KWARA STATE UNIVERSITY, MALETE, NIGERIA

SCHOOL OF POSTGRADUATE STUDIES (SPGS)

EFFECT OF DRIPPER DEPTH AND MULCHING ON AGRONOMIC PERFORMANCE OF COCKS COMB *(Celosia argentea)*

MUHAMMED LAWAL, AHMED

18/27/MFE002

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BY

MUHAMMED LAWAL, AHMED

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DECLARATION

I hereby declare that this thesis, titled: *Effect of Dripper Depth and Mulching on Agronomic Performance of Cocks comb (Celosia argentea),i*s a record of my research. It has neither been presented nor accepted in any previous application for higher degree.

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Signature/Date

APPROVAL PAGE

This is to certify that this thesis by Muhammed Lawal, Ahmed has been read and approved as meeting the requirements of the Department of Food and Agricultural Engineering for award of the degree of (Masters of Engineering) in Food and Agricultural Engineering (Soil and Water Engineering).

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DEDICATION

This project is dedicated to the Almighty Allah, the creator of the universe, who can do and undo, for fortifying my mental arsenal of information and knowledge.

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LIST OF ABBREVIATION

Abbreviation	Meaning
LGA	Local Government Area
EU	Emission Uniformity
QV	Emitter Flow Variation
CV	Coefficient of Variation
UC	Uniformity Coefficient
DI	Deficit Irrigation
FAO	Food And Agricultural Organization
GAP	Good Agricultural Practice
COAG	Coordinadora de Organizationes de Agricultores
KARI	Kenya Agriculture Research Institute
IAEA	International Atomic Energy Agency
QG	Gravimetric Water content
PA	Pressure
PW	Density of Water
SDI	Sub-surface drip irrigation
Or	Volumetric water content
DP or DP;	Deep percolation
GWI	Ground water contribution
MAD	Management Allowed Deplection
IWR	Irrigation water requirement
DS	Change in soil water storage
LR	Leaching requirement
BWUF	Beneficial water use friction

ETC	Crop Evapotranspiration
VSWC	Volumetric soil water content
FDR	Frequency domain Reflectometry
TDR	Time domain reflects meter
WUE	Water use efficiency
FLM	Formatted logical messaging
FCM	Flow cytometry
SDI	Serial digital interface
ASAE	America Society of Agricultural Engineers
RCBD	Randomized complete block design
N	Nitrogen
P	Phosphorus
K	Potassium
CA	Calcium
MG	Magnesium
OM	Organic matter
EC	Electrical conductivity
ANOVA	Analysis of variance
LSD	Least significance difference

ABSTRACT

Cocks comb (Celosia argentea) is an annual growing vegetable leaves of high economic and medicinal values, commonly see in several parts in Nigeria. This vegetable was planted to study the Effect of dripper depth and mulching on agronomic performance of Cocks combs (Celosia argentea). The physico-chemical of soil parameters of the field were collected at depth of 00 cm, 10 cm and 20 cm and analyzed at Lower Niger River Basin Development Authority Ilorin, before planting the seeds and the soil was cultivated and mulched with polythene , and setup with the plastic Bottles of 75cl as a dripper water system at depth of 00 cm 10 cm and 20 cm . The experiment comprised of two by three factors $(2 \times 3 \times 3)$. *The first factor has two levels i.e mulching and non-mulching (control), while the second factor has three levels of 00 cm, 10 cm and 20 cm depth under randomly allocation with three replication. The results obtained on the soil analysis of the field, shows that, the mean average value of soil pH(7.8), organic carbon (1.25%), organic matter (2.1%), textural class (sandy, clay, loamy), soil NPK (0.74 ppm, 21.2 ppm and 0.2 ppm), exchangeable calcium (4.35mol/kg), exchangeable magnesium(0.38mol/kg) and electric conductivity (61.9 µs/cm) were compared with FAO (2008) standard, guide to laboratory establishment for plant nutrient analysis. Likewise, the study revealed that field emission uniformity(EU) mean values range between 85.61% and 99.11% from lowest to the highest,* N_3D_{00} *replicate1 and* N_2D_{10} *replicate3. Emitter flow variation (Qvar) mean values range between 2.63% and 23.33% under* N_3D_{10} *replicate 3 ,* M_2D_{00} *replicate 1 and* M_3D_{00} *replicate 3. Coefficient of variation (CV) mean values range between the lowest to the highest of 1.55 and 14.14 under* N_3D_{10} *replicate3 and* M_2D_{00} *replicate1. and uniformity coefficient (UC) mean values range between 89.39 and 98.81 replicate1* M_2D_{00} *and replicate3* N_3D_{10}. *The result was compared with (ASAE EP 4015.1) standards for individual parameters. Lastly, The mean value of agronomic parameters i.e height, leave number, fresh weight and economic value(the price in naira) were 198.889, 139.222, 410.011 and 78.889 and compared with probability standard* $(p = 0.05)$ *analysis of variance ANOVA. The depth at which emitters were placed with mulching had a statistically significant impact on Cocks comb agronomic performance. As a result, this study suggests a new level of inexpensive drip-irrigation technology.*

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Cocks comb (*Celosia argentea)* is an annual growing vegetable commonly in several parts of Nigeria especially in the southern and middle belt regions. It grows to a height of 0.5m and in yoruba it islocally called *Shawkawyawkawto*. It is an important vegetable leaf or herb that belongs to Amaratus family and is grown extensively in many parts of the world such as China, India, and so on (Ahmad *et al.*,2014).It is propagated by seeds which are very small in size. It is an important and nutritious vegetable with high protein content, highly demanded by consumers and has highly economic value(Ahmad *et al.*,2014).

The producers of the vegetable often modify the growing pattern-through the use of different mulching types to suppress weed, conserve soil moisture and soil temperature regulation during the dry season. This depends on material properties of mulches, and the level of physiochemical properties of the soil, which may directly influence the growth height and number of the leaves (Yang *et al.*, 2000).

Celosia is also commonly referred to as Qingxiang. It is an annual herb considered to be the earliest classic herb in China and is combined as an anthelmintic for the treatment of eye diseases (swelling of the eyes), diabetes, diarrhea and nepatic asthenia. Widely used in traditional Chinese medicine to treat sexual congestion (Yang *et al*., 2000).

Deficit irrigation is a technique in which irrigation is done during drought sensitive growth stages of a crop. Outside these periods, irrigation is limited or even unnecessary if rainfall provides a minimum supply of water. Water restriction is limited to drought tolerant phonological stages. Often, the vegetative stage and the late ripening period.

While this inevitably results in plant drought stress and consequently in production loss, deficit irrigation (DI) maximizes irrigation water productivity, which is the main limiting factor. In other words, DI aims at stabilizing yields and for obtaining maximum crop water productivity rather than maximum yield *(*Yang *et al.,*2000).

Drip irrigation is used in horticulture (Yang *et al*., 2000) and is the most effective way to supply nutrients and water directly to plants. In addition to saving irrigation water, it also increases yields (Tiwari et. Al., 2003). Traditional methods of subsurface irrigation can conserve scarce water resources in less developed parts of the world. Subsurface irrigation systems are capable of applying small amounts of water directly to the plant root zone where the water is needed and these small amounts can be applied frequently to maintain suitable moisture conditions in the root zone. The potential benefit of subsurface irrigation include the improvements in both yields and quality. Therefore, reducing the costs of the production (Tiwari *et.al.,* 2003). Sprinkler irrigation can be replaced by subsurface drip irrigation that saves approximately 50% of the investment costs, with the subsurface irrigation, fertilizer can be applied hear the center of the crop root zone (Lamm,2002*).*

At the high Institute of Agronomy of Chott Merien, Tunisia, an experiment was conducted to compare the effect of surface and subsurface drip irrigation on water saving and yield of egg plant (Douh, 2013). The emphasis on increased water use efficiency for the irrigation sub-sector is one of the advocated strategies for averting the impending water crisis, and one way for farmers to ensure efficient irrigation water use is for them to switch from the traditional surface flooding method to drip irrigation systems, which are highly efficient irrigation systems. The drip irrigation system has surpassed all other irrigation systems as the most effective way of water application. Drip irrigation systems deliver regular and tiny volumes of irrigation water to the field surface/subsurface inside the plant root zone from a single or multiple sites (Yang *et al*.,2000). According to them (Khan *et al*.,2018). Drip irrigation is one of the greatest strategies for ensuring optimum water content in the root zone by applying water often and directly on the land or into the crop root zone rather than the entire land surface. Traditional pipes and emission devices used for most of the outstanding drip irrigation programs in Nigeria are imported, despite being quite efficient and appropriate (Awe *et al*., 2011). According to the FAO (2010), Nigeria is among the countries that are technically unable to meet their food demands using rain-fed agriculture. As a result, the search for locally available irrigation materials is now being promoted with the goal of enhancing productivity and maintaining food security (FAO 2010).

One of the primary factors for evaluating irrigation system performance is the uniformity of water distribution on the land surface (Yavuz *et al*.,2008). Irrigation uniformity is the most significant metric for evaluating the performance of an irrigation system (Letely *et al*., 2000), and it is influenced by field topography, drip system hydraulic design, and the degree of partial or complete clogs (Zhu *et al*.,2009).

The uniformity of emitter discharge is taken into account while measuring water uniformity in a drip system. The homogeneity of emitter discharge has been studied by a number of authors (Asenso *et al*., 2014; Sah *et al*.,2010). In a research conducted to evaluate trickle irrigation system performance in Turkey's Antalya area, (Topak *et al*.,2011) found that emission uniformity ranged from 41% (poor or unacceptable) to 92 percent (perfect or good).

Mulching is one of the management strategies that helps soil utilise water more efficiently. Mulch is any material spread on the soil's surface to protect it from sun radiation, evaporation, or raindrops. Mulching can have an impact on soil temperature and water content (Acharya *et al*.,2005). Mulch is any substance that is spread on top of the soil to preserve moisture, lower soil temperature near plant roots, prevent erosion, and inhibit weed growth. Mulches are made up of both organic and inorganic components (Acharya *et al*.,2005). Mulching does not work miracles overnight, but it helps promote greater plant growth and development.

These benefits occur whether plants are growing in the coolest highland circumstances in Vietnam, the warmest climatic conditions of desert Kuwait (Abdal *et al*., 2000)Erenstein, 2003; Damasa and Lovereal, 2005). Mulching is frequently cited as a beneficial agricultural method in the production of vegetables (GAP). GAPS stands for "practices for on-farm operations that address environmental, economic, and social sustainability and result in safe and high-quality food and non-food agricultural products" (FAO-COAG, 2003, White et.al; 2005).As with other developing nations in Asia, Africa and other country, the severity of China’s water shortage is arguably the nation greatest social and environmental challenge of the 21st century.

Irrigated agriculture comprises 70% of the world annual freshwater withdrawals (United Nations 2012). Others have recommended a more integrated approach to managing water scarcity that includes small-scale agronomic water saving methods including crop rotation, tillage changes, and the use of plastic mulch (World Bank, 2002).

Plastic film mulch is called “Mulch” even though its appearance as a thin sheet of plastic film does not resemble traditional types of organic mulch, such as straw or leaves. It is purchased in rolls and applied the length of field rows to seal the upper layers of the soil. Crops are allowed to grow up through holes that are cut into the plastic. There is a wide array of plastic mulch product varying in colour, thickness dimensions, plastic type, and intended purpose. Farmers in different parts of the world have different ways of installing the plastic film. The methods used range from fully mechanized installation to installation with hand tolls. A partial list of desired outcomes from plastic mulch may include increased yield, conserving water, weed suppression, rain shedding, promoting earliness in ripening or compressed cropping cycles, enhanced germination, agrochemical fumigation, greater variety of crop types, reduced soil erosion, and others (Ingman 2012).

Existing agronomic water conservation research primarily focuses on conservation resulting from technological advancements, such as overhead irrigation and micro-irrigations systems. These categories of irrigation system commonly take the form of center-pivot and drip irrigation, respectively. There are three types of micro-irrigation that differ based on the type of emitter used.

These are drip (the most common form of micro- irrigation), bubbler and micro-sprinkler. Smallholders in the developing world often lack access to pressurized irrigation water. They also often lack the necessary capital to purchase the required micro-irrigation components, such as pumps, emitters, filters and pressure reducers (Li *et al.*,2004)

Thus, a key advantage of mulching is that it reduces water use by up to 25-26 % as it protects the soil from evaporation. Problems associated with mulching include:

It offers cover for small slugs, which can be devastating on crops such as peas and carrots.

It can be unsuitable for crops that need fine sandy soil to flourish (for example, carrots) or are subject to caller rot in moist conditions (for example, garlic).

Mulching with plastic film has been reported to cause increase in soil temperature during the summer months in sub-tropical areas *(*Knowler and Bradshaw, 2007; Erenstein, 2003).

Since, with the observation of many previous existence researches on the dripper irrigation and plastic mulching on vegetable leaves may common, but then utilization with plastic bottle are not common in rural area these were what prompt the trial to study the effect of dripper depth and mulching on the agronomic performance of (Cocks comb). Since rapid population growth poses a major challenge for both efficient and sustainable agricultural practices given the limited, availability of arable land in order to meet the increasing food demand (God fray *et al.*,2010).

1.2 Statement of the Research Problem

The challenge of the twenty-first century and massive environmental degradation across the globe, this problems lead to water scarcity and soil erosion, motivate the desire to modify the way to conserve the available soil and water resources through the uses of plastic mulching and dripper bottles for planting Cocks comb due to its medicinal and economic value. And also to encourage the uses of plasticulture for smallholders farmers in the developing world who lack capital and access to pressurized irrigation water, thus, this will serve as a new dimension in affordable way for drip irrigation water system.

1.3 Aim and Objectives

The aim of this research was to determine the effect of dripper depth and mulching on the agronomic performance of Cocks comb *(Celosia argentea)*. The objectives are as follows:

i. Measurement of emission uniformity, coefficient of variation, emitter flow variation, and coefficient of uniformity at all levels of soil depth and yielding condition under mulching and non-mulching conditions

ii. To assess the agronomic performance of (Cocks comb) on a weekly basis i.e. Plant height, Leave numbers, Weight of the leaves and Economic value (price in naira and kobo)

iii. To estimate the soil's physiochemical parameters in accordance with the United Nations Food and Agricultural Organization's (FAO,2008) guidance to laboratory establishment for plant nutrient analysis. Irrigation is the process of applying water to the land artificially in order to create sufficient moisture for agricultural cultivation.

1.4 Justification of the Study

Water is the key to agricultural productivity to avoid the excessive water wastage and the drought faced by the plant during the critical growth stage and the variability of rain water distribution, it is necessary to adopt a water conservation measure with dripper depth and mulching method which is not readily available to the rural farmers. Thus, there is need to improvise this method of irrigation by using plastic bottle and plastic mulching before recommending the improvised system to the farmers dwelling in rural areas. Therefore, it's worthwhile to know the performance.

1.5 Scope of the Study

This work is limited to study the effect of dripper depth and plastic mulching on agronomic performance of Cocks comb*(Celosia argentea)*,observation of soil parameters and evaluation of medi-emitter at Duman Fadama Field,Sango. At depth of 00 -10 cm, 10 - 20 cm, the parameters are:organic matter, organic carbon, soil textural classes, nitrogen, phosphorus, and potassium P^H, EC, Ca^+, Mg^{2+}, at different depths.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Irrigation History and Types of Irrigation

Irrigation, according to Phocaides (2000), is the use of water for agricultural production that is not supplied directly by precipitation. Rain-fed agriculture is erratic, and man cannot rely solely on his activities without supplemental water application, so the need of artificial water application in developing a sustainable agriculture cannot be over stated.Agriculture is the world's largest user of water resources, accounting for 70% of total withdrawals and more than 80% of water consumption (Baudequin and Molle, 2003; Stockle, 2001). There are significant regional differences, ranging from 88 percent in Africa to fewer than 50 percent in Europe. Irrigated agriculture is the major user of water resources in South Africa, according to Ascough and Kiker (2002), accounting for 53% of the total yearly amount used.

Irrigation systems can be divided into two categories: open canal systems and pressurized piped systems (Phocaides, 2000). Irrigation is thus carried out using surface and pressurized systems, which are distinguished by the mode of water transport to the point of application. Subsurface irrigation, surface/gravity irrigation, trickle/drip irrigation, and sprinkler irrigation are the four types of water application (Scherer, 2005).

2.1.1 Surface Irrigation

Surface irrigation is a technique in which water is supplied to the soil surface and spread by gravity. It is by far the most widespread type of irrigation in the world, and it has been used in many locations for thousands of years with little alteration (Hagen *et al*., 2007).

Surface irrigation is frequently referred to as flood irrigation, meaning that the water distribution is fundamentally inefficient. In actuality, some of the irrigation techniques included under this heading require a significant amount of management.

Basin irrigation has historically been used in small areas having level surfaces that are surrounded by earth banks. The water is applied rapidly to the entire basin and it allowed to infiltrate. Basins may be linked sequentially so that drainage from one basin is diverted into next once the desired soil water deficit is satisfied. A closed type basin is one where no water is drained from the basin. Basin irrigation is favoured in soils with relatively low infiltration rates. Furrow irrigation is conducted by creating small parallel channels along the field length in the direction of predominant slope. Water is applied to the top end of each furrow and flows down the field under the influence of gravity. Water maybe supplied using gated pipe, siphon and head ditch or bankless system(Hagen *et al.*,2007).

The speed of water movement is determined by many factors such as slope, surface roughness and furrow shape but most importantly by the inflow rate and soil infiltration rate.

Cockscomb (Celosia argentea), sorghum, sugarcane, cotton, tobacco, peanuts, potatoes, and vegetables are all ideal for this approach. The size and shape of the furrow are determined by the crops that are planted. By altering the number of furrows irrigated at any one moment to meet the available flow, both big and small irrigation streams can be utilised. Furrows can be used to quickly dispose of runoff from rainfall in regions where surface drainage is required (Hagen *et al*., 2007)

The process of surface irrigation can be described using four phases. As water is applied to the top end of the field it will flow or advance over the field it will either run after or start to pond. The period of time between the end of the advance phase and the shut-off of the inflow is turned the wetting, pending or storage phase. As the inflow ceases the water will continue to runoff and infiltrate. Until the entire field is drained. The depletion phase is that short period of time after cut-off when the length of the field is still submerged. The recession phase describes the time period whereas the water front is retreating towards the downstream end of the field. The depth of water applied to any point in the field is a function of the opportunity time, the length of time for which water is present on the soil surface. (Mehta *et al.*,2004).

2.1.2 Sprinkler Irrigation System

A sprinkler irrigation system is made up of a network of pipes through which water is pumped under pressure before being sprayed on the crop via sprinkler nozzles. The technique essentially imitates rainfall in the water by spraying it from above. As a result, these irrigation systems are frequently referred to as overhead irrigation systems (Antonious,. 2002) As a result, the wind patterns and velocity in a given location have a significant impact on the water distribution of certain sprinkler systems.

Sprinkler irrigation systems are suitable for most crops, with the exception of leaves that are sensitive to extended water contact or crops that require pounding of water at some point in their lives. Unlike most surface irrigation systems, they are often ideal for mild, frequent irrigations.

There are two types of sprinkler irrigation systems: set systems (risers), which separate with sprinklers in fixed positions and can also be mobile, and continuous more systems, which separate while moving (centre pivot, linear more system, travel gun systems) (Antonious,. 2002).

2.1.3 Drip Irrigation System

The total water present in the earth is about 1.41 billion m^3 of which 97.5% is brackish and only about 2.5% is fresh (of which 87% is in ice caps or glaciers, in ground or deep inside the earth).

In the last two centuries (1800 – 2000), irrigated area in the world has increased from 8million to about 260 million hectares for producing required food for the ever growing population (Mehta*et al.*,2004). Water scarcity seems to be a threat to global food production thus necessitating use of water efficiently while at the same time aiming to improve productivity of land. This necessitates introduction of drip system. In India for example drip has been used in irrigation of nearly 2million hectares out of the over 39million hectares under irrigation.

In Kenya, approximately 80% of land is classified under arid and semi arid, with low rainfall and frequent crop failures. A step towards drip irrigation promotion has been taken up by KARI through production of low-cost drip irrigation technologies. This has helped farmers across the country i.e. Maasai community in Namanga area through collaboration with Green Belt movement and AMREF. Drip irrigation is also being used in the green houses especially for high valued crops i.e. tomatoes, spinach, cucumbers etc., most area across the Country also make use of bucket systems and drum kits as reservoirs (FAO/IAEA, 2013).

2.1.4 Problems of Drip Irrigation.

The most serious issue with a drip irrigation system is clogging of the tiny conduits in the emitters. Flows via emitters can be obstructed by sand and clay particles, debris, chemical precipitation, and organic development. Several manufacturers have developed emitters to reduce discharge variance caused by lateral pipe friction-induced pressure fluctuations. These emitters are complicated and prone to clogging, resulting in a high initial and ongoing cost to the system.

In other cases, a graphical technique was created by using simple emitters of various sizes along the lateral pipe to correct for frictional losses, which is difficult to implement in practice due to cost concerns. Drip irrigation has a large initial investment as well as ongoing maintenance costs. Researchers discovered that the system's application on tiny plots of land in impoverished countries is limited due to high initial and ongoing costs (Sah *et al*., 2010).

2.1.5 Soil Water Potential

In terms of energy, the potential of soil water is stated (bars or MPa). The soil water potential is the difference in energy between pure water and soil water at standard pressure and temperature. Equation 2.1 can be used to express the total water potential: (Sah *et al*., 2010).

$$Y_t = Y_g + Y_p + Y_o \qquad 2.1$$

where, Y_t = total soil water potential energy, Y_g= gravitational potential energy, Y_p= pressure potential, Y_o= Osmotic potential due to salt (Don Scott, 2000).

2.1.5.1 Water Potential

Energy required, per quantity of water, to transport and infinitesimal quantity of water from the sample to a reference pool of pure free water. To understand what that means, compare the water in a soil sample to water drinking glass. The water in the soil glass is relatively free and available; the water in the soil is bound to surfaces diluted by solutes and under pressure or tension. In fact, the soil water has a different energy state from “free” water. The free water can be accessed without exerting any energy. The soil water can only be extracted by expending energy. Soil water potential expresses how much energy you would need to expend to pull that water out of the soil sample. (Ley *et al.*,2006)

2.1.5.2 Matric Potential

Matric potential arises because water is attracted to most surfaces through hydrogen bonding and Van der waals force. Soils are made up of small particles, providing lots of surfaces that will bind water. This binding is highly dependent on soil type. For example, sandy soil has large particles which provide less surface binding sites, while a silt loan has smaller particles and more surface-binding sites. Matrix potential is always negative or zero and is the most significant component of soil water potential in unsaturated conditions.(Ley *et al.*,2006)

2.1.5.3 Osmotic Potential:

The description in the dilution and binding of water by solutes that are dissolved in the water. This potential is also always negative. Osmotic potential only affects the system if there is a semi-permeable barrier that blocks the passage of solutes. This is actually quite common in nature. For example, plant roots allow water to pass but block most solutes. Cell membranes also form a semi-permeable barrier. A less-obvious example is the air-water interface where water can pass into air in the vapor phase but salts are left behind as given in equation 2.2:*(*Ley *et al.*,2006)

$$Q_0 = C\emptyset VR \qquad 2.2$$

where C is the concentration of solute (mol/kg), Ø is the osmotic coefficient (-0.9 to 1 for most solutes), V is the number of ions per mol (NaCl = 2, $CaCl_2$ = 3, Sucrose = 1), R is the gas constant, and T is the Kelvin temperature.

Osmotic potential is always negative or zero and is significant in plants and some salt – affected soils.

2.1.5.4 Gravitational Potential

Gravitational potential arises due to water location in a gravitational field. It can be positive or negative, depending on where you are in relation to the specified reference of pure, free water at the soil surface. Gravitational potential is then as given in equation 2.3: *(*Ley *et al.*,2006)

$$Q_G = GH \qquad 2.3$$

where G is the gravitational constant ($9.ms^{-2}$) and H is the vertical distance from the reference heights to the soil surface (the specified height).

2.1.5.5 Pressure Potential

The hydrostatic or pneumatic pressure being applied to or pulled on the water. It is a more macroscopic effect acting throughout a larger region of the system. There are several example of positive pressure potential in the natural environment. For example, there is a positive pressure present below the surfaced of any ground water. You can feel this pressure yourself as you swim down into a lake or pool, similarly, a pressure head or positive pressure potential develops as you more below the water table. Tugor pressure in plants and blood pressure in animals are two more examples of positive pressure potential. Pressure potential can be calculated from as in given in equation 2.4: *(*Ley *et al.,*2006)

$$Q_P = {}^{P}/_{Pn} \qquad 2.4$$

where P is the pressure (Pa) and P_w is the density of water though pressure potential is usually positive, there are important cases where it is not. One is found in plants, where a negative pressure potential in the xylem draws water from the soil up through the roots and into the leaves. (Kirkham and Mary 2014).

2.1.6 Soil Water Content

The expression on a gravimetric or volumetric basis. Gravimetric water content (Øg) is the mass of water per mass of dry soil. It is measured by measured by weighing a soil sample (M_{wet}) drying the sample to remove the water, then weighing the dried soil m dry. It is given as expressed in equation 2.5:(camp, 2003),

$$\emptyset g = \frac{M_{water}}{M_{soil}} = \frac{M_{wet} - M_{dry}}{M_{dry}} \qquad 2.5$$

Volumetric water content (Ɵr) is the volume of liquid water per volume of soil. Volume is the ratio of mass to density (e) which gives in equation 2.6:(camp, 2003),

$$\emptyset_{2} = \frac{Volumewater}{VolumeSoil} = \frac{M_{water}}{e_{water}} = \frac{\emptyset_{g} * e_{soil}}{e_{water}} \qquad 2.6$$

2.1.7 Soil Water Movement and Hydraulic Conductivity

The hydraulic head is the sum of the suction and gravitational potentials. Water moves from soil with lower potential to soil with higher potential, and the hydraulic head determines the direction and rate of water movement.

Potential of the soil matrix and evaporative demand The water required for crop establishment is fulfilled by upward flow from the subsurface drip, according to the scientific assumption that underpins this study's evaluation of the modified SDI. Hydraulic conductivity is a measure of a soil's ability to conduct water, and it is determined by the soil's permeability to water (Don scott, 2000).

Understanding soil – water behavior, such as the movement of water and solutes within the soil profile and studies of water uptake by plant roots, requires knowledge of the hydraulic conductivity of soil. The amount of water in the soil has a big impact on hydraulic conductivity (Miyazaki, 2006). As a result, it is frequently determined in both saturated and unsaturated states.

2.1.8 Soil Water Balance

Irrigation water requirements, the soil water balance is calculated for the effective rooting depth as given in equation 2.7: *(*Miyazaki, 2006)

$$\emptyset_{i} = \emptyset_{i-1} + \frac{(Pi - ROi) + Iwt - ETci - DPi + GWi}{1000Zri} \qquad 2.7$$

where, in addition to the symbols used before, DP represents deep percolation (mm), $GWi$is ground water contribution (mm), and Zri is the rooting depth (m), all referred to day i. DP is often estimated as $DPi = 0$ where $\emptyset_i < \emptyset_{fc}andDp_i = 1000(\emptyset_i - \emptyset_{fc})Zri$. Otherwise, the water table depth and soil hydraulic properties are used to calculate GW. Zri can be expected if the growth rate is linear from planting to maximum rooting. The latest data for scheduling irrigation to avoid water stress is when $\emptyset_i = \emptyset_p$, however, irrigation is often scheduled when the “Management Allowed Deplection”, MAD, is attained. Generally, $MAD < p$ where there is risk aversion or uncertainty, and $MAD > p$ when plant water stress is interational. (Miyazaki, 2006).

Then

$\emptyset_i = \emptyset_{MAD} = (1 - MAD)(\emptyset_{fe} - \emptyset_i)$. The net irrigation depth to be applied will be $I_{wi} = 1000Zri(\emptyset_{fe} - \emptyset_i)$which summed for the entire season leads to the irrigationwater requirement (IWR) and as given in equation 2.8: (Miyazaki, 2006).

$$IWR = \frac{ET_c - P_e - GW - DS}{1 - LR} \qquad 2.8$$

Where:ET_c is evapotranspiration rate of the crops under standard condition (no stress condition), P_e is the effective precipitation (gross precipitation less all run off and deep percolation), GW is ground water contribution or capillary rise, LR is the leaching requirement (the percentage of irrigation water that must pass through the root zone to keep the soil salinity below a set value) and DS is the change in soil water storage in the root zone between planting and harvesting. Crop water simulation models, such as the SIM Dual kc model, which uses a dual crop coefficient approach, are currently used to simulate the soil water balance and enable for the selection of the best irrigation schedule options.

The gross irrigation water requirement is computed as given in equation 2.9: (Segal *et al.*,2000).

$$GIWR = \frac{IWR}{BWUF} \qquad 2.9$$

Where BWUF is the beneficial water use friction, which includes ET_c and LR, and is total water applied. Indicative value of BWUF are presented. Table 2.1 shows the value of the beneficial water use fraction (BWUF):

Table 2.1: Indicate Value of the Beneficial Water Use Fraction (Bwuf) System

Beneficial water use fraction	Percentage
Surface irrigation, Precision levelling	
Furrow	65 –85
Border	70 – 85
Basin	70 – 90
Surface, traditional	
Furrow	40 – 70
Border	45 – 70
Basin	45 – 70
Basin Rice fields	25 – 50
Sprinkler	-
Solid set	65 – 90
Hand – move lateral	65 –85
Side – roll wheel move	65 – 80
Traveller sprinkler	55 –80
Lateral move system, center pivot	65 – 90
Micro–irrigation	-
$Trickle \geq 3$ emitter per plant	85 – 95
Bubblers and sprayers	85 – 95
Line source emitters	70 - 90

(Segal*et al*., 2000)

2.1.9 Monitoring Soil and Plant Water in Irrigation Scheduling

The successful operation and management of an irrigation system necessitates a proactive approach to soil water management. Monitoring and scheduling irrigation can be done in three ways. Method for estimating soil status based on its look, feel, or, more objectively, water content or suction.

Plant-based technique that incorporates observable signs like wilting, which represent leaf turgor and consequently leaf water potential indirectly. The Scholander, sometimes known as the "pressure bomb," is a device that measures plant water potential and won contact thermometry using an infrared thermometer (a water stressed plant transpires less and is cooled less by evaporation).

The water budget approach, which uses weather data to estimate agricultural water demand and, as a result, irrigation requirements.

Soil water sensors measure either soil water potential (SWP) or volumetric soil water content and can be used to determine when to irrigate, avoiding over and under irrigation (VSWC). The Tensiometer, gypsum blocks, and granular matrix sensor are all devices used to measure soil water potential. A Wide Range of FDR (Frequency Domain Reflectometry). For detecting volumetric soil water content, TDR (Time Domain Reflect Meter) and capacitance probes are available (Charles worth, 2005).

2.1.10 Soil Water Storage

Many studies have indicated that plastic film mulch could significantly reduce soil water evaporation and water erosion, thereby increasing the precipitation use efficiency in rain –fed farming systems. If the soil is dry during the seeding stage, the seed cannot absorb sufficient water and germination may be impossible or delayed, while root productions might be decreased after seed germination, thereby affecting above ground growth and seed yield. Our results showed that the plastic film mulch plots significantly increased the soil water storage (0–200cm) compared with CK during the early growth stage (0 – 40 DAP), especially in FLM and FCM plots, and similar results were also reported by (Liu,*et al.*,2010).

2.2 Water Use Efficiency (WUE)

It has been widely reported that plastic film mulch can significantly increase the WUE (Li*et al.*,2010) similarly, in our study, the plastic film mulch plots significantly increased the WUE by 10.5 – 22.8%. surface plastic film mulch enhances the soil moisture regime by controlling evaporation from the soil surface (Wang *et al.*,2009), which improve infiltration and soil water retention, as well as providing a favorable soil microclimate for seeding emergence (Liu *et al.*,2010). So is could not be used by the (Cocks comb) Celosia argentea crop and it only increased the ET, Thereby decreasing the WUE. Whose results also demonstrated that the effect of plastic film mulch on the WUE was higher in normal season than a wetter – than –normal season, especially in FLM and FCM plots, which agreed with (Li *et al.*,2003). The optimum rainfall amount for ridge and furrow harvesting system is 230 – 440mm and there are no significant improvements in the WUE. When the rainfall exceeds 440mm.

2.2.1 Water Transmission Properties

The bulk density value of the surface soil reduced from 1.45 (initial value) to 1.40, 1.41 and 1.43Mgm^{-3}in the plots with Subabul leaves, basooti and sugar cane trash, respectively, the reduction in bulk density may be ascribed to increased soil porosity and better aggregation by decomposition of crop residues in the soil, the (Cocks comb) *Celosia argentea* cultivar JH3459 was sown on 9^{th} and 16^{th} July 2001 and 2002 respectively. The experiment was laid out in a randomized block design with three replication (Shirani *et al.*,2002).

Shirani *et al.*(2002) also reported a significant decrease in surface layer bulk density of the manured fields. Infiltration rate was found to be the highest in the plots with Subabul application followed by sugar cane trash, basooti and least under control plots. Steady state infiltration that was attained after about six hours was 7.40, 70.10, 6.90 and 6.63 cm/hin Subabul sugar cane, basooti and control plots, respectively. Increase in organic carbon by the decomposition of plant materials helps increasing the infiltration rate.(Shirani *et al.*,2002).Table 2.2 present effect of different crop residues application on bulk density, infiltration rate and organic carbon content.

2.3 Drip Irrigation and Its Adaptation in Surface and Subsurface Drip Irrigation Management.

Water is sprayed uniformly and gently at the plant location with drip irrigation systems, allowing virtually all of the water to reach the root zone.

Drip systems are categorized according to their placement in the field:

1. Drip irrigation on the soil surface: water is supplied directly to the soil surface.
2. Water is applied below the soil surface through perforated pipes in subsurface drip irrigation.

   Citrus, cotton, sugarcane, certain vegetables, sweet corn, lucerne, and potato have all been irrigated with subsurface drip irrigation in Africa and elsewhere (Raine *et al.*, 2000; Alejandroand Eduardo, 2001; Thorburu *et al.*, 2004; shock *et al.*, 2004; Lamm and Trooien, 2005).

Table 2.2: Effect of different crop residues application on bulk density, infiltration rate and organic carbon content

Treatment	Bulk density (g/cm3)Depth (cm)				Infiltration (cm/hr.)	Organic carbon (%)
	0 -15	**15 -30**	**30 -45**	**45 -60**		
Control	1.45	1.48	1.47	1.47	6.63	0.40
Sugarcane	1.43	1.46	1.45	1.46	7.10	0.42
Basooti	1.41	1.48	1.46	1.47	6.90	0.43
Subabu	1.40	1.47	1.46	1.48	7.40	0.45
CD at 5%	0.02	NS	NS	NS	0.29	NS

Shirani *et al*., (2002)

2.3.1 Tape Installation Depth.

The usage of surface and subsurface drip irrigation varies by crop and is frequently depending on perceived vertical placement limits of the drip tape / tube or laterals. The depth of drip tape is determined by the crop, soil climate, and anticipated cultural practices, but it typically ranges from 0.02 to 0.7 meters. Although installation depth is usually determined for other reasons, if the primary goal is to reduce soil evaporation and obtain the potential advantage of enhanced water usage efficiency (yield and quality) that is attainable with SDI, a deeper placement (0.45m) will be necessary (Bryla *et al*.,2003).

Deeper installations, according to shallow systems, should reduce soil evaporation and allow for a larger range of cultural practices. However, as previously stated, deeper installation may limit the SDI system's effectiveness for seed germination and crop establishment. For germination and crop establishment, deeply installed drip lines may necessitate an excessive amount of watering. This method may result in water consumption efficiency being reduced off-site. Deeper placement may limit the availability of fertilizers and other substances applied to the surface (Camp and lamm, 2003).

Corn germination on a silt loam has been aided by relatively shallow tape placement for many years (Lamm and Trooien, 2005). If there is no other source of surface irrigation, it is reasonable to assume that shallow placement is especially important for establishment.

2.3.2 Lateral Spacing and Installation

In heavy textured soil, a wider lateral spacing is recommended; in sandy soil, a narrower spacing is recommended, and lateral spacing is usually on the drip line per row / bed or an alternate row / bed with one drip line per bed, or between two rows (Lamm and Camp, 2007). In a silt loam soil, lateral spacing of 1.5m in sub-surface drip-irrigated corn was successful. Lateral line should be laid as closely as possible to the contour of the land to avoid pressure differences inside the Line due to elevation change. Maintaining correct hydraulic design is the first step in a successful SDI system installation. This enables the system to work around limits such as soil properties, field size, shape, topography, and water supply. Lateral diameter and length influent water application uniformity.

2.4 Emitters

The drip emitters control the flow of water from the lateral into the soil. Common drip emitters have discharge in the range 1–15 litres/h at the standard pressure of 1 atmosphere (= 10 m = 1 bar). They must distribute the water uniformly. The variation in discharge between the emitters in the whole field should not exceed 20%(Acar, 2001).

Another important aspect of drip emitters is their resistance to clogging at the water pressure operational for the system. Information on the emitter's resistance to clogging is supplied by manufacturers and research institutions, but should be supported by local experience. Frequent inspection of emitters to identify clogged ones is necessary. A clogged emitter can be repaired by rubbing it vigorously with one's fingers, blowing in it, or trying to force water out of the outlet (Acar, 2001).

2.4.1 Types of Drip Irrigation Emitters

Emitters are classified into groups based on how their design type and the method they use to regulate pressure. A simple emitter can be created by drilling a very small hole in a pipe. However, a hole alone does not work well. Unless the hole is extremely small, the water tends to forcefully shoot out of it like a tiny fire nozzle and way too much water will come out. More importantly, there is little uniformity of flow when using a simple hole. If you have a long pipe with holes drilled in it the holes on the end nearest the water source will have a large water flow from them, while those at the far end will have a very small flow (Garg,2008).

The following are various types of emitters that are mounted on the pipe and operate as miniature throttles, ensuring a consistent rate of flow. Some are molded into the pipe or tubing, while others are attached with barbs or threads. The emitter controls and limits the amount of water released (Garg, 2008).

2.4.2 Long Path Emitters

Emitters employ a variety of techniques to achieve and maintain this uniformity at low flow rates. Some emitters send water through a long, narrow tube or passage. Because of the tiny diameter and long length of this channel, the water pressure is reduced and the flow is more uniform. Long-path emitters are what they're called. A lengthy water path circles around and around a barrel-shaped core in a typical long-path emitter. Because of the need to fit that long tube in, long path emitters are usually quite large (Garg, 2008).

2.4.3 Soaker Hose, Porous Pipe, Drip Tape, Laser Tubing

Various modifications of the "very small hole in a pipe" kind of drip system include soaker hose, porous pipe, drip tape, and laser tubing. They either have very small holes bored (typically with a laser) into a tube or are built of porous tubing walls that allow water to slowly leak out. The obvious benefit of these is their low cost. The disadvantage is that the tiny pores are readily clogged, especially with hard water that contains many minerals, therefore watering uniformity can be unequal for some products.

These systems are most commonly used for portable irrigation in landscapes (moving the tubes around the yard between irrigations tends to break the mineral deposits loose, preventing them from building up). These products are also widely used in agriculture, where the tubes are removed at the end of each growing season and thrown away or recycled. When compared to other drip irrigation types, experience with permanent installations of these products has shown that they have a relatively short lifespan. They function best with water that is depleted in minerals (Alam *et al*.,2001).

2.4.4 Short-path Emitters

Short-path emitters are similar to long-path emitters in that they both emit light. It's only that their water path is shorter and narrower. Advantages: They're inexpensive, and they'll work in low-pressure systems where other varieties won't. They're the finest emitters for systems with very low pressure, such as gravity flow drip systems fed by rain barrel water. They clog up easily, especially if the water is harsh and contains a lot of minerals. When compared to other types of emitters, they have a low water distribution uniformity. They're ideal for small systems when cost is a concern and water distribution consistency isn't a priority. The most popular of these short-path emitters is a low-cost generic emitter known as “flag emitter” or a “take-apart emitter”.

This emitter comes in a variety of brands and names. The small flag-shaped handle on it makes it easy to identify; you may disassemble it by twisting and pulling on the flag (Muhammed *et al*., 2009).

2.4.5 Tortuous-path or Turbulent-Flow Emitters

These emitters work by pumping water through a path that looks like to a long path but has a lot of sudden curves and obstructions. Turbulence in the water is caused by these turns and obstacles, which reduces the flow and pressure (Camp *et al*.,2000). The emitter water passageways can be shorter in length and larger in diameter by using the convoluted path. The emitter is less prone to clog as a result of the broader channels. This approach is simple, inexpensive, and effective.

2.4.6 Diaphragm Emitters

To lower flow and pressure, all diaphragm emitters have a flexible diaphragm. They do this in a variety of ways: some have diaphragms with holes that expand, while others move the diaphragms back and forth to shrink the neighboring water passageways. The bottom line is that they all use a flexible element that moves or extends to restrict or increase the flow of water. The negative is that, like anything else that moves, they will ultimately wear out (which might take a long time!). They have the advantage of being significantly more precise in managing flow and pressure than prior types (Garg,2008).

2.4.7 Adjustable Flow Emitters

The flow rate of adjustable flow emitters can be adjusted. The flow rate is usually controlled by turning a dial on the emitter. The majority of these emitters have a design that is quite similar to that of a short path emitter. Adjustable flow emitters have little pressure correction and have a wide range of flow. Adjustable flow emitters were only advised for use in pots and hanging baskets. The ability to alter the emitter flow is quite important in these scenarios because the water needs of each pot or basket tend to vary substantially. If you only need a few emitters on a valve circuit, adjustable flow emitters can often handle much higher flows (Mohammed *et al*.,2009).

2.4.8 Mechanical Emitter

The mechanical emitter works by filling a compartment with water and then dumping it out at predetermined intervals. The process is similar to filling a cup with water and then dumping it out (Mohammed *et al*.,2009).

2.4.9 Drip line, Dripper line

Drip line, dripper line, and other versions of that name are used to designate a drip tube with factory installation emitters on it. The emitters are frequently molded inside the tubing, with only a hole for the water to exit visible on the outside. The emitters, according to (Camp *et al*.,2000), are typically of the tortuous-path or diaphragm type, but other forms may also exist. The emitters are evenly spaced along the tube, and several spacing options are frequently available. The primary benefit of drip line is the ease with which it can be installed due to the pre-installed emitters. It's commonly employed in agriculture, but it also works well in settings where a solid band of wet soil is desired, such as watering groundcover beds, vegetable gardens, and lawns (Muhammed *et al*.,2009).

2.4.10 Plastic Drinking Straw as Emitters

According to Umara *et al.*,(2012), plastic drinking straw could also be used as drip emitters. The plastic drinking straws with internal diameter of 0.004m = 4 mmis cut into short length of 0.2m = 200mm and a spongy material of plant origin cut into sizes of $0.04m^2$, rolled into narrow roles is fussed to the straw lining to regulate the flow. With the aid of ascrew driver of 0.005m = 5mm being used to puncture a hole through the laterals at the marked points, the emitters is fit through the holes with a slight drag and an adhesive is being used at the joints so as to provide water tight conditions. The major challenge of this system is that cleansing will be carried out by removing the emitters from time to time and tapping against a hard surface to loose dirt from the sponge filter.

2.4.11 Bamboo Pipe and Medi-Emitter

The performance of a bamboo (bambusa vulgaris schrad)-pipe medi-emitter in a gravity flow drip irrigation system was investigated by Awe, *et al*. (2011). The device used bamboo as a conveyance structure and medical infusion sets as a dripper to distribute water to the field at rates of 10, 15, 20, 25, and 30 drops per minute, respectively. As the flow rate reduces from 30 to 10 drops per minute, the variance in discharge ranges from 6.35 to 10.21%. As the flow rate decreased, the associated manufacturer's coefficient of variation increased from 2.31 to

3.35 percent. Coefficient of Statistical Uniformity and Distribution As the flow rate increased, uniformity varied between 97.21 and 98.33 percent and 96.06 and 97.69 percent, respectively. Though the system worked well, clogging of the emitters was a major issue. The partial clogging observed was primarily due to the formation of green algae in the medi-emitters due to the transparency of the water (a favourable condition for algae growth).

2.4.12 Emitters /Drip Holes Spacing

Spacing Emitters are plastic devices that administer small amounts of water exactly. Two types of emitters were described by Hla and Scherer (2003). Water is discharged from a single or numerous outlets using a point-source emitter. Perforation, holes, porous walls, or emitters extruded into the plastic lateral lines are all examples of line – source emitters (Ayars *et al*., 2007) For widely separated crops such as vines, ornamentals, shrubs, and trees, line – source emitters are commonly utilized. The consistency of drip irrigation's effect. The technical recycline chain on Celosia argentea SDI emitters is similar to that used for surface drip, but the emitters are installed inside in the drip line (Harris, 2005). Emitter spacing is determined by soil factors and plant spacing. Similarly, for deep silt loam soils under subsurface drip irrigation, emitter spacing of 0.3m was suitable for maize yield (Lamm and Aiken, 2005). On a semi-arid setting, 0.45m emitter spacing was employed for drip-irrigated maize in clay loam soils (Howel l*et al*., 2007). Semi-spacing should typically be less than drip lateral spacing and closely related to crop spacing (Lamm and Camp, 2007).

2.4.13 Water Application Uniformity

The regularity of water application in micro-irrigation is determined by the field (Wu*et al*.,2007). System design elements including lateral diameter and emitter spacing, as well as manufacturing variation, have an impact on system uniformity. Emitter clogging also has an impact. The criteria for evaluating a micro irrigation system. The uniformity coefficient (UC), emitter flow variation (Qvar), and coefficient of variation (CV) of emitter flow are all part of the SDI= subsurface drip irrigation application uniformity. Surface and subsurface drip uniformity values anticipated by design or evaluation models are similar (Wu *et al*.,2007). In addition to the system design elements mentioned above (Wu *et al*.,2007), the spatial homogeneity in the field refers to variation in soil water. It is influenced by field topography and soil hydraulic properties.

2.4.14 Causes and Consequences of Non – Uniformity

Uneven and application rates are two sources of non-uniformity (Burt 2004). Even in systems with high uniformity, variations in soil qualities, such as hydraulic conductivity, can alter drainage and cause water content variations. Yield is directly dependent to application consistency. The normal manufacturing coefficient of variation in tube, according to Burt (2004), is about 0.02 to 0.06, which is minimal. Soil excavation was proven to improve flow rate by 2.8 percent to 4%, but not enough to influence uniformity calculations given good crop growth and irrigation. If the application is homogeneous but the soil water holding capacity or hydraulic qualities are not, drainage may be used. SDI faces a difficult problem in getting enough moisture in the soil for germination and crop establishment by administering uniform irrigation to soils that are fundamentally variable (Patel and Rajput, 2007). They discovered that in order to provide appropriate irrigation water for potato plants during their early growth period, they had to over-irrigate, resulting in more downward than upward capillary water circulation in sandy loam soil.

2.4.15 Minimizing Non – uniformity

Minimizing drip system non-uniformity necessitates a design that takes into account the terrain of the field (Wu *et al*. 2007), regular system checks, and irrigation scheduling (volume and frequency).

The use of pressure-compensating emitters in surface and subsurface drip irrigation can improve watering uniformity (Schwanki and Hanson, 2007).

In subsurface drip irrigation, flow meters are generally recommended for monitoring system performance (Alam *et al*.,2002). They are used in an automated irrigation control system to determine the rate and volume of water applied (Ayars *et al*., 2007).

2.4.16 Discharge Rate and Irrigation Frequency in Relation to Crop and Soil Type

Subsurface drip irrigation systems typically use emitters with discharge rates of less than 8 liters per hour (ASAE, 2001). Although the difference in yields across discharge rates was not statistically significant, a discharge rate of 0.251 / h resulted in a high yield of maize in sandy loam soils of real (Assouline, 2002). The soil water availability, plant uptake pattern, and production are all determined by the frequency and emitter discharge rate in a drip system.

(Ruskin, 2005) observed that a coarse grained sandy soil required drip lines with greater flow rates and shorter irrigation cycles than clay soil, demonstrating the significance of matching irrigation frequency to soil type. High-frequency water administration via drip allows salt levels in the roosting zone to be kept at a manageable level (Mmolawa and Or, 2000). Increased irrigation frequency with SDI has been linked to an increase in yield. Improved crop establishment is a lesser-known benefit of greater watering frequency. Given how prevalent crop establishment is in SDI, it's unexpected that there appears to be a link. To increase surface and hear surface soil moisture soaking for crop establishment, more frequent or pulse irrigation has been promoted, which entails delivering little increments of water numerous times per day rather than applying large amounts for long periods of time (Lamm and camp, 2007). However, operational rules for SDI are lacking (Lamm and Camp, 2007). On a Hanwood loam soil in NSW, a study of pulsed and continuous irrigation revealed very little change between treatments. Different mulching materials (Plastic-film-mulch-for half) were used in Maiduguri, leading the author to the conclusion that reaction was dependent on tape depth and soil type (Miller *et al*., 2000). Reduced deep drainage of water is another potential benefit of high frequency SDI, albeit this will require both uniform application and consistent soil and crop growth. SDI with a high frequency may use less water. The drip line's flow rate must correspond to the soil type. When the hydraulic conductivity of the soil around the emitter diminishes, the pressure head of the soil near the emitter rises, reducing the flow rate of emitters. On the other hand, emitter discharge decreases owing to back pressure, which is dependent on the soil type, probable cavities near the dripper output, and the hydraulic properties of the drip system. When the pressure in the emitter increases, the source discharge rate may be greatly reduced (Lazarovitch *et al*.,2007) Table 2.3 shows the emission uniformity standard, table 2.4 shows the emitter flow variation standard, and table 2.5 shows the variation manufactures standard.

Table 2.3: (ASAE, 2001)standard

S/N	EU %	Evaluation
1	94 - 100	Excellent
2	81- 87	Good
3	68 - 75	Acceptable
4	56 - 62	Poor
5	< 50	Unacceptable

Table 2.4: (ASAE, 2001). Standard

S/N	Q_{Var} %	Interpretation
1	0< 1	Desirable
2	10-20	Acceptable
3	20	Unacceptable

Source:(ASAE, 2001)

Table 2.5: Variation manufacturers

S/N	CV	CV%	Classification
1	< 0.05	< 5	Excellent
2	0.05 - 0.07	5 - 7	Average
3	0.07 - 0.11	7 - 11	Marginal
4	0.11 - 0.15	11 -15	Poor
5	> 0.15	> 15	Unacceptable

commended classification of coefficient of manufacturers variation (C M V) (ASAE, 2001)

2.4.17 The Effect of Mulching with Plastic Film

Water scarcity is one of the most significant factors restricting food yields around the world, according to Westgate (2004). Mulching with plastic film was introduced in China in 1978 and quickly expanded, especially in rainfed areas, because it made better use of the scarce rainfall (Dong *et al*.,2009). Spring wheat, Celosia argentea (Liu *et al*., 2009), cotton, potato, and some crops have benefited from the method (Mccraw *et al*.,2007). Film mulching is beneficial to the soil and the micro-environment in many ways: it reduces water loss due to evaporation, redistributes moisture in the soil, and thus alleviates water stress to some extent (Li *et al*.,2004), keeps top soil warmer (Wang *et al*.,2003) after sowing, reduces bulk density of soil (Anikwe *et al*.,2007), increases microbial biomass, and reduces fertilizer leaching loss around the root (Dong *et al*.,2009) , It also boosts nutritional availability. Mulching has indirect benefits such as reducing pathogen populations (Muhammad *et al*.,2009), boosting arbuscular mycorrlizal funsi and spore density in the rhizosphere of spring wheat (Liu *et al*.,2009), and inhibiting most annual and perennial weeds (Muhammad *et al*.,2009). Finally, mulching has direct and indirect effects on the plant, such as boosting photosynthesis and hence the rate at which soluble sugars are changed, and reducing physical damage to roots, resulting in increased toot biomass (Li *et al*.,2004). Mulching, as a result, boosts crop yield both statistically and qualitatively. The advantages outweigh the disadvantages, resulting in improved water use efficiency (WUE) (Tian *et al*.,2003).

Mulching during a crop's whole growth season, on the other hand, might significantly reduce production due to persistently higher temperatures (Wang *et al*.,2003). Mulching has proven popular, especially in fields with ridges and furrows, because the benefits exceed the drawbacks. Rainwater collection with plastic film remains one of the most successful ways to boost WUE and yield (Wang *et al*.,2003).

2.5 Integrated Management

Commercial growers typically use solitary cropping and favor newly released cultivars that are homogeneous and early. Mulching with the right materials has several benefits, including increasing soil warmth, conserving soil moisture, texture, and fertility, and controlling weeds, pests, and diseases. Under polyethylene, soil temperature and moisture were at their maximum levels (Wang *et al*.,2003). The type of ground cover had a substantial impact on temperature in the top 12 cm of the soil, according to the findings. Under black plastic mulch, the soil temperatures were the highest, followed by bare ground. The high soil temperatures associated with certain ground covers may have reduced enttomopathogen detection or survival (Wang *et al*.,2003) The use of different types of mulch (polyethylene and paraffin mulch) raised the temperature of the soil. Clear plastic mulch increased soil temperature more than black and silver plastic mulch, especially during the first weeks after planting or transplanting, when the plants' canopies were insufficient to shade the soil. In terms of surface temperature, plastic mulches have a direct impact on the microclimate around the plant by altering the surface's radiation budget (absorptivity vs. reflectivity) and reducing soil water loss (Wang *et al*., 2003).

2.6 Yields

Mulching with a variety of organic and non-organic materials, such as chopped grasses and cover material, has been shown to promote onion plant growth and bulb yield (Hugh *et al*.,2003). Researchers have previously showed that, when compared to non-mulching soils, mulched soils can increase crop yields by two or three times in vegetables (depending on parameters like as geographical location, soil type, and character of much). Bradshaw and Knowler (2007). Other researchers (Wang *et al*., 2003) have confirmed the findings, emphasizing that mulching irrigated vegetables with organic materials such as Andropogan grass is an important strategy for increasing and maintaining the productivity of small and medium onion cultivation in Ghana's Guinea savannah zone (Hopps *et al*.,2008)

2.7 Contribution to Knowledge on The Effect of Dripper Depth and Mulching on Agronomic Performance of Cocks Comb (*Celosia Argentea)*

The traditional way of planting Cocks Comb is the same way farmers use to plant other vegetable leaves and fruit vegetable with the creation of an embankment of the earth bank and centralised the water against flow to the plant root zone as a basin irrigation system. The concept of modifying this growing pattern arise due to the variation of weather as a result of climatic change, urbanization of agricultural land and high economic value of this vegetable leaves called for soil and water conservation measure through the use of plastic nylon as a mulching and 75cl of plastic bottle as a dripper. To signify the novelty of this device, and make the smallholders farmers, who lack capital and access to pressurized irrigation water to with stand the problems of weather variation which is unknown to the farmer before for planting vegetable leaves especially Cocks Comb(*Celosia argentea*) irrespective consideration of soil nutrient concentration and creation of an embankment for water flow. .

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of Study Site

The experimental field (Figure 3.1) is located at Duma Fadama, Sango, Ilorin east LGA, Ilorin Kwara State, North Central Nigeria. The average elevation is 317 meter, above sea level (latitude 8º30"N and longitude 4º 35"E). The experiment was conducted between January and February 2020. The Ilorin rain fall is around 1217mm/47.9 inch per year, the mean annual temperature is 26.5 C/79.7^{0}F. The climate area is cold and dry from November to April. The Duma Stream near the study area is the major stream a segment of Asa Dam, used by the farmers for furrow and border irrigation. The planting crops in these areas were mainly Cocks comb*(Celosia argentea)* and other vegetable leaves. (Figure.3.1) shows the Duma field.

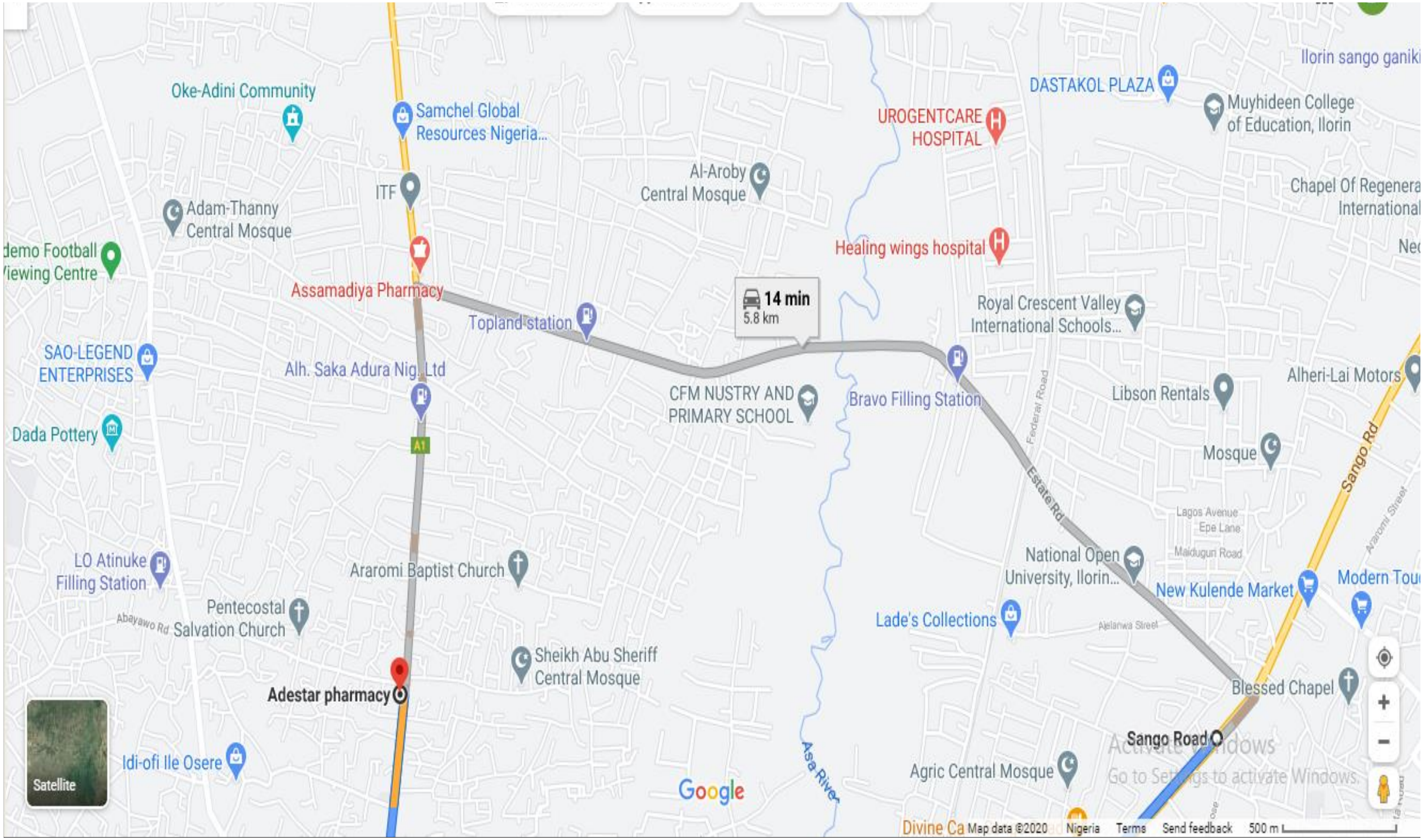


Figure 3.1: Map of the Dunma Field in Ilorin South LGA, Kwara State

3.2 Methods

3.2.1 Experimental Design and Field Procedure

The experiment was a two by three factorial experiment, making six treatment combinations. First factor has three levels, while the second factor has two levels. Three replications design was used. The experiment design was laid out using 3x2x3= 18 plots under three block, six sub plots per block in a complete randomized block design (RCBD).. Three treatment of soil water application depth with control (i.e 0cm, 10cm and 20cm) and two treatments of mulch (i.e mulch and non mulch). The experimental plots area were 15mby 9m, each of the plots was separated 0.8m (buffer zone between plots) wide at the base 0.4m and 0.3m high and plant growth apart at 0.9m respectively. The treatment combination is shown in the Table 3.1.

Table 3.1: Layout of the Field Showing Treatment Combination

Distance along the length		**5m Block I**	**5m Block II**	**5m Block III**
	3m	M_1D_{oo}	$D_{10}M_1$	$N_2D_{oo}^{control}$
		$N_1D_{oo}^{\ control}$	M_3D_{oo}	$^{control}N_1D_{20}$
Distance along	3m	M_2D_{oo}	M_2D_{10}	$M_2D_{20}^{control}N_3D_{10}$
the breadth		M_3D_{10}	$N_2\ D_1^{control}$	
	3m	$N_1D_{10}^{control}$	$N_2D_{20}^{control}$	$M_3D_{20}\ ^{control}N_3D_{20}$
		$N_3D_{oo}^{\ control}$	M_1D_{20}	

Table 3.2: Treatment Code and Treatment Detail

S/N	Treatment Code	Treatment Detail
1	$M_1 D_{00}$	Mulching one at zero (00) centimetre depth
2	$M_1 D_{10}$	Mulching one at ten (10) centimetre depth
3	$M_1 D_{20}$	Mulching one at twenty (20)centimetre depth
4	$N_1 D_{00}$	Non mulching one at zero (00) centimetre depth (control)
5	N_1D_{10}	Non mulching one at ten (10)centimetre depth (control)
6	N_1D_{20}	Non mulching one at twenty (20)centimetre depth (control)
7	M_2D_{00}	Mulching two at zero (00)centimetre depth
8	M_2D_{10}	Mulching two at ten (10)centimetre depth
9	M_2D_{20}	Mulching two at twenty (20)centimetre depth
10	N_2D_{00}	Non mulching two at zero (00)centimetre depth (control)
11	N_2D_{10}	Non mulching two at ten (10)centimetre depth (control)
12	N_2D_{20}	Non mulching two at twenty (20)centimetre depth (control)
13	M_3D_{00}	Mulching three at zero (00)centimetre depth
14	M_3D_{10}	Mulching three at ten (10)centimetre depth
15	M_3D_{20}	Mulching three at twenty (20)centimetre depth
16	N_3D_{00}	Non mulching three at zero (00)centimetre depth (control)
17	N_3D_{10}	Non mulching three at ten (10)centimetre depth (control)
18	N_3D_{20}	Non mulching three at twenty (20)centimetre depth (control)

Figure 3.2: Site lay out

3.2.2 Field Preparation, Irrigation and Mulching Layout.

The field was cleared with hoes and cutlasses. The plots and sub plots were marked out and cultivated while mulching and drippers were laid down according to (RCBD). All other agronomic parameters (such as leave number, plant height, weight were measured, while weed control and fertilizer application, etc) were observed throughout the growing period.

3.2.3 Soil Test

3.2.3.1 Soil Test Analysis

The soil test analysis was carried out at Lower Niger River Basin Development Authority laboratory Ilorin. Before sowing the seeds, a total nine (9) composite soil samples were taken randomly from the study site for laboratory analysis. Three points in the front representing sample A, three points in the middle representing sample B, and three points at the end representing sample C within the field. The soil sample were taken at the interval of 2.7mx5m at the length and the breath of the field. With the aid of Hand Auger, polyethylene bags and measuring tape for measure the depth and collect the soil sample for test at the depth of 00cm, 00-10cm and 10-20cm. The purpose is to know the amount of available Nitrogen(N), Phosphorus(P), Potassium(K), Calcium(Na), Magnesium(Mg), Organic Matter(OM), pH Level, Electrical Conductivity(EC) and textural class (particle size analysis).

3.2.4 Analytical Method

Soil and plant sample were analyzed accordingly to Food and Agricultural Organization of United Nation Guide to laboratory establishment for Plant Nutrient Analysis(FAO, 2008). The sample collected were spread for air-drying, crushing using mortar & pestle and sieved with 2mm-sieve. The un-sieved samples were discarded.

3.2.5 Soil pH

pH is the term used to express the degree of acidity or alkalinity of the soil, while neutral solution have $pH = 7$. The pH of acidic solution is a number less than 7 while pH greater than 7 indicated alkalinity in the soil (FAO, 2006).

Apparatus/Reagents

I. pH meter (universal indicator paper)
II. 250 ml Beakers
III. 20cm Stirring rod
IV. 25cm^3 Distilled water
V. 1M KC1 (Potassium chloride) – Weigh 74.56g of KC1 into a 1000ml volumetric flask and bring to mark with distilled water.
VI. 0.01M Calcium chloride ($CaCl_2$) – Dissolve 0.110g of $CaCl_2$in water and dilute to 1000ml.
VII. Buffer solution

Procedure Followed

I. Weigh 10g of soil (air-dried and passed through 2mm sieve) into a beaker.
II. Add 20ml of distilled (20ml of 1M KCl or 20ml of 0.01M $CaCl_2$)
III. Stir the suspension several times at regular intervals over a period of 30 minutes
IV. Measure the pH by immersing the glass electrode into the suspension just deep enough into the clear solution on top of the suspension.

NOTE: Calibrate the meter with standard buffer solution

3.2.6 Electrical Conductivity

The most influential water quality guideline on soil and crop productivity is the water salinity hazard determined by electrical conductivity. electrical conductivity is used to monitor the soil salinity. The conductance is a strong function of the total dissolved ionic solids (FAO, 2006).

Apparatus/Reagents

I. Electrical conductivity meter(comparator)
II. 250 ml Beakers
III. 20 cm Stirring rod
IV. 20mlDistilled water
V. Potassium chloride (KC1): Dissolve 0.5232g of anhydrous KC1 in distilled water and make up to 1000ml.

NOTE: Anhydrous KCl is prepared by taking small quantity of KCl, place in an oven, dry at 100^0C for at least 1 hour.

Procedure Followed:

I. Weigh 10g of soil into a beaker
II. Add 20ml of distilled water
III. Stir the suspension at regular intervals for a period of 30 minutes.
IV. Rinse the EC meter electrode with distilled water and dry gently.
V. Measure the EC using a conductivity meter by immersing the electrode in water above the settled soil.
VI. Allow reading to stabilize. Record EC value.

3.2.7 Organic Carbon (Walkey-Black Method)

Organic carbon is an essential constituent of all living organisms. It is taken by plants in the forms of carbon dioxide from the atmosphere where it forms only 0.03% of the air (FAO, 2006).

Reagents and Apparatus

I. 50ml Burette
II. 500 mlErlenmeyer flask
III. Concentrated sulphuric acid (H_2SO_4)
IV. 0.167N potassium dichromate solution ($K_2Cr_2O_7$)
V. 0.5M ferrous sulphate ($FeSO_4.7H_2O$)
VI. Ferroin indicator

Procedure Followed

I. Weigh 1g of air –dried soil sieved to pass through 2mm sieve into a 500ml Erlenmeyer flask.
II. Add 10ml of 0.167N $K_2Cr_2O_7$, add H_2SO_4rapidly, immediately swirl the flask gently until soil and reagent are mixed, rotate flask and allow to stand for 30 minutes.
III. Add 100ml of distilled water after 30 minutes.
IV. Add 3-4 drops of ferroin indicator and titrate with 0.5M $FeSO_4.7H_2O$ solution. As the end is approached the solution takes on a greenish cast and then changes to dark green. At this point, add the ferrous sulphate drop by drop until the color changes sharply from blue to maroon color.
V. Make a blank titration in the same manner, but without soil to standardize the dichromate. (Sheshma and Raj, 2014)

Calculation: the following equation used to find the organic carbon,$FeSO_4$

$$organiccarbon\% = \frac{(blank - titre) X NFX\ 0.003\ Xcorrectionfactor(1.33) X\ 100}{weightofsample} \qquad 3.1$$

NF = Normally of $FeSO_4$ = $\frac{concentrationXvolumeof\ \mathrm{K2Cr2O7}used}{titrevalueofblank}$ 3.2

$$organicmatter = organiccarbon \times 1.724 \qquad 3.3$$

3.2.8 Particles Size Distribution (Hydrometer Method)

Reagents and Apparatus

I. 250 ml Beakers

II. Sodium Hexametaphosphate solution (10% Calgon)

III. Mercury-in-Glass Thermometer

IV. (ASTM 152H-type) Hydrometer

V. 20 cm Soil dispersing stirrer

Procedure Followed

I. Weigh 50g of air-dried soil into beaker.

II. Add distilled water to saturation and 10ml of 10% Calgon solution

III. Stir and let it stand overnight

IV. Transfer this suspension for 20 minutes with an electric high speed stirrer.

V. Transfer the suspension into a 1000ml graduated cylinder and the remaining soil into the cylinder with distilled water.

VI. Insert the hydrometer into suspension and add water to the 1000ml mark. Then remove the hydrometer.

VII. Cover cylinder with a tight-fitting rubber bury and mix the suspension by inverting the cylinder carefully 10 times. Note the time.

VIII. At 40 seconds, take a hydrometer reading and measure the temperature of the suspension.

IX. Leave it undisturbed for 2 hours.
X. Take hydrometer and temperature reading
XI. Make necessary temperature corrections and calculate.

3.2.9 Nitrogen

Soil Nitrogen is essential for plant growth and reproduction because it is a characteristic constituent element of proteins, hence, is the protoplasm of all living cells, associated with plant life (FAO, 2006).

I. Weigh 1g of soil sample into digesting tubes and add a tablet of Kjeltab.
II. Add 12ml of sulphuric acid through a dispense and mix thoroughly
III. Place the samples in a rack of 8 and place on a digester that has been pre-heated to 420^{o}C for 1 hour to digest the samples.
IV. Allow the samples to cool down, transfer to the automatic distillatory that will dispense all other reagents and distill for 5 minutes
V. Titrate the distillate against 0.01M HCl with an automatic titrator.

3.2.10 Available Phosphorus

Soil phosphorus; all plants require phosphorus in significant amounts for growth and development, and phosphorus deficiency is likely to be as relevant as nitrogen deficiency in restricting crop performance in the tropics (FAO, 2006).

I. Weigh 5g of air-dried soil into 250ml beaker.
II. Add 35ml extraction solution (Bray-p) and stir for 30 minutes
III. Filter with using filter paper into 100ml volumetric flask and make up to mark with distilled water.

IV. In a 25ml cylinder take 5ml of aliquot, add some distilled water, and then add 4 ml of reagent B and make up to the mark.

V. Pour sample into well labelled test-tubes and allow for colour development

VI. Take absorbance readings at 660nm in a UV spectrophotometer.

VII. Calculate from calibration curve.

3.2.11 Exchangeable Bases (Na, K, Ca, Mg)

Soil potassium is an important element in connection with soil fertility because it is required in relatively large quantities by growing plants. Calcium is also important both as soil conditioner and as plant nutrient. Similarly, Magnesium functions in the soil much as calcium does, it is carried by lime stones (FAO, 2006).

I. Weigh 10g of air-dried soil in a beaker.

II. Add 100ml of 1M ammonium acetate.

III. Place in a mechanical shaker and shake for 1hour.

IV. Filter using what man NO 42 filter paper into 100ml volumetric flask and make up to the mark with the extracting solution.

V. The absorbance of Na and K is taken on a flame photometer, while Ca and Mg is analyzed using EDTA titration.

3.3 Experimentation

3.3.1 Experimental Set up: Laying of mulch and irrigation drippers.

After the experimental set up, there are many different color of polyethylene can be used ,the black polyethylene were choose and laid down in rolls of 1m by 37m on the cultivated soil surface and the breath of the field plots of $N_1$0 (control)$N_1$10 and $N_1$20 in block 1, likewise $N_2$10 ,$N_2$20 and N_2O (control) in block II, lastly $N_3$10, N_3O (control) and $M_3$20 in block III. The upper layers was sealed and side of the ridged soil were buried with soil to prevent the adjacent and side of the plot against each other. Crops are allowed to grow up through the holes that are cut off with razor blade and scissors on the plastic nylon at 10cm wide. shown in (Figure 3.3).

3.3.2 Plant growth parameters

Only two months worth of plant growth features (i.e. responses) were observed. For growth monitoring, five randomly selected plants in each sub plot were tagged. Plant height (PH) and leaf number (LN), which were measured on a weekly basis, were the parameters examined on the site.

Plant height was measured using a graduated measuring ruler from the soil surface to the top of The Cockscomb's terminal point, and the number of leaves was counted and recorded weekly until the plant reached its final stage of development (i.e 60 days). The results of each treatment were statistically analyzed using Analysis of Variance (ANOVA). For all analyses, a 5% level of significance was used, and the mean separation was calculated using the least significant difference (LSD).

3.3.3 Weight Matter and Market Value

The leave weights were determined, the five selected stand of plant on each sub plots, were weighed with weighing balance and recorded as a representative of each, sub-plot. After harvesting the vegetable (i.e wet mass) in kg and market value was followed and quantities is in naira and kobo for the both mulching and non mulching treatments. The comparison among treatment means were made accordingly base on the value of the least significance difference LSD.

A total number of 162 plastic bottles of 75cl capacity were picked while nine per sub plots was scheduled and thoroughly cleaned with water and drilled at diameter of 2mm while

0.01cm by 1cm diameter of cotton bud was fixed as emitter on the cap and placed cap back on the bottle head. the height of 2cm was measured at the bottom of the bottle, and it was excitedly cut off with knife. The bottle head was set down on a pieces of scrap wood of 40cm long and tightened with rope to indicated for 00cm M_10, N_10, M_20, N_20, M_30, and N_30 for sub plots.

While the plots of 10cm and 20cm soil depth was dug with cutlass and measured the depth with graduated meter ruler for dripper's application depth on the both mulching and non-mulching plots base on the design layout. The bottle was placed in the hole through the cut polyethylene with space of 10cm diameter all through cap-side down into the hole and gently pat the soil down around the bottle. Before filling the bottle, the transparent seal tape was used to seal the graduated measuring ruler against the bottle to test run the flow rate of the dripper for M_10, N_10, M_20, N_20, M_30, and N_30 spots, the bottle was latter filled with water, and inverted the cut bottom of the bottle so it rest on the water and ready to catch any debris that could otherwise sink and clog the cap hole of the bottle.

Figure 3.3: **Experimental Field**

3.4 Measurement of Emission Uniformity, Coefficient of Variation, Uniformity coefficient and Emitter flow Variation.

3.4.1 The Materials Used for the Experiment:

The following are the materials used in the field:

I. 75 cl Plastic bottles

II. 1m x 37m Black polyethylene

III. 40 cm Scrap wooden stick

IV. 30cm Graduated meter ruler

V. (ABRD) Transparent seal tape

VI. Plastic cotton bud straw (0.02m)

VII. (ABRD) 100m Rope

VIII. Hammer and Nail

IX. 50 Liters Jerry can

X. 4inchsize Hand auger

XI. Hoe and cutlass

XII. Knife,(tiger razor blade) and pair of scissors

3.4.2 Calibration of the Dripper Bottle

The calibration of the dripper on the field was done by using stop watch , with graduated measuring ruler. The ruler was fitted to the dripper bottle with transparent seal-tape under a three selected dripper sub-plot. The bottle was filled with water. The emitter was gradually adjusted so that water is allowed to drop to observe the time discharge took to run for 1h set to drip from the known volume of the bottle water. The time was recorded and procedure was repeated thrice at random for different sub plots respectively.

75cl bottles were used which is equivalent to 0.75 liter, the total height of the bottle was 25cm, the height of the cut portion was 2cm and diameter was 6cm at the base, therefore the volume of unknown can be derived from known the volume. The volume of the cylinder is as given in equation 3.4.

V=$\pi r^2 h$ 3.4

where,

V= volume

r = radius of the base of the bottle.

h =height of the base

Calculating the total volume of the bottle will be$3.142 \times 9 \times 25 = 706.95\ m^3$

The smallest portion volume will be $3.142 \times 9 \times 2 = 56.556\ m^3$

The unknown volume will be $706.96 - 56.556 = 650.404\ m^3$

To determine the specific litre of water in a container the percentage of the cut side of the

$$base = \frac{2}{100} \times 25 = 0.5\ \%$$

The upper portion will be = $\frac{23}{100} \times 25 = 5.75\%$

The unknown litter will be $\frac{5.75}{0.5} = \frac{0.75L}{xL}$

$$x = \frac{0.5 \times 0.75}{5.75} = 0.065L$$

:. $0.75L - 0.065L = 0.69L$

Therefore, quantity of water in each 162 bottle is 0.69L.

The flow rate was calculated using a straightforward method that involved collecting the volume of water in a container and measuring it in a graduated 1000ml measuring cylinder. To get enough volume, the collection period was set to 30 minutes. The results were compared to the (ASAE EP 405.1, 2003) standard for the best operating system for trick (drip) irrigation.

As determined by equation 3.5, the flow rate in. Kruse(2008).

$$flowrate = \frac{volume}{time} m^3/s \qquad 3.5$$

3.4.3 Evaluation of the Emitter

The widely – used parameters, for measuring emitter discharge uniformity.

Emission uniformity

Coefficient of variation

Emitter flow variation

Coefficient of uniformity

3.4.4 Uniformity Parameter Calculation

The Field emission uniformity (EU) was determined according to the procedure of K*ruse (2008)*. The emission uniformity was calculated by equation 3.6

$$EU = 100 \times \frac{Qmin}{Qave} 3.6$$

Where: EU = Emission uniformity (%)

Q_{min} = Minimum discharge rate (l/h)

Q_{avr} = Average of each subplot field data discharge rate (l/h)

The emitter flow variation (Q_{var}) was obtained using Equation 3.7 (Wu,2007)

$$Q_{var} = \frac{Qmax - Qmin}{Qmax} \qquad 3.7$$

Where,

Q_{var} = Emitter flow variation (l/h)

Q_{max} = Maximum emitter flow (l/h)

Q_{min}= Maximum emitter flow (l/h)

The coefficient of variation (C.V) was calculated according to the Equation 3.8 (Wu, 2007)

$$(CG_V) = \frac{S}{Qa} X100 \qquad 3.8$$

Where :

S= standard deviation of emitter flow rate (l/s)

Q_a= average flow rate (l/h)

The Uniformity Coefficient (Uc) was calculated according to (ASAE, 2003) as given in Equation 3.9

$$U_c = \left(\frac{1-S_q}{Q_a}\right) \times 100 \qquad 3.9$$

Where:

U_c= uniformity coefficient %

S_q= average absolute deviation of all emitters

Flow from the average emitter rate (l/h)

Q_q= average emitter flow rate (l/h)

And to be compared with recommended classification of coefficient of manufacturing (ASAEEP405.1, 2003).

3.4.5 Data Analysis

Statistic Package for social Sciences (SPSS), Minitab and Microsoft Excel Software were used in the Data Analysis.

1. MINITAB and LSD at a 5% level were utilized to examine the data.
2. The effect of extra irrigation was compared using analysis of variance.

3.4.6 Bill of measurement

Table 3.3: Bill of Measurement

Materials	Unit	Quantity	Rate	Amount (₦)
Polyethylene	M^2	2	7,500	15000
Soil analysis	-	-	-	55000
Jerry can	Liter	1	800	800
Land	M^2	15x8	5,000	5,000
Rope	M	2	250	500
Grand total				76300

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

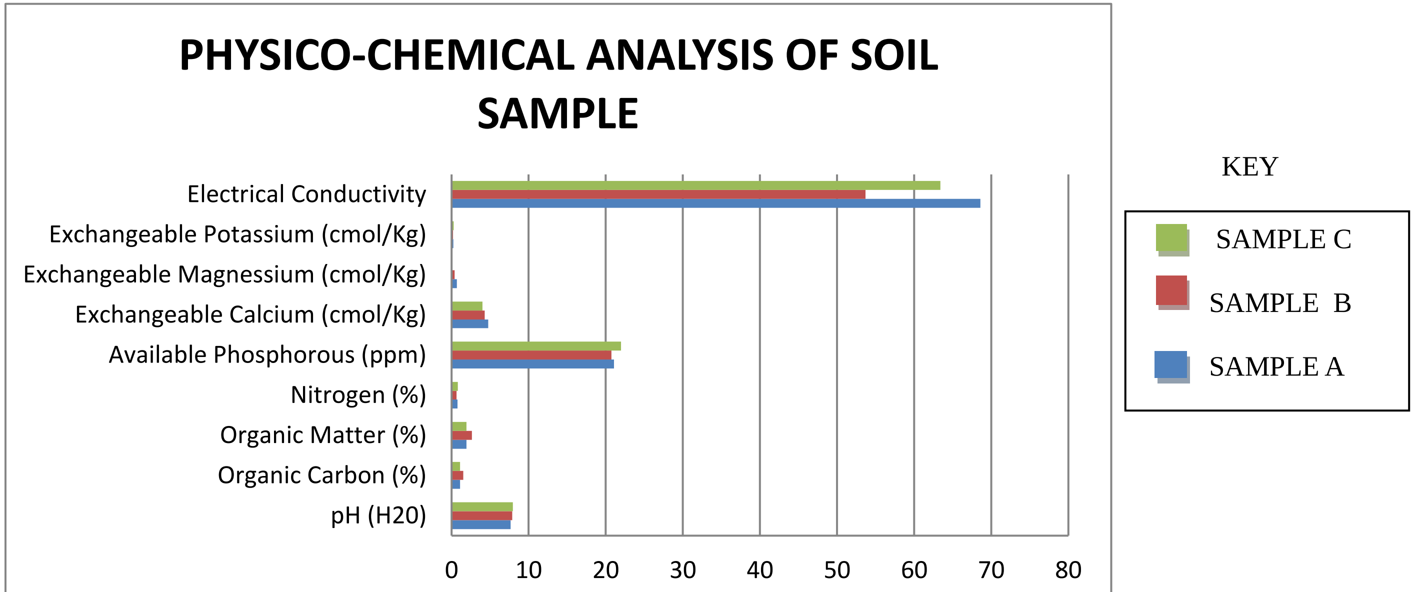
4.1 The Effect Of Physico-Chemical Analysis Of Soil Sample On Dripper Depth And Mulch On Agron Omic Performance Of Cocks Comb ***(CelosiaArgentea)*.**

The results of the physico-chemical properties of soil obtain at different depths. The data related to effect of dripper depth and mulch on soil sample at 0-10(cm) and 10-20 (cm) depth before planting to determine the agronomic performance of *Cocks comb* were given in table 4.1(a)

Table 4.1: (a): Shows Bulk Samples depths.

Dripper Depth	Bulk Sample (mgm^{-3})
Sample A	0-10(cm) 10-20(cm)
Sample B	0-10(cm) 10-20(cm)
Sample C	0-10(cm) 10-20(cm)

The Physico-chemical analysis of soil sample is shown in fig: 4.1(a) which shows the differences between the parameters consider in term of nutrients concentration on each sample soil.



	pH (H20)	Organic Carbon (%)	Organic Matter (%)	Nitrogen (%)	Available Phosphorous (ppm)	Exchangeable Calcium (cmol/Kg)	Exchangeable Magnessium (cmol/Kg)	Exchangeable Potassium (cmol/Kg)	Electrical Conductivity
SOIL C	7.95	1.11	1.91	0.8	21.99	4	0.05	0.28	63.4
SOIL B	7.85	1.52	2.62	0.65	20.73	4.3	0.4	0.19	53.7
SOIL A	7.65	1.12	1.93	0.78	21.05	4.75	0.7	0.24	68.6

Figure 4.1: Physico-chemical analysis of the soil.

Figure 4.1(a) Above indicated the results of the soil sample compared with the soil interpretation standard clearly indicated that the soil pH mean level of the soil sample C, had a maximum value of 7.95 while the mean minimum value of soil obtained from depth sample A, was 7.65. The soil sample C was moderately alkaline while soil sample A was slightly alkaline, in comparism with FAO (2006) soil interpretation standard.

i. In regard to the soil organic carbon concentration (%). The maximum mean result was 1.52(g) of soil sample B, while the minimum mean value was 1.11 of soil sample C, soil sample B was high percentage in carbon, while soil sample C was low in carbon concentration base on soil interpretation standard (FAO,2006).
ii. The data related to organic matter (%) concentration is given in Table 4.1(b): The mean maximum value of2.62(%) of soil organic matter of soil sample B, why the mean minimums of 1.91(%) for soil sample C. In comparison with soil interpretation standard, soil sample B was very high in organic matter while soil sample C was high in carbon.
iii. The effect of Nitrogen (%) concentration soil on dripper depth and mulch on agronomic performance of Cocks comb.

    The concentration of N was shown in Table 4.1((b) The mean maximum value 0.8(%) under the soil sample C and soil sample B minimum was 0.65(%) to compared with soil interpretation standard, soil sample C was very high, while soil sample B was also very high.
iv. The data related to the effect of available phosphorous (ppm) was analysed to the effect of dripper depth and mulch on agronomic performance of Cocks comb. The mean maximum value 21.99ppm of phosphorous on soil sample C while the minimum value is 20.73 for soil sample B. with the comparison of these value with soil interpretation standard, the soil sample C was very low and likewise for soil sample B was also very low.(FAO, 2006).

v. The interactive effect of dripper depth and mulch on agronomic performance onCocks comb The soil exchangeable calcium (cmol/kg) was analysed the mean maximum value of soil sample A 4.75cmol and minimum value of soil sample c was 4cmol/kg with compared with soil interpretation standard, soil sample A, was Low, Likewise soil sample C was also low.

vi. Regard to effect of dripper depth and mulch on agronomic performance of Cocks comb, The soil exchangeable magnesium was analysed to determine the interactive effect of these. The mean maximum magnesium value 0.7cmol/kg of soil sample A while the minimum value of 0.05cmol/kg of soil sample C by comparism these value with soil interpretation standard, soil sample A felled within the range of 0.3-1 rated low and soil sample C rated very low.

vii. The soil exchangeable potassium was analysed to know the significant effect of dripper depth and mulch on agronomic performance of Cocks comb the table 10: show the concentration of potassium in the soil sample. The mean maximum value of 0.28cmol/kg of soil sample C and minimum value of 0.19cmol/kg of soil sample B.

viii. These indicated and rated under the soil, interpretation standard, soil sample C, rated low, while soil sample B, was also rated low.

ix. The data related to the effect of Electrical conductivity on the effect of dripper depth and mulch on agronomic performance of Cocks comb, the mean maximum value 68.6 of soil sample A and minimum value 53.7 soil sample B, was observed before plant in the field. The data was compared with soil interpretation standard, soil sample A, ranked very high concentration while soil sample B also ranked very high.

4.2 The results of dripper emitter Parameters Evaluations

The results of dripper emitter parameters evaluations is shown in Table 4.2 which expressed the three (3) levels of soil depth at 00 cm, 10 cm and 20 cm of emitters flow rate and their percentage performance in each plots.

Table 4.2: Performance criteria determination of flow through the bottle.

Treatments	Replicates	Emission Uniformity %	Emitter flow Variation(Q_{var})%	Co-efficient of Variation%	Uniformity Co-efficient%
M100	Replicate 1	95.03	10.71	5.84	95.71
	Replicate 2	97.18	8.00	4.88	96.24
	Replicate 3	92.18	17.86	10.72	91.85
M110	Replicate 1	89.43	18.92	10.44	92.95
	Replicate 2	91.53	13.51	7.5	94.36
	Replicate 3	95.11	8.57	4.52	96.74
M120	Replicate 1	92.66	15.09	8.38	93.91
	Replicate 2	95.92	6.00	3.53	97.28
	Replicate 3	94.49	10.00	5.27	96.33
N100	Replicate 1	92.20	14.81	8.03	94.51
	Replicate 2	92.20	14.81	8.03	94.51
	Replicate 3	94.26	10.00	5.31	96.18
N110	Replicate 1	95.11	8.57	4.52	96.74
	Replicate 2	96.33	5.41	3.18	97.55
	Replicate 3	91.53	13.51	7.5	94.36
N120	Replicate 1	90.76	15.09	8.32	93.84
	Replicate 2	97.30	4.00	2.34	98.2
	Replicate 3	93.88	13.46	7.58	94.34
M210	Replicate 1	89.85	15.79	8.94	93.23
	Replicate 2	93.36	13.51	7.38	94.70
	Replicate 3	93.88	12.50	6.78	95.14
M220	Replicate 1	92.83	11.32	6.31	95.22
	Replicate 2	95.35	9.62	5.12	96.34
	Replicate 3	94.49	10.00	5.27	96.33
M200	Replicate 1	88.87	23.33	14.14	89.39
	Replicate 2	88.42	21.43	12.09	91.64
	Replicate 3	93.07	12.00	6.43	95.38
N210	Replicate 1	95.81	9.09	4.90	96.41

	Replicate 2	89.72	20.00	11.33	91.90
	Replicate 3	93.46	15.15	8.91	93.23
N220	Replicate 1	96.43	10.00	6.19	95.24
	Replicate 2	94.81	12.50	7.31	94.43
	Replicate 3	98.54	4.26	2.53	98.05
N200	Replicate 1	92.2	14.81	8.03	94.51
	Replicate 2	95.03	10.71	5.84	95.71
	Replicate 3	92.2	14.81	8.03	94.51
M310	Replicate 1	93.36	13.51	7.38	94.7
	Replicate 2	89.85	15.79	8.94	93.23
	Replicate 3	91.5	15.15	8.19	94.34
M300	Replicate 1	92.2	14.81	8.03	94.51
	Replicate 2	89.89	17.86	9.79	93.26
	Replicate 3	87.84	23.33	13.53	90.29
M320	Replicate 1	93.18	14.89	8.48	93.67
	Replicate 2	96.05	7.69	4.00	97.3
	Replicate 3	93.18	14.89	8.48	93.67
N310	Replicate 1	93.05	12.50	6.67	95.37
	Replicate 2	88.42	20.00	11.09	92.28
	Replicate 3	99.11	2.63	1.55	98.81
N300	Replicate 1	85.61	23.33	13.24	90.41
	Replicate 2	88.42	21.43	12.09	91.64
	Replicate 3	92.2	14.81	8.03	94.51
N320	Replicate 1	94.05	9.62	5.26	96.03
	Replicate 2	96.6	6.00	3.13	97.74
	Replicate 3	95.35	9.62	5.12	96.34

4.2.1 Emission uniformity and emitter flow variations

The results evaluated of these findings as an excellent: shows in Table:4.2 the values were given; 95.03, 97.18, 95.11, 95.92, 94.49, 94.26, 95.11, 96.33, 97.30, 95.35, 94.49, 95.81, 96.43, 94.81, 98.54, 95.03, 96.05, 99.11, 94.05, 96.6, and 95.35. while some were categorized under Good. 92.18, 89.43, 91.53, 92.66, 92.20, 92.20, 91.53, 90.76, 93.88, 89.85, 93.36, 93.88, 92.83, 88.87, 88.42, 93.07, 89.72, 93.46, 92.2, 92.2, 93.36, 89.85, 91.5, 92.2, 89.89, 87.84, 93.18, 93.18, 93.05, 88.42, and 88.42,These results conformity with system classification. it is recommended for the evaluation of system uniformity of micro – Irrigation (ASAE, 2001) standard.

Likewise, the results were conformity with ASAE (2003) standards which obtained, a general criteria for emission uniformity greater than 90% and which is characterized as an excellent range of performance. indicated in Table: 2.3

The value of emitter flow variation (Qvar) obtained was justified with the ASAE 2003conformity standard. Below 10% signified desirable results, 10-20 % acceptable and greater than, 25 % unacceptable. Therefore, the results obtained majorly lie between the range of desirable and acceptable. Just only the $M_3$00, rep3: and $M_2$00, replication (1) & replication (2) signified unacceptable under these emitter flow variation.

Medi – emitter adopted for the discharge of water to the irrigated field could be employed instead of the use of a conventional dripper for irrigation system. Mofoke *et al.*,(2004) reported similar findings and employed medi-emitter in the design, construction and evaluation of an affordable continuous flow drip irrigation system.

Variation coefficient and uniformity Coefficient. For the classification of coefficient of variation in the discharge, the American Society of Agricultural Engineering (ASAE, 2003) recommended a value of 10% margin as "excellent" for line source emitters. The coefficient of variation results for all of the samples were different from one another. When compared to Bralts *et al*. (2000), (Qvar) and (CV) should be between ten and twenty percent and one and twenty percent, respectively. (See Table 4.2.)

Therefore, the results obtained majorly within the range of an excellent and poor, not single under unacceptable in the coefficient of manufacturer's. variation (Table 4.2).

The uniformity coefficient obtained from the results shown in the (table: 4.2)within the range of(89. 39% -98.05%.) are excellent as compared to the findings of sah *et al* (2010) obtained within the range of 85.69% to 92.44%.

4.3 The result of the effect of dripper depth and mulching on agronomic parameter of cocks comb

Effect of dripper depth and Mulch on Plant height (cm),leaves numbers, plant weight and economic value of Cockscomb. Plant growth is generally measured in terms of plant height. The data shows the significant effect of dripper depth and mulch on effect of the plant height. Shown in Table(4.6 and 4.7). As regard the dripper depth mulch and non mulching (control) as (factor A). The mean value of mulch plant height (139.222cm) while (100.00cm) for non mulch as a minimum value. And the Duncan Analysis of the differences between the categories with a confidence interval of 95% (Height while the probability difference was 0.002 which is highly significant effect to probability value of ($p<0.05$), therefore, the mulch had significant effect on plant height.

Table 4.3: Shows the Effect of plant height.

Category	LS means	Standard error	Lower bound (95%)	Upper bound (95%)	Groups
Mulching	139.222	6.786	124.438	154.007	A
Non-Mulching	100.000	6.786	85.216	114.784	B

Table 4.4: Shows the contrast between factor A

Contrast	Difference	Critical value	Pr > Diff	Significant
Mulching vs Non-Mulching	39.222	2.179	0.002	Yes

Table 4.5: Factor B and Duncan Analysis of the differences between the categories with a confidence interval of 95% (Height)

Contrast	Difference	Critical value	Pr > Diff	Significant
Depth 00 vs Depth 20	6.500	2.281	0.847	No
Depth 00 vs Depth10	4.667	2.179	0.698	No
Depth10 vs Depth 20	1.833	2.179	0.879	No

Table 4.6: Shows LS mean of factor

Category	LS means	Lower bound (95%)	Upper bound (95%)	Groups
Depth 00	123.333	105.226	141.440	A
Depth10	118.667	100.560	136.774	A
Depth 20	116.833	98.726	134.940	A

Table 4.8 and 4.9 Show the effect of (Factor B) i.e. the dripper depth and Duncan Analysis of the differences between the levels with a confidence interval of 95% (Height) show that the probability difference was 0.847, 0.698 and 0.879 not significant difference to compare to probability value of ($p<0.05$) regard to the data of Duncan analysis.

While, the Tables4.10 and 4.11 show the difference in drippers depth, mulch and non, i.e Factor A and Factor B. Analysis of Variance (Height) under the confidence interval of 95 % the probability value of (Factor A) was 0.001506 which was highly significant in comparism with probability standard of 0.05% (<0.05) and (Factor B) was not significantly difference, in which the probability value of it was 0.851754. and also (Factor A) & (Factor B) 0.669337 probability value were not significant difference compare to probability standard of ($p<0.05$). Therefore, the mulch had effect on plant height of Cocks comb. While the dripper depth had no effect on the plant height. Table: 4.10 shown Analysis of variance of height.

Table 4.7: Analysis of Variance of the Height

Source of Variation	SS	DF	MS	F	P-value
Factor A	6922.722	1	6922.722	16.70586	0.001506
Factor B	134.7778	2	67.38889	0.162622	0.851754
Factor A:Factor B	344.1111	2	172.0556	0.415203	0.669337
Error	4972.667	12	414.3889		
Total	12374.28	17			

Table 4.8: Factor A*Factor B Duncan Analysis of the differences between the categories with a confidence interval of 95% (Height):

Category	LS means	Lower bound (95%)	Upper bound (95%)	Groups	
Factor A-Mulching*Factor B-Depth10	143.333	117.726	168.941	A	
Factor A-Mulching*Factor B-Depth 00	137.333	111.726	162.941	A	
Factor A-Mulching*Factor B-Depth 20	137.000	111.393	162.607	A	
Factor A-Non-Mulching*Factor B-Depth 00	109.333	83.726	134.941	A	B
Factor A-Non-Mulching*Factor B-Depth 20	96.667	71.059	122.274		B
Factor A-Non-Mulching*Factor B-Depth10	94.000	68.393	119.607		B

The figure: 4.2 to 4.6show the means and standard deviation, of the effect of dripper depth and mulch (control) on height of Cocks comb

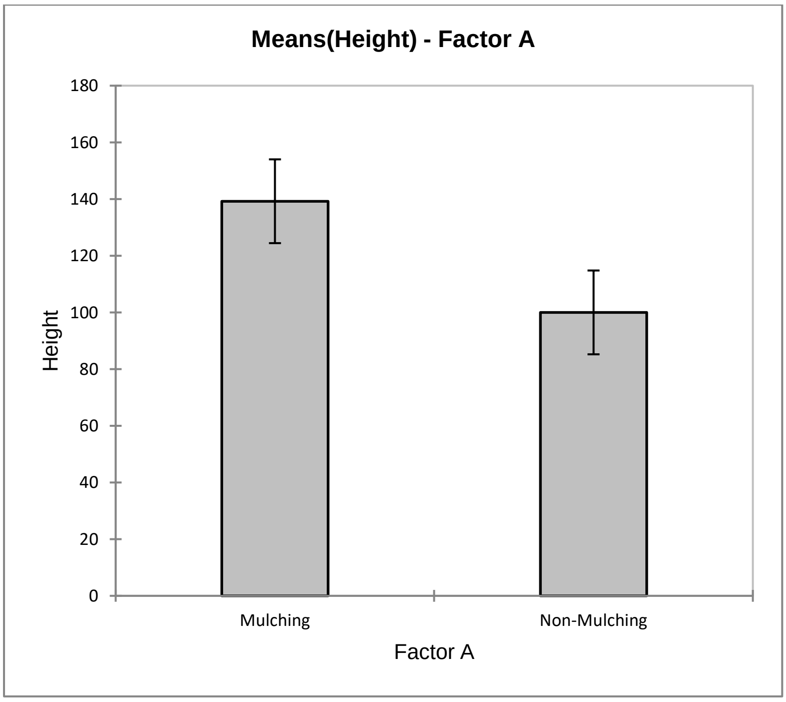


Figure 4.2: Means(height) - Factor A

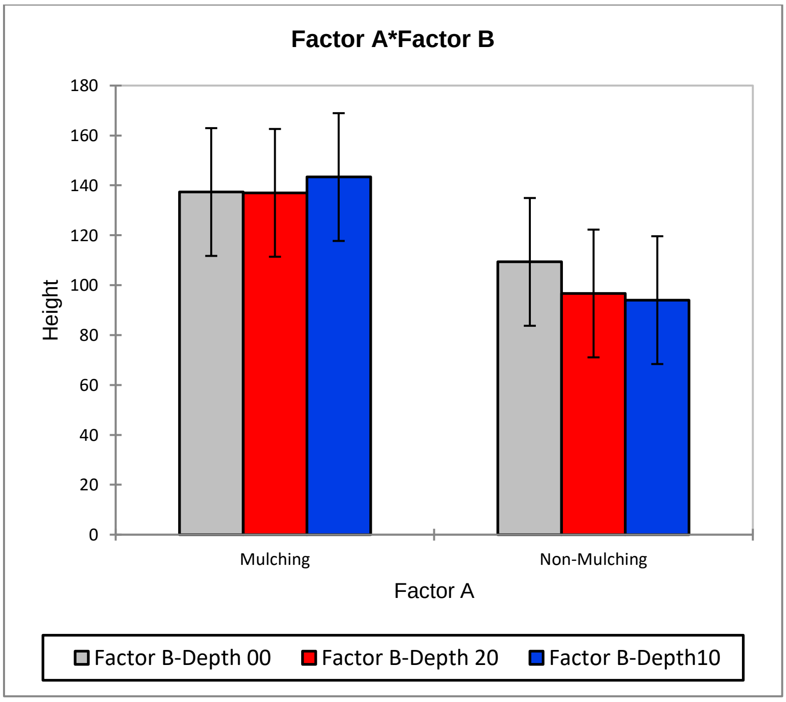


Figure 4.3: Factor A*Factor B

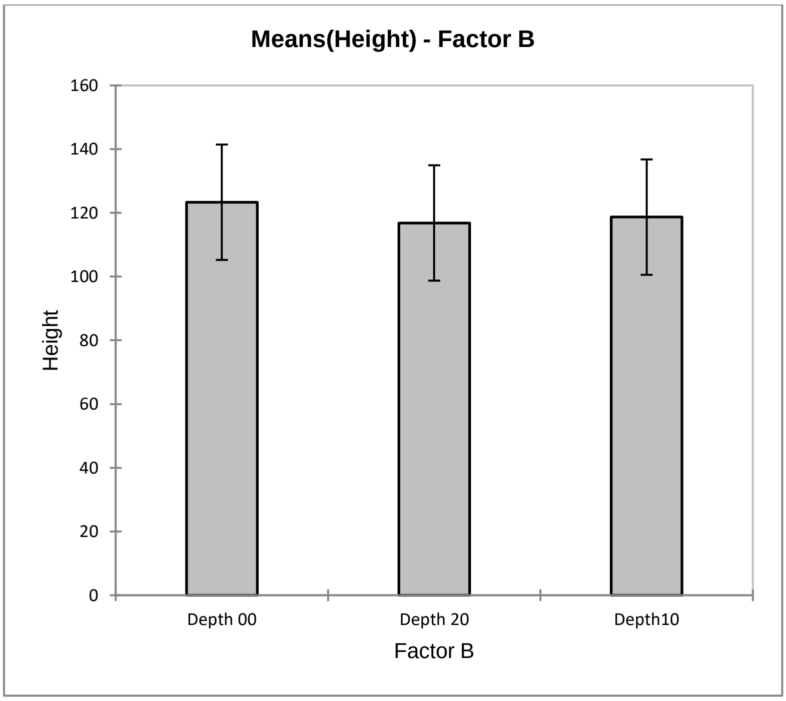


Figure 4.4: Means(height) - Factor B

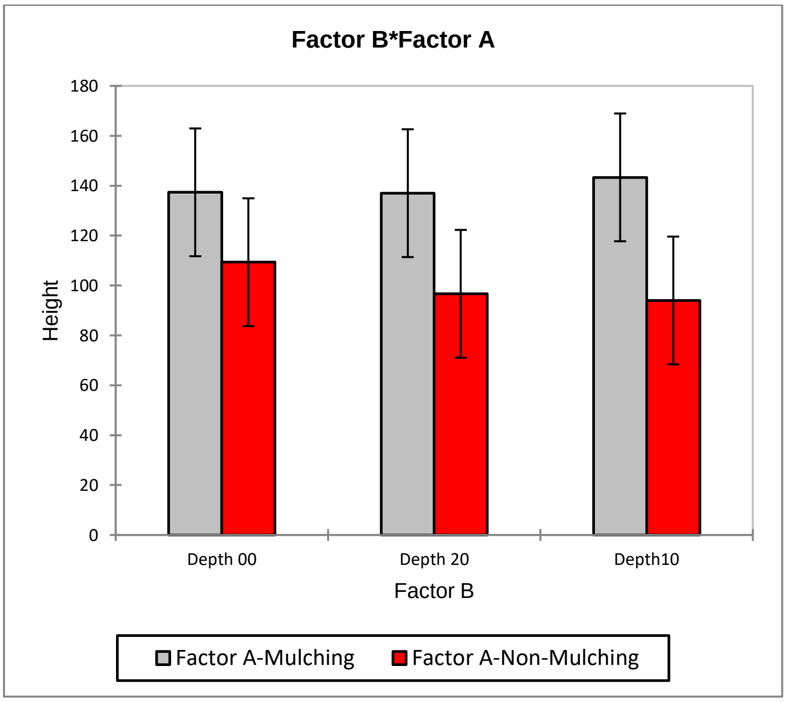


Figure 4.5: Factor B*Factor A

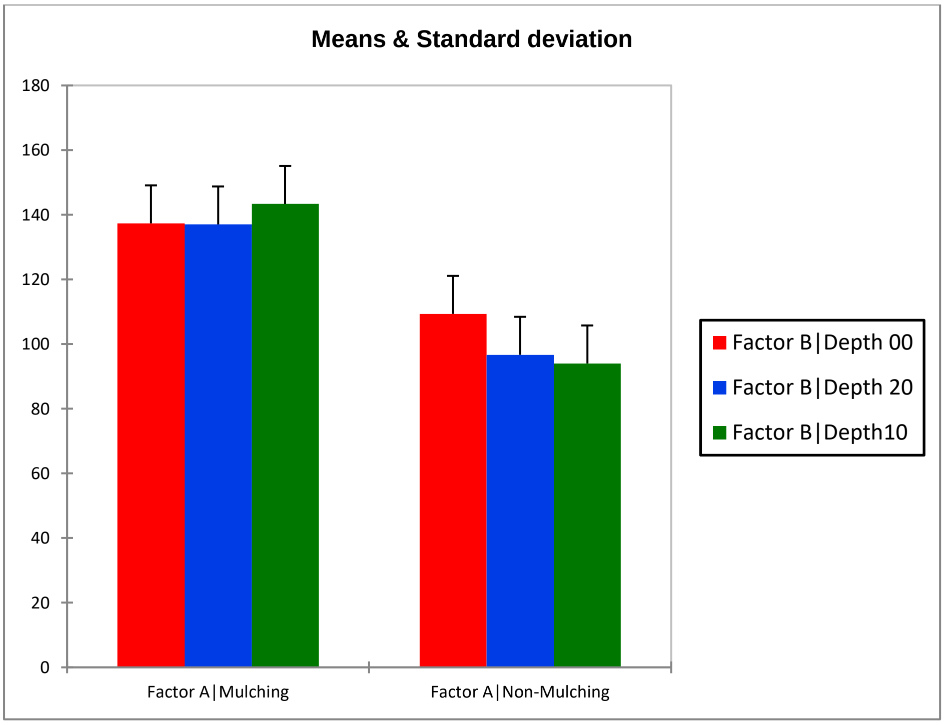


Figure 4.6: Means and standarddeviation

4.3.1 Effect of dripper depth and mulch on plant leaves number of Cocks comb.

As regards to the Duncan Analysis of the differences between the (Factor A) categories with a confidence interval of 95% (Number of leaves). The Mean maximum value for mulch was 198.889, at the upper bound of 215.758, so, for non-mulch the mean minimum value was 119,11 at the upper bond of 135.580.

Based on the data presented in Table: 4.12 - 4.15, while the probability difference between this factor was 0.0001 which is highly significant to the probability standard of ($P<0.05$). therefore mulch had highly significant effect on the leaves number of plant. Likewise (Factor B) at the dripper depth Duncan revealed that the difference between the depths categories with a confidence between the depths categories with a confidences. Interval of 95% (leaves Number) was not significant i.e. 0.288, 0.913 and 0.971 to compare with probability standard of 0.05%.

Table 4.9: Factor A and Duncan Analysis of the differences between the categories with a confidence interval of 95% (Number of Leaves):

Category	**LS means**	**Lower bound (95%)**	**Upper bound (95%)**	**Groups**	
Mulching	198.889	182.020	215.758	A	
Non-Mulching	119.111	102.242	135.980		B

Table 4.10: Shows contrast between factor A

Contrast	**Difference**	**Critical value**	**Pr > Diff**	**Significant**
Mulching vs Non-Mulching	79.778	2.179	<0.0001	Yes

Table 4.11: Shows Factor B and Duncan Analysis of the differences between the categories with a confidence interval of 95% (Number of Leaves):

Contrast	**Difference**	**Critical value**	**Pr > Diff**	**Significant**
Depth10 vs Depth 20	2.000	2.281	0.988	No
Depth10 vs Depth 00	1.500	2.179	0.913	No
Depth 00 vs Depth 20	0.500	2.179	0.971	No

Table 4.12: Shows LS mean of factor B

Category	LS means	Lower bound (95%)	Upper bound (95%)	Groups
Depth10	160.167	139.506	180.827	A
Depth 00	158.667	138.006	179.327	A
Depth 20	158.167	137.506	178.827	A

Factor A and Factor B and Duncan Analysis of the differences between the categories with a confidence interval of 95% (Number of Leaves) and analysis of variance show in Table 4.16 and 4.17 ANOVA show that both the two Factors (A and B) were not significant to the probability standard of 5%. Therefore both the two Factor have no effect on the leaves number of the plants.

Table 4.13: Factor A*Factor B and Duncan Analysis of the differences between the categories with a confidence interval of 95% (Number of Leaves):

Category	LS means	Standard error	Lower bound (95%)	Upper bound (95%)	Groups
FactorA-Mulching*FactorB-Depth10	201.333	13.410	172.115	230.552	A
Factor A-Mulching*Factor B-Depth 00	199.333	13.410	170.115	228.552	A
Factor A-Mulching*Factor B-Depth 20	196.000	13.410	166.782	225.218	A
Factor A-Non-Mulching*Factor B-Depth 20	120.333	13.410	91.115	149.552	B
Factor A-Non-Mulching*Factor B-Depth10	119.000	13.410	89.782	148.218	B
Factor A-Non-Mulching*Factor B-Depth 00	118.000	13.410	88.782	147.218	B

Table 4.14: Shows Analysis of variance of (Number of Leaves):

Source of Variation	SS	DF	MS	F	P-value	F crit
Factor A	28640.22	1	28640.22	53.0866	9.66E-06	4.747225347
Factor B	13	2	6.5	0.012048	0.988036	3.885293835
Factor A:Factor B	38.77778	2	19.38889	0.035939	0.964803	3.885293835
Error	6474	12	539.5			
Total	35166	17				

The Figure. 4.7, to 4.11: Show the mean & standard deviation of the effect of dripper depth on mulching and non-mulching of the (Leaves numbers) Cocks comb.

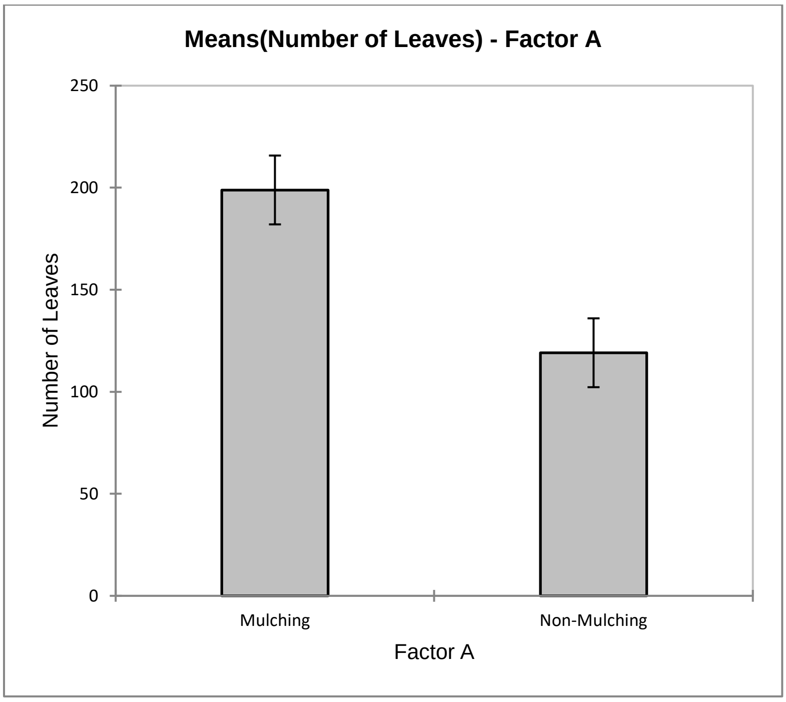


Figure 4.7: Means(Number of Leaves) - Factor A

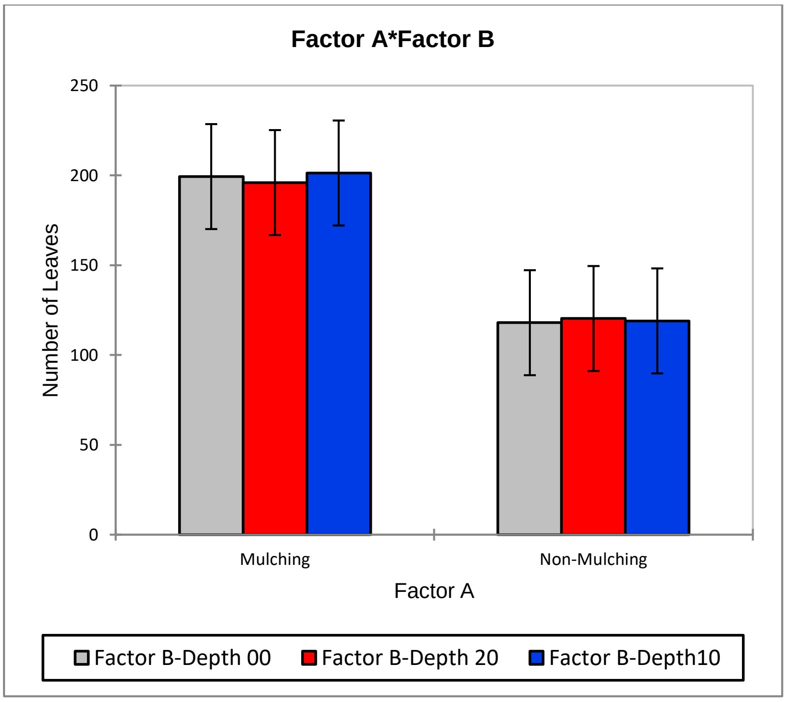


Figure 4.8: Factor A*Factor B

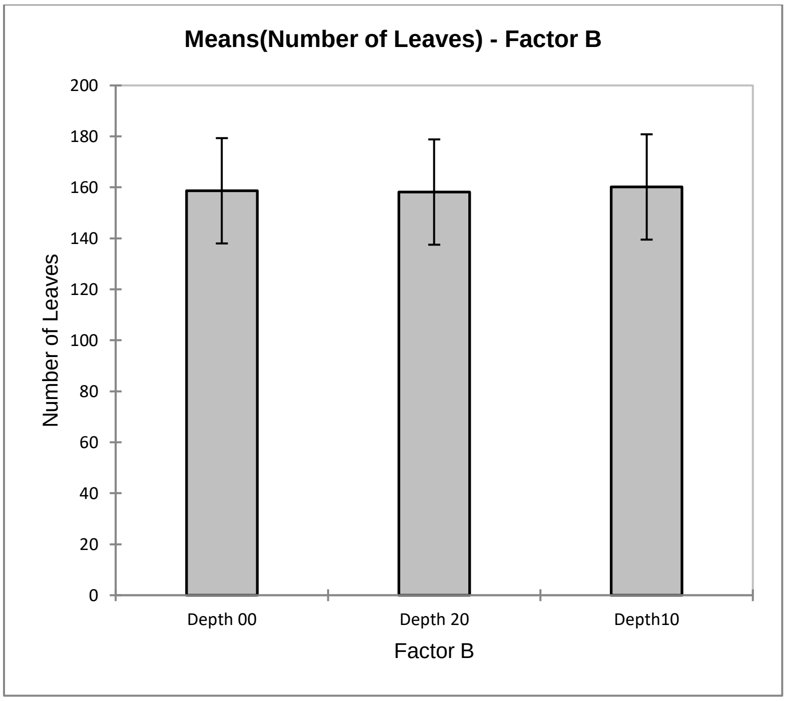


Figure 4.9: Means(Number of Leaves) - Factor B

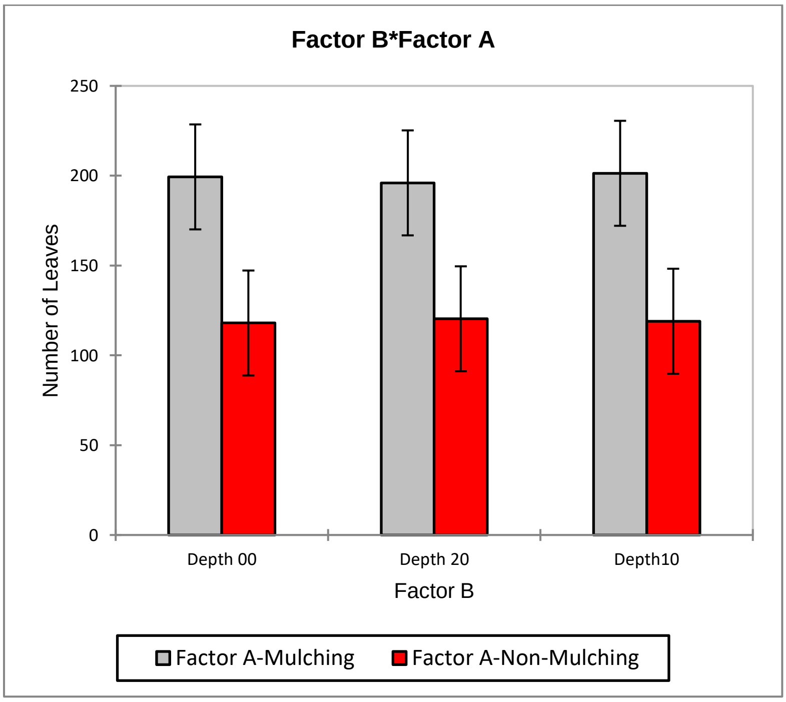


Figure 4.10: Factor B*Factor A

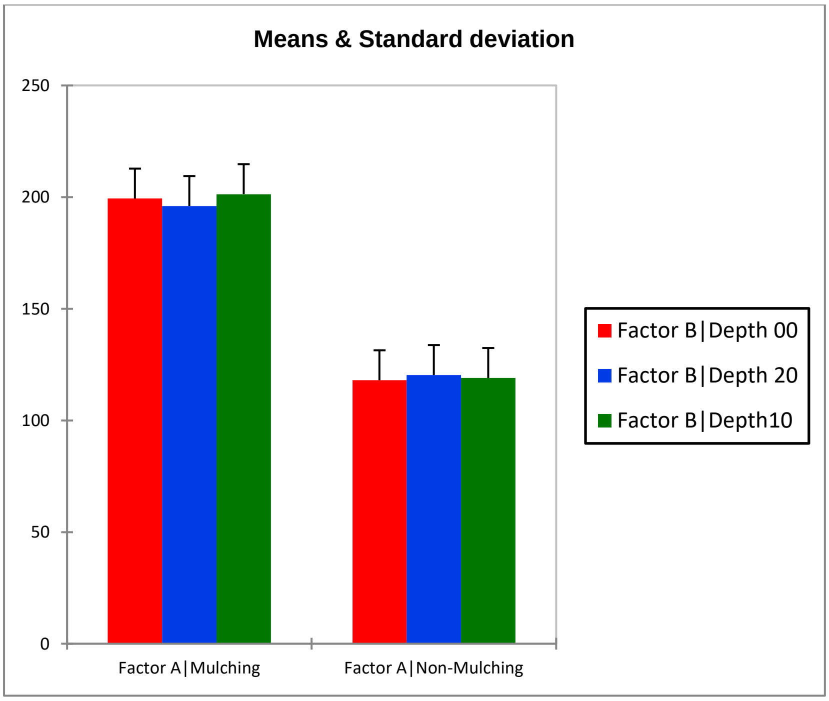


Figure 4.11: Means and standard deviation

4.3.2 Effect of dripper depth and mulch on plant weight of the Cocks comb .

Regarding to the (Factor A) Duncan analysis of the difference between the categories i.e. mulching and non mulching (control) with a confidence interval of 95% (weight). The Table: 4.18 and4.19. reveal that the mulch with 410.011 mean as maximum while non mulch signified 304.267 minimum mean, and the probability value of 0.291 and compared with probability standard of ($p<0.05$) shows that the value was not significant at the level of weight against mulch and non mulch

Table 4.15: Factor A Duncan Analysis of the differences between the categories with a confidence interval of 95% (Weight)

Category	LS means	Standard error	Lower bound (95%)	Upper bound (95%)	Groups
Mulching	410.011	67.724	262.454	557.568	A
Non-Mulching	304.267	67.724	156.710	451.824	A

Table 4.16: Shows the contrast between factor A

Contrast	Difference	Critical value	Pr > Diff	Significant
Mulching vs Non-Mulching	105.744	2.179	0.291	No

Likewise, Tables: 4.20and4.21 show that (Factor B) of dripper depth, Duncan Analysis of the differences between the categories with a confidence interval of 95% (weight) was not significant.

Table 4.17: Factor B Duncan Analysis of the differences between the categories with a confidence interval of 95% (Weight):

Contrast	Difference	Standardized difference	Critical value	Pr > Diff	Significant
Depth20vsDepth10	155.217	1.323	2.281	0.410	No
Depth20vsDepth00	54.667	0.466	2.179	0.650	No
Depth00vsDepth10	100.550	0.857	2.179	0.408	No

Table 4.18: Show LS mean of factor B

Category	LS means	Standard error	Lower bound (95%)	Upper bound (95%)	Groups
Depth20	427.100	82.944	246.380	607.820	A
Depth00	372.433	82.944	191.714	553.153	A
Depth10	271.883	82.944	91.164	452.603	A

(Factor A) and (Factor B) and Duncan Analysis of the differences between the two categories means with the confidence interval of 95% (weight) under Table: 4.22 and 4.23 show two differences between the groups of the two treatment.

Table 4.19: Factor A andFactor B DuncanAnalysis of the differences between the categories with a confidence interval of 95% (Weight):

Category	LS means	Lower bound (95%)	Upper bound (95%)	Groups
Factor A-Mulching*Factor B-Depth 20	531.900	276.324	787.476	A
Factor A-Mulching*Factor B-Depth 00	429.967	174.391	685.543	A
Factor A-Non-Mulching*Factor B-Depth 20	322.300	66.724	577.876	A
Factor A-Non-Mulching*Factor B-Depth 00	314.900	59.324	570.476	A
Factor A-Non-Mulching*Factor B-Depth10	275.600	20.024	531.176	A
Factor A-Mulching*Factor B-Depth10	268.167	12.591	523.743	A

Table 4.20: Analysis of variance (Weight):

Source of Variation	SS	df	MS	F	P-value	F crit
Factor A	50318.49	1	50318.49	1.219006	0.291203	4.747225
Factor B	74381.92	2	37190.96	0.900981	0.431959	3.885294
Factor A:Factor B	35523.13	2	17761.57	0.430288	0.659971	3.885294
Error	495339.5	12	41278.29			
Total	655563	17				

While the (ANOVA) Analysis of variance (weight) was not significant between the two treatments in individual effect and in combine effect of the weight of the Cocks comb

The Figure:4.12,to 4.16: shows the mean standard deviation of the effect of dripper depth and mulching and non-mulching (control) on the weight of the Cocks comb.

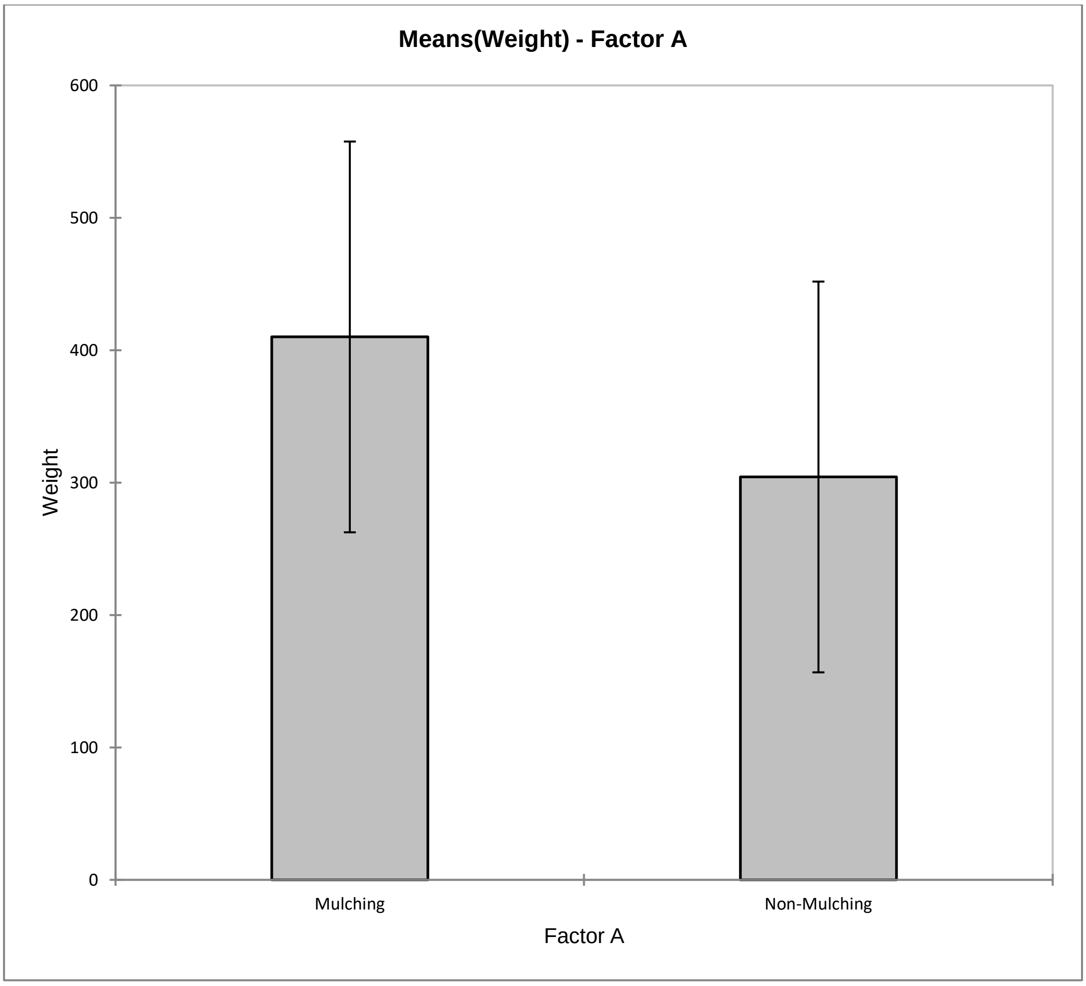


Figure 4.12: Means(Weight) - Factor A

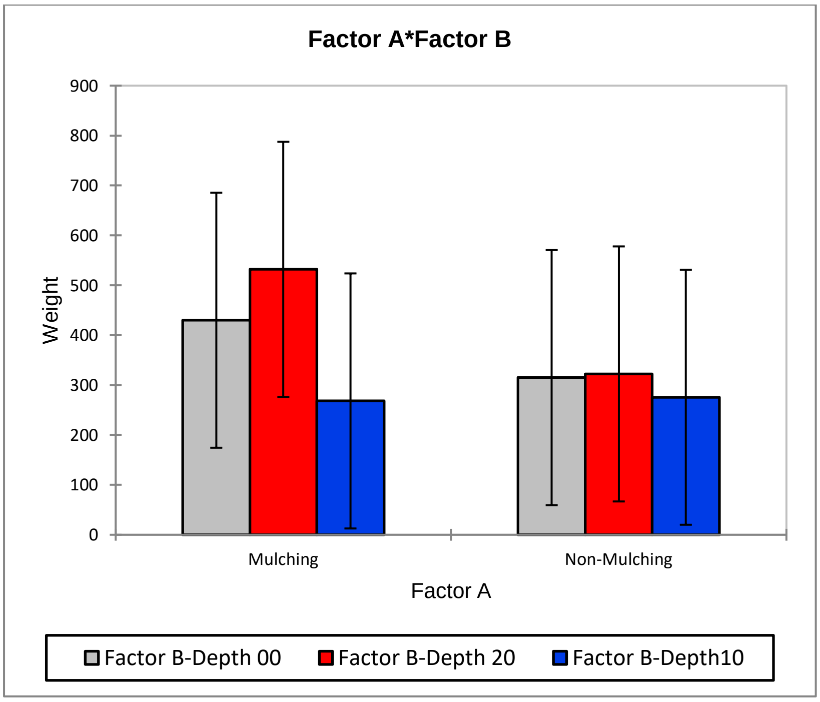


Figure 4.13: Factor A*Factor B

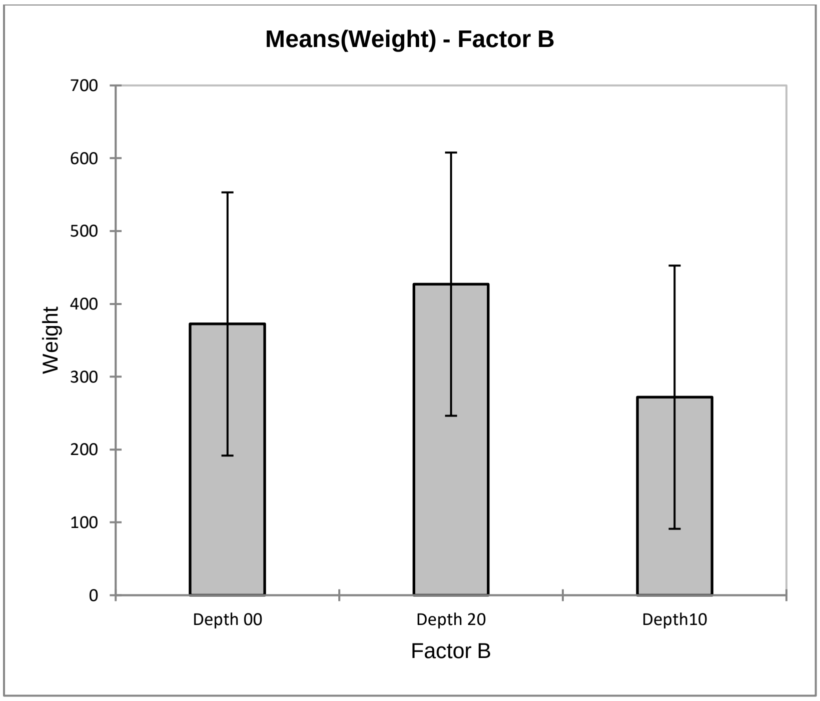


Figure 4.14: Means(Weight) - Factor B

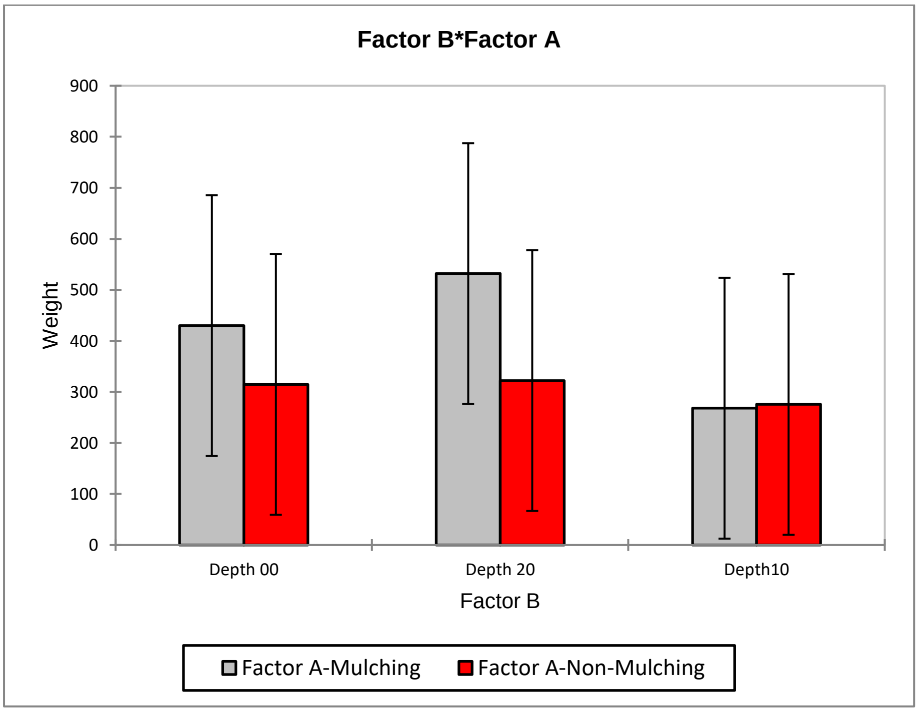


Figure 4.15: Factor B*Factor A

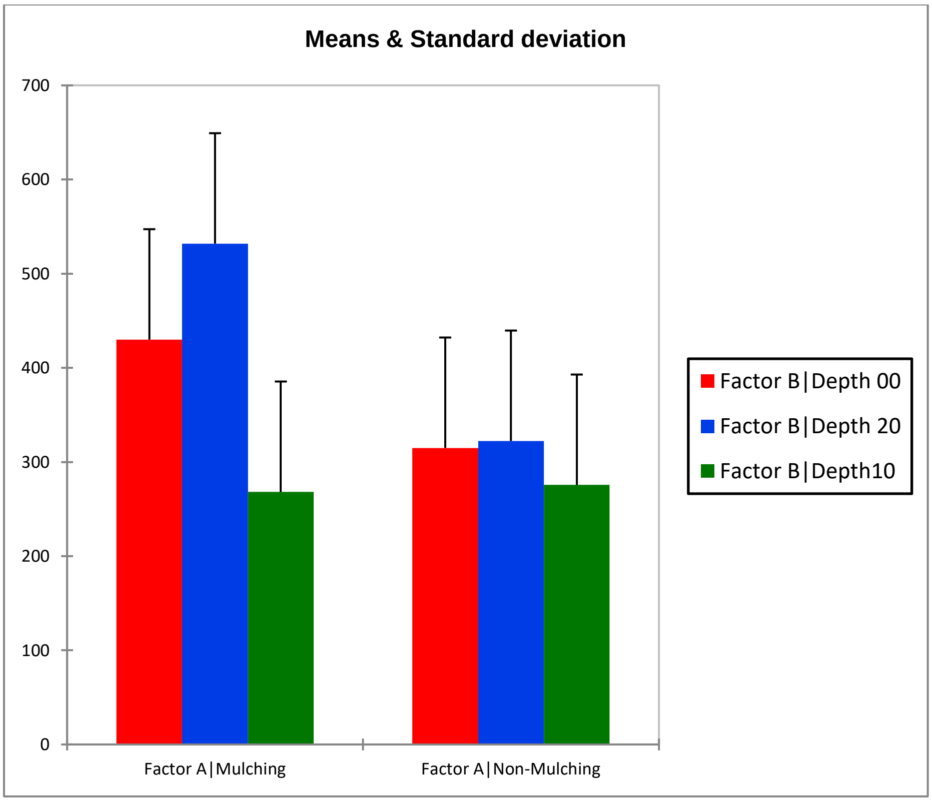


Figure 4.16: Means and Standard deviation

4.3.3 The Effect of dripper depth and mulching on economic value (the selling price in naira and kobo) of Cocks comb.

The data related to effect of dripper depth and mulching on economic value**(**the selling price in naira and kobo) shown in Table 4.24show (Factor A) Duncan analysis of the differences between the means categories with a confidence interval of 95% . The maximum mean was 78.88g, with upper bound with of 95.835, while the minimum mean was 51.111 upper bound of 68.057.The groups show there is difference between these categories of the mulching and non mulching. While the probability differences was 0.027 to compare with probability standard of ($P<0.05$) which shows there was significant in the mulch level on (Economic values) of the Cocks comb.

Table 4.21: Factor A Duncan Analysis of the differences between the categories with a confidence interval of 95% (Economic Value):

Category	**LS means**	**Lower bound (95%)**	**Upper bound (95%)**	**Groups**	
Mulching	78.889	61.943	95.835	A	
Non-Mulching	51.111	34.165	68.057		B

Contrast	Difference	Critical value	Pr > Diff	Significant
Mulching vs Non-Mulching	27.778	2.179	0.027	Yes

More so, (Factor B), under Table:4.25 and 4.26 shows Duncan Analysis ofVariance the differences between the categories with a confidence interval of 95% (Economic values). The probability values was not significant at all categories.

Table 4.22: Factor B Duncan Analysis of the differences between the categories with a confidence interval of 95% (Economic Value):

Contrast	**Difference**	**Critical value**	**Pr > Diff**	**Significant**
Depth 00 vs Depth10	3.333	2.281	0.967	No
Depth 00 vs Depth 20	1.667	2.179	0.904	No
Depth 20 vs Depth10	1.667	2.179	0.904	No

Table 4.23: Shows LS mean of factor B

Category	**LS means**	**Lower bound (95%)**	**Upper bound (95%)**	**Groups**
Depth 00	66.667	45.912	87.422	A
Depth 20	65.000	44.245	85.755	A
Depth10	63.333	42.578	84.088	A

The data related to the effect of dripper depth and mulching under Table: 4.27 and 4.28. show that (Factor A and Factor B) Duncan Analysis of the differences between the categories with a confidence interval of 95% (Economic value) shows that their similarities in the groups, in the combine effect of the two (factors A and B).

Table 4.24: Factor A*Factor B Duncan Analysis of the differences between the categories with a confidence interval of 95% (Economic Value):

Category	LS means	Lower bound (95%)	Upper bound (95%)	Groups
Factor A-Mulching*Factor B-Depth 00	80.000	50.648	109.352	A
Factor A-Mulching*Factor B-Depth 20	80.000	50.648	109.352	A
Factor A-Mulching*Factor B-Depth10	76.667	47.315	106.019	A
Factor A-Non-Mulching*Factor B-Depth 00	53.333	23.981	82.685	A
Factor A-Non-Mulching*Factor B-Depth 20	50.000	20.648	79.352	A
Factor A-Non-Mulching*Factor B-Depth10	50.000	20.648	79.352	A

Table 4.25: Shows Analysis of variance (Economic Value):

Source of Variation	SS	DF	MS	F	P-value
Factor A	3472.222	1	3472.222	6.377551	0.026645
Factor B	33.33333	2	16.66667	0.030612	0.969927
Factor A:Factor B	11.11111	2	5.555556	0.010204	0.989856
Error	6533.333	12	544.4444		
Total	10050	17			

The (ANOVA) Analysis of variance on (Economic values) show that (Factor A) with probability value of 0.026645 was only significant with 0.05% probability standard.(Factor B) was not significant, likewise, not significant in the combine effect of the two factors. In the (economic value) of Cocks comb.

The Figure. 4.17 to 4.22 show the means standard deviation of the effect of dripper depth and mulching and non-mulching (control) on the economic value of the Cocks comb.

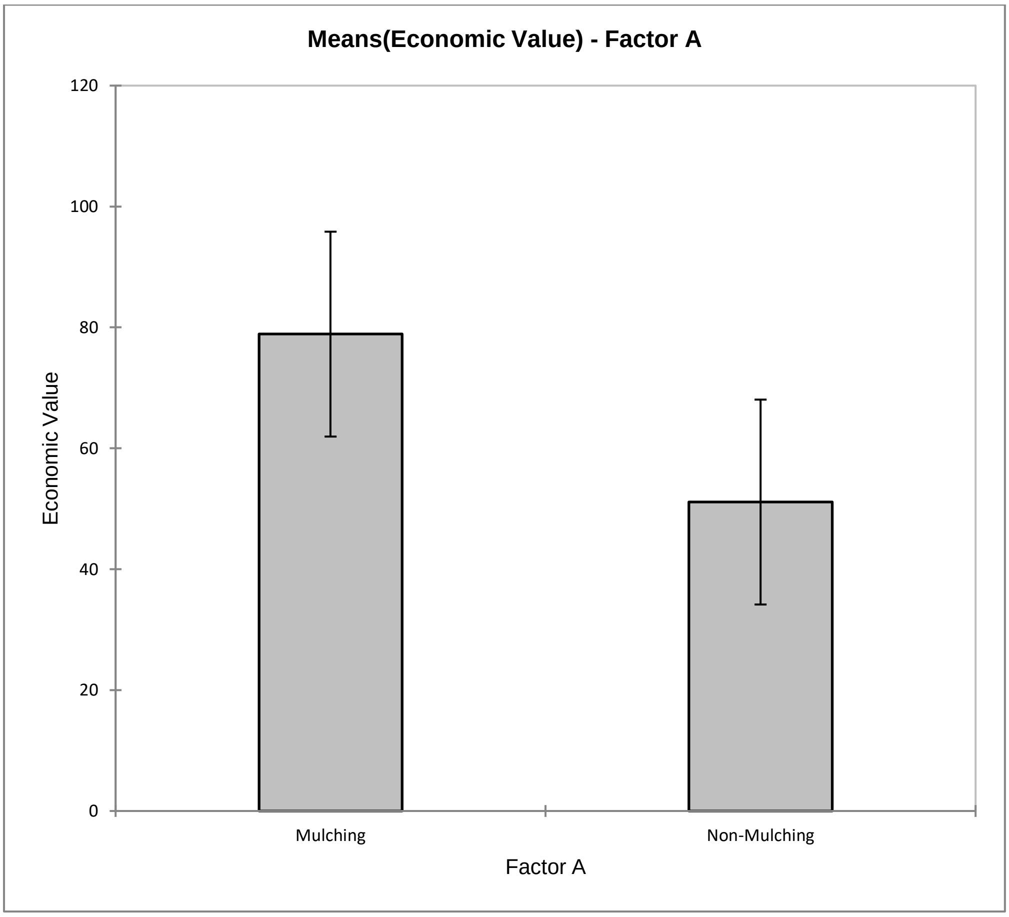


Figure 4.17: Means(Economic Value) - Factor A

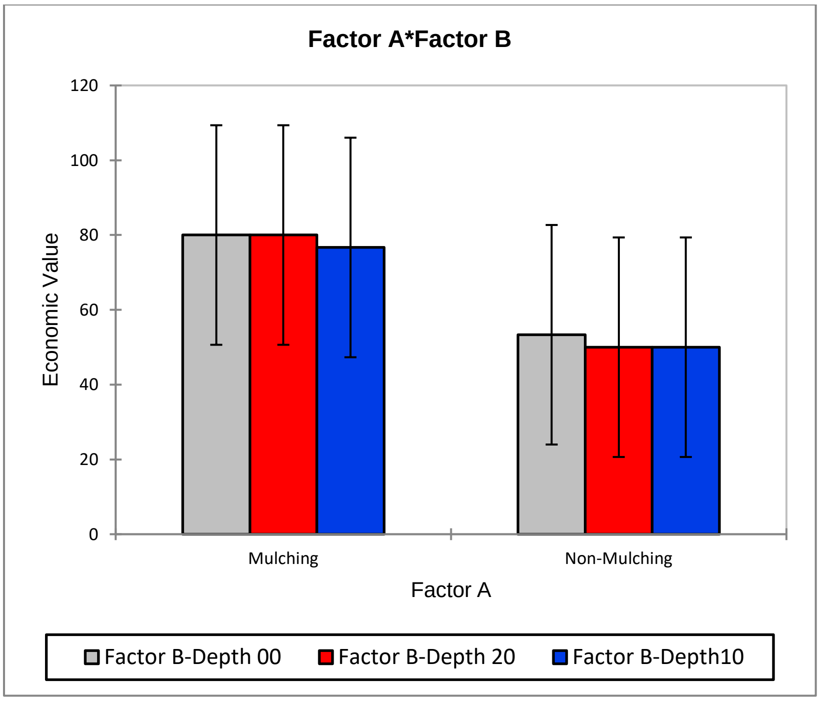


Figure 4.18: Factor A*Factor B

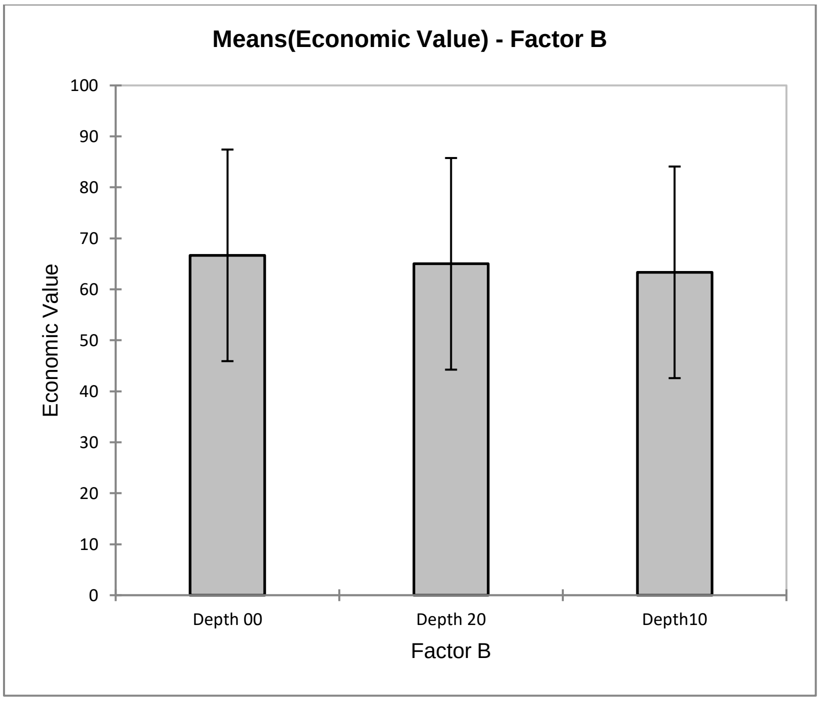


Figure 4.19: Means(Economic Value) - Factor B

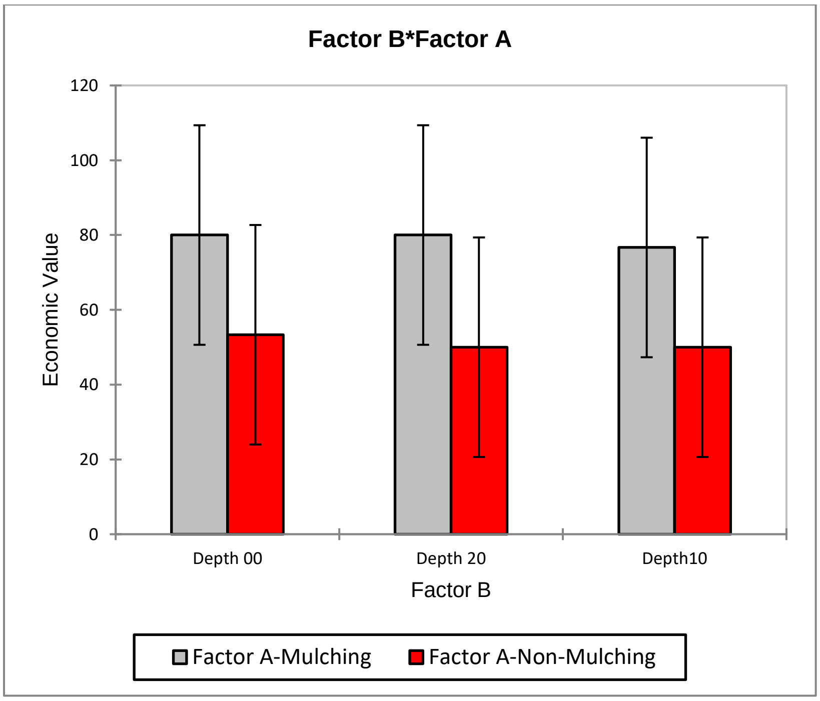


Figure 4.20: Factor B*Factor A

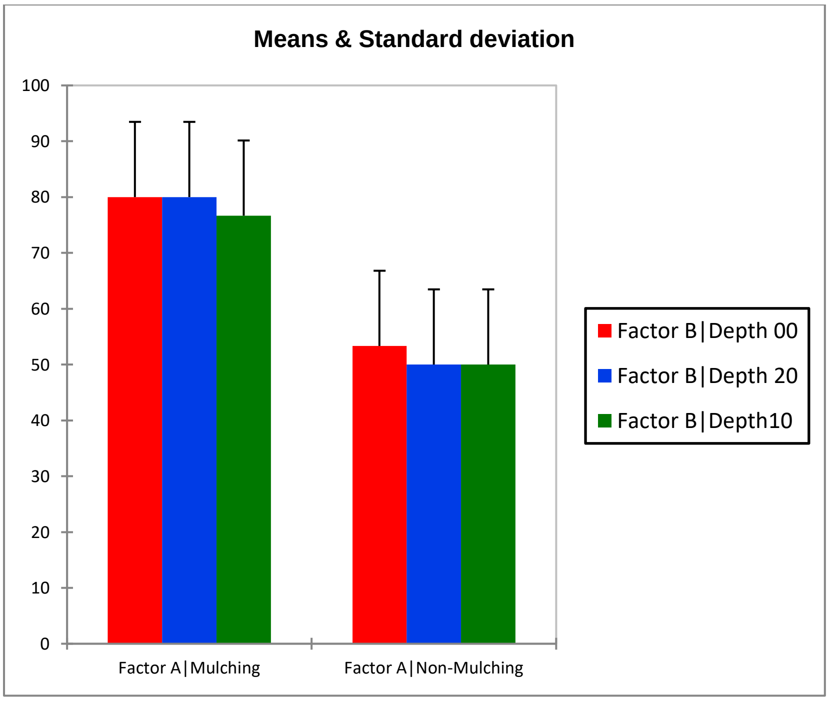


Figure 4.21: Means andstandard deviation.

The Figure: 4.22 show the summary of the economic value of each Block i.e the selling price in naira and kobo of the Cocks comb. Which was know by adding together all the selling price of all mulching and non mulching quantities in each block. for the mulching , in Block (1) the selling price was 280 naira only. Block (2) 300 naira only and Block (3) 130 naira only. While, the values of non-mulching (control) at Block (1) 180 naira only, Block (2) 150 naira only and Block (3) 130 naira only. This results indicated the variation between the mulching and non-mulching (control) theprice in naira and kobo.

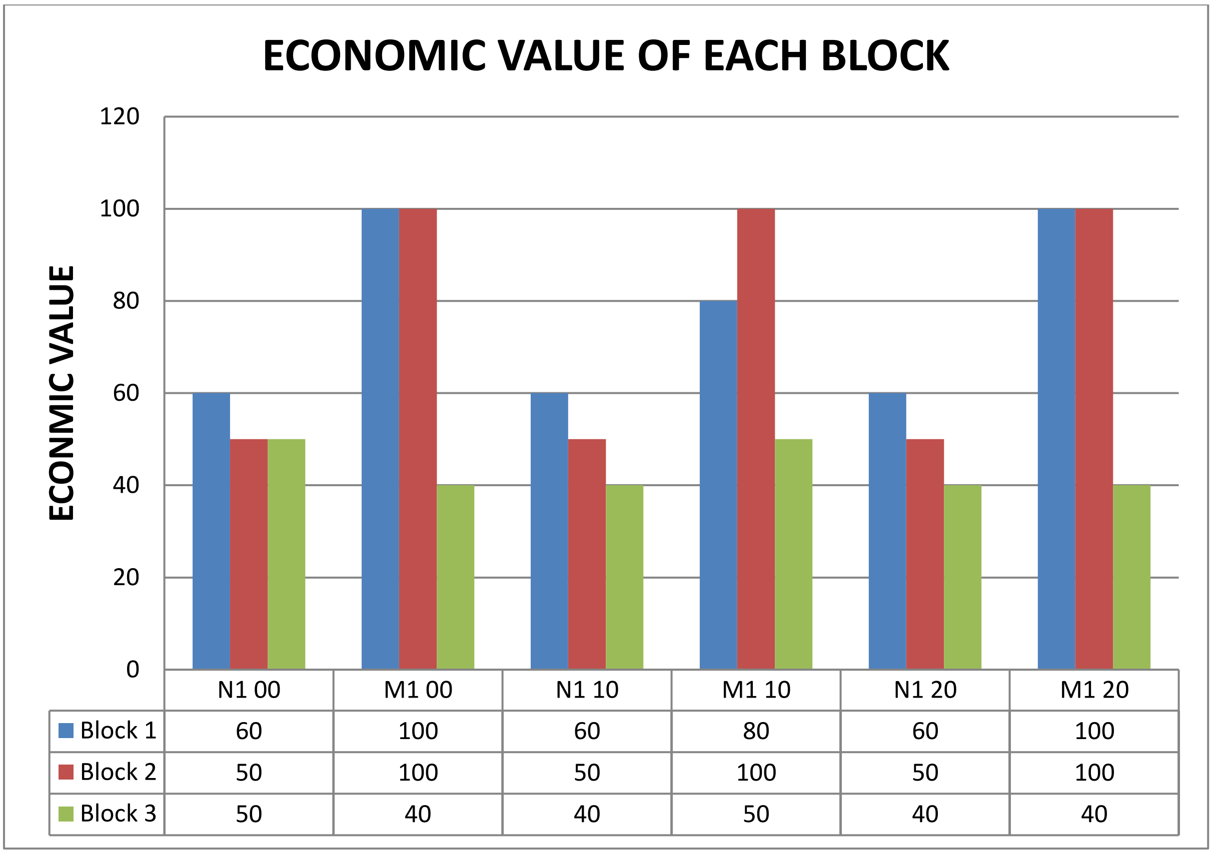


Figure 4.22: Economic value of each block

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

1. This research shows the effect of soil sample properties at different depth of 00 cm, 10 cm and 20 cm considered on plant yield relative to agronomic performance of Cocks comb, It was identified that the soil at this field had high levels of soil salinity hazard of electrical conductivity (E.C) µmho/cm within the range of 68.6 and 53.7 of Sample A at depth of 00 cm - 20 cm and Sample B at depth of 00 cm - 20 cm. Both treatments A and B ranked under soil interpretation standard as very high. Likewise Phosphorus (ppm) for both treatment C and B range within 21.99 ppm - 20.73 ppm, at depth of 00 cm - 20 cm rank under the soil interpretation standard as very low FAO (2008). Soil pH was ranked moderately alkaline while other parameters analysed were low (Table 4.1 (b)).
2. The agronomic performance of Cocks comb.The plant height mean value was 139.222, leaves number mean value 198.889, plant weight mean value 410.011 and economic value mean value 78.888, were statistically and significantly different in yield as compared based on mulching and non-mulching treatment.as shown in fig.4.2,4.6,4.11 and 4.16
3. Therefore, Emission Uniformity values, Emission Flow Variation value, Coefficient of Variation valueand Uniformity Coefficient valuegenerally performed desirable, good and excellent, on the drippers shown in table 4.2.Based on parameter evaluation and compared with ASAE standard of manufacturer variation. The depthsof 00 cm, 10 cm and 20 cm were statisticallynot significant (i.e if the F statistic is high than the critical value, the value that corresponds with alpha usually 0.05, then the difference among groups is deemed statistically significant) based on Duncans analysis on mean and

standard deviation on the effect of agronomic performance of Cockscomb. In general, the depth at which water was applied with mulching had a statistically significant impact on the plant's development and yield. Figures 4.6, 4.10, 4.15, and 4.20 show this quite clearly.

5.2 Recommendations

i. This research is recommended for the farmers dwelling in rural areas as a new dimension in affordable way that could assist them in increasing food production, encourage plastic bottle recycling and plastic mulching material used in any developing nations like Nigeria to mitigate their input and achieving maximum output in a sustainable way.

ii. Finally, this is recommended that the system needs regular checks for uniformness of dripping and blockages. Also a quarterly check on the emitter to know if there is a change in discharge and distribution uniformity with time.

iii. The utilization of this device depends if the government can grant the policy or couple with the existing policy on Irrigation, Soil and Water Conservation.

For further study, the challenges are as follows:

Clogging of the drip holes, the ways out, is by regular check up the dripper hole and repair by rubbing it vigorously with one's fingers and blow out the debris.

Weeds competition with crops on the dripper depth spots. Always uproot the unwanted grasses around the plant growing spots.

It will be difficult to adapt a plastic bottle for a robotic agricultural system, but it is not impossible.

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APPENDIX

Table A1: Summary for all Ys:Pairwise comparison of agronomic performance

	Number of Leaves	Height	Weight	Economic Value
R^2	0.816	0.598	0.244	0.350
F	10.637	3.572	0.776	1.292
Pr > F	0.000	0.033	0.585	0.330

Table A2: Summary of all pairwise comparisons for Factor A (Duncan)

Category	LS means(Number of Leaves)	Groups
Mulching	198.889	A
Non-Mulching	119.111	B

Category	LS means(Height)	Groups
Mulching	139.222	A
Non-Mulching	100.000	B

Category	LS means (Weight)	Groups
Mulching	410.011	A
Non-Mulching	304.267	A

Category	LS means (Economic Value)	Groups
Mulching	78.889	A
Non-Mulching	51.111	B

Table A3: Summary of all pairwise comparisons for Factor B (Duncan)

Category	LS means(Number of Leaves)	Groups
Depth10	160.167	A
Depth 00	158.667	A
Depth 20	158.167	A

Category	LS means(Height)	Groups
Depth 00	123.333	A
Depth10	118.667	A
Depth 20	116.833	A

Category	LS means(Weight)	Groups
Depth 20	427.100	A
Depth 00	372.433	A
Depth10	271.883	A

Category	LS means(Economic Value)	Groups
Depth 00	66.667	A
Depth 20	65.000	A
Depth10	63.333	A

Table A4: Summary of all pairwise comparisons for Factor A*Factor B (Duncan):

Category	LS means(Number of Leaves)	Groups
Mulching*Depth10	201.333	A
Mulching*Depth 00	199.333	A
Mulching*Depth 20	196.000	A
Non-Mulching*Depth 20	120.333	B
Non-Mulching*Depth10	119.000	B
Non-Mulching*Depth 00	118.000	B

Category	LS means(Height)	Groups	
Mulching*Depth10	143.333	A	
Mulching*Depth 00	137.333	A	
Mulching*Depth 20	137.000	A	
Non-Mulching*Depth 00	109.333	A	B
Non-Mulching*Depth 20	96.667		B
Non-Mulching*Depth10	94.000		B

Category	LS means(Weight)	Groups
Mulching*Depth 20	531.900	A
Mulching*Depth 00	429.967	A
Non-Mulching*Depth 20	322.300	A
Non-Mulching*Depth 00	314.900	A
Non-Mulching*Depth10	275.600	A
Mulching*Depth10	268.167	A

Category	LS means(Economic Value)	Groups
Mulching*Depth 00	80.000	A
Mulching*Depth 20	80.000	A
Mulching*Depth10	76.667	A
Non-Mulching*Depth 00	53.333	A
Non-Mulching*Depth 20	50.000	A
Non-Mulching*Depth10	50.000	A

Table A5: Summary (LS means) - Factor A

	Number of Leaves	Height	Weight	Economic Value
Mulching	198.889 a	139.222 a	410.011 a	78.889 a
Non-Mulching	119.111 b	100.000 b	304.267 a	51.111 b
Pr > F(Model)	0.000	0.033	0.585	0.330
Significant	Yes	Yes	No	No

	Number of Leaves	Height	Weight	Economic Value
Mulching	198.889	139.222	410.011	78.889
Non-Mulching	119.	100.000	304.267	51.111

Table A6: Summary 111**of all pairwise comparisons for Factor A (Duncan)**

Category	LS means(Number of Leaves)	Groups	
Mulching	198.889	A	
Non-Mulching	119.111		B

Category	LS means(Height)	Groups	
Mulching	139.222	A	
Non-Mulching	100.000		B

Category	LS means(Weight)	Groups
Mulching	410.011	A
Non-Mulching	304.267	A

Category	LS means(Economic Value)	Groups	
Mulching	78.889	A	
Non-Mulching	51.111		B

Table A7: Summary of all pairwise comparisons for Factor B (Duncan)

Category	LS means(Number of Leaves)	Groups
Depth10	160.167	A
Depth 00	158.667	A
Depth 20	158.167	A

Category	LS means(Height)	Groups
Depth 00	123.333	A
Depth10	118.667	A
Depth 20	116.833	A

Category	LS means(Weight)	Groups
Depth 20	427.100	A
Depth 00	372.433	A
Depth10	271.883	A

Category	LS means(Economic Value)	Groups
Depth 00	66.667	A
Depth 20	65.000	A
Depth10	63.333	A

Table A8: Summary of all pairwise comparisons for Factor A*Factor B (Duncan)

Category	LS means(Number of Leaves)	Groups	
Mulching*Depth10	201.333	A	
Mulching*Depth 00	199.333	A	
Mulching*Depth 20	196.000	A	
Non-Mulching*Depth 20	120.333		B
Non-Mulching*Depth10	119.000		B
Non-Mulching*Depth 00	118.000		B

Category	LS means(Height)	Groups	
Mulching*Depth10	143.333	A	
Mulching*Depth 00	137.333	A	
Mulching*Depth 20	137.000	A	
Non-Mulching*Depth 00	109.333	A	B
Non-Mulching*Depth 20	96.667		B
Non-Mulching*Depth10	94.000		B

Category	LS means(Weight)	Groups
Mulching*Depth 20	531.900	A
Mulching*Depth 00	429.967	A
Non-Mulching*Depth 20	322.300	A
Non-Mulching*Depth 00	314.900	A
Non-Mulching*Depth10	275.600	A
Mulching*Depth10	268.167	A

Category	LS means(Economic Value)	Groups
Mulching*Depth 00	80.000	A
Mulching*Depth 20	80.000	A
Mulching*Depth10	76.667	A
Non-Mulching*Depth 00	53.333	A
Non-Mulching*Depth 20	50.000	A
Non-Mulching*Depth10	50.000	A

Table A9: Summary (LS means) - Factor A

	Number of Leaves	Height	Weight	Economic Value
Mulching	198.889 a	139.222 a	410.011 a	78.889 a
Non-Mulching	119.111 b	100.000 b	304.267 a	51.111 b
Pr > F(Model)	0.000	0.033	0.585	0.330
Significant	Yes	Yes	No	No

	Number of Leaves	Height	Weight	Economic Value
Mulching	198.889	139.222	410.011	78.889
Non-Mulching	119.111	100.000	304.267	51.111

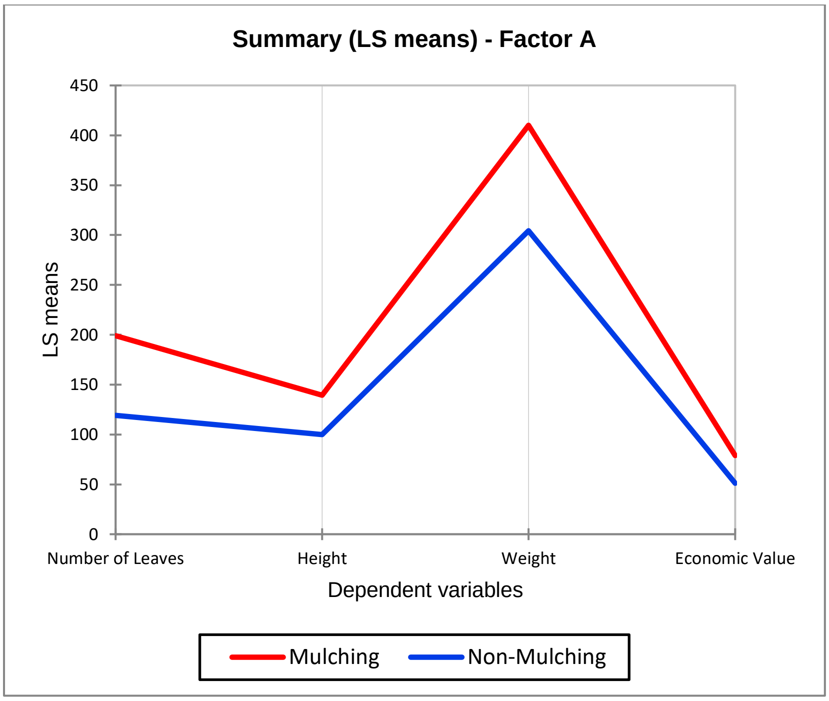

Figure A1: **Summary (LS means) - Factor A**

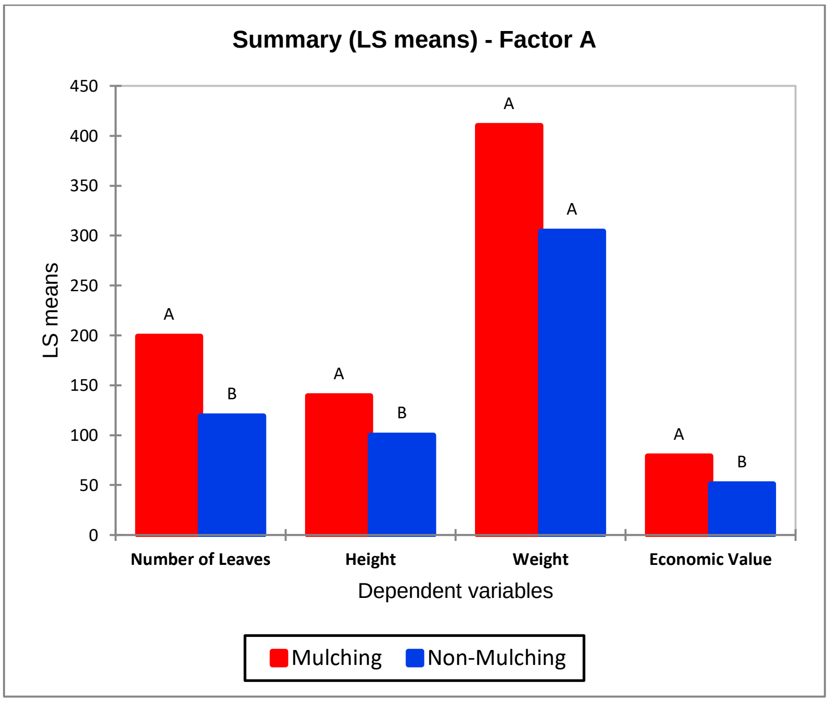

Figure A2: **Summary (LS means) - Factor A**

Table A10: Summary (LS means) - Factor B

	Number of Leaves	Height	Weight	Economic Value
Depth 00	158.667 a	123.333 a	372.433 a	66.667 a
Depth 20	158.167 a	116.833 a	427.100 a	65.000 a
Depth10	160.167 a	118.667 a	271.883 a	63.333 a
Pr > F(Model)	0.000	0.033	0.585	0.330
Significant	Yes	Yes	No	No

	Number of Leaves	Height	Weight	Economic Value
Depth 00	158.667	123.333	372.433	66.667
Depth 20	158.167	116.833	427.100	65.000
Depth10	160.167	118.667	271.883	63.333

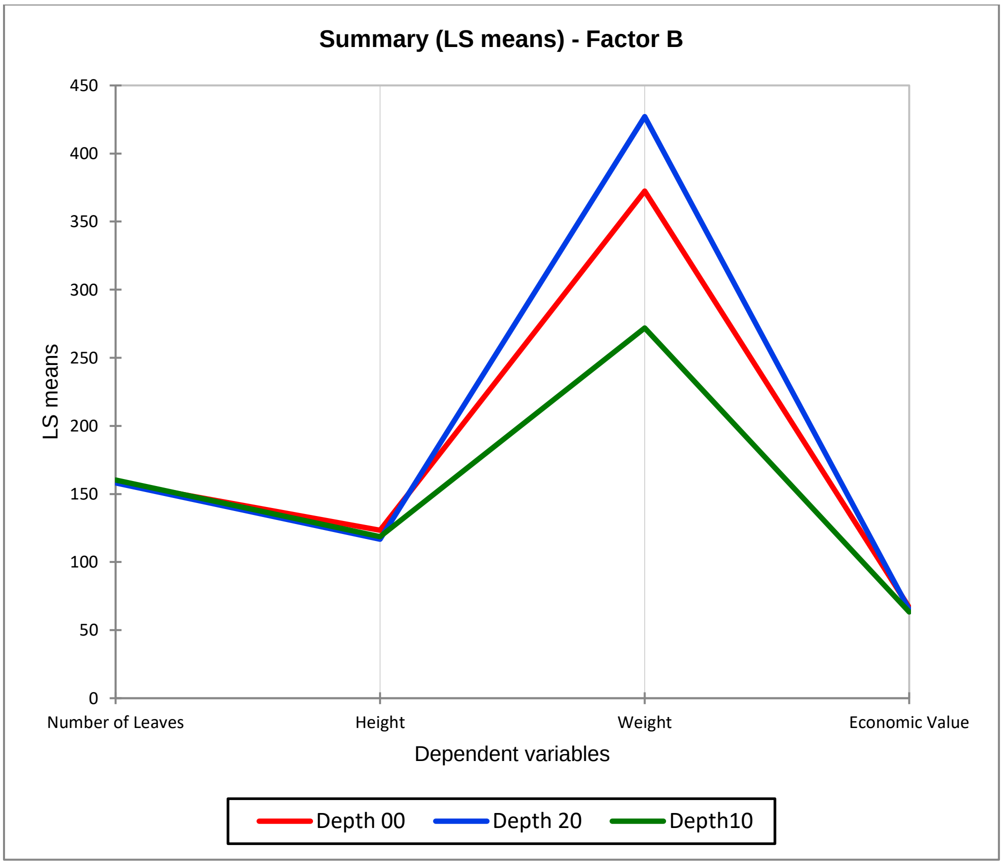

Figure A3: Summary (LS means) - Factor B

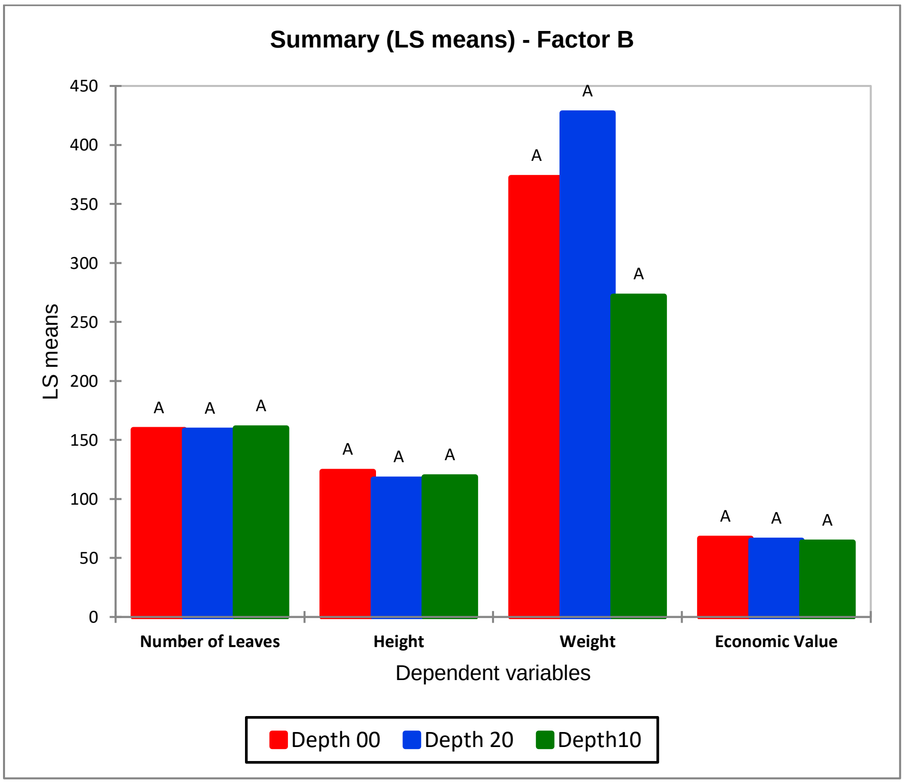

Figure A4: Summary (LS means) - Factor B

Table A11: Summary (LS means) - Factor A*Factor B

	Number of Leaves	Height	Weight	Economic Value
Mulching*Depth 00	199.333 a	137.333 a	429.967 a	80.000 a
Mulching*Depth 20	196.000 a	137.000 a	531.900 a	80.000 a
Mulching*Depth10	201.333 a	143.333 a	268.167 a	76.667 a
Non-Mulching*Depth 20	120.333 b	96.667 b	322.300 a	50.000 a
Non-Mulching*Depth 00	118.000 b	109.333 ab	314.900 a	53.333 a
Non-Mulching*Depth10	119.000 b	94.000 b	275.600 a	50.000 a
Pr > F(Model)	0.000	0.033	0.585	0.330
Significant	Yes	Yes	No	No

	Number of Leaves	Height	Weight	Economic Value
Mulching*Depth 00	199.333	137.333	429.967	80.000
Mulching*Depth 20	196.000	137.000	531.900	80.000
Mulching*Depth10	201.333	143.333	268.167	76.667
Non-Mulching*Depth 20	120.333	96.667	322.300	50.000
Non-Mulching*Depth 00	118.000	109.333	314.900	53.333
Non-Mulching*Depth10	119.000	94.000	275.600	50.000

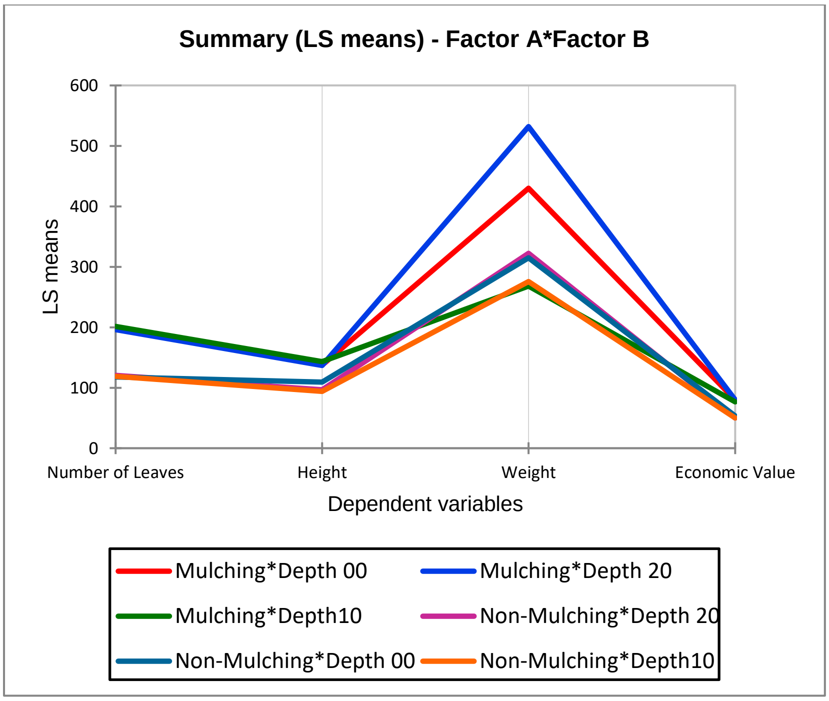

Figure A5: Summary (LS means) - Factor A*Factor B

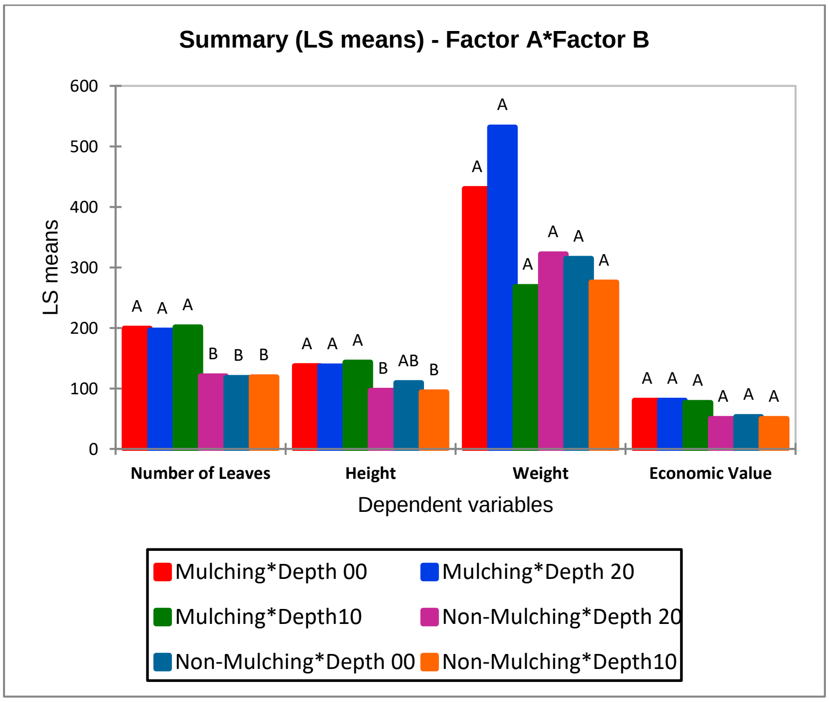

Figure A6: Summary (LS means) - Factor A*Factor B