, temperature, chemical, touch etc.

6. Reproduction. This is simply the process of producing young ones. Like other living organisms plants reproduce in order to perpetuate their species. This usually results in offspring, which resemble their parents genetically. The reproduction may be sexual or asexual.

Asexual: Most of the lower plants reproduced by asexual reproduction methods. In this method only one individual is involved in the reproduction, by means of asexual spores. Vegetative methods are observed in higher plants, which may be natural or artificial.

Sexual: Plants that grow from seeds reproduce sexually. The male and female parts are in the flowers of some plants. The male part is called a stamen. The sperm is called pollen. The female part is called a pistil. The egg grows inside the pistil. Bees, birds, and even the wind carry the pollen to the pistils. Some plant species have different male and female plants. But in many species, the male and female parts are on the same plant.

7. Irritability. like animals plants show reactions towards the external stimulus example: movement towards direction of light, opening closing and of flowers during day and night, closing of leaves on touching some plants etc.

Classification of Plants

Taxonomy

Taxonomy is the science of classification, identification, and nomenclature. For classification purposes, organisms are usually organized into subspecies, species, genera, families, and higher orders. For eukaryotes, the definition of the species usually stresses the ability of similar organisms to reproduce sexually with the formation of a zygote and to produce fertile offspring. Classification and identification of an organism should be based on its overall morphological and biochemical pattern. A single characteristic regardless of its importance, is not a sufficient basis for classifying or identifying an organism

What is classification – explain?

Classification is the orderly arrangement of organisms into groups. There is nothing inherently scientific about classification, and different groups of scientists may classify the same organisms differently. For example, clinical microbiologists are interested in the serotype, antimicrobial resistance pattern, and toxin and invasiveness factors in *Escherichia coli*, whereas geneticists are concerned with specific mutations and plasmids

Why do we classify?

Something like one – and a half million different kinds of living organisms have been discovered on the planet and it has been estimated that there may be 10 – 100 million kinds. If one starts studying them singly, then one’s life is not enough to study even a fraction of them but the grouping into groups makes it possible to study them all in a specified period.

- Classification differs according to feature considered and taken into grouping them together.
- The modern systems of classification often emphasize ideas of evolutionary relationships between organisms.
- As we learn more about living organisms, the classification systems are modified, but it is important to know that there is no single perfect system of classification. They are all designed according to convenience. Classification is known as Taxonomy derived from the word taxon, which means the unit of a group.

- Taxonomy deals with the nomenclature of the organisms.

Identification

Identification is the practical use of classification criteria to distinguish certain organisms from others, to verify the authenticity or utility of a strain or a particular reaction, or to isolate and identify the organism that causes a disease.

Nomenclature ‑ is based on bi-nomial system ‑ worked out by Casper Baulin and popularised by Swedish naturalist Carl Linnaeus (1707 ‑ 78). Nomenclature (naming) is the means by which the characteristics of a species are defined and communicated among scientists

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- Organism has two Latin names, a generic beginning with a capital letter and specific name beginning with a lower case letter. For example:

1. Homo sapiens ‑ man
2. Avena satine ‑ frog
3. Zea mays ‑ maize e.t.c.

Species A: species is a distinct organism with certain characteristic features, or a group of organisms that resemble one another closely in the most important features of their organization.

Taxonomic hierarchy

Linnacus arranged a hierarchy with largest group as Kingdom. The groups propounded one still in use till today in descending order of size.

Kingdom ‑ phyla ‑ clan ‑ order ‑ family ‑ genus ‑ species (with sub divisions if needed).

History ‑ only in brief

Artificial classification ‑ based on one or a few early-observed classifications. It is designed for a practical purpose with an emphasis on convenience and simplicity, e.g. all worms together ‑ nematodes, earthworms, snakes e.t.c.

Natural classification ‑ tries to use natural relationships between organisms. It considers more evidence than artificial classification including internal as well as external features similarities and of embryology, morphology, anatomy, physiology e.t.c.

Classification of plants based on the above features, the whole living organisms were grouped into two kingdoms.

1. Plant kingdom 2. Animal kingdom

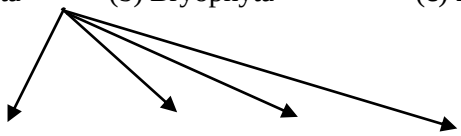
Based on: cytological characters, the presence or absence of cells wall and other features.

Plant kingdom was classified into further grouping based on natural system into two:

1. Cryptogams 2. Phenarogams

1. Cryptogams were grouped into:

(a) Thallophyta (b) Bryophyta (c) Pteridophyta



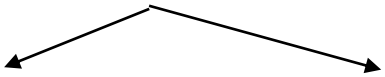
Schizophyta Algae Fungi Lichens

(Bacteria)

2. Phanerogams (Spermatophyta)

(a) Gymnospermae (b) Angiospermae

Opened seeded plants Closed seeded plants



Dicotyledonae Monocotyledonae

Seed with two cotyledons Seed with one cotyledon

Monocotyledonae & Dicotyledonae were further grouped or divided into groups based on floral features (flowers).

This type of classification was accepted and followed for a very long period but for the level twenty years new system of classification has been proposed based on latest cytological evidences instead of separating plants and animals into two separate groups at the initial stage, they were classified into five kingdoms based on the cytological features according to Margulis and Schwarts.

1. Kindom Monera or Procaryotae: are unicellular, prokaryotes, autotrophes or heterotrophs, motile or non – motile e.g. Bacteria or Cynobacteria (Blue green algae). The oldest fossil belongs to this kingdom, so it is thought that they were the first kind of organisms to evolve.

2. Kingdom Protista or Protoctista: are unicellular eukaryotic. They evolved later than bacteria. They resemble the ancestors of plants and animals and fungi include Algae, Protozoa. They live in water because they do not have protection against drying out. Amoeba are animal like feeding on others, Chlorella are plant like autotrophs feed by photosynthesis.

3. Kingdom Fungi – Multicellular without chlorophyll, are heterotrophs, non – motile. They have chlorophyll and are autotrophs.

4. Kingdom Animalia – Multicellular, without (cellular) cell walls, do not have chlorophyll – feed heterotropically.

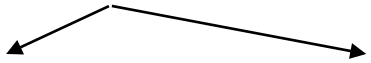
5. Kingdom Plantae - Multicellular with chlorophyll and feed autotrophically.

Kingdom Plantae

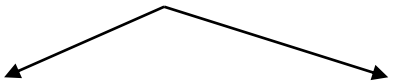
Classification Phylum
Algae Phylum
Bryophyta

Phylum Pteridophyta

Phylum Spermatophyta



Class Gymnospermae Class Angiospermae

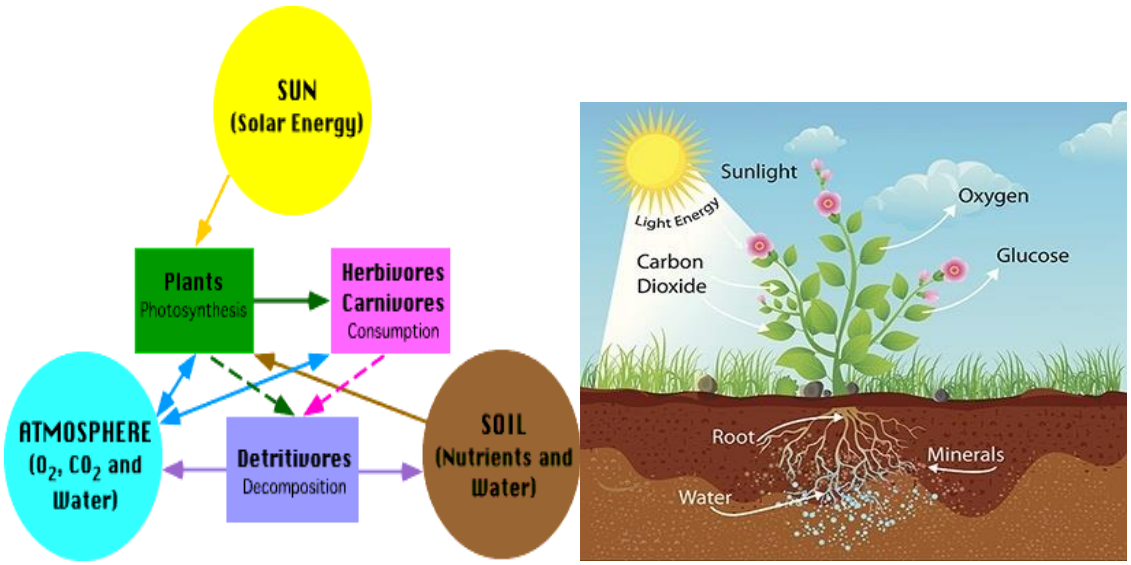


Monocotyledonae Dicotyledonae

1.4 The Role of Plants in Human History

Plants are known as producers, which simply means that they produce their own energy without the need for eating. ... In a way, they are a cycle — plants help humans breathe by providing us with oxygen, and humans help plants "breathe" by providing them with carbon dioxide. Plants are really important for the planet and for all living things. Plants absorb carbon dioxide and release oxygen from their leaves, which humans and other animals need to breathe. Living things need plants to live - they eat them and live in them. Plants help to clean water too.

Humans and plants have a complex relationship extending far back into our joint evolutionary history. This legacy can be seen today as plants provide nutrition, fiber, pharmaceuticals, and energy for people and animals across the globe. Plant domestication and agriculture allowed human society to develop and our settlements to become more complex. As such, our modern cities and cultures rely in part on the stable and reliable production and distribution of food..



(a) (b)

Figure 1: Relationships within an ecosystem (a) **Energy production from plants (b) Nutrient cycle**

Human have coevolved with plants for millions of years; the skulls of ancient hominids reflect the nature of the plant species they ate, while more recently we domesticated plants to suit our needs, leading to a dramatic cultural shift from hunter-gatherer to agricultural societies. Our deep relationship with, and understanding of, plants has enabled us to harness their nutritional, medicinal, and aesthetic benefits.

Many of the major global challenges we face will also impact our relationship with plants; we must protect their biodiversity, which holds vital information and solutions that will help us to cope with these problems. Discoveries arising from the research pipeline of basic and applied research will yield new technologies to both utilize and protect our relationship with plants in the future.

Plants are central to our well-being, not only as food, but also as key components of our cultures, religions, and medicines. This can be seen in way that the beautiful curve of a tendril inspires art, or in the fact that indigenous forest peoples collect plant materials for medicinal use or for religious practices. We do not just get nourishment from plants, they are central to our societies.

We can see the importance of our relationship with plants in ancient art. Ancient petroglyphs carved by the Pueblo Native Americans depict maize (*Zea mays*), illustrating how important

this particular plant is to their culture. Paintings from the Minoan civilization (2600–1100 BC) portray papyrus (*Cyperus papyrus*), while lychees (*Litchi chinensis*) are often represented in the exquisite art of China. Plants have inspired humans for a long time.

Domestication

Plant domestication is one of the most important processes in human history. Over 20,000 years ago, there were no cultivated plants; hunter-gatherers relied on wild plants. Over the course of their association with humans, those wild species became domesticated, that is to say, altered genetically, and eventually converted into crop species that are very different from their wild ancestors. *Oryza rufipogon* is a wild ancestor of cultivated rice; however, the two plants are vastly different. *O. rufipogon* produces very large anthers for cross pollination and long awns to aid seed dispersal, both of which are missing in the modern crop. In most cultivated rice varieties the seeds are fertilized before the flower opens, so these massive changes in appearance are associated with domestication. The genetic changes associated with domestication in many species makes them unable to survive and compete in the wild. Thus, they have become dependent on humans.

Domestication has occurred repeatedly across the globe. There are many centers of domestication; for example, Asia is the home of domesticated rice and soya bean (*Glycine max*). Examples of domestication in Africa include yam (*Dioscorea* sp.), while the Fertile Crescent was the site of wheat and barley (*Hordeum vulgare*) domestication, and the Americas are the home of cultivated maize and potatoes (*Solanum tuberosum*). In the eastern United States, a whole suite of species were domesticated by the indigenous native peoples of America. Jared Diamond (1997) considers domestication to be the most significant technological development of the last 15,000 years. Our ability to domesticate and cultivate plants close to where we live changed the way our ancestors occupied the environment. As food became more reliable, they began to settle into permanent towns, populations grew and the division of labor was established. Not everyone was a hunter-gatherer and not everyone produced food, and this produced a cultural shift.

The future of people and plants

How can we continue to reap new benefits from plants in the future? We live in a particularly challenging time; our technology is changing, we have environmental degradation, and the human population is rapidly expanding with many more mouths to feed. How do we manage

all this and look to the future with optimism? One important difference from earlier times, in which most traditional crops were domesticated, is that we no longer live in isolated communities, but in a global community. We must therefore think globally about plant conservation, the environment, and developing nutritious food. This global approach is important as we consider new challenges and opportunities.

Challenges facing our relationship with plants

For agriculture, the most obvious challenge is that we need to produce enough nutritious food to sustainably feed a growing global population. The United Nations estimates that the human population will grow to 8.6 billion by 2030 (Figure 3; United Nations, 2017), which will put tremendous strain on our relationship with plants, as well as our natural and urban environments more generally. Not all parts of the globe have the same trajectory for population growth, however; the population of Europe is expected to stabilize or decline, while in other areas, such as Africa and Latin America, there is a tremendous potential for population growth over the coming decades (United Nations, 2017). This is a potential concern, as the largest population growth is predicted in areas which often have food insecurity.

Another challenge for food systems is not only the number of calories we can produce, but also the nutrition and safety of the food. Plant-derived amino acids, micronutrients, and vitamins are required for good health. Food must also be safe, free from contaminants, and resistant to fungal growth, bacteria and other diseases. Two types of malnutrition exist around the world; some people do not have access to enough food, while others are challenged by excess calories. One goal is to produce plant-based food that provides complete nutrition in terms of micronutrients and vitamins. Another goal is to provide enhanced nutrition in developed countries, where we can substitute one lipid for another to produce food that is more healthy. We need to provide nutritious food and new crop varieties that give us the right kind of nutrition and enough total calories. Producing enough of the right kinds of food is a challenge, but our future depends upon it.

Stunting in children is highest in sub-Saharan Africa and in south Asia (de Onis, Blössner, & Borghi, 2012). Many of those affected also have cognitive limitations that can also be associated with nutritional inadequacies. The areas with the highest incidences of these developmental issues are those where rapid population growth is expected; therefore, it is imperative for plant scientists, governments and society to work together to enhance nutrition in these regions.

The plant kingdom represents many opportunities to meet these nutritional challenges. It contains around 20,000 edible plant species, of which only 30 are widely used (Levetin & McMahon, 2015). There is substantial potential for the discovery of new types of food that can enhance health, a truly exciting opportunity. The work described at the XIX International Botanical Congress in Shenzhen, China, including the conservation, exploration, systematics, and taxonomy of plants, is extraordinarily important. Not only will this work enhance our knowledge of plants, an important goal in itself, but it will also provide potential new benefits for humankind, including new food crops with improved nutritional quality. Plant biodiversity can also lead to better health. Traditionally, plants have been the source of medicines; for example, aspirin was first extracted from willow (*Salix* sp.) trees. Foxgloves (*Digitalis* sp.) are an early and effective source of medicine for congestive heart failure. Compounds first identified in the Madagascan periwinkle (*Catharanthus roseus*) are used to treat some cancers, while the antimalarial compound artemisinin was discovered in extracts of sweet wormwood (*Artemisia annua*). A vast number of plants with sophisticated biochemistries involving multiple pathways have been analyzed, providing hope that we will identify more plant-derived cures for diseases in the future.

Another important aspect of the plant–human connection is biodiversity. Biodiversity is vital for the preservation of our biosphere, the performance of ecosystem services, psychological wellbeing, culture and pleasure. Conserving plants is important for a number of reasons. A sustainable environmental footprint is a major consideration for the future, particularly regarding agriculture. Agriculture has a large impact on the environment. In the USA, agriculture accounts for 80% of freshwater use; conserving water means rethinking agriculture and developing water-conserving crop varieties, developing precision agriculture practices as well as conserving soils. Modern agriculture often involves a portfolio of agrichemicals, which can pollute streams and aquatic systems and may have long-term environmental consequences. Reducing agrichemicals is an important part of ensuring a sustainable environmental footprint. The majority of land suitable for agriculture is already under cultivation, and needs to be used more effectively and efficiently in the future, as well as adapting plants to tolerate marginal habitats. In addition to conserving land, we must conserve biodiversity in the soil. One area of research receiving a great deal of attention focuses on gaining a better understanding of the dynamics of complex soil ecosystems and how these contribute to plant health and productivity.

Our global transportation network has helped rapidly spread human diseases. Our crop plants are also affected by the spread of pests and pathogens as well as the emergence of new diseases. In part, this is the result of the ongoing evolutionary relationship between plants and their pathogens. At the same time, climate change is also altering the range of pests and pathogens and introducing them to new geographical areas. For example, wheat stem rust (*Puccinia graminis* f. sp. *tritici*) is beginning to emerge in Europe and the USA after spreading rapidly across Africa and Asia, an epidemic that has been partially driven by changes in the climate. Climate change also presents direct challenges to agriculture. Some of the crops currently grown in a region will likely face altered temperature and rainfall regimes. Adapting crops to new climate patterns will be an ongoing activity for crop breeders.

One area for optimism is the many opportunities for new plant-based products. Work is underway to develop products such as precursors for medicines, industrial products, biofuels, or disposable plastics through biotechnological approaches. These developments could enable the production of new products in an environmentally sustainable way, reducing our footprint while meeting future economic demand. Again, this must be achieved in the context of changing world temperatures and climate change.

The research on ecosystem

Facing the challenges of the future requires a vibrant research ecosystem, scientific programs that provide the understanding, applied knowledge, and new technologies required to meet future needs. Agriculture, medicine, aviation, computing, information technology, and nanomaterials are all the result of scientific research and its development into products. For example, the increase in maize yields over the last century was the result of practically applying our scientific understanding of genetics and how plants function. We know that science can be of tremendous benefit to humans; in fact, its justification is twofold: (1) as humans, we want to understand our natural world, which is important on its own, and (2) science serves society, and has enabled modern developments that have increased our well-being.

Science comprises basic research, where people seek to better understand the world, and applied research, which takes the knowledge gained in basic research and applies it to achieve a particular goal. Developing new technologies and better products is not possible without a deep understanding of nature, achieved through a vigorous system of fundamental research. After World War II, Vannaver Bush convinced US President Franklin D. Roosevelt to invest

resources toward basic science, which led to the establishment of the United States' National Science Foundation, the goal of which is to understand the world better through widespread basic research.

A vibrant research ecosystem supports investigations into many areas; one cannot predict what particular investigation will result in a new technology that improves health or develops a product that will lead to a new economic sector. Basic science, including the deep understanding of plants, is an essential component of the research ecosystem and we must accept that some discoveries will never lead to applications, while others will become central for new technologies and the growth of industry.

A classic example of the importance of fundamental research is the identification of the mechanism by which *Agrobacterium tumefaciens* induces the formation of galls on plant stems. This work at first seems like an esoteric and far from useful activity, but has led to much of our modern crop varieties. *Agrobacterium* takes over the metabolic machinery of plant cells by inserting a plasmid into the plant's DNA, inducing it to form a gall and to provide food for the pathogen. This fundamental discovery provided the basis of the genetic modification of plants, which can be achieved by adding a gene of interest to the plasmid and using it to transfer the gene into the plant's genome. This technique and those derived from it have led to pest- and herbicide-resistant varieties of many crops. This basic research in a plant pathology laboratory led to a monumentally important discovery with unexpected applications. Today, basic research into CRISPR/Cas9 and other gene-editing technologies is generating truly exciting discoveries, which have the potential to be applied to the development of cancer therapies, the improvement of agriculture and the facilitation of synthetic biology in the future. The need for basic, fundamental research, especially in plants, has never been greater and politicians ignore at their peril the importance of this research for the future of our planet and its people.

2.0 MY CHOSEN AREA OF SPECIALIZATION IN BOTANY (PHYTOPATHOLOGY)

2.1 Meaning of Phytopathology

Phytopathology or Plant Pathology- Definition

Phytopathology ,also known as Plant Pathology is a branch of agricultural, biological or botanical science which deals with the study of diseases in plants - their causes, etiology, epidemiology, resulting losses and management.

Relation to other Sciences

Plant pathology is related to many other sciences such as virology, mycology, bacteriology, microbiology, physiology, chemistry, genetics, biotechnology etc., all of which provide the knowledge required for the correct diagnosis and management of plant diseases.

Objectives of Plant Pathology

- To study living, non-living and environmental causes of diseases or disorders of the plants.
- To study the mechanism of plant disease development.
- To study interaction between host/susceptible and the pathogens.
- To develop systems of management of plant diseases and reducing losses caused by them.

Causes of Plant Diseases

- Plant diseases are caused by a variety of pathogens.

- The word pathogen can be broadly defined as any agent or factor that incites pathos ‘ or disease in an organism. Thus in strict sense, the pathogens do not necessarily belong to living or animate groups.

Abiotic (Inanimate) factors

- They include mainly the deficiency or excess of nutrients, light, moisture, aeration, abnormality in soil condition, atmospheric impunities etc. Examples are: Black tip of mango (due to SO2 toxicity), khaira disease of rice (due to Zn deficiency), whiptail of cauliflower (Mo deficiency), hollow and black heart of potato (due to excessive accumulations of CO2 in storage), bitter pit of apple (due to Ca deficiency).

Mesobiotic causes

- These are the disease incitants which are neither living nor non-living. They are considered to be on the threshold of life. They are:

- **Viruses:** They are infections agents made up of one type of nucleic acid (RNA or DNA) enclosed in a protein coat. Examples of viral diseases of plants are: potato leaf roll, leaf curl of tomato and chillies, and mosaic disease of many plants.

- **Viroids**: They are naked, infectious strands of nucleic acid. They cause diseases like potato spindle tuber, citrus exocortis, chrysanthemum stunt, cadang cadang of coconut palm, star crack of apple, etc.

Biotic (Animate) causes

This category includes the pathogens which are animate or living or cellular organisms. They are:

- Prokaryotes like bacteria which are unicellular prokaryotic microorganisms lacking true nucleus. Examples of diseases caused by true bacteria are: brown rot or wilt of potato, soft rot of potato and vegetables, , citrus canker, etc.

i) Phytoplasma are wall-less prokaryotes and cause diseases like peach X. ii) Fastidious bacterium, Xylella fastidiosa causes almond leaf scorch, Pierce ‘s disease of grapevine. Eukaryotes are the organisms with true nucleus.

i) Fungi: Potato wart, powdery mildew, rust, smuts, red rot of sugarcane (nearly 80% of plant diseases are caused by fungi).

ii) Straminopiles (Oomycetes): Downy mildews, late blight of potato, white rust of crucifers, damping off etc.

iii) Protozoa: Hart rot of coconut palm and phloem necrosis of coffee.

iv) Algae: Red rust of mango or papaya or litchi

v) Metazoan animals (Nematodes): Root knot of vegetables, ear cockle of wheat, citrus decline etc.

vi) Parasitic flowering plants (Phanerogamic plant parasites):
Dodder, Striga, Orobranche, Loranthus, Phoradendron, etc.

2.2 History of Phytopathology

- All species of plants, wild and cultivated alike, are subject to disease. Although each species is susceptible to characteristic diseases, these are, in each case, relatively few in number.
- The occurrence and prevalence of plant diseases vary from season to season, depending on the presence of the pathogen, environmental conditions, and the crops and varieties grown. Some plant varieties are particularly subject to outbreaks of diseases; others are more resistant to them. .
- Plant diseases are known from times preceding the earliest writings. Fossil evidence indicates that plants were affected by disease 250 million years ago. The Bible and other early writings mention diseases, such as rusts, mildews, blights, and blast, that have caused famine and other drastic changes in the economy of nations since the dawn of recorded history.
- Other plant disease outbreaks with similar far-reaching effects in more recent times include late blight of potato in Ireland (1845–60); powdery and downy mildews of grape in France (1851 and 1878); coffee rust ... etc

2.3 Importance of Plant Diseases or Plant Pathology

Losses they cause.

- About 34% of the crop produce is lost annually due to diseases, insect-pests and weeds on the global basis (FAO 2012); out of which, 12% is lost due to diseases (caused by fungi, bacteria or viruses), 11% due to nematodes, 7% due to insect-pests and 3% due to weeds.
- When plant protection measures are not implemented, annual loss of 30-50% are common in major crops including horticulture (Encyclopedia Britannica, 2002)

2.4 Classification of plant diseases

Disease: According to Horsfall and Diamond (1959), disease may be defined as a malfunctioning process that is caused by continuous irritation by a pathogen and/or environmental factor resulting in some suffering producing symptoms.

Disorder: The diseases caused by the deficiency of nutrients or unfavourable environmental are sometimes termed as disorders or physiological disorders. Pathogen: It is the agent responsible for inciting _pathos ' i.e. ailment or damage.

Parasite: These are the organisms which derive the food materials needed for their growth from other living organism (the host). All the pathogens are parasites but all the parasites are not pathogens. As some of the parasites live on their hosts without causing any damage to them as symbiotic relationships, e.g., Rhizobium bacterium in legume roots, mycorrhizae and lichens.

Biotrophs are the organisms which regardless of the ease with which they can be cultivated on artificial media obtain their food from living tissues only in nature in which they complete their life cycle). They were earlier also called obligate parasites, e.g., rusts, smuts, powdery mildews etc.

Saprophytes/saprobes are the organisms which derive their nutrition from the dead organic matter. Some parasites and saprophytes may have the faculty or (ability) to change their mode of nutrition.

Facultative saprophytes are ordinarily parasites which can grow and reproduce on dead organic matter under certain circumstances. They are also called hemibiotrophs which attack the living tissues in such a way as biotrophs but continue to grow and reproduce after the tissues is dead.

A parasite is called necrotroph when it kills the host tissue in advance of penetration and then lives saprophytically, e.g. Sclerotium rolfsii and Pythium species. Similar to necrotrophs are facultative parasites which live as saprophytes but under favourable conditions they can attack living plants and become parasites. The necrotrophs are also known as perthotrophs or perthophytes.

Pathogenicity is the ability of a pathogen to cause disease under a given set of environmental conditions. Whereas, pathogenesis is the chain of events that leads to development of a disease in the host.

Parasitism is a phenomenon by which a plant parasite becomes intimately associated with the plant; it draws nutrition and multiplies and grows at the expense of the plant host.

Virulence is a measure or degree of pathogenicity of an isolate or race of the pathogen. The term aggressiveness is often used to describe the capacity of a pathogen to invade and grow in

the host plant and to reproduce on or in it. This term like virulence is used as measure of pathogenicity.

Immunity of a plant against a disease is absolute quality. It denotes the freedom of plant from disease, when the pathogen cannot establish parasitic relationship with the host. High resistance and low susceptibility approach immunity. Disease resistance is the ability of an organism to overcome completely or in some degree the effect of a pathogen or other damaging factor; whereas susceptibility in the inability of the plant to resist the effect of the pathogen or other damaging factor.

Hypersensitivity is the extreme degree of susceptibility in which there is rapid death of the cells in the vicinity of the invading pathogen. It halts the further progress of the pathogen. Thus, hypersensitivity is a sign of very high resistance approaching immunity.

Infection is the establishment of the parasitic relationship between the pathogen and host following entry or penetration.

Incubation period is the time elapsing between penetration and completion of infection i.e. development of the disease symptoms.

Invasion and colonization is the growth and multiplication of the pathogen through the tissue of the host varying extent.

Effects of Disease

- The diseased plants do not function or look normal showing structural abnormality and / or physiological disorder and can not grow, develop and reproduce to its genetic potential.

Classification of plant diseases

Based on plant part affected

- Localized, if they affect only specific organs or parts of the plants.
- Systemic, if entire plant is affected. or

They can be classified as root diseases, stem diseases, foliage/foliar diseases, etc.

Based on perpetuation and spread

- Soil borne -when the pathogen perpetuates through the agency of soil.
- Seed borne -when the pathogen perpetuates through seed (or any propagation material).
- Air borne -when they are disseminated by wind e.g. rusts and powdery mildews.

Based on the signs and symptoms produced by the pathogens

- Diseases are classified as rusts, smuts, powdery mildews, downy mildews, root rots, wilts, blights, cankers, fruit rots, leaf spots, etc. In all these examples, the disease are named after the most conspicuous symptom of the disease appearing on the host surface.

Based on the host plants affected

They can be classified as cereal crop diseases, forage crop diseases, flax diseases, millet diseases, plantation crop diseases, fruit crop diseases, vegetable crop diseases, flowering plant diseases, etc.

Based on major Causes

They can be classified as fungal diseases, bacterial diseases, viral diseases, mycoplasmal diseases, etc.

Based on Infection Process

Infectious -All the diseases caused by animate causes, viruses and viroids can be transmitted from infected host plants to the healthy plants and are called infectious.

- Non-infectious- Non-infectious diseases can not be transmitted to a healthy plant.

Also referred as non-parasitic disorders or simply physiological disorders, and are incited by abiotic or inanimate causes like nutrient deficiency or excess or unfavorable weather conditions of soil and air or injurious mechanical influences.

Classification of Animate Diseases in Relation to Their Occurrence

- Endemic diseases -which are more or less constantly present from year to year in a moderate to severe form in a particular geographical region, i.e. country, district or location.

- Epidemic or epiphytotic diseases - which occur widely but periodically particularly in a severe form. They might be occurring in the locality every year but assume severe form only on occasions due to the favourable environmental conditions occurring in some years.

- Sporadic diseases occur at irregular intervals and locations and in relatively few instances.

- Pandemic diseases: A disease may be endemic in one region and epidemic in another. When epiphytotics become prevalent through out a country, continent or the world, the disease may be termed as pandemic.

Disease triangle

- The interaction of the host, the pathogen and the environment results in disease development. It is generally illustrated by a triangle, also called a disease triangle.

Disease Development in Plant Population

This is determined by:

- Host: All conditions in host that favour susceptibility.

- Pathogen: Total of virulence, abundance etc.

- Environment: Total of conditions that favour the pathogen and predispose the host plants to pathogen attack.

- Time: Specific point of time at which a particular event in disease development occurs and the duration or length of time during which the event takes place.

‘Effective disease control or measures aim at breaking this E-H-P triangle’.

2.5. Symptoms and signs of plant diseases

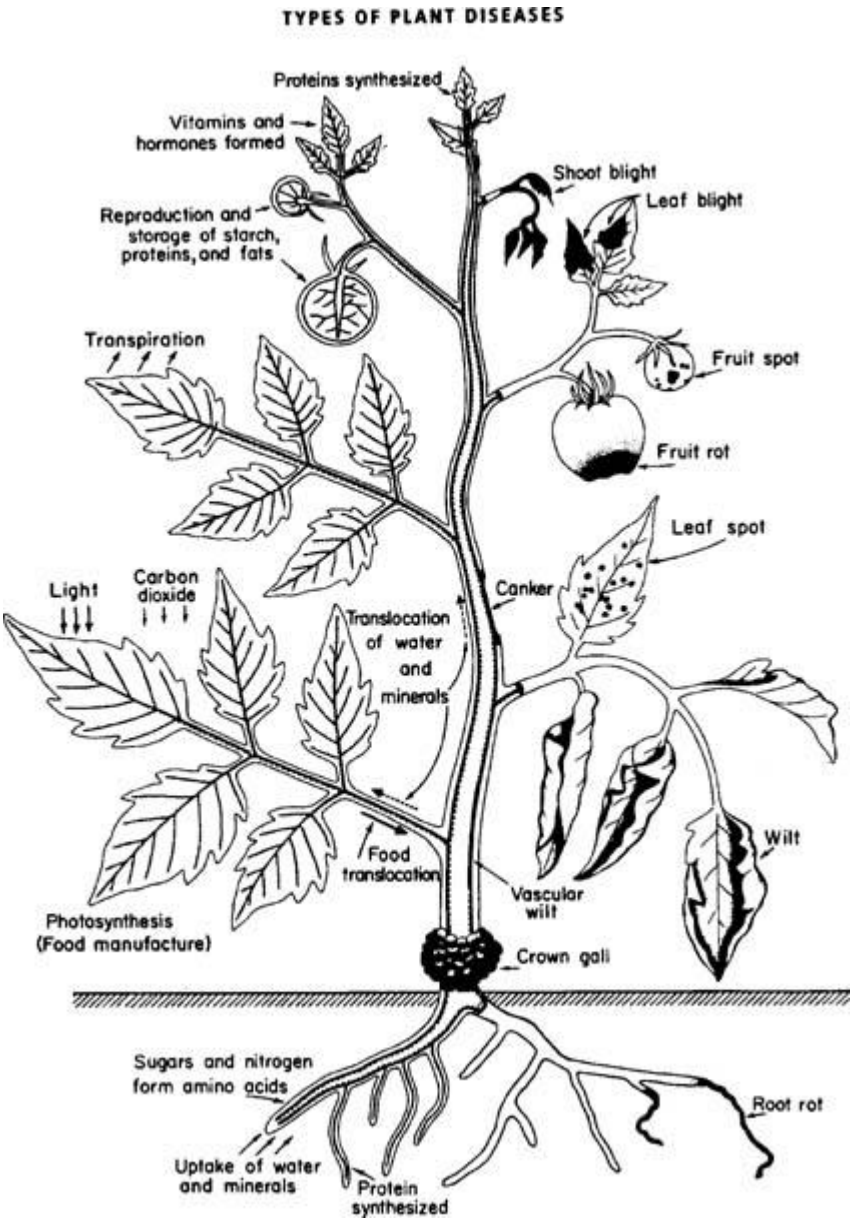


Figure 1.1 Schematic representation of the basic functions in a plant (left) and of the kinds of interference with these functions (right) caused by some common types of plant diseases.

Symptoms and signs

Symptoms- External expression or the evidence of the abnormalities in the appearance of the diseased plants brought about by the pathogens after host-pathogen interaction.

Sign- When the pathogen itself becomes visible on the host surface in the form of its organs or structures. eg. sclerotia, mycelium etc.

Disease syndrome- A sum total of variety of symptoms produced by the disease.

I. **Symptoms** of Plant Diseases Due to the Character and Appearance of Visible

Pathogen, its Structures and Organs

i. Mildews

Mildews consist of white, grey, brownish or purplish pathogen growth on the host surface.

- **Downy mildew** is characterized by a tangled cottony or downy growth mostly on the lower surface of the leaves or other plant parts.

- **Powdery mildew** consists enormous number of spores are formed on superficial growth of the fungus giving a dusty or powdery appearance on the host surface. Black minute fruiting bodies may also develop in the

powdery mass.

Fig.5.1 Grapevine downy mildew

Fig.5.2 Pea powdery mildew

ii. Rust

- Rust appears as relatively small pustules of the spores, usually breaking through the host epidermis.

- **Pustule** is a small blister-like elevation of the epidermis, often opening to expose spores. The pustules may be dusty or compact, and red, brown, yellow or black in colour.

Fig.5.3 Pea rust

iii. Smut

- Smut means a sooty or charcoal like powder.
- The affected parts of the plants show black or purplish black dusty areas.
- Symptoms usually appear on floral organs, particularly the ovulary areas.
- The pustules on the leaves and stems are usually larger than those of rusts.

iv. White Blister

- White blister-like pustules appear on the leaves and other parts of cruciferous plants which break open the epidermis and expose powdery masses of spores.
- Such symptoms are called _white rust‘, although there is nothing common with them and the rusts.

Fig.5.4 White blisters on a crucifer

v. Blotch

- **It consists** of superficial growth giving the affected plant parts i.e., fruits and leaves smoky (blotched) appearance, e.g. sooty blotch of apple.

Fig.5.5 Sooty blotch of apple

vi. Sclerotia

- A sclerotium is a compact, often hard mass of dormant fungus mycelium.

- Sclerotia are mostly dark in colour and are found mixed with the healthy grains as in the case of ergot of wheat and rye.

vii. Exudation

- Mass of bacterial cells ooze out on the surface of the affected organs where they may be seen as a drop or smear in several bacterial diseases such as bacterial blight of paddy, gummosis of stone fruits and fire blight of apple and pear.

- They form crusts after drying.

viii. Mycelial growth

- Appearance of white cottony, mycelial growth of the fungi like Dematophora necatrix on affected roots of apple is an important diagnostic feature of white root rot in the field.

Sclerotium rolfsii sclerotia

White root rot of apple

Mango gummosis

II. Symptoms Resulting from Internal Disorders in the Host Plants

i. Colour change

- Discolouration is change of colour from normal. It is one of the most common symptoms of plant diseases. The green pigment of leaves disappears entirely and is replaced by yellow pigments.

- Etiolation is yellowing due to the lack of light.

- Chlorosis is yellowing due to low temperature, lack of iron, excess of the lime or alkali in soil and infection by viruses, fungi and bacteria.

- Albilinism is the phenomenon in which the leaves become devoid of any pigment and look bleached or white.

- Chromosis is change of colour to red, purple or orange.

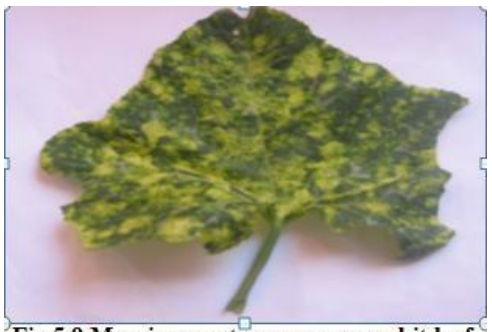


Fig.5.9 Mosaic symptoms on a cucurbit leaf

ii. Overgrowths or hypertrophy

- Hypertrophy is the abnormal increase in the size of the plant organs due to increase in the size of the cells of a particular tissue, whereas

- Hyperplasia is the abnormal increase in the size of the plant organs due to increase in the number of cells of which the tissue or organ is composed, owing to increased cell division.

- The overgrowths cause galls, curl, pockets or bladders, hairy root, witches‘ broom, intumescence etc.

Fig. 5.10 Crown gall of peach

iii. Atrophy or Hypoplasia or Dwarfing

- Atrophy is inhibition of growth and thereby showing stunting and dwarfing effectmon the plants.

- The whole plant may be dwarfed or only certain organs are affected. e.g. rice dwarf, phony peach etc.

III. Necrosis

- Death of the cells, tissues and organs occurs as a result of parasitic activity.

- The characteristic appearance of the dead areas differs with different hosts, host organs and with different parasites.

- Necrotic symptoms include spots, streaks or stripes, canker, blight, damping off, burn, scald or scorch and rot.

Fig.5.11 Colocasia blight

Fig.5.12 Brown rot of pear

IV. Wilt

- Characterized by drying of the entire plant.
- Leaves and other green or succulent parts loose their turgidity, become flaccid and droop down.
- Usually seen first in some of the leaves.
- Later, the young growing tip or the whole plant may dry up.
- May be caused by injury to the host system or the conducting vessels.
- Wilting due to disease is different from the physiological wilting where the plant recovers as soon as the supply of water is retained.

Fig.5.13 Fusarium wilt of pea

Fig.5.14 Bacterial wilt of capsicum

V. Die-back or Wither Tip

- Symptoms are characterized by drying of plant organs, especially stems or branches, from the tip backwards.
- It is also a form of necrosis caused directly by the pathogen or its toxins.

Fig.5.15 Die-back symptom on mango

the higher plants. This is called pseudoparenchyma and consists of rounded fungal cells.

- Prosenchyma: Less compact structures consisting of hyphae made of elongated cells. These are found mostly in the stroma or fruiting bodies of Ascomycota or Basidiomycota.

VI STEM RUST, *Puccinia graminis* tritici

Symptoms. Typical symptoms are elongated, brick red pustules (eruptions) on the leaf blade, sheath, and stem. Pustules turn black late in the season. Pustules may also appear on glumes. Seed has low test weight and poor emergence. Severe yield loss may occur.

Fig. 6 Stem rust of wheat

Survival and Spread. Red spores can be carried great distances by the wind. Spores are carried by wind into North Dakota from wheat growing areas to the south; infection may repeat every eight to 14 days.

Other Crops Affected. Barley and wild grasses.

Control. Most recommended hard red spring wheats and durums grown in North Dakota are resistant to existing races. Winter wheats vary in resistance. Check the current variety recommendations for variety susceptibility. Eradicate common barberry, the alternate host of stem rust. Since the federal eradication program was abandoned, barberry is gradually moving back into the upper Midwest.

Remarks. New races may form on common barberry (not Japanese barberry), and mutations may occur.

VII LEAF RUST, *Puccinia recondita*

Symptoms. Circular to oblong orange-colored pustules occur primarily on leaves. Later in the season the pustules are black and usually do not break through the epidermis. Seed test weight and yield are reduced.

Survival and Spread. Orange spores are spread from plant to plant by the wind; usually they blow in from major winter wheat states in the southern plains. Temperatures of 60-80?F and dew periods of six to eight hours favor infection.

Control. Use resistant varieties. Check the current variety information for susceptibility of available varieties. Fungicide control: spray mancozeb at early boot and 10 days later to protect the flag leaf, or spray a single application of triadimefon at early boot, or propiconazole when flag leaf is emerging (Feeke's growth stage 8).

Remarks. New races may occur by mutations.

IX **POWDERY MILDEW,** *Erysiphe graminis* tritici

Symptoms. A white to grey, powdery superficial growth occurs on leaves, stems and sometimes heads. Black pin-head size dots may develop (fungus fruiting bodies). Eventually, yellowing, browning and drying out of leaf tissue occurs. If severe, yields are reduced.

Survival and Spread. Spores are windblown from residue. The disease is favored by cool, humid conditions.

Control. Crop rotation and destruction of host residues through tillage reduce disease risk. Chemical control: spray sulfur or triadimefon fungicide at early boot to protect the flag leaf or spray propiconazole when flag leaf is emerging (Feeke's growth stage 8).

SEPTORIA LEAF BLOTCH, *Stagonospora nodorum*, (= Septoria nodorum) Stagonospora (Septoria) avenae f. sp. triticea, and Septoria tritici

Symptoms. Leaves develop straw-colored spots that later form grayish-white centers. Very tiny black fruiting bodies (specks) may develop in the spots. Severely diseased plants have "fired" leaves, yield loss, and shriveled seed. Stagono-spora nodorum also infects the glumes (see Glume Blotch).

Survival and Spread. Survives on infected straw and stubble and on seed. Spread by airborne spores and splashing rain.

Other Crops Affected. Barley

Control. Differences in variety response exist: Check current variety information for susceptibilities to leaf spot fungi. Use fungicidal seed treatment to control seed-borne infection. Fungicide sprays are available. Benomyl, copper hydroxide, mancozeb, triadimefon, and propiconazole are registered for Septoria control, with some fungicides requiring tank mix partners for adequate control. Use crop rotation or bury crop refuse with tillage. Clean seed severely and discard shriveled kernels.

Remarks. Infection by all three fungi is favored by wet weather and relatively warm temperatures (60-70?F for S. avenae f. sp.triticea and S. tritici and 70-80?F for S. nodorum).

SPOT BLOTCH, *Cochliobolus sativus* (= *Helminthosporium sativum*)

TAN SPOT, *Pyrenophora tritici*-repentis

Symptoms. Elliptic or diamond shaped tan spots form on leaves, often with a yellow border and a small chocolate brown center. Severe disease causes "firing" of leaves, yield loss, and low test weight seed.

Survival and Spread. Survives on infected straw and stubble, on wild grasses, and rarely on seed. Spores are airborne and also spread by splashing rain. Long periods (24-48 hours) of moisture on the wheat leaves favor infection of modern cultivars.

Other Crops Affected. Bromegrass, rye and wheat grass.

Control. Varieties vary in susceptibility. Check variety information publications for susceptibility to leaf spot fungi. Crop rotations or burying crop refuse by tillage reduces early infection but may not prevent late infection. Later applications may be directed to the flag leaf; propiconazole must be sprayed at early flag leaf emergence (Feeke's growth stage 8.) Early applications of mancozeb or propiconazole fungicides may protect the tillers from early infections. Both fungicides have good activity against leaf spots on wheat.

Remarks. Late in season large numbers of spores may be blown considerable distances.

Stem and Leaf Diseases - Bacterial

BACTERIAL BLIGHT, Xanthomonas translucens pv. translucens (= X. campestris pv. translucens)

Symptoms. Water-soaked dark green stripes develop on leaves, turning yellow and finally dark brown; a yellow exudate forms in wet weather. Also infects heads (see Black Chaff). Early infection causes dwarfed heads and shriveled seed.

Survival and Spread. Survives on infected seed, straw and winter grass hosts. Spread by splashing rain, aerosols, and insects.

Other Crops Affected. Barley and rye.

Control. No satisfactory control; crop rotation and burying infected stubble is of limited value. Avoid seed from infected fields. Not controlled by foliar fungicides.

BACTERIAL LEAF BLIGHT, *Pseudomonas syringae* pv. syringae

Symptoms. Develops on uppermost leaves after plant reaches boot stage. Initial tiny, water-soaked spots expand and become necrotic and turn from gray-green to tan-white. Entire leaves may become necrotic. During very wet periods, white droplets of bacteria may be visible.

Survival and Spread. Survives in soil and water. Spreads by wind-driven rain and enters plants through wounds or natural openings.

Other Crops Affected. Barley and rye.

Control. None recommended.

Stem and Leaf Diseases - Virus

BARLEY YELLOW DWARF, Barley Yellow Dwarf Virus

See description under barley

WHEAT STREAK MOSAIC, Wheat Streak Mosaic Virus

Symptoms. Leaves develop intermittent yellow and green stripes or streaks. Severely diseased leaves turn brown and die. Plants are stunted. Yield is poor and seed has a low test weight.

Survival and Spread. Survives in infected winter wheat, volunteer wheat, and several native grasses. Spread by the wheat curl mite (Aceria tulipae), which is wind-borne.

Other Crops Affected. Barley, corn, oats, rye, and some grasses and volunteer wheat.

Control. Plant winter wheat around mid-September and plant spring wheat early. Destroy volunteer wheat and grasses two weeks before planting winter wheat. Avoid planting winter wheat next to corn and spring wheat next to volunteer winter wheat. Do not overseed damaged winter wheat stands with spring wheat. Check winter wheat variety trial information for differences in susceptibility to wheat streak mosaic.

Remarks. A problem in the winter wheat areas of North Dakota.

Stem and Leaf Diseases - Non-Infectious

HEAT CANKER, Non-Infectious

Symptoms. Seedling stems may be constricted at the soil line; the seedling may fall over. In less severe cases several white bands may appear on one or more leaves; these bands go across the leaf. May be common in a hot, dry spring.

Survival and Spread. Non-infectious. Favored by dark soils and hot sunny days before plants are large enough to shade the soil -- plant tissues at the soil line are injured by hot soil. Mild injury causes white bands; each one corresponds to high soil temperatures when that portion of the leaf was in the whorl at soil line. Severe injury causes a stem constriction.

Control. Early planting, drilling rows north and south for maximum shading and using higher seeding rates may reduce the damage.

Head and Seed Diseases - Fungal

BLACK POINT, Cochliobolus sativus (= *Helminthosporium sativum*) and related fungi

Symptoms. In wet weather, developing seeds in the head are infected by Helminthosporium or Alternaria, resulting in shriveled blackened kernels. The blackened area is often near the embryo or germ end, hence the name black point. The crease also may be blackened. Planting of black-pointed kernels may result in seedling blight. Seedlings turn yellow, roots are blackened and plants die or are stunted.

Survival and Spread. Survives in soil, crop refuse, and on and in black-pointed seed. Spread by wind and splashing rain.

Other Crops Affected. Barley and grasses.

Control. Use fungicidal seed treatment to reduce seedling blight. Use crop rotation. Clean and condition black-pointed seed and discard shriveled seed. Bury crop refuse by tillage to reduce chance of fungal spores splashing to the head.

2.6 Plant disease diagnosis

Field scale patterns of disease.

- Identify the host.
- Look for patterns of damage—circular, down rows, or across rows can provide clues of how the disease spreads.
- Focus on borders between healthy and

diseased; this is likely where the pathogen is most active making the observation of signs,

and pathogen isolation in the lab, more probable.

II. Symptoms and signs

- Be clear on whether you are looking at a symptom or a sign.
- A symptom is an observation of the host response to infection by the pathogen.
- A sign is a visible structure of the pathogen itself, and is much more diagnostic. Observe the full range of symptoms;
- Compare symptoms to pictures.
- Find out what diseases are common locally.
- Don't be surprised if you aren't sure:
- Many diseases need to be identified with laboratory techniques.
- Don't guess.

III. Koch's Postulates

- Koch's Postulate is a method for proving that a particular organism causes disease.
- The organism is removed from the plant, grown in pure culture,and inoculated to healthy plants.
- If disease results and the same organism is re-isolated, the pathogenicity is confirmed.

IV. **Resources for disease diagnosis**

- Resources to help diagnose plant diseases include Cooperative Extension services, others
- professionals, and pictorial disease guides

Stages in Plant Disease Development

In an infectious disease there is a series of more or less district events which occur in sequence and lead to development and perpetuation of the disease and the pathogen. This chain of events is called a disease cycle. The disease cycle involve the changes in the plant and the plant symptoms as well as those in the pathogens, and spans period within a growing season and from one growing season to the next. The main events of a disease cycle include:

(i) Inoculation, (ii) pre-penetration, (iii) penetration, (iv) infection (also includes invasion), (v) growth and reproduction of the pathogen,(iv) dissemination of the pathogen, and (vii) seasonal carry-over of the pathogen.

1. **Inoculation:** Inoculation is the contact of a pathogen with a plant. This is the inoculum that lands on or otherwise brought into contact with plant inoculum may be adults, larvae or eggs, where as in parasitic higher plants it is plant fragment or seed.
Inoculum that survives the off season periods (winter or summer) and causes the original infection in the growing season is called primary inoculums and the infection as primary infection. Inoculum produced from these primary infection that actually spreads the disease in the field under favorable conditions, is called secondary inoculums that brings about secondary infections.
Inoculums in the absence of its host from the field services in plant debris field, soil, seed, tubers, Transplants or other plant parts, perennial weeds, alternate hosts
The inoculums is carried to host plants and this landing or arrival of inoculums is passive by wind, water, insects etc or in some cases also by active growth as in some root-infecting fungi like Armillaria mella.

2. **Prepenetration:** This phase includes all the events prior to actual entry of the pathogen. Such events include (i) germination of spores and seeds, (ii) hatching of eggs (nematodes), (iii) attachment of pathogen to host, and (iv) recognition between host and pathogen (early event-not still understood clearly). Lack of specific recognition factors in plant surface may not allow the attachment of pathogen to it. Such factors in plant include lectins (proteins of glycoprotein's) and some oligo-and polysaccharides. In viral pathogen lack of recognition of its nucleic and by host ribosome's may lead to failure in disease.

3. **Penetration:** This is the actual entry of the pathogen into theirs host plants pathogens penetrate plant surfaces in different ways:
(i) Direct penetration through intact plant surfaces (ii) Through natural openings, and (iii) Through wounds.

4. **Infection:** This is the process by which a pathogen establishes contact with host cells or tissues and procures nutrients from them. This stage also includes invasion and to some extent growth and reproduction of the pathogen. During invasion, the pathogens colonise the host tissue in different ways and to different extent.
This time elapsing between penetration or more accurately spore germination and established infection is called period. We shall describe this stage in detail later.

5. **Growth and reproduction of pathogen:** Pathogens invade and infect tissue by growing and multiplying into them. In this way they colonise and infect more areas or paths of attacked plant. The period between infection, or more accurately spore germination and the appearance of visible symtoms is called incubation period. Thus incubation period includes the full life cycle of the pathogen. It may thus be seed that between spore germination and complete expression of the disease (symptoms), a series of events happens in the host. This chain of events between the time of infection, or more accurately spore germination and the complete expression of disease is called cycle or disease development. For spread of secondary inocula to perpetuate the disease in the field during growing season of plant dissemination is also sometimes included as a stage in disease development. Seasonal carry-over of the inoculums to next season is also similarly included by some under disease development.

6. **Dissemination of pathogen**: After pathogen has grown and multiplied in or on the infected host, it spread to new, healthy plants. Dissemination is the transfer of inoculums from the site of its production to the susceptible host surface. Some pathogens disperse in active manner, whereas most passively with the help of an agent of dispersal. The chief agents of dissemination are:
(i)Air, (ii) water,(iii), vectors i.e. .. Insects, mites, nematodes etc.(v)Man .
7. Seasonal carry-over of pathogen: In the absence of their hosts, the great variety of means of this seasonal carry-over.
At the on-set suitable conditions in the next growing season, these resting structure become active and produce inoculums. These inoculums then are taken to host surface.

2.7 Plant Disease Management

The four basic methods of infectious disease management are: **exclusion, eradication, host resistance, and protection (including the use of fungicides).** These four methods reduce pathogen populations or slow their development. Protectant fungicides and resistant varieties slow down the development of pathogen populations. Cultural practices also can reduce the pathogen's population. In short, management practices prevent or delay the introduction of pathogens or reduce initial pathogen populations and retard their subsequent increase.

Sound management is based on correct diagnosis. This is essential to distinguish infectious from similar appearing non-infectious diseases as well as to correctly identify the pathogen involved in infectious disease.

Correct identification of the pathogen is essential to know the pathogen's life cycle and how it relates to the cycle of disease development. This information is needed to develop a management program that attacks the pathogen at the weakest point in its life cycle. When fungicides are used, the type and the timing are important. For example, in the case of dry bean diseases three different types of fungicides are used for management of each of three major diseases: rust, bacterial blights, and white mold. In each case timing is important and application must be started before the disease is widespread. For head scab of wheat and barley, timing of fungicide application is critical as well, at early heading for barley and early flowering for wheat.

Exclusion

Exclusion means exclusion of pathogens. Pathogens can be excluded (or kept away) from hosts by quarantines that prevent their introduction, and by use of seed stocks certified to be pathogen-free or within certain prescribed tolerances for low levels of pathogens.

Quarantine

International quarantines are familiar to anyone who has traveled overseas. Planes, cars, trucks and luggage are checked at ports of entry to prevent the introduction of pathogens and other pests into areas where they do not occur. Many disease organisms would flourish in our state if they were introduced. State and local quarantines are used to keep black wart of potato and the golden nematode restricted to a few localized areas of the eastern United States. International quarantine has prevented new introductions of pathogens from other countries.

Seed certification

Seed certification is used to certify that potato seed tubers and seed of dry beans have low levels of pathogens or are pathogen-free in the case of potato ring rot. The crop is grown from seed produced under carefully controlled conditions. Sometimes the seed crop is grown in an isolated area to reduce disease potential. For example, foundation seed potatoes are grown in Golden Valley County, a western county isolated from the rest of the potato production in North Dakota. Crops are field inspected and must meet certain tolerances to be certified. Certification may be done in conjunction with indexing. Many seed potatoes are now produced in greenhouses.

Indexing

Indexing involves laboratory or greenhouse tests to determine infection by pathogens in vegetatively propagated plants such as potatoes and fruit trees. Only the healthy materials are saved for further increase.

Eradication

Eradication means elimination of the pathogen. In actual practice, this term may be used when the pathogen is not completely eliminated but the populations are greatly reduced.

Crop rotation

Crop rotation involves growing different crops in the same field or plot in succeeding years. Pathogens such as the fungi that cause tan spot of wheat, dry bean rust, Cercospora leafspot of sugarbeet, and Septoria leafspot of tomato attack only one host, and populations of the pathogen increase when the same host is grown repeatedly on the same land. Crop rotation helps keep populations of these pathogens at low levels. There is one precaution, however: the grower must consider nearby areas as well. Disease organisms may spread from nearby fields or garden plots if disease was present in those areas the previous year. Disease can be expected to develop first in the area next to last year's crop. If weather favors disease development, the entire field or garden plot may eventually become diseased.

Crop rotation is an effective tool for reducing many pathogen populations. However, some pathogens survive many years in the soil and are not affected much by normal crop rotations. Long rotations may be necessary but often are impractical. The sunflower downy mildew pathogen, the sugarbeet Aphanomyces pathogen and the white mold organism survive many years in the soil. The pathogen that causes Verticillium wilt of tomato survives several years in the soil and also attacks

many other garden vegetables, so it is difficult to eliminate by rotation. In the case of Verticillium wilt in tomato, use of resistant host varieties is the practical solution. In the case of white mold, some navy, kidney and black beans show partial resistance to white mold. In the case of sunflower downy mildew, only a few hybrids are resistant to all races of the mildew fungus.

Eradicate alternate hosts

Many rust fungi require two hosts to complete their life cycle. The second host, called the alternate host, is essential to overwintering of many rusts in northern climates. Some of these same rust fungi reproduce indefinitely without the alternate host in warm climates. Examples of alternate hosts include common barberry (not ornamental barberry) for wheat and barley stem rust, buckthorn for oat crown rust, and juniper for apple rust. The rust fungi's sexual phase occurs on these alternate hosts.

It was hoped that eradication of barberry from the Upper Midwest in the 1930s would break the pathogen cycle and eliminate the stem rust fungus. After most barberry had been eradicated, stem rust still occurred. It was determined that stem rust survives year-round in Mexio and the Gulf Coast in the summer spore stage, without requiring the barberry for the overwintering stage. These spores are wind-blown thousands of miles north to the Upper Midwest every year.

Nevertheless, the barberry eradication program had two very important accomplishments: 1) stem rust infections started later in the season, and 2) the sexual phase of the fungus was eliminated, which slowed down the development of new rust races. Elimination of buckthorn near oat fields produces similar results.

To manage apple rust, commercial growers try to remove all junipers within two miles of their orchards. This is not feasible for the homeowner, who must use fungicides or resistant varieties for management of apple rust when weather is wet in spring and early summer.

Sanitation

Sanitation is the removal of crop refuse. Tillage is sometimes used to bury the refuse. The quantity of a pathogen available to produce infection is called the inoculum. Burial by tillage reduces the inoculum of the wheat tan spot pathogen, the barley spot blotch pathogen, and many garden pathogens.

All diseased tomato vines and refuse should be removed, and apple leaves that had apple scab should be raked up and detroyed by burning, burying or sending to the landfill. Diseased leaves and

vines also can be composted if the compost is allowed to heat sufficiently, as described in Extension Circular PP-737 Rev., "Home Garden Disease Control Begins This Fall," or PP-469 Rev., "Plant Disease Control in the Home Garden."

When Septoria leafspot of tomato is severe, picking off badly diseased leaves (sanitation) before spraying with a fungicide helps reduce the inoculum and improves fungicidal control.

Host resistance

Resistance is the ability of a host to resist infection by a pathogen. Resistant varieties are favored by commercial growers and gardeners when they are available.

Resistance has been the best and most cost-effective method of managing stem rust and leaf rust of wheat. Homeowners who have the Verticillium wilt pathogen in their garden soil must grow a resistant tomato variety to manage the disease.

Some foliar (leaf) pathogens may rapidly develop new races quite capable of attacking certain types of host resistance. Many foliar pathogens are extremely variable and produce billions of spores that are disseminated great distances by the wind. Consequently, new races of some foliar pathogens may become widespread in a short period of time. This results in disease outbreaks and a continued need for plant breeding programs.

Soil-borne pathogens (root and vascular wilt pathogens such as Verticillium) are also variable, but new races may not become widespread as quickly.

There are two types of host plant resistance: race specific resistance and general resistance.

Race specific resistance usually provides a high level of resistance, but it fails when new races of the pathogen develop. In the late 1990s new races of wheat leaf rust developed that attacked some of the previously resistant wheat cultivars.

General resistance is usually a stable type of resistance that is effective against all races of the pathogen. General resistance usually does not exhibit as high a level of resistance as race specific resistance. However, general resistance slows down disease development compared to that on a susceptible variety.

Protection

Protection means protecting plants from infection. Storing potatoes and other vegetables in cold storage protects against infection because it is too cold for many pathogens to develop, or

development is greatly slowed down. Seed potatoes are grown in isolated areas where aphid populations are low (exclusion) and thus easily managed (protection); this minimizes aphid-borne virus infection.

Cultural practices

Time of planting may help plants escape infection. Winter wheat is planted in September after the destruction of volunteer wheat. Destruction of volunteers prior to winter wheat planting destroys the green bridge that wheat curl mites survive on between the summer and fall crops. The wheat curl mite is the vector of the wheat streak mosaic virus. Delayed planting of winter wheat also reduces the risk of survival and buildup of the mite in the fall of the year and exposure of the wheat crop to high wheat curl mite populations.

Many dry bean and garden bean pathogens are disseminated in water, so beans should not be cultivated when they are wet.

A plastic mulch used on tomatoes greatly reduces blossom end rot, a non-infectious disease that develops under conditions of drought or fluctuating soil moistures. The mulch produces a more uniform soil moisture.

Most powdery mildews are favored by high humidity. Powdery mildew is a common problem on alpine current, lilac, roses and shaded lawns. Pruning shrubs and trees to allow better air circulation and sunlight penetration may help reduce powdery mildew in shady locations.

Handling practices

Development of potato late blight in storage can be minimized by proper handling practices during the growing season. This includes hilling the soil around the plants to reduce the chances of late blight spores coming into contact with the tubers. The vines should be killed several weeks before harvest by using approved vine killers or chopping the vines off at ground level. The late blight fungus on the tops will be minimal at harvest and tubers will be mature. Mature tubers are less prone to infection.

Managing insect vectors

Many insects carry disease organisms such as viruses and bacteria. Managing these insect vectors may reduce the chance of disease. A prime example is the cucumber beetle, vector of the bacterial

wilt pathogen of cucumber and muskmelon. The bacterium is carried from plant to plant by the beetle and overwinters in the beetle. A good program for managing the cucumber beetle, started as soon as the plants emerge, will prevent serious losses from the bacterial wilt disease. Similarly, good aphid management is essential for raising virus-free seed potatoes.

In addition to successful management of insect vectors, weeds and other hosts that can serve as a reservoir for both vectors and pathogens must be managed. Weed management is essential around plantings of potatoes, tomatoes, cucumbers, melons, peppers and many other commercial and garden crops.

Fungicides

Protectant fungicides act on the plant surface to protect against infection, and systemic fungicides are taken up by the plant tissues and then function to prevent infections. Some new fungicides have limited therapeutic (curative) properties.

Current fungicide recommendations are given in Extension Circular PP-622, "Field Crop Fungicide Guide," and Circular F-1192, "Insect and Disease Management Guide for Woody Plants in North Dakota."

Integrated disease management

Effective, practical disease management usually involves several techniques. Management programs based on only one or two techniques can be effective in the short term but may become ineffective if used frequently. The development of fungicide resistance is a good example; the epidemics of rust caused by newly prevalent races of the fungus is another. Growers need to integrate as many different management tools as possible for long term success.

Stem rust of wheat is managed by host resistance, the elimination of barberry (this prevents the sexual phase that produces new rust races), and by constant monitoring of the rust races by plant pathologists. Monitoring provides early warning for plant breeders of the buildup of new rust races and the need for alternative management for the grower.

The main tools for management of dry bean rust are sanitation, crop rotation, tolerant varieties and fungicides. All of these procedures must be done well and in a timely fashion to produce effective management.

Tan spot of wheat can be reduced by sanitation, crop rotation, and protection (fungicides); researchers are developing varieties with improved tan spot resistance. When wheat is planted directly into standing wheat stubble, both sanitation and rotation are eliminated as management tools and growers must rely primarily on variety choice and fungicides for tan spot reduction.

Homeowners should make every effort to remove diseased plant debris from the yard and garden in the fall - sanitation is the first step to disease management for next spring. Sanitation should be followed by seed treatment, rotation, use of resistant varieties, and timely fungicide applications.

Whenever possible, all the principles of management, eradication, exclusion, host resistance, and protection, should be practiced. The use of these combined practices usually produces the most reliable and stable plant disease management.

Finally, all growers should keep close watch on the weather forecasts, as this helps to anticipate disease-favoring weather and allows more timely preventive measures. Some Disease Forecasting models for major crop diseases have been developed and are now available on the Internet or through toll-free telephone numbers. The disease forecasting information aids in predicting disease outbreaks and the need for fungicides.

2.9 Mycotoxins/ Phytotoxin

Toxins: Mycoses: Mycotoxin: Mycotoxicoses:

- Toxins: poisonous chemicals
- Mycoses:diseases caused by fungi
- Mycotoxins: toxins produced by fungi
- Mycotoxicoses: condition of illlness as a result of contact with mycotoxins

· **Phytotoxin** - substance secreted by a pathogen that is toxic to plants

· Some compounds secreted by fungi are toxic to both plants and animals (e.g aflatoxin)

Mycotoxins - substances synthesized by fungi that are toxic to humans and domestic animals

- One aspect of the saprophytic capability of many of the fungi is their production of a chemically diverse range of metabolites.
- When metabolites occur in food, or animal feeds, and are toxic to man and his domesticated animals they are referred to as mycotoxins.

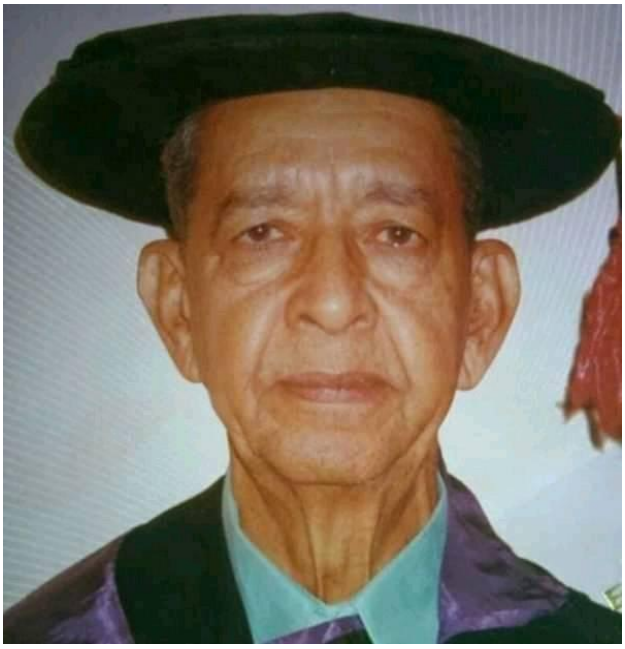
- Mycotoxins my occur in food, either by their direct production as a result of fungi growing on the food, or the raw materials used in its manufacture or indirectly being passed along a food chain e.g excretion of aflatoxin *M*1 in milk of cows fed on a feed contaminated.

- Illness resulting from direct contamination have been referred to as primary mycotoxicoses and those from indirect secondary mycotoxicoses.

3.0 MY CONTRIBUTIONS

3.1 My contribution to plant health and disease management for well being of mankind

It is expedient at this time, to pay tribute to those who had contributed greatly to my academic success and mentored me as I climbed the academic ladder.



LATE PROFESSOR S.H.Z. NAQVI

I humbly recognize my academic mentor and Father, Professor S.H.Z. Naqvi. Of blessed memory He first invited me in February 1991 through then Malam Hayatu Dukku and take part-time appointment with Usmanu Danfodiyo University, to lecture Botany aspect of Predegree/Matriculation Programmes/Undergraduate courses (BIO 101 and BIO 102) He taught me how to set questions, draw marking schemes, computation of results, graph of normal distribution of the results among other things. very rewarding experience Jazakallahu-khairan Sir (May His gentle soul rest in peace amin),

Professor Y.Y. Karatela who carefully supervised my B.Sc project in Bayero University Kano (1989). Professor A.C Odebode and A.O. Oladiran Department of Botany and Microbiology (Now Department of Botany), University of Ibadan (1995) who carefully supervised My MSc. Resarch work.

Prof A.C. Odebode (left) Sanusi Muhammad (middle) and Late A.O. Oladiran (right)

Prof. M.D. Magaji, Prof. H.A. Suberu and Dr. (Mrs) Amina Abubakar of Usmanu Danfodiyo University,Sokoto who supervised me for my Ph.D. work (2001). Prof N.A. Amusa and Prof. Tunde Ikotun of the Department of Crop Protection and Environmental Biology, University of Ibadan, who stimulated my interest in the area of phytopathology and taught me courses in the field. I recognised Prof. R.C. Okechukwu Director Research, International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria who gave me an unrestricted access to his research field and laboratory and Dr. (Mrs) Maria Ayodele of the Plant Health Laboratory, International Institutes of Tropical Agriculture (IITA), Ibadan for preliminary identification of my fungal isolates.

Mr. Vice-Chancellor Sir, my contribution towards the Plant health and disease management for survival of humankind is in the area of manipulation of the pathogen and its weapon of war to the detriment of the pathogen and to the advantage of the entire human race. In other to carve a niche in my chosen career and contribute meaningfully to the struggle, I worked on one of the most devastating diseases of tropical crops, the pathogen responsible, the weapon of the pathogen and finally, the manipulation of such weapons in favour of the plant for the benefit of mankind.

The devastating disease

In Tropical Africa and in fact the entire World, one of the most devastating diseases of crops is anthracnose caused by the fungus *Colletotrichum* species. Anthracnose is a group of fungal diseases that affect a variety of plants in warm and humid areas. Shade trees such as sycamore, ash, oak, and maple are especially susceptible, though the disease is found in a number of plants, including grasses and annuals. Anthracnose causes the wilting, withering, and dying of tissues. (Bergstron, 1982; Han et al., 1988; 1989).

This pathogen is a threat to the cultivation of several food and industrial crops causing diverse type of symptoms ranging from spot to blight (Amusa et al., 1994; Amusa, 2002; Amusa et al., 2003; Amusa et al,, 2005). *Colletotrichum* spp. also attacks stems, twigs, fruits, seeds and flowers (IITA, 1990). The pathogen has been found associated with Maize and Sorghum (Amusa, 1997); Pepper fruit rots (Amusa *et al.,* 2004); Cowpea and Soybean (Ajibade and Amusa, 2001); Guava fruits (Muhammad *et al*., 2005); Melon (Muhammad and Amusa 2003a), Muhammad and Amusa 2004) as well as Yam and Cassava plant (Amusa, 1997; Amusa, 2000;) (**Muhammad** and Amusa 2003b); (Figures 1, 2, 3, 4 and 5).

Compost-inhabiting bacteria were studied for their effect on seedling blight inducing pathogens. *Aspergillus niger*, *Trichoderma harzianum*, *Bacillus cereus* and *Bacillus subtilis* were the microbes found associated with cow dung, sawdust and rice husk composted soils (**Muhammad** and Amusa 2003); Figure 6.

The weapons of the pathogen

The weapons used mostly by these microbes include the use of enzymes, hormones and toxins. Of all these weapons, toxin seemed to be the most potent weapon resulting in direct killing of the plant tissues and cells. Microbial toxins are low molecular weight substances produced by some pathogens which are capable of reproducing symptoms similar to that found in natural infections in plants (Bilgram and Dube, 1976). Wheeler and Luke (1963) also referred to toxins as pathotoxins which was defined as chemopathogens of biological origin which by substituting the producing pathogens provide tools for investigating the nature and course of pathogenesis.

Scheffer (1983) however defined phytotoxins as a product of microbial pathogens, which should cause an obvious damage to plant tissue and must be known with some confidence to be involved in disease development

Pathogenic fungi and bacteria often damage their host (plants) tissues by producing toxic metabolites,which induced various symptoms such as necrosis, chlorosis, wilting, water soaking and eventually the death of plants. These toxic metabolites also known is one of the weapons used by pathogen inducing disease condition in susceptible host plants. Scheffer (1983) Many pathogens are known to produce toxins both *in vitro* and *in vivo* and these toxins have been implicated in the symptom development on the host tissues. Many of these phytotoxic metabolites have also been extracted from diseased plant tissues. Based on the reactions of host crops to the toxic metabolites of respective hosts, methods of rapid screening of germplasm for resistance to plant diseases have been developed. Their application has successfully resulted in resistant lines in some tropical crops like cowpea, cassava, maize, yam, and soybean. (Amusa and **Muhammad** 2006) Nowadays, these evaluation techniques are becoming an important complement to classical breeding methods. (Table 1) The knowledge of the inactivation of microbial toxins has led to the use of microbial enzymes to inactivate phytotoxins thereby reducing incidence and severity of disease induced by microbial toxins. (Amusa and Muhammad 2006) Figure 7.

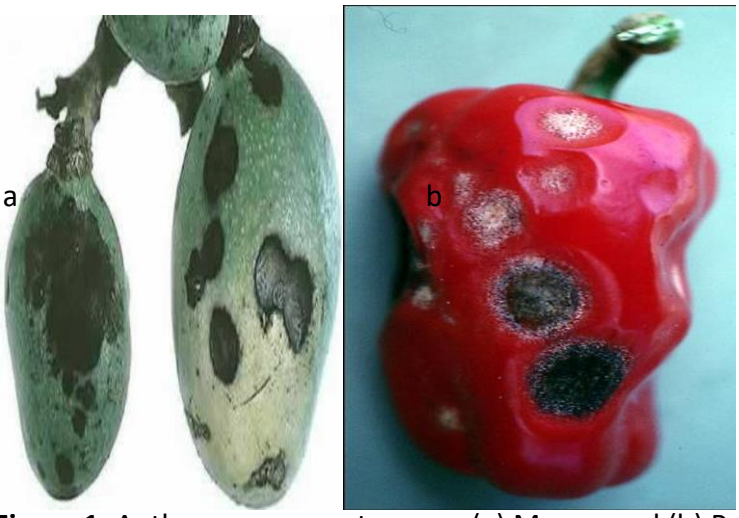


Figure 1. Anthracnose symptoms on (a) Mango and (b) Pepper.

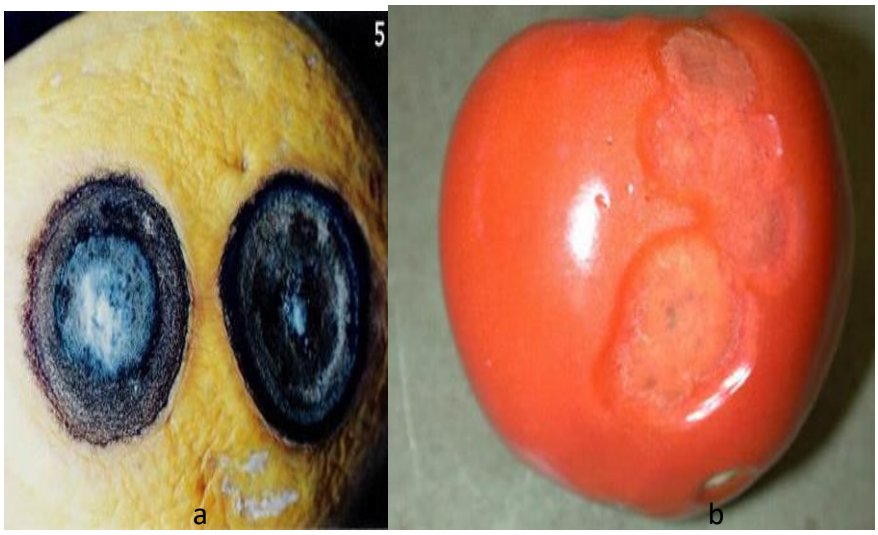


Figure 2. Anthracnose symptoms on (a) Pawpaw and (b) Tomato fruits.

a b

Figure 3. Anthracnose symptoms on (a) Yam and (b) Cassava.

a b

Figure 4. Anthracnose symptoms on (a) Melon leaf and (b) Guava fruits.

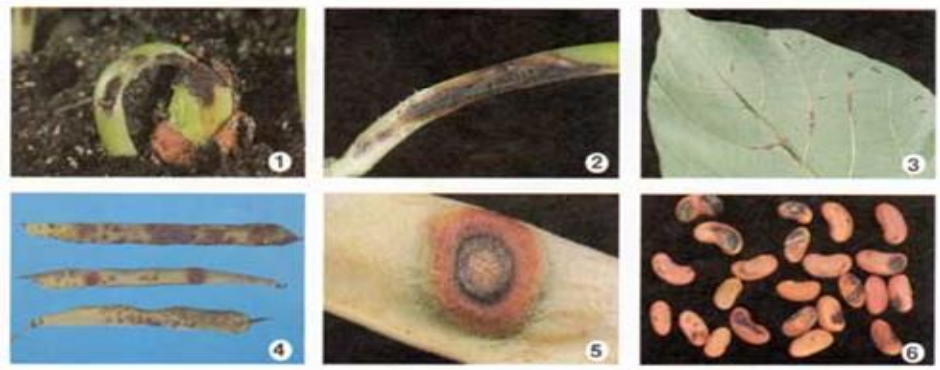


Figure 5. Bean anthracnose (1) on seedling, (2) on stem, (3) on leaf, (4 and 5) on pods and (6) on seeds.

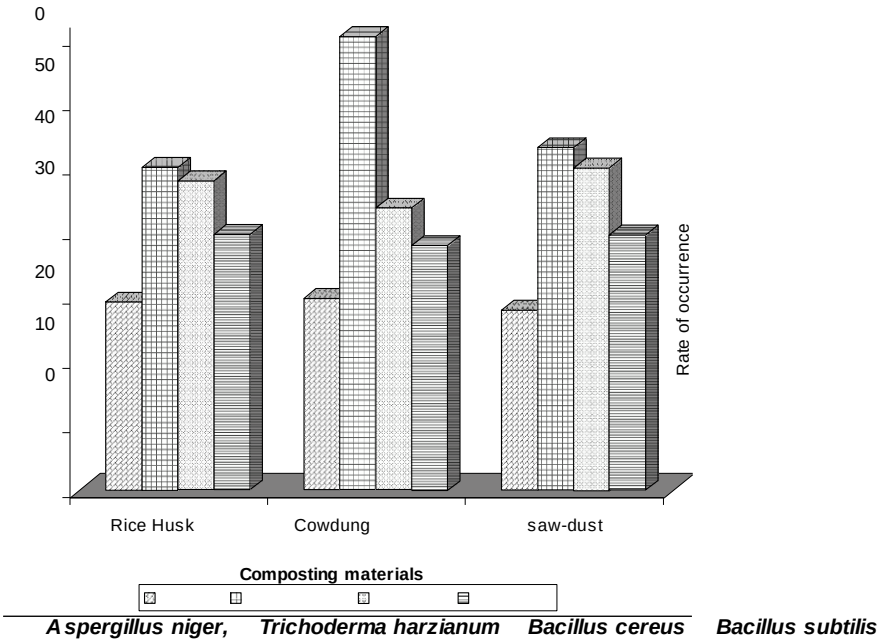


Figure 6. Rate of occurrence of compost-inhabiting microbes

Table 1. Response of 21 cassava clones to natural infection by *Colletotrichum gloeosporoides* f sp *manihotis* and to the toxic metabolites of the pathogen *in vitro* .

Cassava clone	Field screening				*In vitro* screening			
	Disease score		Canker number		Lesion sizes on leaves (mm)		Lesion sizes on stem cuttings (mm)	
95/0084	3.60a	S	20.00	S	20.00	S	18.17a	S
95/0076	3.40ab	S S	18.94ab	S S	19.11ab	S S	16.33b	S S
95/0087	3.40ab	S	18.67ab	S	16.00cd	S	15.00c	S
95/0045	3.40ab	S	16.67c	S	16.00cd	S	15.33bc	S
95/0018	3.20ab	S S	16.50bc	S S	16.00cd	S S	16.33b	S S
95/0078	3.20ab	S	15.67cd	S	17.33bc	S	16.83ab	S
Isu nikan kiyan	3.00ab	S	17.00bc	MS	15.67cd	S	15.33bc	S
95/0079	3.00ab	MS	16.93c	S S	18.00b	MS	15.33cd	MS
95/0088	3.00ab	MS MS	12.00d	MS MS	15.67cd	S MS	15.00c	S MS
95/0065	2.80b	MS	17.03bc	R	14.67d	MS	12.50d	R
95/0069	2.80b	R	16.27c	R	15.50cd	R	15.33bc	R
95/0073	2.40bc	R R	7.00e	R R	10.50e	R R	8.33e	R R
95/0010	2.40b	R	6.47e	R	10.67e	R	11.17d	R
95/0025	1.60cd	R R	4.00f	R R	7.50f	R R	7.67e	R R

Source: Amusa and muhammad (2006).

Each value is a mean of 5 replicates (% measurement/plant), each is a transformation from $\log_e$ value used for the analysis. Each value within the same column is a mean of three replicates (30-plants/clone). Mean value followed by the same letters are not significant (P=0.05) by Duncan's multiple range test. S = Susceptible, MS = Moderately susceptible, R = Resistance, HR = Highly resistance. TDa = Tropical *Dioscorea alata*; TDr = Tropical *Dioscorea rotundata*; Tde = Tropical *Dioscorea esculenta*; TDc = Tropical *Dioscorea cayenesis.*

Toxins and their classification

Several characteristics have been used for the classification of toxins that affect plants. Such features include their chemistry. Based on this, some phytotoxins are regarded as low molecular weight peptides, others have terpenoid structures and still others contain carbohydrates (Amusa, 1991). Another form of

classification is based on the producing organism (fungi, bacteria etc). Phytotoxins classification was also been based on biological activities such as enzyme inhibitors, anti-metabolites, membrane-affecting compound. However, the widely accepted classification is that based on toxic selectivity to plant genotypes (host selective or non- host selective) (Amusa, 1991) and on the general role in disease development (Wheeler and Luke, 1963).

Requisites for pathotoxins (chemopathogens) according to Wheeler and Luke (1963)

The requisites are as follows;

1. It must be isolated from diseased plant but should not be present in healthy plant;

2. It must be characterized chemically and

3. When introduced in pure form into a healthy host, it must produce the symptoms of the disease or a portion of the syndrome.

Pathotoxin is associated with disease symptoms known as necrosis which may be expressed in a number of ways such as:

1. Leaf spots and blights: These are extensive tissue deaths with associated browning of leaves and floral organs

2. Cankers: These are associated with sunken lesions in the stem and branches.

3. Anthracnose: This is associated with sunken necrotic areas on leaves, stems, pods and other fruits.

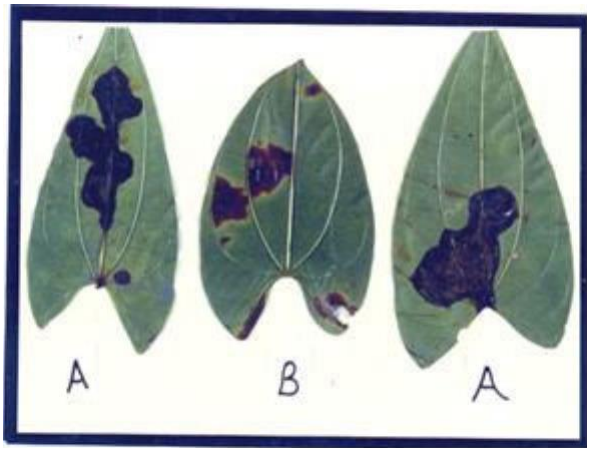


Figure 7. Necrotic lesion induced by phytotoxic substance extracted from infected yam (A) in comparison with that induced by the causal pathogen *Colletotrichiom gloesporioides* (B) on leaves of *Dioscorea alata*.

The principal fungal diseases of green pepper include the vascular wilt, that begins as wilting, browning and dying of leaves and shoots of plants followed by final death of the plants. Ingold, (1976) reported that the vascular wilts are caused by species of *Fusarium* and *Verticillium*, strains of *Fusarium oxysprorum* cause wilts in a number of plant species.

I investigated The effect of soil amendments with rice husks on *Fusarium*-wilt of green pepper and the results have shown yields favourable of plants when organic manures are used as soil amendments in *Fusarium* infected sites (**Muhammad** 1998) Table 2..

Organic matter was found to improved soil structure, texture and plant nutrition (Campbell, 1989). Evidence has shown that various types of compost suppressed different soil-borne plant diseases. Palti (1981) reported that the use of organic matter to control *Streptomyces scabies* known to cause potato scab. Green organic matter incorporated in the planting trench increases general microbial activities which antagonizes the streptomyces. Similarly, general rise in the soil organic matter levels has also been shown to give control to *Phytophtothora cinnamomi* (Muhammad and Manga 1997)

a. b

Figure 8. Fusarium wilt of green pepper symptoms (a) forage and (b) seedling stage.

Table 2: Effect of rice husk amendments on Fusarium wilt of green pepper

Treatment (Avarage)	**Averag e**				**% OF SEED GERMINATION**
Amendment for 0 days	6	4	4	6	50%
Amendment for 4 days	8	6	8	6	70%
Amendment for 8 days	8	10	9	8	87.5%
Amendment for 12 days	10	10	8	10	95%
Amendment for 16 days	10	10	10	9	975
Control	10	10	10	10	100%

Source: Muhammad, (2001)

Biological control

The use of antagonistic microorganisms for the control of plant pathogens has been receiving attention for many years. (Wood and Tveit, 1995), The uniqueness of microorganisms and their often unpredictable nature and biosynthetic capabilities, given a specific set of environmental and cultural conditions, has made them likely candidates for solving particularly difficult problems in the life sciences and other fields as well. Cowpea is exposed to pre and post emergence damping off diseases caused by *Rhizoctonia solani*, *Fusarium solani,* and *Pythium aphanidermatum*.

Four microorganisms known for their antagonistic behaviour *in vitro* were isolated and tested against four plant pathogenic fungi causatives agent of Cowpea pre and post emergence damping off diseases and were observed for any inhibition of growth of the target organisms (pathogens). *Bacillus cereus* inhibited the growth of *Alternaria gossypii, Curvularia lunata* and to some extent *Fusarium solani*, but did not inhibit the growth of *Rhizoctonia solani*. *B. subtilis* inhibited the growth all the four fungal pathogens and was the most effective of the antagonists used. *Trichoderma harzianum* was more of a hyperparasite which physically overgrew and coiled the mycelia of the target organisms. *Aspergillus niger* was effective only against *C. lunata* causing a zone of inhibition of growth, whereas it checked the growth of *F.* solani only on contact. *B. cereus* and *B. subtilis* are recommended for further studies for use on aerial parts of plants to prevent disease while *T. harzianum* is recommended for use on root-borne diseases. Table 3: (**Muhammad** 2004)

Table:3 Inhibition zones (mm-diameter) formed between antagonist and pathogens

Antagonist	*Rhizoctonia saloni*	*Alternaria gossypii*	*Curvularia lunata*	*Fusarium solani*
Bacillus cereus	0.0	10.0	13.0	(5.0) 20.0
Bacillus subtilis	17.0	0.0[2]	0.0[2]	0.0[2]
Trichoderma harzianum	0.0[3]	0.0[3]	0.0[3]	0.0[3]
Aspergillus niger	0.0[4]	0.0[4]	9.0	0.0[4]

(**Muhammad** and Amusa 2004)

3.2. My contributions to other areas of Botany and Biological Sciences in general;

Mr Vice-Chancellor sir, I had to digress a little from pure plant pathology. My first degree was in Applied Biology and as a Professor of Botany I have the liberty to contribute in other areas of Botany and Biological Sciences in general

1. **Medicinal plants** : (**Muhammad** 2009, **Muhammad** and Shinkafi, Aliero and **Muhammad** 2012)

At least nineteen(19) medicinal plants have been identified in the Holy Quran.

They include: **Camphor, Date palm, Fig, Ginger, Grape, Garlic, Lentil, Olive, Onion**, Pomegranate, Summer squash, Sweet basil, Athel tamarisk, Tooth-Brush Tree, Arak, Mustard, Acacia, Cucumber, leek, and Cedrus.

The Quran is regarded as both the spiritual and behavioral guidance for all Muslims [1-4]. Islamic medicine introduced from Prophet Adam (A.S) and was completed at Prophet Muhammad (PBUH) but discover and collecting of these medicine is still continual after the death of Holy Prophet Muhammad (PBUH) throughout the world. (Habiba *et. al.* 2019)

Natural products have interesting and useful biological activities and they also perform various functions.(**Muhammad** 2009, **Muhammad** and Shinkafi,)
Researchers are increasingly turning their attention toward natural products in order to develop better drugs against cancer, as well as viral and microbial infections (Aliero and **Muhammad** 2012)

The practice concerned with the maintenance of health and the prevention, alleviation, or cure of disease is term Medicine. Drug is any chemical agent that affects the functions of living things and the organisms (such as bacteria, fungi, and protozoans) that infect them. The science of drugs, dealing with all aspects of drugs in medicine including their mechanism of action, physical and chemical properties, metabolism, and therapeutics and prophylaxis is term Pharmacology. Pharmacists are therefore responsible for the preparation of the dosage forms of drugs, such as tablets, capsules,

and sterile solutions for injection. They compound physicians', dentists', and veterinarians' prescriptions for drugs. They scope also includes the cultivation of plants that are used as drugs, the synthesis of chemical compounds of medicinal value, and the analysis of medicinal agents. Today drugs are used in treating, diagnosing, and preventing diseases. (**Muhammad** 2009),

Herbal medicine, sometimes refer to as Herbalism or Botanical Medicine is the use of herbs for their therapeutic or medicinal value.

An herb is a plant or plant part valued for its medicinal, aromatic or savory qualities. Herb plants produce and contain a variety of chemical substances that act upon the body.

The last decade has seen numerous changes in the use of botanical products in pharmacy, with certain products being used less and new or other products being used more. The world drugs market manual(1982-1983) has shown the estimated value of the world market in plant pharmaceutical to have exceeded 76.28 billion dollars in 1980, some 13.4% higher than for 1979. EEC imports for 1980 of glycosides and their derivatives, alkaloid and their derivatives and medicine products were 1055,2777 and 80738 million tones while exports were 598,8071 and 16102 million tones respectively (NIMEXE, 1980).

The WHO (world health organization) in its documents ‘Health for all by the year 2000, has accepted the role traditional medicine has to plays in primary health care(WHO, 1977). It has being recognized that 80% of the people in developing countries still rely on traditional medicine as the first line of defense in health care (WHO, 1976). Since animals are also needed for the well-being of mankind. The use of traditional medicine is being advocated by FAO (food and drugs organization) for treating animals, similarly to what is being done by WHO for humans. FAO has initiated the work on documenting and compiling report on traditional veterinary medicine used by small Asian farmers (FAO, 1984a,b,c & 1986).

The statement above stresses the need for the involvement of farmers in any country to develop their plant resources to cater for the needs of the herbal drugs industry. It also emphasizes the need for the involvement of the farmers at grass roots level to identify the new crops for pharmaceutical industry and traditional medicine.

From time immemorial, locally available plants materials have been used as medicine. Several many of these plants species and their products are used today as drugs in tropical West Africa. The rural people in Africa, particularly the poor, depend on forest resources for meeting their energy needs, forest products, and for employment. Tree-species apart from protecting the environment play a vital role in the economy of a nation as sources of food, medicinal products.

Aliero and **Muhammad** (2012) Documented plants with antimicrobial potentials to manage Hospital infection and to:

(i) Appraise the utilization of these medicinal plants, which are available and affordable to rural people in Nigerian and Africa at large.

(ii) Stimulates our pharmacist in carrying research on chemical medicinal properties of these plants and

(iii) Complement Government efforts towards achieving the WHO Alma-Ata Health Declaration of 1978 in the then Soviet Union.“The declaration reaffirmed that “health, which is a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity, is a fundamental human right and that the attainment of the highest possible level of health is a most important world-wide social goal whose realization requires the action of many other social and economic sectors in addition to the health sector.” In its widest form the practice of medicine, that is to say the promotionand care of health, is concerned with this ideal

2. **O**

ral hygiene and use of plants

Oral hygiene and use of plants (**Muhammmad** and Shinkafi 2007; **Muhammad** and Lawal

2010, and **Muhammad** 2012)

Cleanliness is an important part of Islam, including Quranic verses that teach how to achieve ritual cleanliness. Keeping oral hygiene through cleaning the teeth with the use of a form of toothbrush called miswak is considered sunnah, the way of Prophet Muhammad.

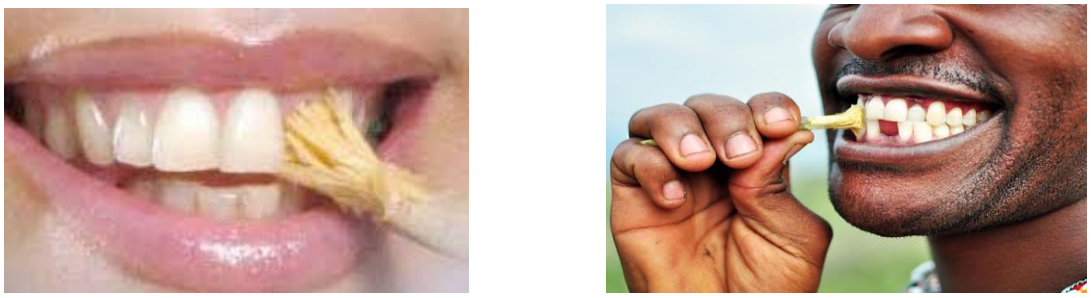
Prophet Mohammad(SAW) recommended miswak(chewing s\tick) to be used to maintain proper oral hygiene, hence is considered by Muslims to be the first dental educator in oral hygiene.

Good oral hygiene is necessary for the healthy teeth, gum and fresh breath. A number of methods ar used in oral hygiene to prevent and cure oral diseases. It is of importance to look at the roles plants play in oral hygiene as a number of them have medicinal properties. When compared to toothpaste, mouthwashes, denitrifies etc. plants used for oral hygiene stands out. In many African homes, teeth are cleaned in the morning by chewing the root or slim stem of certain plants until they acquire brush-like ends. The Babylonians recorded the use of chewing sticks in 7000 BC and its use ultimately spread throughout the Greek and Roman Empires, it is also used by Egyptians, Jews and in the Islamic Empires. It is believed that the counterpart of the modern day toothbrush was unknown in Europe until about 300 years ago. Presently, chewing sticks is being used in Africa, South America, the Middle East and Asia.

In our study, various plant species used as chewing stick and traditional oral hygiene methods with their medical implications**. (Muhammad and Lawal 2010),** Scientific Research and Essays Vol. 5(14), pp. 1788-1795, 18 July, 2010

a.. Customise ready made chewing sticks b. Non customise chewing stick
Figure 2.1. Nigerian Traditional oral hygiene using plant chewing stick
Source: Muhammmad and Shinkafi 2007

a.. Marketed ready made chewing sticks b.Marketed Non customise chewing stick
Figure: 2.2. Nigerian Traditional oral hygiene using plant chewing stick
Source: Muhammmad and Shinkafi 2007



.. a. Healhy clean teeth b. partially clean teeth

Figure 2.3. Nigerian Traditional oral hygiene using natural twig of plant (chewing stick)
Source: *Lybrate.com*

This natural twig is known for its health and medicinal benefits. Below are some of the important benefits highlighted below, so you better go get yourself one, if you don't have one already and enjoy the benefits of the oldest tool for cleaning the tooth.

Fights Tooth Decay and Cavities: Tooth Decay occurs when the enamel is destroyed. There are lots of Bacteria present in our mouth (both good and bad). These bacteria use the starch and sugar present in food to produce acid that wears off the enamel, thereby causing tooth decay and cavity. Saliva helps fight tooth decay by preventing buildup of acid. Chewing Stick helps increase the formation of saliva without any commercial enhancer or additives, thereby fighting tooth decay.

Protects Against Tartar and Plaque: Plaque is a colorless film of bacteria that forms on the teeth and gums as the bacteria grows and multiply. Buildup of plaque leads to formation of tartar, which is a visible yellow coloration that sticks to the teeth and gums and may cause gum disease and tooth loss in the future. The bark of chewing stick contains antibiotics which prevents the growth of bacteria. Brushing your teeth with this twig helps prevent bacterial activities in the teeth thereby saving it from gum disease.

Removes Bad Breath: Bad breath is an indicator of several dental issues ranging from gum disease to dental cavities. Lack of saliva production can also lead to bad breath. Chewing stick has a strong antibacterial property as well as saliva production is an effective remedy for bad breath. Regular use of the twig will help get rid of bad mouth odor.

Protects And Strengthens The Gums: The development of plaque into tartar can affect the gums and teeth by causing Gingivitis, Periodontitis and Advanced Periodontitis. Gingivitis is when the gums suffer from regular swelling and inflammation. Advanced Periodontitis is when untreated gingivitis along with buildup of tartar which affects the bone structure causes the gums to recede and teeth loss. Chewing Stick helps prevent the formation of plaque and tartar thereby reducing the chances of gingivitis and periodontitis thus keeping your gums healthy.

Fights Bacteria And Germs: The mouth harbors more than 500 different types of bacteria, some of them good. Most of the bacteria in our mouth helps in the breakdown of food while some are actively destroying the teeth and gums. In numerous studies, chewing stick has been shown to contain active antibacterial compounds that fight bacterial growth in the mouth, especially when used on a regular basis.

3.

Use of colanut *Cola nitida* (GORO):

Our pilot studies revealed that people chewing Cola nut (*Cola nitida*) Goro hardly have any problem with teeth decay bacteria an eighty (80) year old Man chewing Cola nut will have his stained teeth intact strong and healthy;

a. Partial-stained teeth b. Total-stained teeth

Figure 3.1 Partial and total stained teeth affected by cola phenolic compounds
Source: *Lybrate.com*

The kola nut is the fruit of the kola tree (*Cola acuminata* and *Cola nitida*), indigenous to West Africa. Kola nuts have a bitter taste when chewed fresh. When they're dried, the taste becomes milder and they reportedly smell of nutmeg.

Forms and uses

The kola nut is a cultural staple in many West African countries, prized for its effects as a central nervous system stimulant.

a. Fresh Cola nut b. Dried Colanut

Figure 3.2 Fresh and tried Colanut (Cola nitida)
Source: *Lybrate.com*

Throughout West Africa, every market, bus depot, and corner shop has small piles of kola nuts for sale. It's a significant cash crop for poor rural farmers. Many people chew them daily for a dose of caffeine. Each nut contains more caffeine than two large cups of American coffee.

In the West (the United States and Europe), you are more likely to encounter kola nut extract than the fresh nut itself. Kola extract is a common food flavoring found in Coca-Cola, Pepsi-Cola, and now many popular energy drinks.

In the past, kola extract was used in certain weight loss drugs and over-the-counter stimulants.

Potential health benefits of kola nut

Stories about the many health benefits of kola nut go back thousands of years. People have claimed that kola nut sweetens stale water, treats fatigue, and eases hunger pains. Most of these claims should be seen as folklore until proven otherwise.

While kola nut may have health benefits, they have yet to be scientifically researched and proven. Most of the benefits of kola nut are connected to its high caffeine content, which increases energy and reduces hunger.

Claims have also been made that it treats:

- infections
- skin diseases
- ulcers
- toothaches
- morning sickness
- intestinal diseases
- headaches
- depression
- low sex drive
- coughs and asthma
- dysentery
- constipation
- various eye problems

Side effects of kola nut

The side effects of kola nut and kola nut extract parallel the effects of a comparable dose of caffeine.

Caffeine has many effects on the body, including:

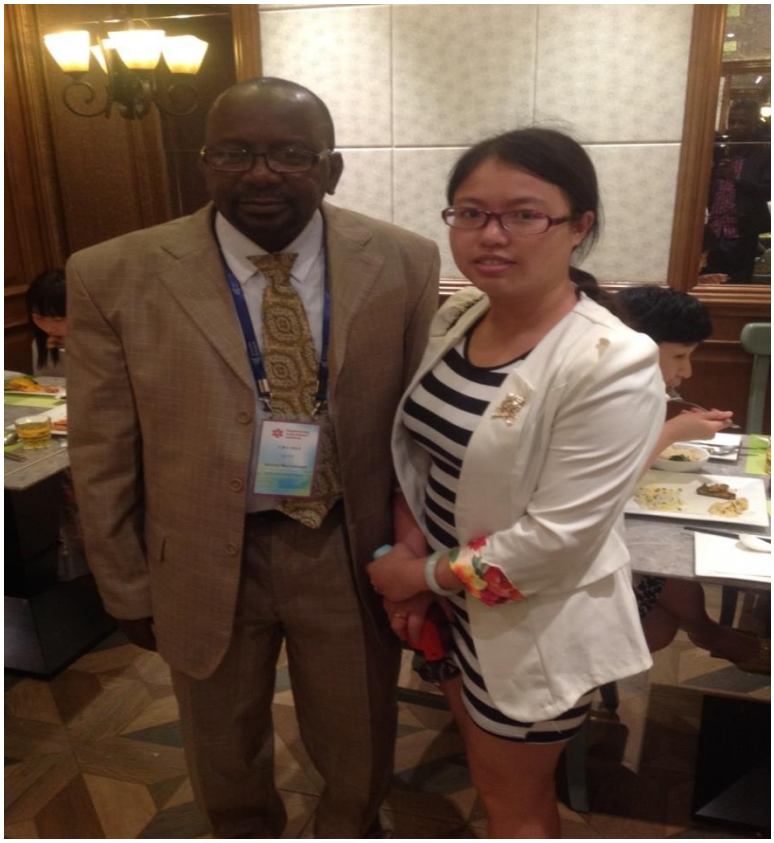
- stimulating your central nervous system, making you feel awake and energetic
- acting as a diuretic, helping your body expel extra salt and water through increased urination
- increasing the release of stomach acid, which can lead to heartburn and stomach upset
- interfering with your body's ability to absorb calcium
- increasing your blood pressure

Most people can safely tolerate about 400 milligrams of caffeine per day. But caffeine can affect some people differently than others.

Energy drinks are not required to list the caffeine content of herbal ingredients, so an energy drink with kola nut extract may have much more caffeine than the label indicates. Too much caffeine can produce unwanted side effects, such as:

- restlessness
- insomnia
- jitteriness and shakiness
- headaches
- dizziness
- rapid or abnormal heart rate
- dehydration
- anxiety
- dependency and withdrawal

Prof. Sanusi Muhammad presenting a lead paper on Colanut at a conference in Shanghai China 2014



Prof. Sanusi Muhammad (right) with the Secretary local organizing committee (right) at International Conference on engineering and Bioremediation at presentation of lead paper on potentials of Cola nut. Shanghai China 2014

Our Studies on Phytochemical Evaluation and Antibacterial Properties of Two Varieties of Kolanut (*Cola nitida*) in Nigeria showed that TLC analysis revealed the presence of quercetin and coumarin in red kola and keamferol and coumarin in white kola respectively. The result of antibacterial activity of red *C. nitida* showed a zone of inhibition of 18 mm and 23 mm at 60 mg/ml for aqueous extract on *Proteus vulgans* and *Streptococcus anginosus*. Similarly white kola inhibited the growth of *S. anginosus* at 90 mg/ml with a zone of 18 mm. Methanol extract of red kola inhibited the growth of *P. vulgans* and *S. angi- nosus* at 60 mg/ml with a zone of 16 mm and 20 mm respectively. Acetone and ethyl acetate ex- tracts of both red and white kola nut did not show any activity against the tested organism at all concentrations. The results obtained indicate that *C. nitida* which posses promising chemothera- peutic and antibacterial potentials respectively that could be useful against odontopathogens. The study may serve as baseline for further studies.

(Muhammad and Fatima (2014) Journal of Biosciences and Medicines, 2014, 2, 37-42)

4. Pesticide/chemical residue in vegetable

Pesticide/chemical residues detection from vegetables survey from Sokoto markets, Nigeria

(**Muhammad** and Shehu 2004; **Muhammad** 2008; Muhammad *et al* 2010)

a. Healthy Lettuce b. Healthy Amaranthus

Figure 4.1. Healhy Vegetables with the trace of pesticide residues sold at kasuwar daji vegetable Market Sokoto, Nigeria

Pesticide residue refers to the pesticides that may remain on or in food after they are applied to food crops. It is defined by WHO (2016) as any substance or mixture of substance in food for man or animals resulting from the use of pesticide and includes any specified derivatives, such as degradation and conversion products, metabolites, reaction products, and impurities that are considered to be of toxicological significance. Waldrum *et. al.* (1996) defined a pesticide as any product that kills or control various types of pest (plant o ranimal that is harmful to man or the environment.

Well balanced diets rich in vegetables are especially valued for their ability to prevent vitamin A and C deficiencies and are also reported to reduce the risk of several diseases (Kalia and Gupta, 2006). Vegetables are known to be rich in vitamins, iron, calcium, proteins, fats and minerals. Leafy green and yellow vegetables are highly valued for their vitamin A and iron contents. Vegetables are helpful in neutralizing the acid substances produced in the course of digestion of meat, cheese and other foods as they are valued as roughages which promotes digestion and helps to prevent constitpation (Oyenuga and Fetuga, 1985).

Most vegetables are low in calories, low in fat and dont have any cholesterol. Vegetables when eaten can also decrease a person's chances of developing many chronic diseases including type 2 diabetes, stroke, some types of cancer and may even help prevent cardiovascular disease and high blood pressure (Vincent Iannelli, 2008). Vegetables when consumed can help achieve or maintain a healthy body weight some of the nutritive properties of vegetables include; 70% of their weight is water, 3.5% protein and about 1% fat they provide comparatively little energy. Examples include tomatoes, onions, pepper, lettuce, cabbage, cucumbers, mushrooms, green peas, corn, carrots, spinach, broccoli, cauli flower, pumpkin, dry beans, green beans, sweet potato, white potatoes etc (Vincent Iannelli, 2008).

Despite their nutritional and health benefits, outbreaks of human infections associated with the consumption of fresh or minimally processed vegetables have increased in recent years (Hedberg*et al.,* 1994; Alterkruse and Swerdlow, 1996; Beuchat, 1996 and 2002). The surfaces of raw vegetables are contaminated with a variety of microorganisms and this depends on the microbial population of the environment from which the food was taken, the condition of the raw product, the method of handling, the time and conditions of storage (Pelczar*et al.,* 2006). They therefore harbor a diverse range of microorganisms including plant and human pathogens (Nguyen and Cardin, 1994; Dunn *et al.,* 1995; Carmo*et al.,* 2004). In developing countries like Nigeria, continued use of untreated waste water and manure as fertilizers for the production of vegerables is a major contributing factor to contamination (Olayemi, 1997; Amoah*et al.,* 2009). Street selling of handy ready to eat sliced vegetables has recently become very common. Unpublished observeations showed that some people even book for the spoilt vegetables being that it was cheap. This can be seen as avenue through which some low income earners are exposed to the consumption of a low grade commodities health wise (Mukhtar*et al.,* 2008).

5. Mycotoxin/Aflatoxin

First Aflatoxins detection from rotten Tomato in Sokoto Nigeria. (Muhammad et al 2004), Aflatoxins were extracted according to (Hell et al. 2001), without modification.

Aflatoxin, an Aspergillus toxin, was first detected in rotten tomatoes commercialized sold and consumed in Sokoto Nigeria(**Muhammad** and Shehu 2004)

b. Healthy Tomato

b.Rotten pepper

c. Rotten Tomato

Figure 5.1. Healhy and Rotten Tomatopepper sold at kasuwar daji Market Sokoto-North Local Government

Our studies revealed that many people prepare to buy rotten Tomatoes because is cheaper than healthy ones many others due to either ignorance or the poverty level in the land, most Nigerians prefer these types of food materials, without minding the consequences of taking them. Most of the fruit and plant produce infected by some of these pathogens were found to have lost significant nutrients, which were depleted by the microbes. Some of those food materials include, powdered food stuffs (Amusa and Baiyewu, 2000), African star apple (*Chrysophylum albidum*) (Amusa et al., 2003a), pepper (Amusa and **Muhammad,** 2004) and pawpaw fruits (Baiyewu et al., 2007).

Aflatoxins are a family of toxins produced by certain fungi that are found on agricultural crops such as maize (corn), peanuts, cottonseed, and tree nuts. The main fungi that produce aflatoxins are Aspergillus flavus and Aspergillus parasiticus, which are abundant in warm and humid regions of the world.

Large doses of aflatoxins lead to acute poisoning (aflatoxicosis) that can be life threatening, usually through damage to the liver. Outbreaks of acute liver failure (**jaundice, lethargy, nausea, death**), identified as aflatoxicosis, have been observed in human populations since the 1960s.

A survey of the market diseases and aflatoxin contamination of tomato fruits was conducted in Sokoto in northwestern Nigeria in 2001 and 2002, respectively. Rotten

tomato fruits sold at five different markets in Sokoto town, located at Central market, Kasuwar daji, Mabera, Minanata and Arkilla were heavily contaminated with moulds. Eight different fungi were found associated with the rotten tomato fruits sold in the five different markets. The associated fungi were *Aspergillus niger*, *Aspergillus ochraceous*, *Aspergillus flavus*, *Aspergillus fumigatus*, *Penicillium citrinum* and *Helminthosporim fulvum*, *Curvularia lunata* and *Sclerotium rolfsii*. *A. flavus* and *A. niger* have the highest rate of occurrence among the isolated fungi, while *S. rolfsii* was the least encountered. Pathogenicity tests revealed that of all the isolated fungi, *A. ochraceous*, *A. flavus*, *Sclerotium rolfsii* and *P. citrinum* were highly pathogenic with the first three leading to rapid disintegration of treated fruits in 3-5 days. *A. niger* was moderately pathogenic, while *H. fulvum* was least pathogenic on tomato fruits. Aflatoxins were detected from the sampled diseased-marketed tomato fruits and also from the marketed rotten tomato fruits after autoclaving for 15 minutes at 121° C.

Prof. Sanusi Muhammad (Recipient of merit award) by organizers of International conference on mycotoxin organized by Universal Researchers in U.A.E. Dubai 2016

Prof. S. Muhammad (Middle) with some participants of International conference on Mycotoxins organized by Universal Researchers in U.A.E. Dubai 2016

Prof. Sanusi Muhammad as a Keynote speaker (middle) with some participants of the Conference on mycotoxins in U.A.E. Dubai 2016

Mr. Vice-Chancellor sir, I have never regretted being a plant pathologist. At least three of the several students who had pass through my tutelage are already professors in Nigerian universities, with two of them as Associate professors (Readers), and about a score of them as senior lecturers. I have served as external examiner at M.Sc and Ph.D levels in many universities within and outside the country. Besides, Im currently supervising about seven (7) Ph.D. and 11 MSc. Students and serve as co-editor/Reviewer of not less than five National/international reputable journals.

3.3. My future Research plans

1. A current and burgeoning challenge for the discipline of plant pathology is the introduction and spread of pathogens to new locations, and emergence or re-emergence of new pathogens against a background of a changing climate (Sumner 2003; Garbelotto and Pautasso 2012; Gottwald et al. 2019; Carvajal-Yepes et al. 2019).

2. In phytopathology, biological control refers to the purposeful utilization of introduced or resident living organisms, other than disease resistant host plants, to suppress the activities and populations of one or more plant pathogens.

3. Phenolic compounds have been implicated in host resistance to pathogens. Phenolic compounds of many fruits, such as apples, pears, and· grapes have been analyzed. Extraction from many plant species and separation of active ingredient in large commercial quantity is important for formulating biopesticides against plant pathogens and to replace synthetic toothpaste in oral hygiene

4. Five challenges to integration of medicinal plants into health care system: a lack of understanding of traditional medicine, discrimination, high turnover of biomedical staff, declining interest in healing as a profession, and equipment scarcity.

5. Mycotoxins are unevenly distributed in food. In so-called „mycotoxin pockets “, concentration can be very high, while the rest of the batch may be unaffected. Representative sampling is therefore essential, and a larger sample size is always more meaningful than a smaller sample size.

3.4. Some of my publications in the field

Muhammad S, and S.B Manga (1997) The effects of soil amendment with cassava peels On *Pythium* wet rot of tomato caused by *Pythium aphanidermatum*. *The Beam: Journal of Arts and Science* Vol. 1(1) 160-165

Muhammad S, and H.M Maishanu**.** (1997) Growth inhibition of *Pythium Aphanidermatum* by some antagonistic microorganisms isolated from soil *Proceedings of soil science society of Nigeria.* P 113-116

Muhammad S, (1998) Effects of soil amendment with rice husk on *Fusarium* wilt of pepper *Capsicum annum The Beam: Journal of Arts and Science* Vol. 4 (2) 108-113

Muhammad S, (2000) Effect of soil amendments with rice husk and cattle manure on control of foliar fungal\ diseases in Cowpea *Vigna unguiculata Nigerian Journal of basic and Applied Sciences*.**(2000) 9:203-208**

Muhammad S**,** A Abubakar, and M.D Magaji (2000) Control of foliar fungal Diseases of *Tamarindus indica* Linn. Caused by *Aspergillus niger* and *Trichoderma harzianum* by soil amendment with sawdust or rice husk *The Beam:: Journal of Arts and Sciences* 2000 Vol. 5 (2) 185:188

Muhammad S, A. Abubakar, and M.D Magaji (2002) Studies on chemical control of fungal foliar diseases in Parkia biglobosa *The Beam:: Journal of Arts and Sciences* 6 (1) 14-16

Muhammad S, A. Abubakar, M.D Magaji and T. Amusa (2001) Effects of soil amendments with sawdust and rice husks on growth and incidence of Seedling Blight in *Tamarindus indica* Linn . *Journal of Sustainable Agriculture and The Environment* Vol 3 (1) 39-42

Muhammad S, N.A Amusa, A. Abubakar, H.A Suberu and M.D Magaji (2001) The effects of soil amendments with sawdust and sawdut and rice-husk on the incidence of seedling blight caused by *Fusarium solani* and *Rhizoctonia solani Moor Journal of Agricultural Research* Vol. 2 (1) 40-46

Muhammad S, N.A Amusa, M.D Magaji and A.M Shinkafi (2002) Effects of Sulphuric acid and hot water treatments on seed germination of African Locust Bean *Parkia biglobosa* (Jacq) Don *Journal of Sustainable Agriculture and The Environment* Vol. 4 (2) 309:**315**

Muhammad S, Amusa N.A.,. . and O. O. Kafaru (2002) The aetiology of sorghum seed Discolouration in the humid forest of South-western Nigeria and its effect on seed Viability *Nigerian Journal of basic and Applied Sciences* 11: 199-208

Muhammad S. and Amusa N.A.,. (2002) Stem and Root rot diseases of Cassava (*Manihot esculenta* Crantz) in the transitional forest of South western Nigeria. *Nigerian Journal of basic and Applied Sciences* 11: 261-272

Muhammad S, and Shehu K (2002) Control of stem rot of Tomato caused by *Sclerotium rolfsii* using metal salts *Nigerian Journal of basic and Applied Sciences.*11: 239-246

Muhammad S. and K. Abdullah (2003) Plants in Medicine in Tropical West Africa (Areview) *Book of proceedings of the 39th congress of the Nigerian Veterinary Medical Association NVMA* 40 - 48

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3.5 My rough ride through life,

Mr Vice Chancellor ladies and gentlemen, *Every successful person has a painful story. Every painful story has a successful ending. Accept the pain and get ready for success*.

At the secondary education level (1973-1979), I was the only one in the entire family of 34, to proceed to higher school as it was being called; very difficult time for me as many call me names that affected me so much that, I atempted running away to my grandmother relatives in Zaria to study Qur'an in tsangaya school (Karatun-Allow)

One memorable occasion that I cannot forget was during my undergraduate days (1985) at Bayero University, Kano when all my money+ food provisions was stolen the very day I arrived 1st term (Not semester) I have no means of communicating home to tell them what happened to me No Ten naira (N10) transport money as we used to pay (Sokoto-to-Kano by road or N25 by Air then) I trekked several times from BUK Oldsite-Kabuga to Tashar-kuka (a distance of about 7 kilometers) to see if I can find somebody business men coming from my village to send message home. At a time on my way to Tashar-kuka I stopped at a house under construction and asked them if they can employ me to work with them they all laughed for I was too young to do such a work. The owner of the house asked me I told him about my story and presented my ID card to him. He assisted me with some money I cannot remember the exact amount which I used to managed myself till I got message from my Mother who incidentally is here seated with us (Mum, May Allah reward you with Al-Jannatul Firdaus, and May you live, live longer to ripe more fruits of your labour)

I can not forget my terrible/bitter experiences during my Masters degree at University of Ibadan (1993-1995). Another One memorable occasion that I cannot forget was a BOSON Conference (1999) attended at University of Portharcourt My humbleself, B.L. Aliero and A.M Umaru were taken as hostage in a hotel and after regaining freedom on our way back to Sokoto, our encounter with Arm-Robbers very very terrible and rewarding experiences indeed. I have many of such memorable occasions to that you tell you but decided reserve them to tell our young ones, junior colleagues and students

Mr Vice Chancellor, Ladies and gentlemen, The lesson to learn from my story is that, you must know that there is a road that leads to success and this road is not very straight. On this road, there is a curve called Failure, a loop called Confusion, speed bumps called Friends, red lights called Enemies, caution lights called Family.

You will have flats called Jobs. But, if you have a spare called Determination, an engine called Perseverance, insurance called Faith and a driver called Almighty Allah, you will make it to a place called Success and become whatever you want to be irrespective of your background.

My humble advice to the young ones is that they should make Allah as priorority not an option.

Quotes of wisdow

Destiny and determination can make anyone successful, but both needs ACTION

BUT prayer without action is a day dream and action without prayer is a nightmare

“ GOD IS NOT AN OPTION, HE IS A PRIORITY.
HE is not a destination, you must travel with HIM

Don’t go to GOD only when you are hungry EAT WITH HIM

3.6 UDUS My Alma Mater

Let me seize this opportunity to pray that; May the Almighty Allah direct the visitor to the university, the President Commander-In-chief Federal Republic of Nigeria Muhammadu Buhari (GCFR), the amiable chairman of council, Senator (Alh) Ibrahim Ida **OON** (Sardaunan-Katsina) the Vice Chancellor, Prof. Lawali Sulaiman Bilbis **FSAN FNSBMB** and the principal officers of the university, on ways to lead this University out of its financial predicament. I will like to plead that effort should be geared towards transforming this great university, to a standard that is creditable in relation to a world-class training centers. The Usmanu Danfodiyo University, Sokoto (formerly University of Sokoto) is one of the four Universities established by the Federal Government of Nigeria in September 1975 , at which time three University Colleges (now full-fledged Universities) were established.

The development of the university started on a temporary site (now called City Campus), situated along Sultan Abubakar Road, Sokoto. classes started in October 20th, 1977, with an initial enrolment of ninety-three undergraduate students for the degrees of Bachelor of Arts, Bachelor of Arts/Science in Education and Bachelor of Science; and an academic staff strength of thirty-three.

The University has made names through the achievements of her products, with many of them occupying exalted positions across the globe. In the academia, this University has produced so many professors, some of which are even appointed and serving in other parts of the world including the United NationS. In the other spheres of life, many of them hold enviable positions in the medical fields, financial institutions, banking sector, oil and gas sector, industries, politics and the legal professions within and outside Nigeria.

My very self is a testimony that this great institution has been offering meaningful academic training since its inception till date. The entire public must take note that certificates ever awarded by this university are standard. I am particularly proud to be a distinguish professor of phytopathology whose foundation was from this university and by the grace of Allah attained the peak of my career at a record time, to be an inaugural lecturer today.

This submission should be a source of encouragement to the employers of labour. The greatness of universities like University of Ibadan, Ahmadu Bello University and University of Nigeria was as a result of the contributions made by their alumni. Hence, they become the envy of many universities in Nigeria today. I therefore My strong appeal to the visitor, and the entire council members of the University, is to build positively on the reputable legacy left behind by our founding fathers, through provision of adequate funds to manage the University.

I also appeal to all members of Alumni and greatest Danfodites to pay back by immensely contributing our quarter in money or kind for taking this University to greater height. There should be synergy between members of Alumni Association with the management of the univetrsty.

Mr. Vice Chancellor sir permit me to use this opportunity in this August gathering to announce My humble Donation of one-thousand seedlings of plant species to our Great University through the Alumni Association with the breakdown as follows: Three hundred (300) Medicinal plants another Three hundred (300) fruit trees and Four hundred (400) ornamental plants. *Greatest Danfodites*

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusions

The survival of mankind strictly depends on the continued existence of green plants. Microorganisms stand as the principal enemies of plants and by implication of man; competing with him and depleting the available raw materials for industries, food, fibre and even shelter.

Prior to now, the use of microbes against microbes has been the major breakthrough in the struggle of man to overcome the menace of this enemy called microbes. However, several factors often limit the use of microbes directly in biological control of plant diseases. Factors such as low inoculum levels, low virulence of biocontrol agents and poor spore dispersal mechanisms; environmental factors such as unfavourable moisture and/or temperature conditions; and widely dispersed host populations often limit disease control by biological agents.

people prepare to buy rotten vegetables because is cheaper than healthy ones many others due to either ignorance or the poverty level in the country land, most Nigerians prefer these types of food materials, without minding the consequences of taking them. Most of the fruit and plant produce infected by some of these pathogens were found to have lost significant nutrients, which were depleted by the microbes

4.2 Recommendations

1. Vegetable consumers can further limit their intake of pesticide residues by peeling or washing fruits and vegetables, which also reduces other foodborne hazards, such as harmful bacteria.
2. The phytotoxic metabolite approach is an attempt to bypass many of these restraints on disease management using bio-control agents, since same quantity of the metabolites will be

applied to the host tissue directly. Mass production of microbial toxins via fermentation or otherwise is easier than spore production.

3. The commercial world is now interested in extracting phytotoxins from micro-organisms to use as herbicides, Insecticides and fungicides rather than using living organisms with their inherent problems of sensitivity to the environment.
4. Federal, State and Local governments should invest in research and development of indigenous herbicides, insecticides and fungicides using phytotoxins, most especially when able-bodied men are leaving farming business. People should be encourage to use of soil amendments with agricultural waste (rice husks cattle manure and sawdust)l two weeks before planting (through programmes in the media on the befits) that will reduce disease incidence

5. Nation Assemble should amend the legislation on NAFDAC , that prohibits the sale of counterfeit, fake drugs and unwholesome processed foods. .etc to cover Rotten and unproccesss food like rotten vegetales..

CITATION ON PROFESSOR SANUSI MUHAMMAD

Prof. Sanusi Muhammad

B.Sc. (BUK) M.Sc. (UI) Ph.D. PGDE (UDUS)

Sanusi Muhammad is a Professor of Botany, born on the 13th day of January 1966 to the family of Late Alhaji Muhammad Namadina (May Allah have Mercy on Him) in Dirin daji, then Zuru Local Government of Sokoto State (Now Sakaba local Government of Kebbi State).

He is the son of Alhaji Namadina and grandson to the renowned cattle-merchant Alhaji Muhammadu Dan-baduku of blessed memory (May Allah forgive them and grant them eternal rest Ameen). His Father Late Alhaji Muhammad Namadina hails from Gidan-Rairai, Kware Local Government of Sokoto state and Mother Hajia Rabiatu Muhammad Danbaduku hails from Kwatarkwashi present day Bongudu Local Government Area of Zamfara State.

EDUCATION

Prof. Sanusi started his primary education in 1973 at Dirin-daji Primary School now Model primary School and completed in 1979 (1st set of 6- year primary school). He gained admission into the prestigious Government College Sokoto in 1979 (now Nagarta College Sokoto), where he successfully obtained easily his Secondary School Certificate (WASC) in 1984. Immediately afterwards young Sanusi gained admission into 2-Year Pre-degree Programme at Bayero University, Kano in 1984 and later degree Programme in 1986 respectively, where He graduated with BSc. (Hons). Applied Biology in 1989.

WORKING EXPERIENCE

After graduation from the University, the young Sanusi was called to National Service (NYSC) (1990) to former Oyo State, he later redeployed back to former Sokoto State on Medical ground and posted to State College of Arts and Science (SCAS) now Sokoto State Polytechnic where he taught Remedial and IJMB courses. He was subsequently retained as Assistant Lecturer in 1991 after one year mandatory National service (NYSC). He participated in WAEC marking for Nine (9) years at 15kobo per script (1990-1999)

JOURNEY TO UDUS

Professor S.H.Z. Naqvi of blessed memory, First invited me in February 1991 through then Malam Hayatu Dukku to take part-time appointment with Usmanu Danfodiyo University, to lecture Botany aspect of Predegree/Matriculation Programme/Undergraduate courses (BIO 101 and BIO 102)

In 1992 He subsequently joined the services of Usmanu Danfodiyo University Sokoto as Graduate Assistant in the Department of Biological Sciences in Botany Unit. In 1993 he was awarded study fellowship by Usmanu Danfodiyo University and gained admission to the Nation's Premier University, **(the first and the best)** University of Ibadan for his M.Sc. Degree in Botany, which he successful completed with a Ph.D. grade in 1995. Three years later in 1998 again he was awarded study fellowship and gained admission into **(the most peaceful university in the country)** Usmanu Danfodiyo University to pursue Ph.D. degree in Botany, which he completed in 2001. In 2001 National University Commission (NUC), advice all lecturers in Nigerian Universities without a teaching qualification to obtain one, immediately Sanusi applied and gained admission (2002) to read Postgraduate Diploma in Education, Usmanu Danfodiyo University, Sokoto which he successfully completed in (2003). He registered with Teacher Council of Nigeria (TCN) in 2004

PROMOTION

Sanusi has never miss his promotion year from Graduate Assistant in 1992 to Professor in 2008; Graduate Assistant (1992-1993), Assistant Lecturer (1993-1996), Lecturer II (1996-1999), Lecturer I (1999-2002), Senior Lecturer (2002-2005), Reader (2005-2008), and finally Professor of Botany (2008-date)

اَلْحَمد لله

TEACHING/SUPERVISION

Prof Sanusi has taught courses at all level in the field of Biological Sciences for over 30 years now He lectured and taught students in different cadres ranging from the Senior Secondary School Certificate (SSCE) (participated in WAEC marking for 9-years), Interim Joint Matriculation Board (IJMB), Predegree/Matriculation programme, Undergraduate, and postgraduate (postgraduate diplomas Masters and Doctoral degrees) and has supervised 7 Ph.D^{s}. 21 M.Sc. degree and over 100 undergraduate projects in the area of Biological Sciences to successful completion. He is Co-editor and Reviewer to many scientific peer review National and International Journals (Such as Nigerian Journal of Botany, Nigerian Journal of Pure and Applied Sciences, African Journal of Biotechnology among others).

AREA OF SPECIALIZATION

Prof Sanusi holds B.Sc. degree in Applied Biology (BUK), M.Sc. degree in Botany (Phytopathology) (UI) (1995), PhD. In Botany (Phytopathology) (2001) His major areas of research interest is Phytopathology/ Biotechnology and other sub discipline of Botany

GRANTS/ACADEMIC-AWARDS

Prof. Sanusi has attracted Research grants from the Tertiary Education Trust Fund TETFUND (NRF) (2020). He is also a recipient of several academic awards for presenting;

1. A Lead-paper at 33rd Annual Conference of Nigerian Society for plant protection, ABU Zaria (18th to 21st April 2006)

2. A Lead-paper from Engineering Information Institute and co-sponsored by the Scientific Research Publishing:**Bacteriological Conference Suzhou, China** (2014)

3. A keynote Speech Presenter: (2016) at the 3rd International Conference on Civil, Environment and Waste Management (CEWM-16) Dubai, UAE

CONTRIBUTION IN THE RUNNING OF THE UNIVERSITY

Prof. Sanusi has contributed immensely in the running of the University, one time Head of Botany (2003-2005) Faculty of Science Examination officer (2007) Head of Biological Sciences (2007-2009) and served as Chairman/member to many University committees such as Chairman, Faculty of Science Junior staff establishment committee (2007-2009), Faculty of Science, Seminar Coordinator 2005-2007 and Member University monitoring Committee on University special projects 2005-2007 among others

SABBATICAL/VISITING APPOINTMENTS:

Prof Sanusi was at different times served on Visiting/Sabbatical appointment to many Universities; Bayero University, Kano, Kano University of Science and Technology Wudil, Kaduna State University, Kaduna, Police Academy Wudil Kano State, Kebbi state University of Science and Technology Aliero. Federal University, Gusau Federal University Dutse-Ma and Umaru Musa University, Katsina

EXTERNAL EXAMINER/EXTERNAL ASSESSOR

Prof Sanusi was at different times served as External Examiner/Assessor to many Universities both within and outside the country (Including BUK, ABU Zaria, KASU, NDA Kaduna, KSUSTA, University of Ibadan, Federal University, Birnin Kebbi, University of Maiduguri, Federal University, Dutse, Federal University of Agriculture, Abeokuta FUNAAB, and Makerere University Uganda to mention a few). He assessed over 10 Academic staff to the rank of Professor in the field of Biological Sciences.

NUC/NBTE ACCREDITATION PANEL ATTENDED

Prof Sanusi has served as ADHOC Chairman/Member of NUC and NBTE Panel of accreditation exercise to over 10 Universities and 5 polytechnics across the Country.

EXECUTIVE SUMMARY OF MY CONTRIBUTIONS

Prof Sanusi has contributed to knowledge towards Plant health against the enemies of humankind in the area of **manipulation** of the pathogen and its **weapon of war** to the detriment of the pathogen and to the advantage of the entire **human race** through his publications (In over 100 peer reviewed published articles, Published Text-Books: (INTRODUCTORY BOTANY Muhammad and Amusa (2009) 1st&2nd. Editions *Available online on subscription at https://www.morebooks.de/store/.../**introductory**..Botany./978-3-8383-2556-9*) **LAP Lambert Academic Publishers (2011) Available @ Eu 79 only**.(hard copies available in UDUS and many sister higher institutions labraries/bookshops and SUCCESS IN BIOLOGY 1st Edition Muhammad *et al* 2010; Chapters in Books: DENTAL HORIZONS *Essentials of oral Health* (**Muhammad** 2011) *Available online* ; HOSPITAL INFECTION CONTROL Aliero and **Muhammad** (2012) *Available online* and some 30 Conferences/Seminar papers presented within and outside Nigeria) virtually, Sanusi has contributed to all discipline within Botany Namely;

1. Plant morphology
2. Plant Anatomy.
3. Plant Physiology.
4. Plant Taxonomy.
5. Plant Evolution.
6. Plant Reproduction.

7. Plant Cytology.

8. Plant Genetics.

9. Plant breeding.
10. Plant Ecology and finally
11.. Phytopathology or Plant Pathology (My chosen area of specialization).

Guest–writer: (2009-2012) National open University of Nigeria (NOUN) I wrote Five modules on SOIL PEDOLOGY AND CLASSIFICATION modules 1-5 available online

(Muhammad 2009**)** https://www.nou.edu.ng/NOUN

Others include;

1. Documented: Uses of Medicinal plants (**Muhammad** 2009, Aliero and Muhammad 2012) *available online*

2. Oral hygiene and use of plants (**Muhammad** and Lawal (2010 Muhammad and Shinkafi 2011, Muhammad and Fatima 2014), *available online*

3. **For the First-time:** Benefit of chewing Colanut **(Goro)** Antibacterial (odontopathogens) activity preventing teeth decay **(**Odebode and **Muhammad 1998; Muhammad** and Fatima 2014) *Available online*

4. **Toxins/Chemical Residues** in fresh/contaminated vegetables consumed in Sokoto Nigeria (**Muhammad** and Shehu 2003, 2004, Muhammad 2018) *Available online*

5. **For the First-time:** First Aflatoxins detection from rotten Tomato in Sokoto Nigeria (**Muhammad** *et al* 2004), *Available online*

COMMUNITY SERVICE

In community service, Prof. Sanusi is the current Chairman; Sakaba Local Government Education Authority, (LGEA), Chairman; Sakaba Sokoto resident, Secretary General Bayero University, Kano Alumni Association Sokoto zonal chapter, Proprietor of Islamiyya School and Community Leader

in his Community. Sanusi is member of Alumni Association of Bayero University, Kano, (BUK) University of Ibadan (UI) and Usmanu Danfodiyo University Sokoto (UDUS)

Sanusi is a member to many scientific and professional societies both within and outside the country including Botanical Society of Nigeria, Nigerian Society of Plant Protection, Mycological Society of Nigeria, Council member Science Association of Nigeria (SAN) 2005-2006 and Member National Mycological Institute (NMI) CABI Bioscience, United Kingdom etc.

FAMILY:

Prof. Sanusi is happily married (3-wives: Lantana Saadatu and Maryam) and blessed with Fourteen (14) children (8-male: Aminu Anas, AbdulRahman Abbas, AbdulAzeez, Abdullahi, Ibrahim and Al-Mustapha) and (6-female: Amina, Asmau, Aisha, Fatima, Saratu and Hajara) / 2-grand-children (Sanusi & Juwayriya)

HOBBIES: Reading/ Travelling

ACKNOWLEDGEMENTS'

Foremost, my profound and earnest gratitude goes to Almighty Allah (S.W.A) for His multifarious favours on me and may peace and blessings be showered upon His Prophet, Muhammad (PBUH) and His companions.

Birth is a seed of plant called life, whose ultimate fruit is death but ripening of fruit is warmed by many colors of infinite support from your loved and dear ones"

I find words inadequate to express my indebtedness and deep respect to my respected teachers, who helped me in understanding the subject. I will like to first acknowledge my principal in secondary school, Government College Sokoto (1979-1984) Alh. Haliru Sarki Aliero.

Mr Vice-Chancellor sir, this lecture cannot end without my showing profound gratitude to many people that have contributed in one way or the other towards my advancement in life. Without their sacrifice and contribution to my life, it would not have been possible for me to stand before you today as an inaugural lecturer. Permit me therefore to mention the following,

My father Alh. Muhammad Namadina of blessed memory, and my mother Hajiya Rabiatu Muhammad. Let me also acknowledge my teachers and academic mentors, Prof. S.H.Z Naqvi, of blessed memory Prof. Y. Y. Karatela,(BUK) Prof. M.D. Magaji, Prof H.A. Suberu Dr. (Mrs) Amina Abubakar. My family members: My wives: Lantana Saadatu and Maryam, My Fourteen (14) children (8-male: Aminu Anas, AbdulRahman Abbas, AbdulAzeez, Abdullahi, Ibrahim and Al-Mustapha) and (6-female: Amina, Asmau, Aisha, Fatima, Saratu and Hajara) / 2-grand-children (Sanusi & Juwayriya) Thank you for your patience and prayer (Baba adawo lafiy Allah kiyaye)

Botany family UDUS Prof. B.L. Aliero, Mal A.M. Umaru Prof. A.A. Aliero (My HOD Sir) Dr. H.M. Maishanu Dr. Aminu Sanda Dr. (Mrs) Habsatu Shehu, Dr. Sule Anka Dr. A. Waziri Dr. A.M.Gumi (Coordinator) Dr.(Mrs) Amina Rabe Dr. Ibrahim Karaye Mal. Ibrahim Tafinta: Mal. Abdlrahman Barau, Mal. Dambuwa Baba-Sidi thank you all May Allah reward you abundantly.

My colleagues whom I worked with from other Departments UDUS:**Zoology:** Prof. Q. Majeed, Prof. T. Adamu, Prof. S. Kiran Dr. Aminu Yabo Dr. Bandia, Dr. Yahya M.M. Dr. Yahya M.A. Mal. Sabiu, Mal. U. Batagarawa, Mal.Mainara **Biochemistry:** Prof. Riskuwa Shehu (former VC) Prof. L.S. Bilbis, Prof. A. Kaoje, Prof. M.J. Ladan,

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Prof. Sanusi has contributed immensely in the running of the University, one time Head of Botany (2003-2005) Faculty of Science Examination officer (2007) Head of Biological Sciences (2007-2009) and served as Chairman/member to many University committees such as Chairman, Faculty of Science Junior staff establishment committee (2007-2009), Faculty of Science, Seminar Coordinator 2005-2007 and Member University monitoring Committee on University special projects 2005-2007

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Prof Sanusi was at different times served as Visiting/Sabbatical/External Examiner/Assesssor to many Universities in both within and outside the country (Including BUK, ABU Zaria, KASU, NDA Kaduna, KSUSTA, UI, UNAAB, and Makerere University Uganda to mention a few). He served as External Assessor for Professorial Cadre to many Universities and assessed over 10 Academic staff to the rank of Professor in the field of Biological Sciences He also served as ADHOC Chairman/Member of NUC Panel of accreditation exercise to over 10 Universities in the Country.

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