# EXPERIMENTAL DETERMINATION OF GROWTH RESPONS OF JATHROPHA PLANT TO DIFFERENT IRRIGATION INTERVALS

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2005/21655EA

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FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA,

NIGER STATE


DECEMBER, 2010.

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MATRIC No. 2005/ 21655EA

BEING A FINAL YEAR PROJECT REPORT SUBMITED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG.) DEGREE IN AGRICULTURAL AND BIORESOURCES ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE.

DECEMBER, 2010.

## DECLARATION

I hereby declare that this project work is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any university or institution. Information derived from personal communications, published and unpublished work were duly referenced in the text.

..................................................... ............................14/12/10

Olokesusi, Tunde Williams Date

## CERTIFICATION

This is to certify that the project entitled "Experimental Determination of Different Irrigation Interval on Growth Parameter of Jathropha Crop" by Olokesusi, Tunde Williams, meets the regulations governing the award of the degree of Bachelor of Engineering (B.ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary Presentation.

.................................. 14/12/10 ..................................

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External Examiner

Date

# DEDICATION

This project work is dedicated to my parent Late Chief Adedoyin Olokesusi and Mrs. Susanah Olokesusi.

# ABSTRACT

Experimental determination of different irrigation interval on growth parameters of Jathropha crops was done. It was carried out in the field at Gidan- kwano Campus, Federal University of Technology Minna, Niger State. Jathropha were planted in nine different containers. This indicated three containers for a sample and three different samples were observed for the period of 90 days.

The parameters monitored during the period were leaf area index, stem girth, number of leaf and rate of growth. During the period, different irrigation intervals were also experimented. The first sample were irrigated 3 days interval, while the second sample were watered 5 days interval and 7 days interval given in sample C, all for the period of 90 days.

At the end of the period, the results of the parameters monitored are for Sample A. Leaf area index 7.5x8.3, Sample B 7.3x7.3, while Sample C recorded 7x7cm. Stem girth, Sample A 15.3cm while B Sample was 12.3cm and 11cm for C Sample

Number of leaves for Sample A was counted 7, while B was also 7 and 6 leaves were counted for Sample C. Rate of growth, Sample A was given 25.4cm, Sample B was 21.5cm while Sample C was recorded lowest to be 15.6cm. It was deduced that the result of 90 days showed that the growth parameters of Sample A, B and C were different from one another. Sample A, were better than Sample B and consequently C due to their irrigation intervals which were different.

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CHAPTER ONE

**1.0 Background of study.**

Jathropha is believed to have been spread by Portuguese seafarer from its centre of origin in central America and Mexico via cape Verde and Guinea Bissau to other countries in Africa and Asia .It is now widespread throughout the tropics and subtropics. Until recently,Jathropha economic importance in cape Verde since the first half of the nineteenth century .with it's ability to grow on poor soil with low rainfall , it could be exploited for oilseed production. Cape Verde exported about 35000 tonnes of jathropha seeds per year to Lisbon aiong with Madagascar , Benin and Guinea ,It also exported jathropha seeds to Marseille where oil was extracted for soap production .However this trade declined ih the 1950s with the development of cheaper synthetic detergents and by the 1970s the trade in jathropha oil had disappeared[wiesenhwtter,2003;Henning,2004a].in the past jathropha oil was for lighting lamps[Gubitz et al, 1998] Today, rural communities continue to use it for its medical value and for local soap production . India and many countries in Africa use the jathropha plant as a living hedge to keep out grazing livestock. Jathropha is planted In Madagascar and Uganda to provide physical purport for vahilla plants. Jathropha's potential as a petroleum fuel substitute has long been recognize. It was used during the second world war as diesel substituted A number of jathropha species are well known and widely cultivated throughout the tropics as ornamental plants ,there are some 170 known species of jathropha, mostly native to the new world, Although 66 species have been identified as originating in the old world[heller,1996] jathropha a succulent perennial shrub or small tree, can attain heights of more than 5 meters depending on the growing condition In each case the tree are slightly more than two years old. Seedling generally from a central taproot ,four lateral roots and many secondary root .the leave arranged alternatively on the stem .Jathropha is monoecious ,meaning it carries separate male and female flower on the same plant .Jathropha grows readily from seed which germinate in around 10 day or from stem cuttings .Growth is rapid ,The plant may reach one metre and flower within five months under good condition [Heller,1996]. Jathropha has proven effective in reducing the taproot anchors the plant in the ground while the profusion of lateral roots near the surface bind the soil and keeps its from being washed out by heavy.rain ,It from being washed out by heavy rain ,It also improves rainwater infiltration when planted in line to farm contour

## 1.2 Irrigation Background

Looking at the population explosion of human, there is need for adequate and constant crop production to meet the trend in which humanity is growing and for its survival since all factor of survival of humanity depends on regular and adequate crops production Rain needs to be utilized and preserved for crop production through farming system, In a situation of adverse effect of either lack of rain or excessive rainfall, The chain of technological advancement tracking on agriculture has made it possible only through a systematic system of irrigation. Excess water can be stored by constructing dams, reservoirs and releasing it to the field whenever is needed [Gupta,1972].In technical term, this system of technological advancement in agriculture is know as irrigation system. It is a very important system for increased yield of crops in order to meet the required expectation of crop production for the survival of humanity and to curb famine. Irrigation system had been in existence as far back as 3300BC in Egypt practiced near Nile However, with the trend of development in engineering and technology.Irrigation can be practiced on large scale project as means of curbing the population explosion of humanity by providing high productivity of food. in ancient practise of irrigation, surface irrigation method was being practised such as furrow,basin,borders,flooding,checks but in technological age, The practise of irrigation has been extended beyond surface irrigation in which irrigation water is applied to the soil surface and infiltrate through the soil within the root zone of crops. The modern practise of irrigation method include sub-surface irrigation know as sub irrigation sprinkler, trickle or drip. High productivity of crops is achieved when there is available of crops at affordable cost to the generality of humanity by taking this into consideration, there are some factors that influence irrigation system applicability and not undermine the output. In view of this it involves some consideration in selection of a suitable irrigation regimes for a farm or a region and such consideration include the following factors (Dyara and Reger,1990).

1. The technical efficiency in terms of control of the amount of water applied.
2. The cost of investment operation and maintenance
3. The cropping system
4. General economic data that is the availability and cost of capital, labour and cost of input and output. In addition, the general data pertaining to the crop to be irrigated.

### 1.3.1 AIMS AND OBJECTIVES OF THE PROJECT.

In an attempt to find available data ready for proper irrigation design for Jatlhropha crop, the following are to be established:

1. To determine the growth parameter of Jathropha at different irrigation interval.
2. To study the effect of water stress in different stages of Jathropha growth

### 1.3.2 Scope of the study

In most developing countries, farming system depends solely on rainfall which restrict production of crops to only during rainy season. Irrigation system is a way to this climatic dependence of rainfall but the problem lies on inadequate estimate of irrigation water requirement of crops (Linsky, FranziniFreybers and Techobanoglous)

These problems among others are:

1. Determination of sources of available water,
2. Design of storage reservoir to assure necessary water
3. Analysis of chemical quality of available water.
4. Economic analysis of the project to determine whether the estimated cost is returnable from the potential benefit and
5. The financial analysis to establish a repayment plan.

## 1.4 Justification

Irrigation is an expensive scheme that involves large sum of capital in the limitation of the project success of irrigation project depends on the available data/information in designing irrigation project. In addition irrigation system is a means to enhance growth in crop production.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1.0 JATHROPHA CROP

In Congo, this plant is found in almost all the areas. The population uses it for the clothes industry of the fences and in the pharmacopeia, in reason of its many the rapeutic virtues (Kerharo, 1974). *Jathropha curcas*, is a drought resistant tropical tree and the oil from its seeds has been found useful for medicinal and veterinary purposes, as insecticide, for soap production and as a fuel substitute (Gubitz*et al*., 1999).There is a large variability in different accessions of *Jatropha curcas* from diverse agro climatic regions (Kaushik*et al*., 2007). Augustus *et al*. (2002) have reported that *Jatropha curcas* seeds contain around 20-40% oil. Its oil fraction consists of both saturated (14.1%palmitic acid and 6.7% stearic acid) and unsaturated fatty acids (47% oleic acid and 31.6 of linoleic acid). Recently, there is a report (Martinez-Herrera *et al*., 2006) reported that the major fatty acids found in the oil samples w ereoleic (41.5-48.8% ), linoleic (34.6-44.4% ), palmitic (10.5-13.0%), and stearic (2.3-2.8%) acids. Because of the strong competition between human consumption and the soap factory for the use of vegetable oils, it is advantageous that Africa develops other sources of vegetable oils of production. *The curcas of Jatropha* is instigator, because the seed contains oil 58% roughly

### 2.1.2 Occurrence:

Jathropha originates from Mexico and Central America, but has spread all over the world and is mostly used for hedges.

### 2.1.2. Properties

Many investigations have been done on the content of the Jathropha seeds.

The seeds contain:

Material Kernel (60%of weight)

Shell (40%of weight) Meal

Crude protein 25.6 4.5 61.2

Lipid (crude fat) 56.8 1.4 1.2

Ash 3.6 6.1 10.4

Neutral detergent fibre 3.5 85.8 8.1

Acid detergent fibre 3.0 75.6 6.8

Acid detergent lignin 0.1 47.5 0.3

Gross energy (MJ/kg) 30.5 19.5 18.0

Sources: [3,5]

The seed oil is 80 percent unsaturated, made up mainly of oleic and linoleic acid. Most vegetable oils that are liquid at room temperature have a comparable fatty acid composition.

### 2.1.3 Uses

Jathropha Curcas

Whole Plant:

- Erosion control
- Hedge plant
- Medicinal use
- Plant protestants
- Fire wood
- Green manure

Fruits Fruit hulls Combustibles, green manure Seeds

Seed oil Seed cake

- Soap production - manure

- Fuel - input for biogas production

- Medicinal uses - input for combustion or charcoal production

### 2.1.4 Use of the whole Plant:

Erosion control as hedge plant

In the tropics, the plant is widely used as a hedge in fields and settlements. It protects plants against wind erosion and keeps animals out. Jatropha is chosen for this purpose mainly because it can easily be propagated by cuttings, densely planted for this purpose, and because the species is not browsed by cattle. The roots also forma protection against water erosion, and can protect against soil erosion by runoff if planted with Vetiver grass or lemon grass. When grown from seeds, the plants are edible for the first 3 months, since the toxic material has not been developed yet. It should be protected from animals in these early stages. It can also be eaten safely, when steamed or stewed.

Consumption of seeds or seed cake should be avoided in all cases!!

Medicinal use

The name "Jathropha" refers to medicinal uses, from the Greek jatrós, meaning "Doctor" and "trophè", meaning food". Preparations of all parts of the plant, including seeds, leaves and bark, fresh or as a decoction, are used in traditional medicine and veterinary purposes. The oil has a strong purgative action and is widely used to treat skin diseases and to soothe pain from rheumatism. The sap flowing from the stem is used to control the bleeding of wounds.

**Plant protectant**

Extracts from all parts of the physic nut showed insecticidal properties on plants. Most of the experiments done are still in experimental stage.

**2.1.5 Viruses**

Unfortunately the physic nut is a host for viruses that attack also cassava, since they belong to the same family of plants (such as the cassava super elongation disease).Therefore physic nut should not be used to fence in cassava fields. For some countries it should be investigated if it does not contain viruses for major crops. One issue raised in Mozambique, for example, was that it could possibly contain viruses harmful to cashew nut trees, which occur in large quantities all over the country.

**Firewood and green manure**

The plants and fruit hulls could be used for firewood, but it is low quality wood. The leaves and the fruit hulls can be used as green manure in the fields.

Seed oil uses

The seed oil can be used for production of soap, directly as fuel in oil lamps or Stoves, or as PPO for diesel engines.

**Soap Production.**

In former times Portugal imported Jatropha seeds from the Cape Verde islands to produce soap. From the '20s to the '60s some 2000 tons of seeds were imported per year on average. Presently soap is produced by artisanal methods in Mali and Tanzania (Arusha) and for short in Zimbabwe. The oil is boiled with a soda solution (Henning, 1994) and poured into moulds, in which it hardens out into soap during cooling of. The soap has positive effects on the skin and is therefore marketed for medicinal purposes. The local production of soap is one of the most economically attractive uses of Jathropha oil. In [2, The Jathropha system, Henning, 2004], some economic calculations are given for the production of soap, as well as the production of PPO, in Tanzania.

**Fuel**

After pressing the seeds, the filtered oil can be directly used as PPO in diesel Engines. Because of slightly different properties of PPO compared with fossil diesel, newer types of diesel engines must be adapted. Generally the Diesel engine is very suited to run on PPO. In fact Rudolf Diesel designed his first engine to run on plant oil as well. Many types of diesel engines have indirect injection (IDI) with pre-chambers. The PPO can be used freely in these engines, which are still commonplace in developing countries. Some typical brand names are: Lister, Deutz, IFA, DMS, and Farymann. Probably most of these are IDI types. Elsbett diesel engines have been designed especially for the use of PPO.. Direct Injection diesels can also run on PPO, but some modifications have to be made to the engines. Mainly cold start and low-load situations (idling etc.) are dangerous when using PPO. A two-tank system, using PPO only for full load of the hot engine, overcomes most problems. The engine should be monitored properly for lubrication oil production or consumption and coke deposit in the combustion chamber. To produce a generally usable bio fuel for any diesel engine, the PPO can be converted to biodiesel with a trans-etherification process. The resulting biodiesel can be used in any diesel engine without adaptations (except for pure rubber hoses which deteriorate after longer contact with pure biodiesel).

This is not a complex process, but requires the addition of methanol (or ethanol) and caustic soda, increasing the cost of the final product. This is mostly done in Europe, notably in Germany and France, from rape seed oil.

This process requires the use of electricity, and therefore bio-diesel production is typically feasible on a large scale, at centralized production plants. It is not so suitable for small scale applications, although small systems have been designed in India, powered by human pedalling force (cycling).

**Medicinal uses**

The oil can also be used for medicinal purposes, see earlier.

**Seed cake uses**

**Manure**

A good application for the seed cake is to use it as organic manure, replacing Chemical fertilizer. It has nitrogen content similar to that from cake of castor bean or chicken manure. The nitrogen content ranges from 3.2 to 3.8 %.

## 2.2.0 Irrigation Engineering and Scope of Irrigation System

Irrigation technology include design of works related to river control, drainage of water logged areas and generation of Hydro-electric power. It also deals with the design construction of all related works, such as dams, head works distribution system in connection with storage or diversion of water and its distribution as well as sub soil drainage. (Gupta, 1972).

The application of water to the crops at proper time in proper quantities, its distribution on the field and the best method for its application is also an aspect of irrigation science. In a broader approach, irrigation water serves the following purposes:

1. Acts as a solvent for the soil.
2. For the chemical action within the plant leading to its growth.
3. Controls temperature of the soil.
4. Dilutes the salts present in the soil.
5. Supports moisture to the soil.
6. It softens the tillage pans

### 2.2.1 Method of Irrigation.

Basically, irrigation is accomplished with the following methods:

1. Surface irrigation.
2. Sub-surface irrigation
3. Sprinkler irrigation.

### 2.2.2 Surface Irrigation

The traditional form of irrigation in the arid zones is the surface irrigation whether the method used is basin, furrow or simple flood irrigation, the basic principle is the same. Water is applied to the surface of the soil at some distance from the roots of plants, and the characteristics of the soil surface – slope and permeability are relied upon to control the supply of water to the plant root zone. The simplest system is a man with a horse. This is often used in the Middle East with small basins around each tree or shrubs to flood grass areas.

### 2.2.3 Sprinkler Irrigation

The second most widely used irrigation system is sprinkler or overhead irrigation. The equipment used ranges from the very large centre pivot units which irrigate areas up to 100 hectares with a single unit to a small closely-spaced sprinklers for nursery or decorative works to the wide availability of light weight aluminium tube resulted in considerable use of portable and semi-portable system which have relatively low cost. The characteristic of this type of system is that water is piped to distributed point from which it is sprayed on to the crop on the soil below the crop. Sprinkler irrigation is in a sense most natural form of irrigation since it essential simulates rain.

### 2.2.4 Drip Irrigation

The use of drip irrigation on a wide scale is relatively recent development. Drip (or trick) irrigation delivers water in controlled quantities to individual plant or group of plants. The system uses a network of small bore plastic tube laid on the ground surface adjacent to each plant a dripper – a specially constructed calibrated orifice delivers water at a rate normally between 2 -12 litres per hour by delivering exactly the amount of water the plant required and applying it directly to the soil adjacent to the plant trickle irrigation system achieved high irrigation efficiencies.

### 2.2.5 Irrigation

The fourth majour type of irrigation system is sub – irrigation. This is normally achieved by either creating an artificial water table just below the ground surface or by burying a drip irrigation system or a network o f perforated pipes. When the water is supplied at a depth of about 30 – 75cm moisture rises by capillary action into the root zone. The system normally requires an impermeable layer below the excessive losses to the percolation.

### 2.2.6 Soil Physical Properties Influencing Irrigation

Soil is made up of three phase components such as solid phase made of mineral organic matter and various chemical compound; the liquid phase called solid moisture and thee gaseous phase called soil air. The solid phase includes soil particle, size and shape. Numerous living organisms such as bacteria, fungi algae protozoa, insects and small animals which directly or in directly affect soil structure and plant growth.

### 2.3.0 Drainage

More than 100 million hectares of land have been drained throughout the world. Much of this is in the humid temperate area like the Eastern USA and Europe, but artificial drainage is also necessary in many irrigated land of arid and semi– arid to prevent Stalinization. The Netherlands are good example of an intensively drained humid area with more than half of the 2.5 million hectares of cultivated land drained.

### 2.3.1 Surface Drainage

Surface drainage system must be a suitable for mechanized operations on various type of topography such as pothole areas, flat field, and gently sloping land irrigated areas such as drain are needle to collect waste water from surface irrigation pothole areas are frequently found in glaciated region where the topography is relatively flat and geographic erosion has not had time to develop natural outlets.

### 2.3.2 Effects of Poor Drainage.

The effects of poor or inadequate drainage system can be summarized as follows:

- Results in poor aeration
- Uptake of nutrient and water restricted
- Nitrogen becomes limiting factor that is not easily absorbed by root hair.
- High water table destroy soil structure
- Soil temperature is affected

### 2.3.3 Chemical Nature of Soil

Mineral components of the soil are made largely of silica and silicates. Chemical composition of particles varies from profile to profile which contains the larger particles having larger silica while finer particles contain more potassium, calcium and phosphorus. Dominant minerals are quartz in sand, quartz and feldspar in fine sand and silt, mica, vermiculite, montmorillomite, kaolimite and amorphous colloids in clay. (Michael 1978).

### 2.3.4 Plant Structure

The morphology of a plant consists of roots, stem and leaves. Leaves are borne through stem in all plants. These organs are mainly responsible for the loss of water. Pore on the leaves are the stomata and surrounded by guard cells. The stoma regulates the loss of water as vapours and the exchange of carbon dioxide in the leaf and other organs. The leaves maintain their continuity of structure with the stem which has conducting tissues which are the xylem and phloem. Xylem is the main channel of water transport. Root hair is largely involved in water uptake. (Michael 1978).

### 2.4.0 Water Relation of Soil

Pore spaces in soil are partly filled with soil air liquid vapour and partly with liquid phase of soil water. (Ghuman and Maurya, 1986) gave the assertion that irrigation water is very necessary because a large amount of irrigation water would affect the suitability of the soil for crop production. Water affects intensely many physical and chemical reaction of soil as well as plant growth. Soil serves as storage reservoir for water.

### 2.4.1 Movement of Water into Soil.

The movement of water in the soil is complex because of the various state and direction water moves and also because of the forces that cause it to move. The movement of water from the surface and through the soil is called soil water intake (Obiechefu 1990).

### 2.4.2 Plant Water Relationship

The importance of water to living plants is given by (Chapman and Carter 1976) as follows:

Water is the majour constituent of the living cell. Between 85% and 95% of the live weight of most plant tissue in plant. Water in the living cell is a universal solvent that carries essential nutrients through the plant and allow critical chemical reaction to occur.

Water through its complex relation with osmotic substance (such as salt) in the cell is essential for cell turgidity and for cell elongation.

The metabolic activity of cells and plants is closely related to their water content. Growth of plants is controlled by the rates off cell division and enlargement and by the supply of organic and inorganic compounds required for the synthesis of new protoplasm and cell walls. Water plays a leading role in photosynthesis of a plant.

### 2.4.2 Soil Water

The presence of water in soil is essential for the survival and growth of plants and other soil organisms. The soil moisture regime often relative of climatic factors is a majour determinant of the productivity of terrestrial ecosystems including agricultural system movement of water and substance dissolved in it through the soil profile is of great consequence quantity of local and regular water resources. Water moving through the regolith is also a major driving force in soil formation.

### 2.4.3 Ground Water Flow

The quantitative description of water flow through a porous medium was given by Henri (1856) who reported on the filtration of water flowing through a sand bed for an improved supply for Dijon. The modern statement of Darcy's law for flow in a saturated medium is

$$V = \frac{Q}{A} = K(_2 - _1)$$

where Q is the rate of discharge of water through a cross section area, which is taken normal to the direction of flow, K is a proportionality constant ▯ is the hydraulic potential given by P+Z and V is the discharge per unit area.

### 2.4.4 Gravitational Potential

The water content of soil can be measured by finding the mass $M_w$ of water lost upon drying a sample in an oven at $105^0C$ to a constant mass $M_s$ the water constant on a mass basis is

$$m = \frac{M_w}{M_s}$$

Since the amount of water lost increases with the drying temperature in any soil that contain clay or organic matter. The oven temperature must be controlled within a range of about 100 - 110°C for routine work the procedure is set out by Gardner (1986).

### 2.4.5 Soil Water Potential

Water in the soil is seldom in the static state under non-equilibrium condition there is a tendency for it to move at a given point in a direction that results from the combined effects of gravity, hydrostatic pressure and either possible force. The movement is towards a position of lower energy sources. Energy is used up in overcoming the viscous resistance to flow. The force resulting from the various water moving forces can be obtained in both magnitude and direction from the gradient of potential energy at a point.

### 2.4.6 Matrix Potential

Water is held within the soil matrix by adsorption at the surface of particles and by capillarity in the pore. Clay particles in particular are able to absorb water actively and swelling can occur as a consequence. Surface of quartz grains are not so relative and only limited surface adsorption can be drawn into pores between the grains by capillarity.

### 2.4.7 Hydrological Cycle

The science of metrology is a plant of the much broader field of hydrology which include the study of water as it occurs in the atmosphere as well as on and below the surface of the earth. The formation of precipitation, which may occur as rain, snow, sleeve or hail. Some of this precipitation evaporates partially or completely before reaching the ground. Precipitation reaching the earth surface may be interpreted by vegetation. It may infiltrate the surface of the ground, it may evaporate or it may run off the surface. Evaporation may be from the surface or from leaves of plants through transpiration. A total rainfall moves over the earth surface as run-off another portion moves into the soil surface is used by vegetation becomes part of deep ground water supply.

### 2.4.8 Precipitation

Precipitation may occur in any of a number of forms and may change from one form to another during its decent. The form of precipitation consisting of falling water droplets may be classified as drizzle or rain drizzle consists of quite uniform precipitation which drops less than 0.5mm in diameter. It may also occur as froze water particles including snow sleet and sleet from where raindrops are falling through air having at a temperature below freezing a hail stone is an accumulation of many of them. Layers of ice over a snow pellet of the form of precipitation, rain and snow make the greatest contribution to our water supply.

### 2.4.9 Infiltration

Water enters the soil pore space and becomes soil water and the rate at which water can enter the soil

$$I = \frac{Q}{A * T}$$

Where Q is the volume quantity of water ($M^3$). Infiltration A is the area of the soil surface ($M^2$) exposed to infiltration and T is the time (s). The infiltration capacity is not constant over time but generally decreases during an irrigation or rainfall episode.

### 2.5.0 Surface Run Off

Runoff occurs only when the rate of precipitation exceeds the rate at which water may infiltrate into the soil after the infiltration rate is satisfied, water begins to fill the depression. Small and large on the soil surface. As the depression are filled over land flow begin the depth of water build up on the surface until it is sufficient to result in equilibrium with the rate of precipitation less than interception.

### 2.5.1 Percolation

It is a transitional phenomenon that takes place at the soil surface. Once the water has infiltrated the soil, the water moves downward into the profile. Both saturated and unsaturated flows are involved in percolation of water down the profile and the rate of percolation is related to the soil's hydraulic conductivity. In case of water that has infiltrated a relatively dry soil; the progress of water movement can be observed by darkened colour of soil as it becomes wet.

## 2.6.0 Evaporation, Transpiration and Consumption Use

Evaporation is a process which converts water into vapour. The conversion occurs through absorption of heat energy. Evaporation of liquid water transformation into vapour from open water bore soil or vegetation with soil beneath.

Transpiration occurs as the part of the total evaporation which enters the atmosphere from the soil through the plant.

Evapotranspiration is the sum of the amount of water transpired by plant driving the growth process and that amount that is evaporated from the soil and vegetation around the growing crop. (Ekwue, 1998).

Potential evapo-transpiration (PET) is the evapo – transpiration from large vegetation covered land surface with adequate moisture at all times (Thornth Waite, 1948). (Penman, 1947) concluded that potential evapo-transpiration as the evapo-transpiration from an activity growing short green vegetation completely shading the ground and never short of moisture available.

# CHAPTER THREE

## 3.0 EXPERIMENTAL DESIGN

Plastic containers were used for the experiment. The containers are of 20cm height and 20cm in diameter respectively. Soil was put into each of the containers after it was tested too be sand loamy soil and of the same soil texture and structure.

Water was applied to the container till saturation was reached at different water table depth. The whole containers were carved by net to avoid external effect or any disturbances, then white nylon was also used to cover the top after being net to avoid falling of rain inside the containers.

### 3.1 Planting

The Jathropha seeds were sown with a seed per hole about 3cm deep and at a distance of 5cm between holes within container. The seed was selected because of its maturation which is ready for harvest as dry seeds.

### 3.2 Water Application

Water was applied at three day interval for the first sample which was labelled $A_1$, $A_2$, $A_3$ using measuring cylinder and plastic container and the second bucket that was labelled $B_1$, $B_2$, $B_3$ was also irrigated at 5 days intervals while the third sample labelled $C_1$, $C_2$, $C_3$ was irrigated at an interval of seven days. The amount of water applied on each sample was recorded. Water was applied to the containers gradually till the level gets to the required water table depth.

## 3.0 Methods Used In Getting Sand Loam Soil.

### 3.3.1 Soil Texture

Determination of soil texture used for the experiment which is refers to the fineness or coarseness of the mineral; particle of the soil and it is the relative proportions sand and loamy using mechanical analysis data in conjunction with the triangle indicated.

Initial weight of sieves of different sizes in diameter were taken, soil sample was put into the sieve and through shaking was done using mechanical vibrator, to allow passing of soil particle of different size, those whose size are larger than the sieve diameter were retained; the sieve reweighed plus soil particle, difference in weight gives the weight of the soil particle retained.

### 3.3.2 Bulk Density

Bulk density was determined using core method. Soil sample core was driven into the field using auger height of soil sample core was taken and its diameter. The sample were transfer into can with initial weight of can was recorded and the weight of soil sample plus can was taken again. The soil sample placed in oven for drying the soil moisture content at $105^0$C for 4 hours. After oven drying at that specification mentioned above dried soil sample were weighed to give the mass of dried soil sample.

### 3.3.3 Porosity

The porosity of soil is related with availability of pore spaces in the soil. Porosity of a soil is determined through this relationship:

$$Porosity = 1 - \frac{bulk\ density}{particle\ density}$$

Bulk density of soil sample is determined as Bulk density particle density of the soil sample is determined as follows:

Empty pycrometer bottle was weighed. 10 grams of soil sample was taken and transferred quantitatively into the bottle. The bottle was weighed again. The bottled was half filled with water and boiled over a hot plate. This was done to eliminate entrapped air in the soil. The soil moisture was allowed to cool and the bottle was refilled to the brim with water and weighed again. The soil mixture was thrown away and the bottle was refilled with water only and weighed. The temperature of water was taken. The computed data is presented in chapter four.

### 3.3.4 Moisture Content

To determine the moisture content, weight of empty can was taken. Weight of soil sample plus can was recorded. The soil sample was put into oven for drying the soil moisture at $105^0C$ for 24 hours. After oven drying at the specification, dried soil was weighed again to give mass of the dried soil sample. The available moisture content of the soil sample is presented in chapter four.

### 3.3.5 Field Capacity

Determination of field capacity which is the moisture content above which water will freely drain out of the soil by gravity was done by putting soil sample into a perforated container underneath the container moisture content of the soil was taken as described in moisture content. Water was applied to the soil sample till saturation was reached. After two days, the soil sample was taken to know the available moisture content of the soil sample after water might have drained out freely from soil sample by gravity. The result is presented in chapter four.

### 3.3.6 Organic Matter Content

To determine the organic matter content, one gram of soil sample for treatment at different depths were sieved and measured using 0.5mm sieve. The sieved sample of 1g each was put into a conical flask. 10ml of potassium dichromate ($K_2Cr_2O_7$) and 20ml of concentrated sulphuric acid ($H_2SO_4$) were added to the soil sample. The soil sample solution were cooled, 100ml of distilled water and 4 to 5 drops of Barium diphenyl-amine Sulphate (indicator) were added respectively to the soil sample solution. 0.5g normal $FeSO_4$ was titrated against the soil sample solution to attain an end point of grey cast colour was observed. A solution of blank sample was prepared without soil sample which served as control experiment.

### 3.4.0 Measurement of Plant Parameters.

The following parameters were observed:

Stem height.

Leave area index.

Stem girth (diameter).

Leave number.

Rate of growth.

### 3.5.0 Materials Used.

1. Measuring tape
2. Vernier calliper
3. Meter rule

### 3.6.0 Measurement of Plants Parameter:

**Leaf area index.**

This was measured at an interval of 10 days which started from 30 days after planting and was measured using a meter rule, and which different measurement was taking from the leafs of each of the jathropha plantation and all the measurement taking were recorded

**Number of leaf**

During the period of irrigation the jathropha leaves were counted at an interval of 10 days which started from 30 days after planting for each of the jathropha plantation i.e A B C respectively and all the numbers counted for each day of the period of 90 days were recorded

**Stem girth [diameter]**

The measurement used to measured stem girth [diameter] was venire calliper, each stem of the jathropha was measured at 10 days interval for a period of 90 days the measurement was taking from 30 days after planting and each of jathropha plantation were measured and recorded

**Rate of growth.**

The rate of growth were observed in every 10 days interval and was measured by measuring tape in which all the samples were measured at an interval of 10 days and the proper measurement were taking and recorded

# CHAPTER FOUR

## 4.0 RESULTS AND DISCUSSION

The table below showed the results of experiment carried out in sample A after a period of 90days.

Table 4.1 Results of Sample A after 90days.

| No. | Days. | Leaf area index(cm) | Numbers of leaf | Stem girth (diameter) (cm) | Rate of growth(cm) |
|---|---|---|---|---|---|
| 1 | 30 | 4.7 x 5 | 4.0 | 9.80 | 20.20 |
| 2 | 40 | 6.0 x 6.0 | 4.0 | 10.40 | 21.40 |
| 3 | 50 | 6.0 x 7.0 | 5.0 | 11.60 | 21.90 |
| 4 | 60 | 7.6 x7.0 | 6.0 | 13.00 | 22.60 |
| 5 | 70 | 6.3 x 7.0 | 6.0 | 13.10 | 22.60 |
| 6 | 80 | 7.0 x7.3 | 7.0 | 15.00 | 24.10 |
| 7 | 90 | 7.5 x 8.3 | 7.0 | 15.30 | 25.40 |

The table below showed the results of experiment carried out in sample B after a period of 90days.

Table 4.2 Results of Sample B after 90days.

| No. | Days. | Leaf area index(cm) | Numbers of leaf | Stem grilth (diameter)(cm) | Rate of growth(cm) |
|---|---|---|---|---|---|
| 1 | 30 | 4.3 x 5.0 | 4.0 | 7.60 | 15.70 |
| 2 | 40 | 5.6 x 6.0 | 4.0 | 8.10 | 16.70 |
| 3 | 50 | 6.0 x 7.0 | 5.0 | 8.40 | 17.60 |
| 4 | 60 | 6.0 x 6.3 | 6.0 | 9.60 | 18.20 |
| 5 | 70 | 6.7 x 7.0 | 6.0 | 10.70 | 19.50 |
| 6 | 80 | 7.0 x 8.3 | 6.0 | 10.90 | 20.40 |
| 7 | 90 | 7.3 x 7.3 | 7.0 | 12.30 | 21.50 |

The table below showed the results of experiment carried out in sample C after a period of 90days.

Table 4.3 Results of Sample C after 90days.

| No. | Days. | Leaf area index(cm) | Numbers of leaf | Stem grilth (diameter)(cm) | Rate of growth (cm) |
|---|---|---|---|---|---|
| 1 | 30 | 4.0 x 4.3 | 3.0 | 7.60 | 10.50 |
| 2 | 40 | 5.0 x 6.0 | 4.0 | 8.20 | 11.80 |
| 3 | 50 | 6.0 x 6.0 | 5.0 | 8.70 | 12.40 |
| 4 | 60 | 6.0 x 6.3 | 5.0 | 9.60 | 12.70 |
| 5 | 70 | 6.3 x 7.0 | 5.0 | 9.90 | 14.00 |
| 6 | 80 | 7.0 x 7.3 | 6.0 | 10.50 | 14.50 |
| 7 | 90 | 7.0 x 7.0 | 6.0 | 11.00 | 15.60 |

The table below showed the result of soil physical properties

Table 4.4 Soil Physical Properties.

| S/N | Soil properties | Values |
|---|---|---|
| 1 | Bulk density | 1.38 $g/cm^3$ |
| 2 | Porosity | 36% |
| 3 | Moisture content | 12.65% |
| 4 | Organic matter | 88% |
| 5 | Field capacity | 9.25% |
| 6 | Water holding capacity | 12.76cm/m |
| 7 | Soil texture | Sand loam |
| 8 | Sand loam composition | 60% sand.<br>20% silt.<br>20% clay. |

## 4.1.0 DISCUSSION OF RESULTS.

With respect to the result of the experiment obtained from different samples of jathropha plants that is, sample A, B and C.

Sample A were planted for a period of 90 days which were irrigated every 3 days over the period. Sample B were also planted for the same period, but sample B were irrigated every 5 days interval over the period of 90 days, while sample C were as well planted for the period of three months and were wanted at 7 days intervals.

The results of the parameters showing below:

**Leaf Area Index**

The leaf area index were measured and showed different measurement for each jathropha plantation. The results were given thus:

The leaves area have different dimensions in length from the base to the tip and maximum width with respect to the water interval of the treatments. However, the leaves were different de to their different water up takes, Sample A takes more water than B and consequently C therefore made A improved faster than the others that is, B and C

Sample A was recorded as 7.5 x 8.3; Sample B was also measured to be 7.3 x 7.3, while 7 x 7 was taken for Sample C.

**Stem Girth**

Stem girth were not the same at the irrigation period which showed that different measurement was recorded for the three samples the results of sample A was 15.3cm while that of Sample B was 12.3cm and Sample C was 11cm. The result of Sample A, B, C which were different stem diameter showed that the rate at which they takes water were different, Sample B and consequently C. Therefore the more it received water, the more it improves in thickness.

**Number of Leaves**

The Jathropha leaves were different in number and some were the same. After 90 days the leaf were counted and recorded. Sample A was counted as 7 leaves, Sample B was also recorded 7 and 6 leaves was counted for Sample C. The results obtained from the number of leaves showed that Jathropha needs more water to improve in numbers of leaves because it was observed that Sample A has highest number of leaves while Sample B has high and C has the lowest numbers. These was due to their different irrigation intervals

**Rate of Growth**

The result showed that, the rate of growth were different for the period of 90 days, one grow higher than the other, the rate of growth in Sample A was recorded highest, that is 25.4cm, that of sample B also recorded 21.5cm below Sample A and finally Sample C was recorded lowest which is 15.6cm. The results of 90 days showed that the growth parameters of Sample A, B and C were different from one another. Sample A were better than Sample B and consequently C due to their irrigation intervals which were different. This could be as a result of water uptake rate and different interval. It could be said that plant root developed fast to enable it to tap soil moisture through capillary action that helps in developed faster.

Plate 1: Showing the measurement of the jathropha plant on the field

# CHAPTER FIVE

## 5.0 CONCLUSIONAND RECOMMENDATION.

### 5.1 Conclusion

Sample A, B and C had different growth parameters due to different irrigation intervals which were 3, 5, and 7 days intervals respectively. It therefore showed that sample A has highest growth rate while B sample has higher and finally high growth rate for sample C.

The soil sample used for the experiment was sand loam for the various samples of Jathropha plants with the physical properties of the following: Bulk density of 1.38g/cm3, Porosity of 36%, Moisture content of 12.65%, 88% of Organic matter, Field capacity of 9.25%, 12.76cm/m of water holding capacity.

### 5.2.0 Recommendation.

It is recommended that experimental determination of the effect of water in crop yield of Jathropha at different irrigation interval should be carried out.

Also experimental determination of the sizes of crop yield of Jathropha at different irrigation interval should be carried out.

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# APPENDICES

30 DAYS AFTER PLANTATING

| PARAMETERS | SAMPLES | | |
|---|---|---|---|
| | A1 | A2 | A3 |
| Leaf Area Index | 5x5 | 5x5 | 4x5 |
| Number of Leaf | 4 | 4 | 4 |
| Stem Girth(diameter) | 0.97 | 1.00 | 0.98 |
| Rate of Growth | 20.50 | 20.10 | 20.00 |
| | B1 | B2 | B3 |
| Leaf Area Index | 5x5 | 4x5 | 4x5 |
| Number of Leaf | 4 | 3 | 4 |
| Stem Girth(diameter) | 0.78 | 0.71 | 0.80 |
| Rate of Growth | 15.4 | 15.9 | 15.9 |
| | C1 | C2 | C3 |
| Leaf Area Index | 4x4 | 4x5 | 4x4 |
| Number of Leaf | 4 | 3 | 3 |
| Stem Girth(diameter) | 0.75 | 0.72 | 0.82 |
| Rate of Growth | 10.20 | 10.10 | 11.30 |

40 DAYS AFTER PLANTATING

| PARAMETERS | SAMPLES | | |
|---|---|---|---|
| | $A_1$ | $A_2$ | $A_3$ |
| Area Index Leaf | 6x6 | 6x6 | 6x6 |
| Number of Leaf | 5 | 4 | 4 |
| Stem Girth(diameter) | 1.00 | 1.02 | 1.10 |
| Rate of Growth | 21.70 | 21.30 | 21.10 |
| | $B_1$ | $B_2$ | $B_3$ |
| Leaf Area Index | 5x6 | 6x6 | 6x6 |
| Number of Leaf | 5 | 4 | 4 |
| Stem Girth(diameter) | 0.82 | 0.79 | 0.83 |
| Rate of Growth | 16.8 | 16.6 | 16.7 |
| | $C_1$ | $C_2$ | $C_3$ |
| Leaf Area Index | 5x6 | 5x6 | 5x6 |
| Number of Leaf | 4 | 4 | 4 |
| Stem Girth(diameter) | 0.81 | 0.76 | 0.89 |
| Rate of Growth | 11.50 | 11.40 | 12.60 |

50 DAYS AFTER PLANTATING

| PARAMETERS | SAMPLES | | |
|---|---|---|---|
| | $A_1$ | $A_2$ | $A_3$ |
| Leaf Area Index | 6x7 | 6x7 | 6x7 |
| Number of Leaf | 6 | 5 | 5 |
| Stem Girth(diameter) | 1.10 | 1.18 | 1.20 |
| Rate of Growth | 22.3 | 21.9 | 21.6 |
| | $B_1$ | $B_2$ | $B_3$ |
| Leaf Area Index | 6x6 | 6x7 | 6x7 |
| Number of Leaf | 5 | 5 | 5 |
| Stem Girth(diameter) | 0.89 | 0.87 | 0.92 |
| Rate of Growth | 17.6 | 17.5 | 17.8 |
| | $C_1$ | $C_2$ | $C_3$ |
| Leaf Area Index | 6x6 | 6x6 | 6x6 |
| Number of Leaf | 4 | 5 | 5 |
| Stem Girth(diameter) | 0.86 | 0.81 | 0.94 |
| Rate of Growth | 12.0 | 12.0 | 13.1 |

60 DAYS AFTER PLANTATING

| DATA | SAMPLES | | |
|---|---|---|---|
| | $A_1$ | $A_2$ | $A_3$ |
| Leaf Area Index | 7x7 | 6x7 | 7x7 |
| Number of Leaf | 7 | 5 | 6 |
| Stem Girth(diameter) | 1.28 | 1.34 | 1.30 |
| Rate of Growth | 22.9 | 22.7 | 22.2 |
| | $B_1$ | $B_2$ | $B_3$ |
| Leaf Area Index | 6x7 | 6x6 | 6x6 |
| Number of Leaf | 6 | 5 | 6 |
| Stem Girth(diameter) | 0.90 | 0.98 | 1.00 |
| Rate of Growth | 18.1 | 18.2 | 18.4 |
| | $C_1$ | $C_2$ | $C_3$ |
| Leaf Area Index | 6x6 | 6x6 | 6x7 |
| Number of Leaf | 5 | 5 | 5 |
| Stem Girth(diameter) | 0.91 | 0.97 | 1.00 |
| Rate of Growth | 12.50 | 12.20 | 13.40 |

70 DAYS AFTER PLANTATING

| PARAMETERS | SAMPLES | | |
|---|---|---|---|
| | $A_1$ | $A_2$ | $A_3$ |
| Leaf Area Index | 7x7 | 6x7 | 6x7 |
| Number of Leaf | 8.0 | 6.0 | 6.0 |
| Stem Girth(diameter) | 1.45 | 1.40 | 1.39 |
| Rate of Growth | 23.6 | 23.4 | 23.0 |
| | $B_1$ | $B_2$ | $B_3$ |
| Leaf Area Index | 7x7 | 7x7 | 6x7 |
| Number of Leaf | 6 | 6 | 6 |
| Stem Girth(diameter) | 1.00 | 1.02 | 1.12 |
| Rate of Growth | 19.0 | 19.4 | 20.2 |
| | $C_1$ | $C_2$ | $C_3$ |
| Leaf Area Index | 6x7 | 6x7 | 7x7 |
| Number of Leaf | 5 | 5 | 6 |
| Stem Girth(diameter) | 0.94 | 1.00 | 1.02 |
| Rate of Growth | 13.90 | 13.60 | 14.50 |

80 DAYS AFTER PLANTATING

| PARAMETERS | SAMPLES | | |
|---|---|---|---|
| | $A_1$ | $A_2$ | $A_3$ |
| Leaf Area Index | 7x8 | 7x7 | 7x7 |
| Number of Leaf | 8 | 7 | 5 |
| Stem Girth(diameter) | 1.58 | 1.49 | 1.40 |
| Rate of Growth | 24.8 | 24.2 | 23.4 |
| | $B_1$ | $B_2$ | $B_3$ |
| Leaf Area Index | 7x9 | 7x8 | 7x8 |
| Number of Leaf | 7 | 5 | 6 |
| Stem Girth(diameter) | 1.02 | 1.04 | 1.22 |
| Rate of Growth | 19.5 | 20.3 | 21.4 |
| | $C_1$ | $C_2$ | $C_3$ |
| Leaf Area Index | 7x7 | 7x8 | 7x7 |
| Number of Leaf | 5 | 6 | 6 |
| Stem Girth(diameter) | 1.00 | 1.08 | 1.06 |
| Rate of Growth | 14.20 | 14.20 | 15.10 |

90 DAYS AFTER PLANTATING

| PARAMETERS | SAMPLES | | |
| --- | --- | --- | --- |
| | $A_1$ | $A_2$ | $A_3$ |
| Leaf Area Index | 8x9 | 7.5x8 | 7x8 |
| Number of Leaf | 9 | 7 | 6 |
| Stem Girth(diameter) | 1.67 | 1.52 | 1.41 |
| Rate of Growth | 25.5 | 25.8 | 24.9 |
| | $B_1$ | $B_2$ | $B_3$ |
| Leaf Area Index | 8x8 | 7x7 | 7x7 |
| Number of Leaf | 9 | 6 | 7 |
| Stem Girth(diameter) | 1.13 | 1.14 | 1.42 |
| Rate of Growth | 20.8 | 21.5 | 22.2 |
| | $C_1$ | $C_2$ | $C_3$ |
| Leaf Area Index | 7x6 | 7x7 | 7x8 |
| Number of Leaf | 5 | 5 | 6 |
| Stem Girth(diameter) | 1.00 | 1.20 | 1.15 |
| Rate of Growth | 15.5 | 15.4 | 16.0 |