# EFFECT OF DRIP IRRIGATION FREQUENCY AND MULCHING ON GROWTH AND YIELD OF OKRA (*Abelmoschus esculentus L.*)

BY

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## CERTIFICATION

This is to certify that this is an original and independent research project carried out by Bello, Oluwatoyin Zainab (SLM/12/0474) in the Department of Soil Science and Land Resources Management in partial fulfillment for the award of Bachelor of Agriculture (B.Agric.) in Soil Science, Federal University of Oye, Oye-Ekiti Nigeria.

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## DEDICATION

This glorious work is dedicated to Almighty God, who has been my help throughout my program for His love, care and grace given to me; despite all odds he loves me.

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## ABSTRACT

Field experiment was conducted to evaluate the combined effects of drip irrigation frequency and different mulching materials on the growth and yield of okra *(AbelmoschusesculentusL, Moench)*. The field experiment was 3 x 3 factorial using Randomized Complete Block Design. The factors were three irrigation intervals (daily, twice and thrice weekly) and three mulches (plastic, grasses and no mulch) and replicated four times. It was observed from the result that okra responded significantly ($P<0.05$) to different drip irrigation intervals and mulch treatment imposed.

Mulching produces the tallest plants (50cm). The yield of okra increased (26.05kg/$m^2$) with the use of appropriate irrigation intervals and mulch type. Correlation analysis was carried out to study the character association and contribution, for seven quantitative characters plant height (cm), number of branches per plant, fruit length (cm), fruit diameter (cm), fruit weight (kg), number of fruits per plant, number of branches. Correlation coefficient analysis revealed that plant height, fruit length, fruit diameter, fruit weight, number of fruits per plant, number of branches, were significantly correlated. It was observed that there was positive correlation between number of fruits and fruit weight, ($r= 0.583$), while a negative correlation was observed between fruit diameter and fruit weight ($r= -0.341$).

The use of drip irrigation in combination with mulch treatment increases the total okra yield significantly. Application of black plastic mulch significantly ($p < 0.05$) increased okra fruit yield, due to available soil moisture and well timed irrigation particularly in early growth season and greatly controlled the weeds.


Keywords: Growth, Yield, Drip Irrigation, Mulches.

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# CHAPTER ONE

## 1.0 INTRODUCTION

Okra (*Abelmoschusesculentus L.*) is one of the most widely known and utilized species of the family malvaceae. It is an important vegetable crop in Nigeria, and is grown extensively, throughout the country as summer crop. It originated in Ethiopia and was then propagated in North Africa, in the Mediterranean, in Arabia and India by the 12th century. It is called lady's finger in England and gumbo in the United States of America.

Okra is a tropical crop. Its optimal temperature for germination, growth and fruit setting is between 25°C and 30°C. The plant needs warm weather and plenty of sunshine. It shrives well in different soil condition, but it is best to grow in the well-drained soil, especially with rich organic matters.

In Nigeria, water is becoming a dominant limiting factor for crop diversification and production due to urbanization, increasing population and effect of climate change. The competition for limited water resources for domestic and industrial need is increasing considerably. It is therefore essential to formulate an efficient, reliable and economically viable irrigation management strategy in order to irrigate more land area with existing water resources. Improper irrigation management practices not only waste the expensive and scarce water resources but also decrease crop yield (Fapohunda 1992, Fasinaital; 2008). Due to lack of information on irrigation management techniques, the average yield of most vegetable crop produced under irrigation is very low because of either an excess or lack of soil moisture. The irrigation scheduling which determines the timing and amount of water is governed by many factors but microclimate plays the most important role. Numerous studies have been carried out on the development and evaluation of irrigation scheduling techniques under a wide variety of irrigation system and management, soil and agronomical conditions (Jensen et al; 1970, Imuyaz et al; 1996, Fasina et al; 2008).

The meteorological approach such as pan evaporation replenishment and the ratio between irrigation water applied and cumulative pan evaporation est. for scheduling were used by many researchers because it is easy for farmers to use and it is adaptable. (Sing *et al*; 1997). The primary aim of irrigation is to complement the water available from natural sources such as rainfall, dew, flood and ground water that seeps into root zone. It is needed in most part of West Africa where there might be a prolonged drought period and mostly where water sources are adequate for effective crop germination and crop production (Fasina, 2008). Total irrigation potential of Nigeria is about 3.14million (ha); 1.10million (ha) for Fadama irrigation projects (Fasina, 2008). Estimated irrigated crop land varies from one source to the otherbut its total water managed area is estimated to be a little over 950,000ha.

Furrow, use of watering cans and rubber hose are the most common methods of irrigation in Nigeria. However, drip irrigation is trying to be popular due to numerous advantages over other methods (Fasina*et al;* 2011).

There is the need to introduce and pilot-test appropriate small-scale irrigation technologies suitable for enhancing crop production and income of farmers in Nigeria. Therefore the present study was to introduce kits with and pilot-test small-scale irrigation kits with some mulching techniques to see whether it is suitable for enhancing crop production and income of farmers in Nigeria.

## 1.1 Problem Statement:

Water loss due to evapo-transpiration affects the yield of okra

Excess water may lead to leaching of soil and nutrient and it affects growth

Weeds on the field compete for nutrient, water and space.

## 1.2 Justification:

Drip irrigation technique promotes nutrient savings

Drip irrigation gave overall better crop establishment

Efficient use of applied water and nutrients

Drip irrigation help to control weeds and reduce soil crusting (Lamm and Trooine, 2003).

## 1.3Thegeneral objective:

The general objective of the study is to evaluate the effect of different irrigation regimes and mulching materials on the performance and yield of okra in Ikole, Southern Nigeria.

## 1.3 The specific objectives are to:

assess okra response to different drip irrigation regimes.

evaluate the effects of different mulching materials on the growth and yield of okra.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1 OKRA PLANT

Okra (*Abelmoscusesculentus L. (Moench*), is an economically important vegetable crop grown in the tropical and sub-tropical parts of the world. This crop is suitable for cultivation as a garden crop as well as on large commercial farms. It is grown commercially in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Burma, Japan, Malaysia, Brazil, Ghana, Ethiopia, Cyprus and the Southern United States. India ranks first in the world with 3.5 million tons (70% of the total world population) of okra produced from over 0.35 million hectare land (FAOSTAT, 2008)

Okra is known by many local names in different parts of the world. It is called Lady's finger in England, Gumbo in the United States of America, Guino-gombo in Spanish, Guibeiro in Portuguese and bhindi in India. It is quite popular in India because of its ease of cultivation, dependable yield and adaptability to varying moisture conditions. Okra is cultivated for its green non-fibrous fruits or pods containing round seeds which are cooked and eaten in countries like Sudan, Egypt and Nigeria (Olaniyi et al; 2010). The fruits are harvested when immature and eaten as a vegetable. Despite its nutritional value, its optimum yield (2-3t ha-1) in the tropical countries is low partly because of continuous decline in the soil fertility (Abd El-kader et al., 2010).

### 2.1.2 Origin and Geographic Distribution

According to Schippers (2000) okra (*Abelmoscusesculentus L. Moench*) is an annual crop, requiring warm growing condition and found in almost every market all over Africa. There are two hypotheses concerning the geographical origin of *A. esculentus*. Some scientists argue that one putative ancestor (*A.tuberculatus*) is native from Northern India, suggesting that the species originated from this geographic area. On the basis of ancient cultivation in East Africa and the presence of the other putative ancestor (*A. ficulneus),* others suggest that the area of domestication is Ethiopia or North Egypt, but no definitive proof is available today (Department of Biotechnology, 2009).

Okra plant was previously included in the genus Hibiscus. Later, it was designated to *Abelmoschus*, which is distinguished from the genus Hibiscus (Aladele et al., 2008).

*Abelmoschus* was subsequently proposed to be raised to the rank of distinct genus by Medikusin 1787. Okra originated somewhere around Ethiopia, and was cultivated by the ancient Egyptians by the 12th century BC. Its cultivation spread throughout the Middle East and North Africa (Lamont 1999). Okra is grown in many parts of the world, especially in tropical and sub-tropical countries (Arapitsas, 2008; Saifullah and Rabbani, 2009). This crop can be grown on large commercial farms or as a garden crop (Rubatzky and Yamaguchi 1997). Okra plants are grown commercially in many countries such as India, Japan, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Myanmar, Malaysia, Thailand, India, Brazil, Ethiopia, Cyprus and in the Southern United States (Benjawan et al., 2007; Qhureshi, 2007). Okra is found all around the world from equatorial areas to Mediterranean Sea as may be seen from the geographical distribution of cultivated and wild species. Cultivated and wild species of okra clearly showed overlapping in Southeast Asia, which is considered as the centre of diversity. The spread of the other species is the result of their introduction to Africa and America (Qhureshi, 2007; Aladele et al., 2008).

The species *A. manihotsubsp. Tetraphyllus* comprises of two wild forms differentiated on the basis of their ecological adaptation. First, *var.tetraphyllus* grows at low altitudes between 0 and 400m in the regions with a marked dry season of Indonesia, Philippines, Papua New Ireland. Second, *var. punens,* grows at altitudes between 400 and 1600 m in Philippine and Indonesia (Department of Biotechnology, 2009). The species *A. esculentus* cultivated as a vegetable in most tropical and sub-tropical regions of Africa such as Ghana, Guinea, Ivory Coast, Liberia and Nigeria. The wild species *A. tuberculatus*, related to *A. esculentus*, is endemic to the medium altitude hilly areas in India (IBPGR, 1990). The wild species *A. Fisculensis* found in a vast geographic area stretching from Africa to Asia and Australia. It flourishes in tropical areas of low altitude with a long dry season, i.e. desert regions of Sahelian Africa (Niger), Madagascar, East Africa, India, Indonesia, Malaysia and Northern Australia (Lamont, 1999).

### 2.2.2 Economic Importance

Okra (*Abelmoscusesculentus L.*) is an annual vegetable crop grown throughout the tropical and sub-tropical parts of the world, either as the sole crop or intercropped Emuh et al., (2006). It is a chief vegetable crop grown for its immature pod that can be used as a boiled or fried vegetable, or it may be added to salad or soup (Kashif et al., 2008). Okra plays an immense role in the human diet, providing carbohydrates, fats, proteins, vitamins, and minerals (Abd El-Kader et al., 2010). It is grown mainly for its leaves and young pods which are frequently eaten as vegetable. Therefore, the consumption of okra plays an important role in human nutrition. Okra contains carbohydrates, proteins and vitamin C in large quantities and also essential and non essential amino acids which are comparable to that of soybean (Adeboye and Oputa, 1996).

According to FAO (2003), the fruits and leaves contain, in 100g respectively: proteins (2.1g and 4.4g); fats (0.2g and 0.6g); carbohydrates (7.0g and 9.0g); beta-carotene (190µg and 730µg); vitamins B1, B2 and B6 (0.04µg and 0.25µg; 0.08µg and 2.80µg; 0.22µg and 0.0µg), besides niacin, B5 (0.6g and 0.2g) and vitamin C (47mg and 59mg), as well as calcium (84mg and 530mg) and iron (1.2 and 0.7mg).

Okra leaves are considered good as cattle feed, but this is seldom compatible with the primary use of the plant. The leaf buds and flowers are also edible (Doijode, 2011). Moreover, okra mucilage is suitable for industrial and medicinal applications (Akinyele and Temikotan, 2007). Industrially, okra mucilage is usually used for glace paper production and also as a confectionery use. Okra has found medical application as a plasma replacement or blood volume expander (Lengsfeld et al., 2004).

### 2.2.3 Ecology and Season Growth

Okra needs temperature above 20°C for normal growth and development. (Lamont, 1999; Abd El-Kader et al., 2010). Germination percentage and speed of emergence of okra plant are optimal at 30-35°C (Akandele et al., 2003). Flower initiation and flowering in okra are delayed with increasing temperatures (positive correlation between temperature and number of vegetative nodes) *Abelmoschusspp.* Is a short-day plant, but its wide geographical distribution (up to latitudes of 35-40°) indicates that cultivars differ markedly in sensitivity (Lamont, 1999; Abd El-Kader et al., 2010).

Okra is mainly propagated by seeds and has duration of 90-100 days. It is generally an annual plant. Its stem is robust, erect, and variable in branching and varying from 0.5 to 4.0 metres in height. Leaves are alternate and usually palmately five lobed, whereas the flower is auxiliary and solitary. Okra plants are characterized by indeterminate growth. Flowering is continuous but highly dependent upon biotic and abiotic stress. The plant usually bears its first flower one to two months after sowing. The fruit is a capsule and grows quickly after flowering. The greatest increase in fruit length, height and diameter occurs during 4th to 6th day after pollination. It is at this stage that fruit is most often plucked for consumption. The okra pods are harvested when immature and high in mucilage, but before becoming highly fibrous.

Generally the fibre production in the fruit starts from 6th day onwards of fruit formation and a sudden increase in fibre content from 9th day is observed (Nath, 1976). Okra plants continue to flower and to fruit for an indefinite time, depending upon the variety, the season and soil moisture and fertility. In fact the regular harvesting stimulates continued fruiting, so much that it may be necessary to harvest every day in climates where growth is especially vigorous.

Flower initiation and flowering are hardly affected by day length in popular subtropical cultivars. Most tropical cultivars show quantitative short-day response, but qualitative responses also occur. The shortest critical day length reported is 12:30 hours. This explains why flowering of local cultivars of common okra is only quantitatively affected by day length in the coastal areas of the Gulf of Guinea (5°N). However, more inland at higher latitudes (10°N) one can occasionally observe very tall non-flowering plants of common okra due to a qualitative response. Okra tolerates poor soils, but prefers well-drained sandy loams, with pH 6-7, and a high content of organic matter (Lamont, 1999). Okra requires a moderate rainfall of 80-100cm well distributed to produce its young edible fruits over a relatively long period. An average temperature of 20°C to 30°C is considered optimum for growing, flowering and fruiting (Dada and Fayinminnu, 2010).

### 2.2.4 Cultural Practices

Most farmers harvest seed from their own local cultivar or rather heterogeneous landrace (Moekchantuk and Kumar, 2004). The easiest way to keep the seed is to leave it in the pods. Seed weight varies from 30 to 80g, 1001 seeds. To soften the hard seed coat, the seed is often soaked in water or chemicals prior to sowing. The seed is usually dibbled directly in the field (2-3 seeds per hole). Optimum plant densities are in the range of 50,000 -60,000 plants per hectare (Olasotan, 2011). Emergence is within one week. When the plants are about 10cm tall, they are thinned to one plant per hole. Germination and initial growth are improved greatly by cultural practices that lower soil temperature, e.g. mulching, watering before the hottest part of the day, and sowing on ridges sides least exposed to direct sunlight (Doijode, 2001).

Okra requires a long, warm and humid growing period. It can be successfully grown in hot humid areas. It is sensitive to frost and extremely low temperatures. For normal growth and development a temperature between 24°C and 28°C is preferred (Chalabesa, 2002).

Okra is considered to grow well under drought conditions, although plant has shown reduction in yield under drought stress (Ahmad et al., 2003). Although okra is a drought tolerant plant, the availability of water has significant impact on okra production. For high yields, an adequate water supply and relatively moist soils are required during actual growth period. Yield reduces with reduction in water supply during growth period. In general, greatest reduction occurs when there is a continuous shortage of water until time of first pick period. Water shortage prior or during early flowering reduces fruit numbers. Therefore, low soil moisture status in the root zone limits productivity of rain fed okra. Under humid conditions full grown okra consumes about 8mm of water per day. Controlled irrigation is essential for high yields because the crop is sensitive to both over and under irrigation (Al-Harbi et al., 2008).

Okra is furrow irrigated crop throughout the growing season. If the soil has good moisture at planting, the young seedlings will grow 3 to 5 inches before irrigation is needed. Heavy early irrigation tends to cool the soil and slow plant growth. The plants should not be water stressed for maximum yields. During the harvest period, every other row is irrigated leaving a dry furrow for pickers to walk (Lamont, 1999).

For seed germination optimum soil moisture and a temperature between 25°C and 35°C is needed with fastest germination observed at 35°C. Beyond this range the germination will be delayed and weak seeds may not even germinate (Whitehead and Singh, 2000). It is grown on sandy to clay soils but due to its well-developed tap root system, relatively light well-drained, rich soils are ideal. As such, loose, friable, well-manured loam soils are desirable. A pH of 6.0-6.8 is ideally-suited. All soils need to be pulverized, moistened and enriched with organic matter before sowing (Bhatt and Rao, 2005).

### 2.2.5 Harvesting

The pods are ready for harvesting in about 45-60 days after seed sowings, depending on the varieties and season. Normally, okra pods are harvested every second day from the time the first pod is formed. It takes 5 to 10 days from flowering to picking fruits ready for markets (Adetuyi et al., 2008). Harvesting is usually done early in the morning, after which it enters the market (Moekchantuk and Kumar, 2004). Fruits are harvested 4 to 6 days after the flower has opened, and the fruits are not fibrous (fruits 2 to 4 inches long). Mature fruits should be removed and discarded as they reduce the plant growth and decrease yield. Immature fruits of 8-9cm long are ready for harvest. Harvesting is recommended at least every other day for size and quality (Adeniji and Peter, 2005).

### 2.2.6 Fertilizer Requirement

Alasiri and Ogunkeyede (1999) reported that the application of poultry manure at the rate of 10t/ha gave the optimum seed yield of okra in Southwest in Nigeria. Okra responds well to the dressing of organic manure. Nitrogen 30-50 acres applied at planting with an addition 35-50 when plants are 8-10 inches tall or use 2 tonnes after first fruit set and again after 4-6weeks at the same rate. Adequate poultry manure and nitrogen fertilizer is necessary to ensure a long harvest period. Generally, nutrient requirement of okra (*Abelmoschusesculentus*) are given as 120kg/ha, 250kg/ha and 70kg/ha K2O/ha (Anan 1989,Usoroh,1992). The growing plant require nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sodium (Na and sulphur (S) for soil fertility maintenance and crop production. Okra have high yield when it is adequately supplied with the essential nutrients (Ojeniyi, 2009), showed that poultry manure had high N and low K and C: N ratio values. Applying poultry manure before planting crops may result in 5-10% loss in N, the extra ways allow soil micro organism to fully decompose the manure and release its nutrient for yield during subsequent cropping environment protection and maximum plant growth. Nutrition in manure must be released from the organic manure in water from the plant uptake. Excessive rate are extensively vegetative soil pH should be maintained above 6.0 and preferably near 6.5.

### 2.2.7 Nutritional Value

Okra contains vitamin A and C and is a good source of iron and calcium. It also contains starch, fat, ash, thiamine and riboflavin and many more. Okra is low in saturated fat, very low in cholesterol and sodium, it is a good source of protein, niacin, iron, phosphorus, zinc and good source of dietary fibre, vitamin, C, K, A, thiamin, foliate, manganese.

**Table1. NUTRITIONAL FACTS AND INFORMATION OF OKRA**

| | |
|---|---|
| **Carbohydrates** | 73% |
| **Fat** | 9% |
| **Protein** | 18% |
| **Sugar** | 12.9% |
| **Water** | 232% |
| **Ash** | 1.9% |
| **Calcium** | 234mg |
| **Iron** | 1.7mg |
| **Zinc** | 1.6mg |
| **Vitamin A** | 864mg |
| **Vitamin C** | 3.1mg |
| **Vitamin K** | 122mg |

### 2.2.8 Uses of Okra

Okra help lubricated large intestine due to its bulk laxative qualities. The okra fiber absorbs water and ensures bulk in stools. This helps in the preventing and improving constipation. The mature pods contains a mucilaginous substances that can be used in plasma replacement or blood volume expander and manufacture of paper (Majanbu et al., 1985)

Ogunkeyede, (1999) reported that okra is used for healing ulcers and to keep joints limbs. It helps to neutralize acids, being very alkaline and provides a temporary protective coating for the digestive tract. The mature stems of some varieties contain crude fiber which is beneficial in increasing intestinal peristalsis.

Alasiri and Ogunkeyede, (2004) reported that okra was used to treat lung inflammation, sore throat, and irritable bowel syndrome, also for experimental blood plasma replacement. Okra controls Asthma, diabetes, antherosclerosis.

Eating okra helps to support the structure of capillaries; okra fiber is excellent for feeding the good bacteria (pro-biotic). Okra seeds contain a high content of edible oil and quality protein due to its high lysine content (Savello et al., 1983, Tindal 1983). The crop can also serve as a supplement to cereal base diet (Al-wansawi, 1983).

## 2.3 Drip Irrigation

Drip irrigation is a controlled method of irrigation, consisting of tubes with emitters. It allows increasing water use efficiencies by providing precise amounts of water directly to the root zone of individual plants (Burt and Styles, 2007).

### 2.3.1Advantages of Drip Irrigation

Many claims as to the advantages of Drip irrigation have been and are still being made. Currently, the following advantages are recognized:

1. The evaporative component of evapo-transpiration is reduced, as only a limited area of the soil is wetted. This is more prevalent with young trees;
2. The higher degree of inbuilt management that localized irrigation offers reduces substantially deep percolation and runoff losses, thus attaining higher irrigation efficiencies. Consequently, localized irrigation is considered as a water-saving technology;
3. The limited wetted area results in reduced weed growth;
4. Applicable to all forms of plots;

5. Unaffected by wind;
6. Reduced operating costs and labor. Human intervention is reduced to the periodic inspection of equipment for filtering and control, and the proper operation of drippers;
7. Reduced risk of fungal diseases;
8. Reduced sensitivity to the use of salt water. The salts are leached to each application and trained at the periphery of the bulb humidifying outside the scope of the active root zone. No risk of damage to the aerial parts of plants by spraying of saline water.

**2.3.2Disadvantages of Drip Irrigation**

The major disadvantages of drip irrigation are:

1. Rodents, dogs and other animals in search of water can damage the lateral lines;
2. For crops of very high population density, the system may be uneconomic because of the large number of laterals and emitters required;
3. The relatively high investment cost of the system;
4. The spatial development of the root zone is limited and concentrated in the vicinity of the dripper making plants more susceptible to wind throw.

Drip irrigation system, is being used for growing vegetable crops. It has created interest because of decreased water requirement and possible increase in production (Jain et al; 2000). The system has proved superiority over other conventional methods of irrigation. This is especially so for irrigating fruit and vegetable crops owing to its precise and direct application of water in the root zone with considerable saving in fertilizer and water. It also has the potential to increase the yield of crops even at reduced irrigation water application (Yohannes and Tadesse 1998).

Mulching is the practice of covering the soil around plants to make conditions more favorable for growth, development and efficient crop production (Nagalakshmi et al., 2002). Mulches are used for the moderation of soil temperature, though the effects were highly variable. Color of mulch affected soil temperatures, white or reflective plastic, decreases temperatures (Unger, 1984). Uses of straw and similar material mulches in different vegetable crops have greater insulating effect than pulverized soil mulch.

Mulches of plant material like straw, dry grass and leaves etc. reduced the soil temperatures (Dhesi et al., 1964 ; Bansal et al., 1971). Black polyethylene induces soil temperature, more conservation of moisture, more activity of soil micro organisms resulting in more mineralization and availability of nutrients to the plant (Patil and Bansod 1972).

However, the mulches, changes the plants environment depending on the properties of the mulches and the level of the physical contact between the mulches material and the soil.

### 2.3.3 Influence of Mulching and Irrigation on Growth and Vegetative Characters of Crops

Saptharishi and Azariah (1954) reported that mulch protects the top soil from the beating effects of the down pour, preventing wash-down of the soil and the manure from the land.

Emmert (1955) reported that all mulches increased the availability of soil phosphorus and potassium, soil moisture and water penetration rate, also reduced soil temperature in the summer, soil aeration and water evaporation.

Kashyap et al. (1967) reported that use of black polythene as mulch has been found to increase the yield of Allium Cepa crops. But it is costly, the use of paddy husk and even the paddy straw has been recommended as they increase the yield significantly. Paddy husk seems to be more effective than other mulches in providing favorable conditions to the crop.

Bernstein and Francois (1973) conducted a trail to compare the methods of irrigation viz., drip, furrow and sprinkler and found that drip irrigation required 1/3 rd less water than furrow irrigation for maximum growth and yield in bell pepper (Sivanappan 1979).

Beese et al. (1982) conducted an experiment to determine okra growth and development when irrigated by trickle irrigation at different levels of water application. Water application rates of 0.8, 1.2 and 1.4 times and control treatment was maintained; the results indicated that limiting the water applied to pepper during the period of rapid vegetative growth reduced the final yield. However, the water use efficiencies varied little and were between 8.1 and 8.2 cm actual ET per tonnes of dry mass production.

Adetunji (1990) reported that to optimize the use of irrigation water for dry season okra production in the semi-arid region of N.E. Nigeria, Saw dust, millet stover and groundnut shell mulches were applied under 3 irrigation frequencies (3, 7 and 11 days intervals). Mulching reduced the day temperature of the soil and conserved soil moisture. Growth and yield attributes of lettuce were significantly higher under groundnut shell and millet stover mulches than under saw dust mulch and non-mulched control. Irrigating at 7 days intervals was more economical. A soil temperature above 25°C was deleterious to normal growth and yield.

Srivastava et al. (1974) reported that the positive residual effect of organic mulches on the growth and yield of okra grown in the second season was convincingly because some quantity of such mulches being in touch with the wet soil got decomposed which would have improved the physical properties and nutritional status of the soil, the treatments like plastic film mulch, cultivation mulch and the control, which did not possess such property, proved identical in their action and did not cause any beneficial effect.

Aiyelaagbe and Ogbonnaya (1996) reported that okra cultivars NHae 47-4 and OP 80 were subjected to irrigation regimes of 25, 15, 7.5 or 3.8 mm water per week in a trial for seed production and 75, 30, 15 (or) 7.5 mm per week in a second trial for green pods and seeds. Growth and fruit yield of NHae 47-4 were greater than those of OP 80. In the first trial, irrigation did not significantly influence vegetative growth, fruit yield (or) seed yield of okra but in the second trial, 15 mm water per week resulted in the highest early fruit yield, while 7.5 mm per week reduced seed yield compared with other treatments. Mulching significantly increases seed yield of okra.

### 2.3.4 Influence of Mulching on Plants Growing Environment

Plastic mulches are used to adjust the growing environment of a crop or group of crops. The most popular beneficial effect of most plastic mulches is an increase in temperature which has shown to be beneficial to most plants. There are numerous other advantages to color plastic mulches such as improved fruit quality (Brown and Lewis, 1986; Brown and Channell-Butcher, 2001; Lamont, 1996), reduced weed problems (Lourduraj et al., 1997; Khan et al., 1990; Munguia et al., 1998), reduced water evaporation (Batra et al., 1985; Maynard, 1987; Lamont, 1996), increased yield (Baker et al., 1999; Brown et al., 1995; Farias-Larios et al., 1999; Lamont et al., 2005; May et al., 2005), reduced fertilizer leaching (Mahbub and Zimmerman, 2006; Clarkson,1960), reduced soil compaction (Gough, 2001; Lamont, 1996), improved phytochrome response (Kasperbauer et al., 1992; Bradburne et al., 1989), and other benefits (Benoit and Ceustermans, 2000; Bextine et al., 2001; Boyhan et al., 2000; Brown et al., 1993; Caldwell and Clarke, 1999; Csizinszky et al., 1995). Certain color plastic mulches have been recommended for specific crops and for certain periods during the growing season (Batra et al., 1985).

### 2.3.5 Mulching Versus Soil Warming

Polyethylene (plastic) mulch was first noted for its ability to increase soil temperature in the 1950's (Emmert, 1957). Due to the monetary value of many horticultural crops, it is beneficial to adjust the soil's microclimate to prolong the growing season and increase the plant's growth (Tarara, 2000). The heating properties of plastic such as "reflectivity, absorptive, and transmittance" and their interaction with the sun's radiation will have a direct effect on the soil temperatures beneath the plastic mulch (Schales and Sheldrake, 1963).

### 2.3.6 Influence of Mulching on Earlier Growth and Production of Crops

The use of color plastic mulch has resulted in more growth and earlier yields than the use of bare soil. The earlier a grower can produce a quality crop, the greater the chance the grower will be able to get his or her produce to the market before a competitor. A grower's ability to produce an early crop in dry season is not only beneficial in outperforming competitors but it gives the crop a chance to mature before the onset of disease. Brown et al. (1992) and Decoteau et al. (1989) found earlier growth in tomatoes with the use of plastic mulch. Rangarajan and Ingall (2001) ascertained that the use of red, silver, and blue plastic mulch increased earliness of radicchio head formationcompared to bare soil. In an experiment performed in Virginia, Powell (2000) recorded earlier growth of watermelon with the use of color plastic mulch. Color plastic mulch reduced the number of days for eggplant to flower (Valdaz-Fields et al., 2002). The use of red and black plastic mulch helped establish earlier yield of bell pepper than the use of bare soil (Wells, 1999).

### 2.3.7 Mulching Versus Weed Population

Plastic mulch reduces the weed population in vegetable field crops in comparison to bare soil. A weed will compete with a crop for nutrients, light, and moisture. Plastic mulch creates a barrier to herbicide dissipation into the atmosphere and thus renders herbicide more effective. Unlike bare soil, plastic mulch reduces the amount of light in the photosynthetic ally active range (PAR) of 400-700nm from reaching the soil beneath the plastic mulch. Reducing PAR beneath the plastic mulch helps to prevent the growth and limit the germination of weeds (Ngouajio and Ernest, 2005). Weed control with plastic mulch has been found by a wide array of researchers (Clarkson and Frazier, 1957; Lourduraj et al. 1997; Rahman and Shadeque, 1999; Saikia et al., 1997; Lamont, 1993). It is this reduction in weeds that helps make the use of plastic mulch more economical for the grower.

### 2.3.8 Mulching and Soil Moisture

Plastic mulch helps maintain soil moisture for improved plant growth and development. Drip tape is the preferred means of irrigating vegetables when using plastic mulch. The use of drip tape along with plastic mulch not only allows a vegetable crop to receive adequate moisture but it is also more cost efficient than overhead irrigation. One of the most popular reasons for using plastic mulch is its ability to maintain soil moisture (Orzolek et al., 1993; Lamont, 1996). Numerous studies have concluded that soil beneath plastic mulch and drip tape will have higher soil moisture than bare soil with drip tape (Gough, 2001; Mahbub and Zimmerman, 2003; Infante et al. 1998). Liakatas et al. (1996) documented that the ability of plastic mulches to alter the plant's microenvironment was due in part to its ability to restrict soil water evaporation. When comparing drip irrigation to furrow irrigation, Tiwari et al. (1998) established a 40% reduction in water application with the use of black plastic mulch in conjunction with drip irrigation. Kirknak et al. (2003) discovered that the plastic mulches' ability to improve soil moisture in the process it improves nitrogen availability for plants.

### 2.3.9 Mulching Versus Fruit Quality

Improved fruit quality is another beneficial aspect of the use of plastic mulches. Fruit quality is measured by cleanliness, taste, insect damage, etc. Csizinszky et al. (1998) and Benoit and Ceustermans (2000) detected less insect damage to vegetable crops grown on colored plastic mulch. Turnips grown on blue plastic mulch were found to have a "sharp" taste while those grown on green plastic mulch were found to have a "sweet" taste (Antonious et al., 1996). Bell peppers from plots grown on plastic mulch were found to be cleaner than those grown on bare soil (Brown and Channell-Butcher, 2001). Fruit quality improvement that plastic mulch offers is vital to growers when attempting to sell a vegetable crop.

Many studies have been completed on yield effects of squash grown with plastic mulch. Brown et al. (1996), Dickerson et al. (2003), reported that black plastic mulch did not have an effect on summer squash yields compared to bare ground treatments. Caldwell and Clarke (1999) found aluminum-covered mulch reduced cucumber beetles yet still had no significant difference in yield then squash grown on black plastic. Orzolek and Murphy (1993) and Stapleton and Duncan (1994), reported significantly higher yields of zucchini squash on various color (red, yellow, gray, blue and black) mulches in relation to that of bare soil treatments. The use of black plastic mulch caused a significant increase in yield with calabaza and butternut squash (Rulevich et al., 2003). By reducing aphid populations and thus the onset of virus infection, Brown et al. (1996b) established 96% higher yields of summer squash with aluminum plastic mulch than with bare soil.

Research has been done on the affect of plastic mulch on okra yield. In research that took place in India, Batra et al. (1985) found higher yield of okra with polyethylene mulch compared to bare soil. Due to plastic mulch's ability to reduce weeds and reduce leaching of fertilizers, both Vethamoni and Balakrishnan (1990) and Brown and Lewis (1986) recorded higher yield in okra grown on black mulch instead of bare soil. In an experiment conducted in Florida, Simone et al. (2002) reported that different varieties of okra had significantly higher yields when grown on plastic mulch rather than bare soil.

The use of plastic mulch created significantly higher yields of okra compared to bare soil due to improved moisture retention in the soil (Lourduraj et al., 1997; Tiwari et al., 1998; Saikia et al., 1997). The increase in ambient temperatures provided by plastic mulch has been cited as a factor in okra grown on plastic mulch has out yielded okra grown on bare soil (Khan et al., 1990a; Khan et al., 1990b; Lamont, 1999; Incalcaterra and Vetrano, 2000; Brown and Channell-Butcher, 1999).

## 2.4 Influence of Irrigation and Mulching on Flowering, Fruiting and Fruit Size of Crops

Gupta (1987) reported that the fruit number plant is directly related to the frequency of irrigation. Irrigation at 20 mm CPE (frequent irrigations) had significantly more number of fruits plant as compared to 80 mm CPE.

Hegde (1988) also observed significant differences in number of fruits plant due to varying irrigation regimes. Irrigations at 30-40 per cent of yield capacity, moisture content was found to be optimum for okra (Vuelvas, 1982) and excessive irrigation reduced its productivity through reduction in fruit number (Lepori and Genmari, 1977; Hedge, 1988). Masuda and Hayashi (1957) opined that fewer fruits under low soil matrix potential may be due to reduced number of flowers.

Welbaum et al. (1994) reported that Drip irrigation increased the average fruit fresh weight by 48 per cent, compared with the fresh weight and fruits from control plots (no irrigation and no mulch. Fruit size was not increased) when drip irrigation was used in conjunction with the black plastic mulch in tomatoes.

Mosoum and Gharib (1996) reported that the effects of black (or) clear plastic mulches on the growth and yield of winter Okras (cv. Demsonspine less), all treatments received drip (trickle) irrigation. Mulches promoted flowering, fruit set, fruit growth, the number of branches/plant and the number of leaves per plant. (The highest fruit yields (8.2 – 8.9 t/ha) were obtained from the black mulch treatments).

### 2.4.1 Influence of Mulching and Irrigation on Yield of Crops

Patil and Bansod (1972) reported that different mulches like black polythene saw dust and grass reduced the fluctuations in soil temperature at 4½" depth and retained more moisture than unmulched plots. Black polythene retained more moisture over the rest of the mulches.

Weeds were suppressed to certain extent, black polythene was more efficient in this respect the different mulching treatments did not have any effect on the growth of the plant but yields were significantly increased. Redge and Flatbed planting did not show any significance difference in soil properties, on weed control growth of the plant and yield of okra.

Srivastava et al. (1973) reported that higher temperature during summer causes greater evapo-transpiration, hence more frequent irrigations. Organic mulches effectively reduced the soil temperature and conserved the moisture frequency of irrigation was reduced by 55.5% in plots provided with irrigation at 70-75% depletion of available moisture over the plots provided with irrigation at 20-25% depletion, without any adverse effect on yield of okra.

Wierenga and Hendrickx (1984) conducted a study on clay loam to determine the relationship between the amount of irrigation water applied and the yield and quality of trickle irrigated chilli pepper (Capsicum annum L.). They reported that the yield of trickle irrigated green and red chilli increased with the amount of irrigation water applied and maximum yields were obtained from the treatment that received 20% more than control. The green chilli yields reduced by 68 per cent when the amount of water applied was decreased from 75.9 to 66.3 cm. Maximum yields obtained by applying 80 to 95 cm of water the pungency of the green chilli showed a clear trend with the irrigation treatments i.e., the drier the treatment, the more pungent the chilli pepper.

Rahman et al. (1989) reported that mulched with dried sun grass (Imperatacylindrica) and non-mulched plants were irrigated with 90.42, 113.82, 139.52, 161.32 (or) 209.37 mm water/ha plant growth and yield increased with increasing irrigation rates from 29.8 t/ha at 90.42 mm/ha to 47.9 t/ha at 209.37 mm/ha; presence of mulch the maximum growth and yields of okra were obtained with irrigation at 161.71 mm/ha.

Shrivastava et al. (1994) reported that the use of drip, either alone (or) in combination with mulching, can increase the okra yield substantially over the normal method of irrigation, with about 44% saving in irrigation water. In the absence of drip, even mulch alone would increase the yield by about 30%. The net income would be increased by about 86% over the normal method by adopting drip along with sugarcane trash as mulch.

Chandio et al. (1995) observed higher yields in drip irrigated plots over furrow irrigated plots and the yields were significant with chilli in black soils of Pakistan. They also found that water use was less with drip irrigation.

Christopher et al. (1996) reported that the improved attributes might be due to higher amount of moisture conservation, weed suppression and optimum soil temperature favorable for the plant growth and development.

# CHAPTER THREE

# 3.0 MATERIALS AND METHODS

## 3.1 EXPERIMENTAL SITE DESCRIPTION

Field experiment was conducted between January- April 2017, at the Teaching and Research Farm, Federal University, Oye-Ekiti, Ekiti-State, Nigeria. The area lies between Latitude 07$^0$ 48.456 N and Longitude 005$^0$ 29,722. The area experiences a tropical climate with distinct wet and dry seasons. Generally, Ekiti State is underlied by metamorphic rock especially, granite gneisses. The soil of the area has been classified as TypicPlinthoudult by Gbaja (2016).

### 3.2.1 Land Preparation

The site of the experiment has been cultivated to maize and vegetation crops over the years. The site was cleared and ploughed to give a fine tilth, afterwards it was demarcated into plots.

### 3.2.2 Collection of Soil Sample for Analysis

The surface soil sample (0-15cm) was collected randomly from the experimental field, air-dried, sieved (<2mm), analyzed using IITA (1979) methods forsoil organic matter (SOM), total nitrogen (TN), available p, exchangeable bases (Na, Ca, Mg, K), pH, Sand, Silt and Clay.

### 3.2.3 Experimental Design and Treatments

The experimental layout used was a 3 x 3 Factorial in a Randomized Complete Block Design (RCBD), with a split-plot arrangement.

**Main Treatment:** **Drip Irrigation Frequency**

F1- Daily

F2- Twice Weekly

F3- Thrice Weekly

**Sub Treatment:** M1- Plastic Mulch

M2- Natural Mulch

M3- No Mulch

**Treatment Combinations**

Treatments combinations are:-

F1M1: Daily and polythene black mulch

F1M2: Daily and Natural mulch

F1M3: Daily and no mulch

F2M1: Twice and black mulch

F2M2: Twice and natural mulch

F2M3: Twice and no mulch

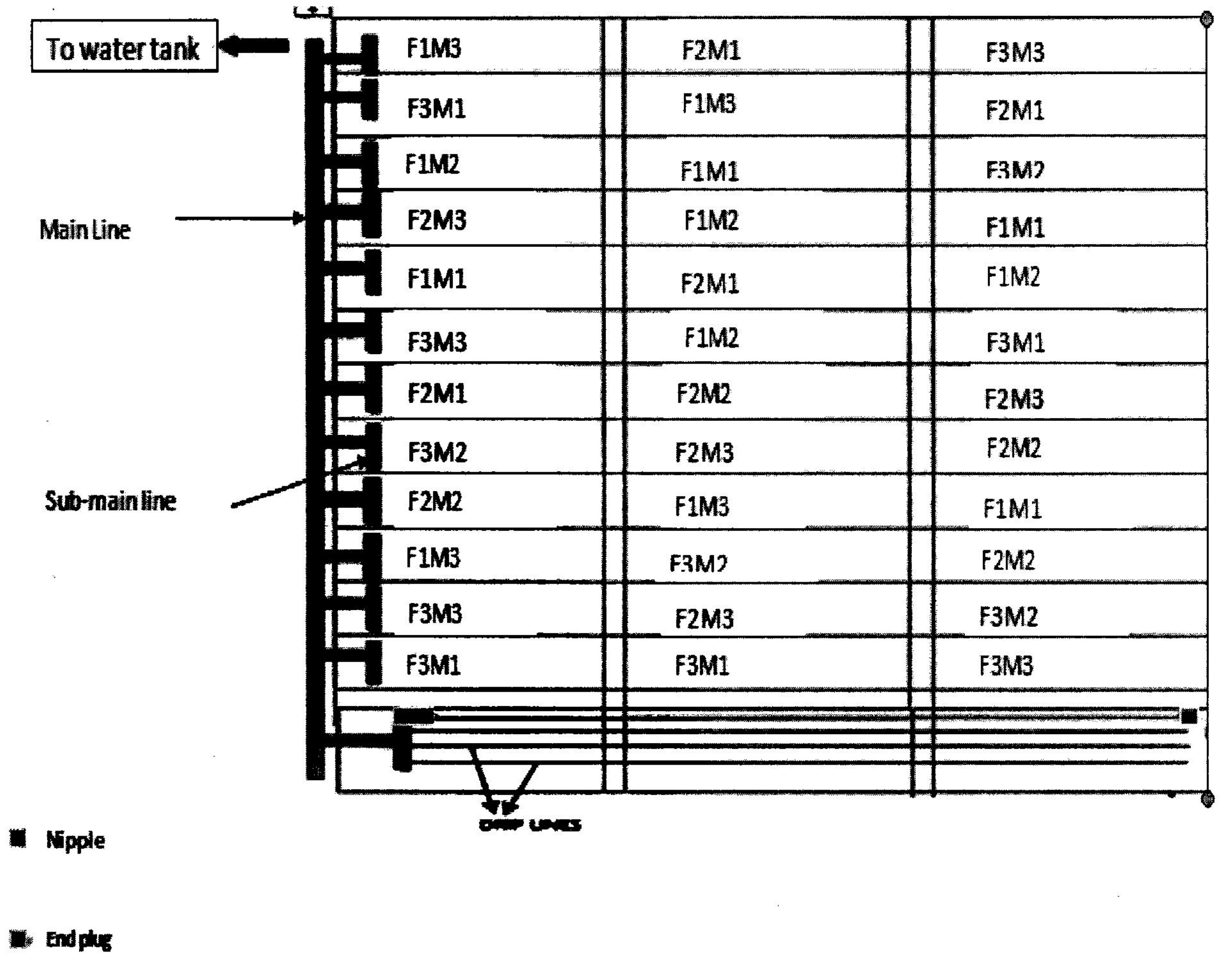
F3M1: Thrice and black mulch

F3M2: Thrice and natural mulch

F3M3: Thrice and no mulch

Each treatment combination was replicated four (4) times. Each bed was 9.0m x 1.5m.

**FIGURE1: Field Layout showing the different treatment combinations.**



### 3.2.4 Planting and Weeding

Planting of okra was carried out on 8th of February, 2017 using 2-3 seeds per stand at 5cm depth and spacing of 90cm x 30cm. Regular weeding was done around the base, using a hoe.

### 3.2.5 Seed Germination

Seeds germinate and emerge in three days under optimum conditions. During this time seed coat remains tight. Once cotyledons emerge, roots develop quickly. Sunlight delivers photosynthesis to true leaves and root system.

### 3.2.6 Plant Protection

The field was kept free from pests and diseases by adopting need based plant protection measures as detailed below:

| Date of application | Chemical |
|---|---|
| 21-02-2017 | Komba 2.5EC- Emulsifiable concentrate |
| 15-03-2017 | Komba 2.5EC@ 12g/ 20L of water |
| 05-04-2017 | Komba 2.5EC@ 12g/ 20L of water |

### 3.2.7 Mulching

In this experiment three mulching treatments were used: no mulch (M3), natural mulch (M2) and plastic mulch (M1). Mulches were applied two days before planting; the natural mulch was spread on the soil surface immediately after planting.

### 3.2.8 Irrigation Water Application

The field was irrigated immediately after planting with 5.0 cm depth of water to facilitate early establishment of the crop. The subsequent irrigationwas scheduled as per the treatments.

### 3.2.9 Harvesting

Fruits were harvested when they are still fresh starting first harvest after planting and 3days consequently. The time taken from 1st picking to last picking (duration of harvest) was 90 days.

### 3.3 Observation Recorded

The observations on morphological characters of okra with regard to growth parameters were recorded at crop growth period to till harvest at different intervals. Five plants of Okra were selected randomly in each treatment for sampling by tagging to record the plant height and other observations.

#### 3.3.1 Plant Height (Cm)

Plant height was recorded from the base to the apical end at 60, 90, 120 days after planting and plant height at harvest expressed in centimeter.The plant height of Okra was measured with a graduated meter rule from the soil surface to the tip of the flag leaf at harvest, where five randomly selected plants in each plot.

#### 3.3.2 Number of Branches/Plant

The total number of primary, secondary branches in five randomly selected plants in each treatment was counted before final harvest and average was arrived.

#### 3.3.3 Length of Fresh Fruit (Cm)

Fruit length was measured at the time of harvest, recorded by 5 individual fruits from the sample plants in each treatment and average was worked out.

#### 3.3.4 Average Fruit Weight (G)

Average fruit weight was recorded at peak harvest by weighing five individual fruits from the sample plants in each treatment and average was worked out.

#### 3.3.5 Circumference of Fruit (Cm)

The pod girth (cm) was measured by taking 5 individual fruits with a verniercaliper by twining around the pod at the middle portion and the caliper measured to calculate the circumference of the pod.

#### 3.3.6 Yield Kg/Ha

Yield of the total fruits of the okra harvested in different pickings from the sample plants in each treatment was recorded and extrapolated to yield per hectare.

### 3.3.7 Statistical Analysis

Data were subjected to analysis of variance (ANOVA) and where F values were significant, mean values were separated using Least Significant Difference (LSD) test at 5% level of probability. Pearson correlation analysis was performed on the growth parameters, yield and yield components. Analysis was done in SPSS® (IBM version 2

# CHAPTER FOUR

## 4.0 RESULTS AND DISCUSSION

### 4.1 SOIL FERTILITY EVALUATION OF EXPERIMENTAL SITE.

The results of the soil physical and chemical properties of the soil in the experimental site are given in Table 2. The pH of the site slightly alkaline (7.7%). The organic matter is high (3.20%). This value is higher than the critical value of 3%. This shows that the soil is moderaterly fertile. The total N is moderate (0.79%), while available P (ppm) is high (96.00ppm).The CEC is high ($47.61Cmol^{-1}$) showing that the soil has a very high retentive capacity for retaining water and nutrients. The soil texture is sandy loam. Generally, the soil is moderately fertile.

**Table 2: Physico-chemical properties of the experimental site**

| PROPERTY | VALUE |
|---|---|
| Ph | 7.7 |
| Organic matter (%) | 3.20 |
| Exchangeable Ca ($Cmol^{-1}$) | 5.300 |
| Exchangeable Na ($Cmol^{-1}$) | 0.72 |
| Exchangeable K ($Cmol^{-1}$) | 0.33 |
| Exchangeable Mg ($Cmol^{-1}$) | 2.22 |
| Available P (ppm) | 96.00 |
| Total N (%) | 0.79 |
| Base Saturation [illegible] | 62.67 |
| Electrical Conductivity (ms $cm^{-1}$) | 95.00 |
| Bulk density (g/[illegible] | 1.51 |
| Cation Exchange Capacity ($Cmol^{-1}$) | 47.61 |
| Clay % | 36.40 |
| Silt % | 17.90 |
| Sand % | 45.70 |
| Textural Class | Sandy Loam |

### 4.1.1 Effect of Drip Irrigation Frequency and Mulching on Plant Height of Okra.

The result of the effect of drip irrigation frequency and mulch on plant height is presented in Table 3. The result shows that irrigation intervals significantly ($P< 0.05$) influence plant height of okra at 4 to 8 weeks after planting (Table 3). Mulching significantly ($P< 0.05$) influenced plant height from 4 to 8 weeks after planting. The interaction of irrigation interval and mulch application was also significant from 4 to 8 weeks after planting.

The results obtained shows that okra plants that received plastic mulch produced the tallest plants compared to the control treatment from two to eight weeks (Table 3). In addition, results of interaction effects indicated that plant height varied from 43.3 to 50.11cm and the highest value was recorded in plants irrigated daily and that received plastic mulch per plot. This is expected because enough water and nutrient were available for the utilization of their vegetative growth. This is supported by the findings of Abdul Hafeez (1984). The control plots recorded the least number of plant height irrespective of irrigation treatment. The use of plastic mulch increased the plant heightwhich agrees with the findings of Abdul Baki (1992).

The highest value recorded at 8 weeks after planting (50 cm) was recorded in plant irrigated daily with plastic mulch treatment combination. Soil moisture conservation was observed under polythene as earlier observed by Abdul Hafeez and Abu-Gourk(1984). The higher moisture conservation under the polythene as mulch was mostly due to prevention of evaporation from the soil surface (Puszai1972).

**TABLE3: EFFECT OF DRIP IRRIGATION FREQUENCY AND MULCHING MATERIAL ON OKRA PLANT HEIGHT.**

| | 2 | 4 | 6 | 8 |
|---|---|---|---|---|
| Treatment | Weeks after planting | | | |
| F1 | 8.7 | 32.1 | 38.1 | 45.4 |
| F2 | 9.2 | 30.4 | 39.0 | 46.6 |
| F3 | 8.4 | 29.6 | 37.1 | 46.6 |
| LSD($p<0.05$) | | 0.511 | 0.416 | 0.202 |
| M1 | 9.2 | 33.4 | 41.3 | 50.0 |
| M2 | 8.2 | 30.3 | 37.7 | 45.3 |
| M3 | 8.8 | 28.3 | 35.1 | 43.3 |
| LSD($p<0.05$) | $1.48^{ns}$ | $*2.01^{s}$ | $*4.44^{s}$ | $*4.88^{s}$ |
| SEM | 0.40 | 1.79 | 1.48 | 1.54 |

**Keywords:**F1: Daily irrigation, F2: Twice weekly, F3: Thrice weekly, M1: Plastic mulch, M2: Natural mulch, M3: No mulch

### 4.1.2 Effect of Drip Irrigation Frequency and Mulching on Number of Leaves of Okra.

The result of the effect of drip irrigation frequency and mulching on number of leaves is presented in Table 4. The result shows that irrigation interval did not significantly (P< 0-05) influenced number of leaves at 2 to 8 weeks after planting. Application of mulch did not significantly (P< 0.05) influence the number of leaves of okra after planting. The best number of leaves (14) was obtained on plants that received plastic mulch and daily irrigation (F1M1), this may be due to the plastic mulch inducing in soil temperature, more conservation of moisture, more activity of soil micro organisms resulting in more mineralization and availability of nutrients to the plant. Plastic mulch significantly increased number of leaves than organic and no mulchin tomato (Christopher 1996).

**TABLE 4. EFFECT OF DRIP IRRIGATION FREQUENCY AND MULCHING ON NUMBER OF LEAVES OF OKRO.**

| Treatment | 2 | 4 | 6 | 8 |
|---|---|---|---|---|
| | Weeks after planting | | | |
| F1 | 4.32 | 5.93 | 9.33 | 11.55 |
| F2 | 4.23 | 5.84 | 8.10 | 11.37 |
| F3 | 4.29 | 5.38 | 8.21 | 12.49 |
| LSD(p<0.05) | $0.16^{ns}$ | $0.83^{ns}$ | $1.27^{ns}$ | $0.57^{ns}$ |
| M1 | 4.24 | 6.32 | 9.47 | 13.87 |
| M2 | 4.31 | 5.33 | 7.64 | 11.35 |
| M3 | 4.28 | 5.49 | 8.53 | 10.19 |
| LSD(p<0.05) | $0.10^{ns}$ | $2.72^{ns}$ | $2.27^{ns}$ | $5.57^{ns}$ |
| SEM | 0.12 | 0.32 | 0.61 | 0.80 |

**Keywords:** F1: Daily irrigation, F2: Twice weekly, F3: Thrice weekly, M1: Plastic mulch, M2: Natural mulch, M3: No mulch. ns: no significant difference between mean values at 5% level of probability by least significant difference (LSD) test.

s: significant difference between mean values at 5% level of probability by least significant difference (LSD) test. SEM: standard error of mean.

### 4.1.3 Effect of Drip Irrigation and Mulching on Yield and Yield Components of Okra.

The result of the effect of drip irrigation frequency and mulching on yield and yield components of okra is presented in Table 5. Okra responded significantly to drip irrigation and mulch treatments. Treatment combination F1M1 (Daily irrigation + Plastic mulch) gave a significantly ($P < 0.05$) higher fruit yield (26.05kg/$m^2$) than other treatment combination. Theuse of plastic mulch and applying irrigation water daily was economically advantageous for okra production as okra fruit yield increased (doubled). The effect of irrigation and mulch treatments on fruit diameter was not significant while fruit length was significantly influenced by irrigation interval and mulching, but the interaction between these treatments was not significant. Irrigation frequency was not significant on fruit weight but was significant with mulch treatments; interaction between these treatments was not significant. The same trend was observed for all other yield components.

The yield in plants that were irrigated daily with plastic mulch was higher than plants that were not mulched. The positive effect of mulch on yield might be due to water conservation and moisture effect on the vegetative growth characters which form the basis for flowering and fruiting (Abu – Gourk et *al* 1984). Similar results have been reported in experiments on lettuce by (Adetunji, 1990). The Interaction between irrigation and mulch treatments on fruit yield was not significant. Among all the treatments irrigation daily and application of plastic mulch gave the highest fruit yield (26.05kg/$m^2$). These results coincide with that obtained by Tarara(2006) who found that fruit yield of okra had a positive response to plastic mulch under different irrigation levels.

**TABLE 5. EFFECT OF DRIP IRRIGATION FREQUENCY AND MULCHING MATERIALS ON YIELD AND YIELD ATTRIBUTES OF OKRO.**

| Freq. | Mulching | FrtLngth, cm | FrtDia, cm | NoBranch | NoFrt | FrtWt, kg/m$^2$ |
|---|---|---|---|---|---|---|
| | M1 | 5.91 | 2.55 | 2.05 | 4.91 | 26.05 |
| F1 | M2 | 6.00 | 2.64 | 1.32 | 5.24 | 22.16 |
| | M3 | 5.66 | 2.67 | 1.10 | 2.79 | 18.85 |
| | M1 | 5.80 | 2.63 | 1.84 | 4.72 | 25.01 |
| F2 | M2 | 5.58 | 2.53 | 1.68 | 4.79 | 23.44 |
| | M3 | **4.89** | 2.65 | 1.13 | 2.98 | 19.51 |
| | M1 | **6.02** | 2.50 | 0.90 | 4.86 | 24.49 |
| F3 | M2 | **5.56** | 2.36 | 1.99 | 4.98 | 23.53 |
| | M3 | **4.61** | 2.50 | 1.42 | 2.96 | 18.43 |
| | SEM | **0.24** | 0.11 | 0.15 | 0.22 | 1.86 |
| | F | **3.40**$^{s}$ | 2.10$^{ns}$ | 0.40$^{ns}$ | 0.35$^{ns}$ | 0.06$^{ns}$ |
| | M | **10.29**$^{s}$ | 0.57$^{ns}$ | 7.79$^{s}$ | 81.81$^{s}$ | 8.80$^{s}$ |
| | F x M | **0.25**$^{ns}$ | 0.88$^{ns}$ | 0.00$^{ns}$ | 0.70$^{ns}$ | 0.94$^{ns}$ |

**Keywords:**F1: **Daily** irrigation, F2: Twice weekly, F3: Thrice weekly, M1: Plastic mulch, M2: **Natural mulch, M3: No mulch,** F: effect of irrigation frequency; M: effect of mulching;

**F x M: interactive effect of** irrigation frequency and mulching material

**ns: no significant difference** between mean values at 5% level of probability by least significant **difference (LSD) test.**

**s: significant difference** between mean values at 5% level of probability by least significant **difference (LSD) test.**

**SEM: standard error** of mean

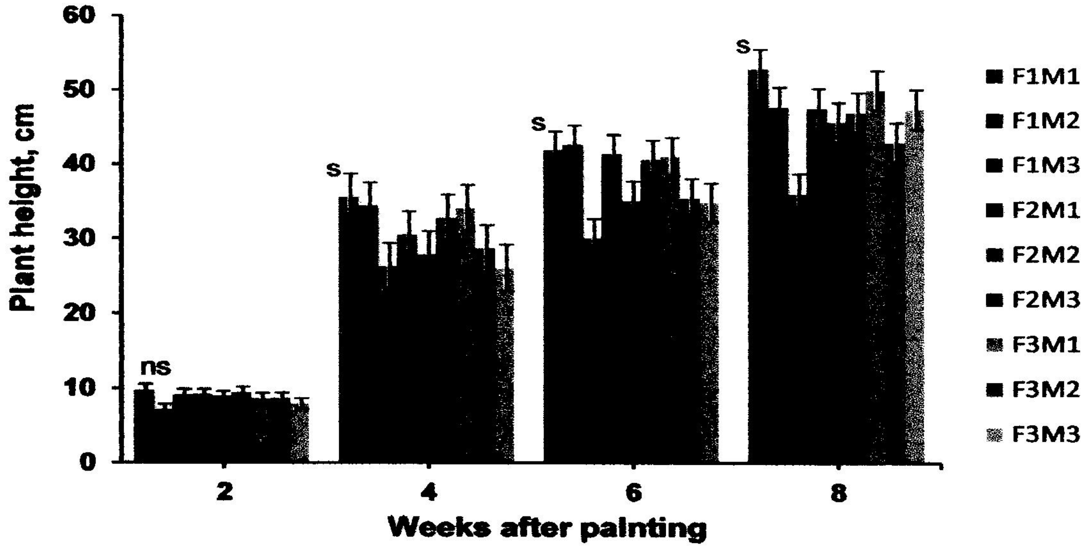



Figure 2. Interactive effect of drip irrigation frequency and mulching materials on okro plant height.

ns: no significant difference between mean values at 5% level of probability by least significant difference (LSD) test.

s: significant difference between mean values at 5% level of probability by least significant difference (LSD) test.

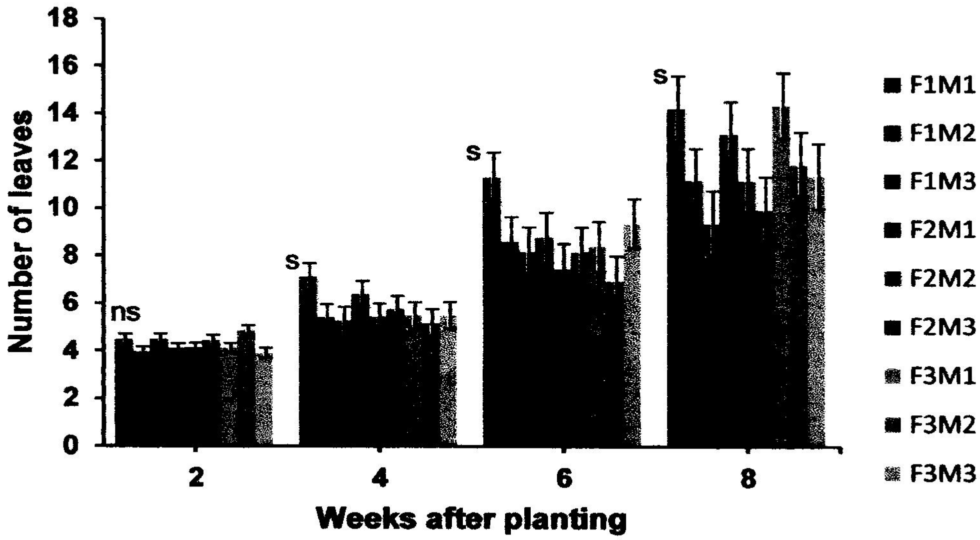



Figure 3. Interactive effect of drip irrigation frequency and mulching materials on okro plant height.

**Keyword:**

F1M1: Daily irrigation and Plastic mulch

F1M2: Daily irrigation and Natural Mulch

F1M3: Daily irrigation and No mulch

F2M1: Twice weekly and Plastic mulch

F2M2: Twice weekly and Natural mulch

F2M3: Twice weekly and No mulch

F3M1: Thrice weekly and Plastic mulch

F3M2: Thrice weekly and Natural mulch

F3M3: Thrice weekly and No mulch

s: significant difference between mean values at 5% level of probability by least significant difference (LSD) test.

ns: no significant difference between mean values at 5% level of probability by least significant difference (LSD) test.

### 4.1.4 Correlation Analysis between Yield Components and Fruit Yield

Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component on which selection can be based for improvement in yield. Therefore, knowledge of correlation coefficients between yield and itscomponents may be a valuable indication regarding the components, where selection could be profitable exercised in order to obtain an increase in yielding ability. It was observed that there was positive correlation between number of fruits and fruit weight, (r= 0.583), while a negative correlation was observed between fruit diameter and fruit weight (r= -0.341). Number of leaves positively correlated and plant height. Similar results were obtained by Al Masoum*et al* (1996) in tomato and Aiyelangebeand Ogbonnaya(1996) in okra. Significant positive interrelationships among yield and yield-contributing traits that would increase yield are [illegible] in crop improvement.

**TABLE 6. CORRELATION AMONG GROWTH PARAMETERS, YIELD AND YIELD COMPONENTS.**

| Parameter | Frtwt | PH | NOL | FrtLn | FrtDia | NoBran | NoFrt |
|---|---|---|---|---|---|---|---|
| Frtwt | 1.000 | 0.178 | 0.224 | 0.212 | -0.341* | 0.244 | 0.583** |
| PH | | 1.000 | 0.654** | 0.164 | -0.026 | 0.062 | 0.300 |
| NOL | | | 1.000 | 0.263 | -0.045 | 0.236 | 0.122 |
| FrtLn | | | | 1.000 | 0.336* | 0.076 | 0.497** |
| FrtDia | | | | | 1.000 | -0.015 | -0.171 |
| NoBran | | | | | | 1.000 | 0.394* |
| NoFrt | | | | | | | 1.000 |

**Keywords:** Frtwt: fruit weight; PH: plant height; NOL: number of leaves; FrtLn: fruit length; FrtDia: fruit diameter; NBran: number of branches; NoFrt: number of fruits

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

## CHAPTER FIVE

## 5.0 SUMMARY AND CONCLUSION

The use of drip irrigation promotes efficient use of applied water and nutrients. It controls weeds and reduces soil crusting. The objective of this experiment is to evaluate the effect of different irrigation regimes and mulching materials on the performance and yield of okra. The effect of three irrigation intervals (daily, twic and thrice weekly) and three mulch type (no. natural and plastic) and their interaction on growth, yield and yield components were studied in a 3x3 factorial layout in a Randomized Complete Block Design (RCBD) with split-plot arrangement in Federal University Oye-Ekiti, Ekiti State.

Results indicated that the growth characters: plant height, number of leaves per plant, were influenced by irrigation levels and mulching treatments. The highest plant height was recorded (50.11cm) in plants irrigated daily and that received plastic mulch. Application of mulch significantly ($P< 0.05$) influenced the number of leaves of okra only at 8 weeks after planting. The best number of leaves (14) was obtained on plants that received plastic mulch and daily irrigation (F1M1).

The results indicated that the yield characters: length of fruit, average weight of fruit, circumference of fruit, number of branch per plant, yield per plant, yield per hectare responded significantly to drip irrigation and mulch treatments imposed. Treatment combination F1M1 (Daily irrigation + Plastic mulch) gave a significantly ($P< 0.05$) higher agronomic yield (26.05kg/m$^2$) than other treatment combination. The effect of irrigation and mulching treatments on fruit length was significant. Number of branches was significantly influenced by mulching. Mulching was significant on fruit weight. The same trend was observed for all other yield component. The yield of plants that was irrigated daily with plastic mulch was higher than plants that were not mulched.

The results on the correlation analysis among growth parameters, yield and yield components gave a significant and positive correlation between number of fruit and fruit weight (0.583), plant height and number of leaves (0.654), fruit diameter and fruit weight (0.341), fruit length and fruit diameter (0.366), fruit length and number of fruit (0.497), number of branches and number of fruits (0.394).

This result shows that, applying the drip irrigation system, irrigation management and plastic mulches can optimize the water consumption. Therefore, drip irrigation system and mulching is recommended for growing okra in the region where limited water was available.

## 5.1 RECOMMENDATION

In conclusion although most of the mulching materials have showed some promises, polythene sheet mulch had a high growth performance in comparison. Therefore, for optimum growth production of Okra under Ikole- Ekiti state agro-ecological climate, it is recommended that the polythene mulch is use as an agronomic practice by farmer. The use of drip irrigation in combination with mulch treatment increasesthe total okra yield significantly. Application of black plastic mulch significantly ($p < 0.05$) increased okra fruit yield, due to available soil moisture and well timed irrigation particularly in early growth season and greatly controlled the weeds.

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