EFFECT OF ENVIRONMENTAL FACTOR ON THE SEED YIELD AND OIL CONTENT OF SUNFLOWER (HELIANTHUS ANNUUSL.)

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CERTIFICATION

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DEDICATION

I sincerely dedicate this report to God for His wisdom bestowed on me and also to my late father Mr. Olu Adaramodu.

ACKNOWLEDGEMENTS

I am grateful to God for His immeasurable love upon my life. I appreciate my loving family, the Adaramodus. You have all brought me up and you are always doing all you can to see that I become someone great. May the Lord bless all your labour of love and help me to always honor you.

My sincere gratitude also goes to my wonderful friends Adebisi Blessing, Okpoko Precious, Kolade Oluwatosin, Jegede Joluwanisola, Olakunle Jeremiah. You are one in a million

I specially appreciate my supervisor, Dr. Adekoya. I honestly cannot thank you enough.

Dr. Brai, Dr Fasae, Dr Olosunde, Mr Asarabioyo, Mr Adebisi, Mr Aroge, Mr Arowosoge, MrOlaiya I appreciate you all for your support in the successful conclusion of this work.

I appreciate Mr Yahyah (Ahmadu Bello University, Samaru, Zaria) for the help while sourcing for Sunflower seed.

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ABSTRACT

Sunflower *(Helianthus annuus*L.*)* occupies the fourth position among vegetable oilseeds after soybean, oil palm and canola in the world.A field experiment was conducted on a farm in Ado Ekiti South-West Nigeria (Latitude7'37'23 N and longitude 5'13'15E with 1440 ft above sea level) between December 2017 and April 2018 to evaluate the performance of two Sunflower varieties (SAMSUN 1 and SAMSUN 2) as affected by the geographical location and abiotic factors. Soil analysis was carried out on the soil used in planting the Sunflower seeds. Proximate analysis was also carried out on the seeds.Oil was extracted from the seeds using a soxhlet apparatus with n-hexane as the extraction solvent. The result from the soil analysis showed 5 as the soilpH and 1 as the soil nitrogen. During the vegetative stage, 61cm was recorded as the highest plant height for SAMSUN 1 and 46cm was recorded as the highest plant height for SAMSUN 2. The number of leaves for SAMSUN 1 was 28 and 24 for SAMSUN 2 after 84days of planting. 1.8cm was recorded as the final stem diameter for SAMSUN 1 and 1.6cm for SAMSUN 2. Harvesting of seeds was carried out after 124 days of planting and the seed yield was 3.74kg and 2.96kgfor SAMSUN 1 and SAMSUN 2 respectively. Proximate analysis on the seeds showed that SAMSUN 1 contain 5.88% moisture,1.58% ash, 7.10% crude protein, 3.35% fat and 3.35% crude fibre% while SAMSUN 2 contain 4.37% moisture, 2.05% ash, 6.45% crude protein, 4.16% fat and 4.16% crude fibre. 400ml and 460ml of sunflower oil were recorded for the two varieties. The oil analysis showed that SAMSUN 1 contain 5.37% moisture, 0.74% ash and 11.91% crude protein and SAMSUM 2 contain 7.12% moisture, 0.72% ash and 13.93% crude protein. The result of the experiment was compared with that from thenorthern region of Nigeria where it is predominately cultivated. It can be concluded after the whole experiment that sunflower will give more yield and oil in the northern region of Nigeria.

CHAPTER ONE

INTRODUCTION

Sunflower *(Helianthus annuus*L.*)* is an annual plant native to the Americas belonging to the family Asteraceae (Hamed*et al.*, 2012). Sunflower occupies the fourth position among vegetable oilseeds after soybean, oil palm and canola in the world (Rodriguez *et al.*, 2002; Ahmad *et al.*, 2011). Per 100 g, the seed enclose protein up to 20.78 g, total lipid (fat) up to 51.46 g, ash up to 3.02 g, fibre up to 8.6 g with total energy of 2445 kJ. The oil accounts for 80% of the value of the Sunflower crop, as contrasted with Soybean which derives most of its value from the meal (Hamed*et al.*, 2012).

Sunflower oil is generally considered a premium oil because of its light color, high level of unsaturated fatty acids and lack of linolenic acid, bland flavour and high smoke points. The primary fatty acids in the oil are oleic and linoleic (typically 90% unsaturated fatty acids), with the remainder consisting of palmitic and stearic saturated fatty acid (USDA, 2008). The primary use is as salad and cooking oil or in margarine. In the USA, Sunflower oils account for 8% or less of the market, but in many Sunflower-producing countries, Sunflower is the preferred and the most commonly used oil (Hamed*et al.*, 2012).

Sunflower meal is higher in fibre with low energy value and lysine content and extracts from its grains have varied medicinal values. Since its discovery, Sunflower oil has served in the manufacture of soaps and detergents, as surfactants in agrochemicals, and as an alternative for diesel oils due to its viscosity and excellent lubricating properties (Putman, 2008). The major goal of growing Sunflower is for its seed (achene) that contains oil (36–52%) and protein (28–32%) as reported by Rosa *et al.*,(2009). There are two types of Sunflower seeds produced:

oilseed and confectionary. Sunflower seeds can be sun dried or roasted and used as a medicine in South America. Sunflower oil has cleansing properties, it is both a diuretic and an expectorant. Mainly, there are three types of Sunflower oil available, namely Mid-Oleic, Linoleic and High Oleic Sunflower oil. They all have different oleic levels, making the uses for Sunflower oil vast. (Schild*et al.*, 1991)

The crop has been receiving steady attention by various scientists from diverse disciplines in recent past because Sunflower oil is a premium oil and is widely used in the diets of heart patients as it contains very low cholesterol and high (90%) unsaturated fatty acid concentration (Flagella *et al.*, 2002; Qahar*et al.*, 2010). Lately, there has been a steady increase in its demand globally because of the health risks posed by conventional method of production (Yiridoe*et al.*, 2005).

1.1 Justification

Compared to other edible oils, Sunflower oil has not been in wild circulation except in foreign countries. Sunflower is under-utilized in Nigeria because fewer farmers cultivate it, some farmers doubt that Sunflower will grow and the seeds are not even available (presently in Nigeria Sunflower seeds can only be gotten from Institute for Agricultural Research A.B.U Zaria) and only cultivated in the northern region of Nigeria (Showemimo*et al.*, 2010). The above established importance of Sunflower justifies and rekindles the interest of National Institute with the genetic mandate of Sunflower improvement, Institute for Agricultural Research (IAR) of Ahmadu Bello University (ABU), Zaria to intensify Sunflower improvement, adaptation,

registration and release to Nigerian farmers so as to compliment the short fall in vegetable oil production (Showemimo*et al.*, 2010)

1.2 Aim of the study

To ascertain the effects of the environment on the growth of *Helianthus annuus* (Sunflower)

Objectives:

1. To evaluate the yield, oil content and quality of Sunflower in the Southwest Nigeria
2. To estimate the effect of environment on the yield and oil content of Sunflower
3. To determine the suitability of the two Sunflower genotypes for breeding work

CHAPTER TWO

LITERATURE REVIEW

2.1 Taxonomy

Kingdom	Plantae
Division	Angiosperms
Order	Asterales
Family	Asteraceae
Genus	Helianthus
Species	annuus

Binomial name: *Helianthus annuus*

2.1.1 General description, cultivation and use as a crop plant

Helianthus L. is a genus in the tribe Heliantheae of the Asteraceae family. The genus consists of annual and perennial species. The cultivated species *H. annuus* known also as Sunflower has close wild relatives (BIO, 2005).

The cultivated *H. annuus* as described by Heiser (1978) and Seiler (1997) for the most part are tall, but varieties have been developed that range from 50 to 500 cm in height. The stems are typically unbranched and along with most other parts of the plant vary from glabrous to very densely pubescent. Stem length is determined by the number of internodes. The first leaves are always opposite but in some varieties become alternate. The leaves are usually petiolate and

three nerved, vary in shape from linear to ovate and are usually entire. The color intensity could vary from light to dark green. They are usually large and yellow but the color can range from lemon-yellow, orange to reddish (Heiser, 1978; Seiler,1997).

The inflorescence is a capitulum or head which is a characteristic of the Asteraceae family. It consists of 300 to 1000 flowers but could be higher in non-oil Sunflower cultivars. The outer whorl of disk flowers open first, at about the time that ray flowers spread out from their folded position against the buds of disk flowers. Successive whorls of one to four rows of disk flowers open daily for 5 or more days (Heiser, 1978; Seiler,1997).

The attitude of the head is variable. The head shape varies, being concave, convex or flat.

The achene or fruit of the Sunflower consists of a seed, often called the kernel, and adhering pericarp, usually called the hull. In the absence of fertilization, the achenes will be empty, with no kernel. Achenes vary from 7 to 25 mm in length and 4 to 13 mm in width. They may be linear, oval or almost round (Heiser, 1978; Seiler,1997).

Early cultivation of Sunflower in North America was mainly for silage and to some extent as scratch feed for poultry (Dedio*et al.,* 1980). It was not until the crop was re-introduced from Russia that it received attention as a possible oilseed crop (Putt, 1978). Due of its long season, its centre of production in Canada is in Southern Manitoba, extending to Northern States, with small amounts grown in Saskatchewan and Alberta. Its fair drought resistance and susceptibility to disease particularly sclerotinia makes it suitable for production in drier areas of the country (BIO, 2005).

Sunflower is cultivated primarily for its seeds, which yield one of the world's most important sources of edible oil. Sunflower oil is considered a premium oil because of its light color, high

level of unsaturated fatty acids, lack of linolenicacid, lack of trans-fat, bland flavour, high oxidative stability and high smoke points. The oil is used for cooking, margarine, salad dressings, baby formula, lubrication, bio-fuel, hydrolic fluids, soaps, illumination and certain types of paints, varnishes and plastics (BIO, 2005). The meal left after the oil has been extracted is a valuable animal feed with 50-60% protein. Lately, traditional Sunflower in Canada has shifted somewhat to non-oil Sunflower varieties. Their large achenes are lower in oil and higher in protein than those of the smaller oilseed type. These seeds are used for human consumption either raw, roasted, salted, made into flour or as dehulled kernels in bread baking. They are also used as birdfeed and as a high protein meal for livestock. The flowers are used as a yellow dye, and the plant itself can be used for fodder, silage and as a green-manure crop (BIO, 2005).

2.2 The centres of origin of the species

Sunflower (*Helianthus annuus* L.) is native to North America, it may have been domesticated before corn. Archeological evidence seems to indicate the crop was domesticated in the central part of USA. There are both annual and perennial species, (Heiser 1954).

2.3 The reproductive biology of *Helianthus annuus*

Sunflower can be propagated by seed only and can hybridize spontaneously with few wild relatives (Burke *et al.*, 2002). Until the 1960's the cultivars grown were cross-pollinated mostly by insects. They, alongside the wild species, were exceptionally self-incompatible. Present commercial Sunflower varieties are self-compatible, nevertheless environmental conditions can have impact on the level of self-fertility expressed (Snow *et al.*, 1998). Pollen exchange is by the means of insect pollinators, principally bees. The pollen is spiny and adjusted to be transported by insects. Little is pollinated by wind, as the pollen is rather heavy (Fick, 1978). It may be

viable for several days. Although the anthers holding the pollen and the stigma are on the same floret, the two lobes of the stigma are at first not exposed to their own pollen. However, they are defenseless to pollination from other florets of the same head by insects, wind or gravity, (BIO 2005).

2.4 Climatic requirements

Temperature

Sunflower is tolerant to both low and high temperatures, however, it is more tolerant to low temperatures (SPG, 2010). The crop is particularly sensitive to high soil temperature during emergence. Sunflower seeds will germinate at 5°C, however, temperatures of at least 14 to 21°C are required for satisfactory germination. Seeds are not affected by cold in the early germination stages. At later stages freezing temperatures could damage the crop. Temperatures lower than the freezing levels are required before maturing, else Sunflower plants would die off. The optimum temperature for growth is 23 to 28 °C, however, a wider range of temperatures up to 34 °C show little effect on productivity. Extremely high temperatures have been shown to lower oil percentage, reduce seed fill and germination, (SPG, 2010).

Rainfall requirement

The rainfall requirement ranges from 500 to 1000 mm. Sunflower is an inefficient user of water, as measured by the volume of water transpired per gram of plant above-ground dry matter. It is a crop which, compared to other crops, performs well under drought conditions, however, the crop is not considered highly drought tolerant, but often produces satisfactory results while other crops are damaged during drought. Its extensively branched taproot, penetrating to 2 m, enables the plant to survive times of water stress. A critical time for water stress is the period 20 days

before and 20 days after flowering. If stress is likely during this period, irrigation will increase yield, oil percentage and test weight, Protein percentage, however, will decrease (SPG, 2010).

2.5 Soil requirements

Sunflower will grow in a wide range of fertile soil types; sandy loam to clays with pH value ranging from 6.0 to 7.5. Traditionally, Sunflower cultivation has been limited to soils where the clay percentage varies between 15 and 55 % (in other words, sandy loam to clay soil types). At present the major planting areas are in soils with a clay percentage of less than 20%. Sunflower has a low salt tolerance; however, it is somewhat better than field bean or Soya-bean in this respect. Good soil drainage is required for Sunflower production, but this crop does not differ substantially from other field crops in flooding tolerance. Soils with good water-holding capacity (clays) will be preferred under dry-land conditions, (SPG, 2010).

2.6 Planting

Sunflower is propagated by seed. The planting density for Sunflower ranges from 25,000 to 35,000 plants per hectare, depending on the yield potential of the area. Row width has little influence on grain yield. It can range from 90 to 100cm, however, wider rows such as 1.5 m to 2.1m can also be used, particularly to accommodate other farm implements. Sunflower is planted from the beginning of July to the end of September in the Nigeria (Lawal*et al.*, 2011)

Sunflower seeds are planted at relatively shallow depths. In soil with high clay content, seeds are planted at a depth of 25 mm. In sandy soils, seeds can be planted at a depth of up to 50 mm, (SPG, 2010).

Irrigation

In areas with low rainfall, water supply can be supplemented with irrigation in order to increase yield. The method of irrigation will depend on the water availability and the available irrigation equipment. The pH of the irrigation water should be slightly neutral (SPG, 2010).

Weed control

Efficient weed control is a prerequisite for high Sunflower yields. It is achieved by a combination of mechanical and chemical practices. Young plants are highly sensitive to strong weed competition and cannot develop fast enough to form a full shade covering which can suppress weed seedlings. Therefore, the first six weeks after planting are critical period for the crop. Yields can be increased significantly by keeping fields free of weeds during this time, (SPG, 2010).

- Mechanical weed control

Mechanical weed control can be very effective, provided it is done in time and with care not to damage the crop (SPG, 2010).

- Chemical weed control

The use of herbicides has many advantages, of which the most important is that effective weed control can be achieved during wet periods when mechanical weed control is impossible. If

Sunflower is cultivated in crop rotation with maize, weeds can be controlled more effectively in both crops as grass and broadleaf herbicides can be used in continuous succession, (SPG, 2010).

2.7 Harvesting

Harvesting should commence as soon as 80 % of the Sunflower heads are brown in order to minimize losses caused by birds, lodging and shattering. The leaves turn yellowish during harvesting maturity. The Sunflower plant is physiologically mature when the back of the head has turned from green to yellow and the bracts are turning brown, about 30 to 45 days after bloom, and seed moisture is about 35 %. The total growing period (from seeding to harvesting) for Sunflower ranges from 125 to 130 days. Harvesting is done either manually or mechanically. Manual harvesting is practiced by cutting the crop with a sickle or knife (SPG, 2010).

2.8 Oilseed and non-oilseed Sunflowers

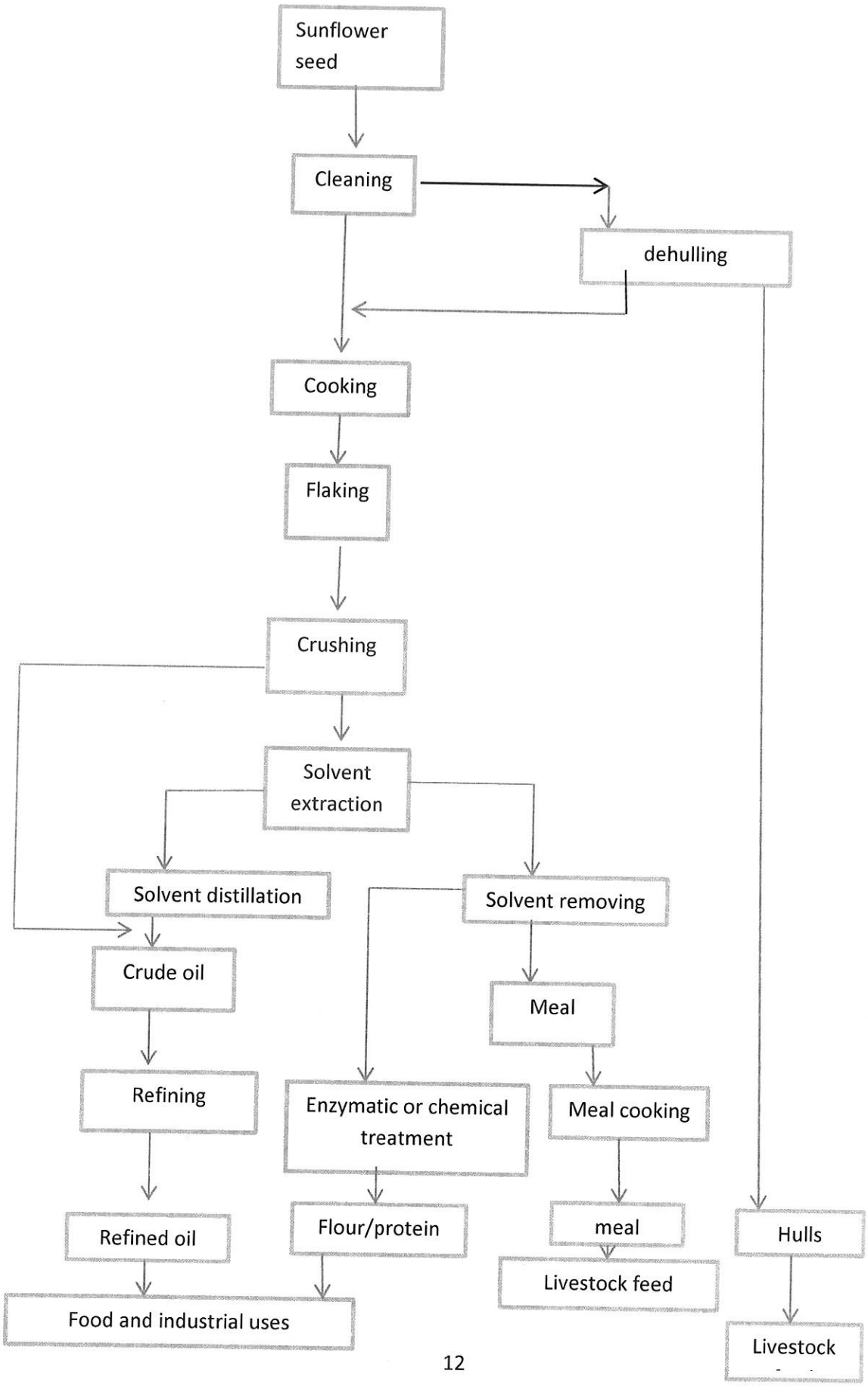
There are two types of Sunflowers, oilseed and non-oilseed (or confectionery), which are nevertheless of the same species. Oilseed Sunflower seeds, constituting the major part of the world production, are characterized by their solid black hulls that are firmly attached to the seed. The seeds are crushed in the industry for oil and for use in the feeding of wild and domestic birds. Meal resulting from this crushing is mainly used for livestock feeding. The industry has bred high oleic acid oilseed Sunflower that has a fatty acid profile similar to Canola oil. The market share for this variety is relatively small but increasing. It is estimated that 95 % of the world production plant the traditional oilseed type, and only 5% plant the confectionery type (Schild*et al.*, 1991).

Seeds of non-oilseed Sunflowers are characterized by larger, thick, striped, loosely attached hulls that lend themselves to a relative complete dehulling process. These seeds are used for the

human food market, as roasted snack foods with shell or as dehulled seeds for the baking industry. Materials from non-oilseed Sunflowers may be used as both livestock and bird feed, (Schild*et al.*, 1991).

Processing of oilseed Sunflower seeds

European crushing of Sunflower has stabilized at approximately 4,800 thousand tonnes in 2000, after a large increase between 1991 and 1997, due to the high worldwide demand for oils (and particularly Sunflower oil) during this period. The process traditionally used worldwide in crushing plants is described in figure 1.


Sunflower seed
Cleaning
dehulling
Cooking
Flaking
Crushing
Solvent extraction
Solvent distillation
Solvent removing
Crude oil
Meal
Refining
Enzymatic or chemical treatment
Meal cooking
Refined oil
Flour/protein
meal
Hulls
Livestock feed
Food and industrial uses
Livestock

Sunflower oil for food consumption is traditionally obtained through two main steps:

1. the crushing of the seeds (mechanical compression followed by solvent extraction)
2. The refining of the crude oil.

The co-product of oil extraction is the meal, which is used in animal feeds as a protein source. In the 1980's, the fibre fraction of the Sunflower meal was reduced by dehulling the seeds. Dehulling increases the protein and energy contents of meal and decreases the amount of wax in the crude oil (Evrard*et al.*, 1986).

It also has technological benefits which include increasing the output, while decreasing wear and tear on the equipment, although the benefits from dehulled seeds do generally not compensate for the processing costs. There is no good estimate of the amount of the world's oilseed Sunflower seeds that are dehulled or partially dehulled (part-dehulled) prior to crushing, (Sunflower Technology and Production Agronomy, 1997).

Table 1: Stages of Sunflower growth

Stage	Description
VE Vegetative Emergence	Seeding has emerged and the first leaf beyond the cotyledons is less than4cm long.
V(number) Vegetative Stages (e.g. V-1, V-2, V-3 etc.)	These are determined by counting the number of true leaves at least 4cm in length beginning as V-1, V-2, V-3, V-4, etc. if senescence of the lower leaves has occurred, count leaf scar(excluding those where the cotyledons were attached) to determine the proper stage.
R-1 Reproductive Stages	The terminal bud forms a miniature floral head rather than a cluster of leaves. When viewed from directly above, the immature bracts have a many-pointed star-like appearance.
R2	The immature bud elongates 0.5 to 2.0cm above the nearest leaf attached to the stem. Disregard leaves attached directly to the back of the bud.
R3	The immature bud elongates more than 2cm above the nearest leaf.
R4	The inflorescence begins to open. When viewed from directly above, immature ray flowers are visible.
R5	This stage is the beginning of flowering. The stage can be divided into sub-stages dependent upon the percent of the head area (disk flowers) that have completed or are in flowering. Ex. R-5(30%), R-5.8(80%), etc.

R6	Flowering is complete and the ray flowers are wilting.
R7	The back of the head has started to turn a pale yellow.
R8	The back of the head is yellow but the bracts remain green.
R9	The bracts become yellow and brown. This stage is regarded as physiological maturity.

Schneiter and Miller, 1981

CHAPTER 3

MATERIALS AND METHODS

3.1 Experimental site

The experiment was carried out on a farm in Ado-Ekiti, Ekiti State, a rainforest region of Nigeria with coordinate Lat 7'37'23 N and log 5'13'15E with 144m above sea level

3.2 Seeds and seed origin

The seeds used for the experiment were SAMSUN 1 and SAMSUN 2

- SAMSUN 1

The Sunflower variety has an old name of Vniimk 8883 (SSL 803) and it originated from Romania

- SAMSUN 2

This Sunflower variety originated from Canada. It was formally called Cherneanka 66 (SSL 806)

The seeds were gotten from the Institute for Agricultural Research (IAR), Ahmadu Bello University (A.B.U), Zaria Nigeria with coordinate Lat. 11'5'7.9476'' N and Log7'43'11.8020'' E and elevation of 2,103 ft above sea level.

Plate 2: SAMSUN 2

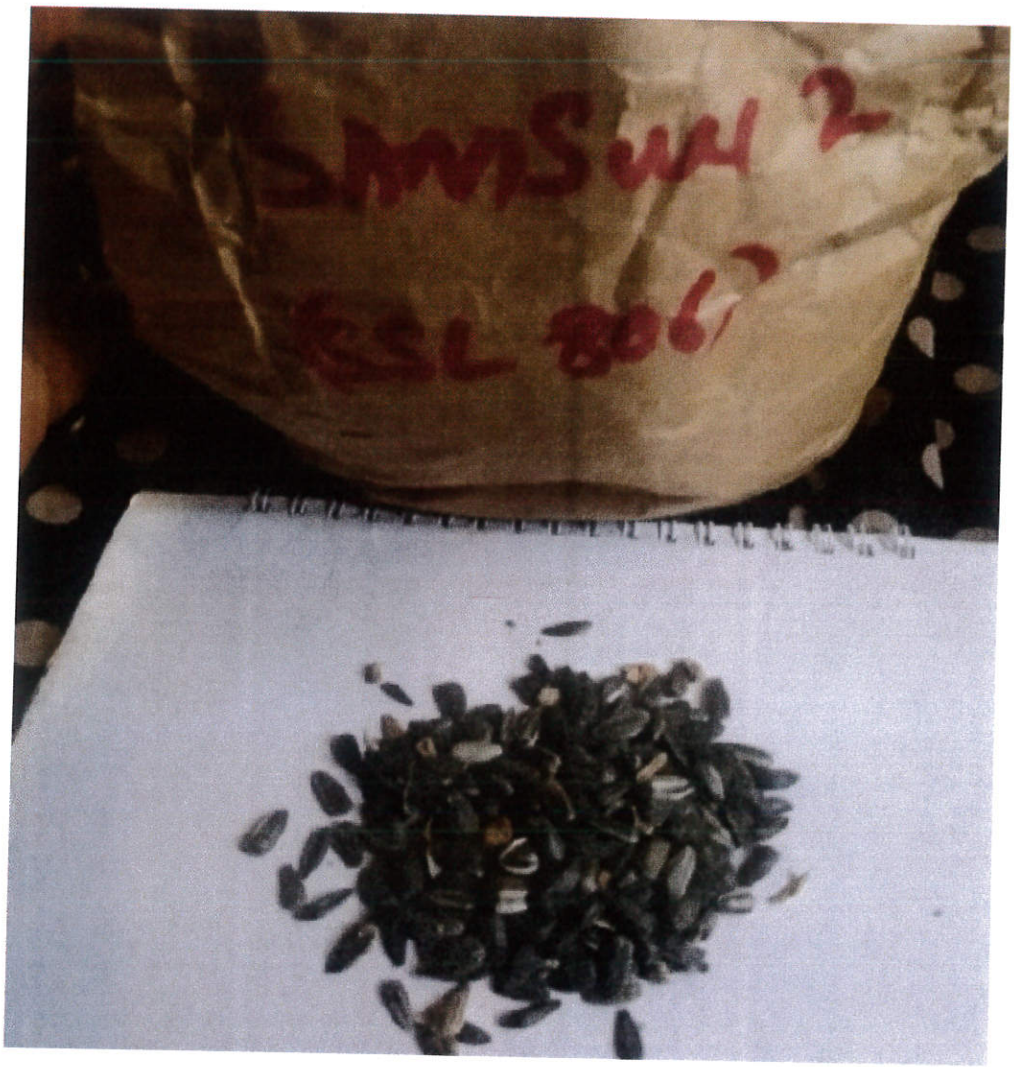


Plate 1: SAMSUN 1

3.3 Type of soil

The soil used for the experiment was a Sandy Loam soil. Soil analysis test was done to elucidate the soil composition

3.4 Replication

Three (3) replications of 50 stands each were planted for each Sunflower variety

3.5 Sowing date and seeding rate

The seeds were planted on 16th of December 2017

Three seeds were planted in polythene bags at 2cm depth with inter and intra-row spacing of 70cm by 30cm and were later thinned to one plant per bag, 14 days after planting.

3.6 Weed control

The weeds in the polythene bags were controlled manually by hand (manual weeding)

3.7 Harvesting

The seeds were harvested 124 days after planting.

Harvesting was done manually. Manual harvesting is practiced by cutting the umbel containing the seeds of the plant with a knife.

Plate 3: Dry Sunflower Plant indicating harvesting time

Plate 4: Seed arrangement on the Sunflower

Plate 5: Harvested seeds of Sunflower

After harvesting, the seed were sundried. The cleaning process followed immediately after harvesting. This involves hand picking of stones and dirt accumulated during the harvesting process.

3.8 Data collection

Data were collected every two weeks on the plant height, stem diameter and the number of leaves.

Plant height: This was done by placing a long rope on the plant stem from the soil level to the plant apex and then measuring the rope on a ruler.

Number of leaves: the number of leaves on each Sunflower plant was counted manually by hand

Stem diameter: This was done by placing a rope round the stem of the plant and placing the rope on a ruler.

Data analysis

The agronomic data from the two plant varieties were analyzed mathematically USING IBM SPSS 21(Paired Samples Test)

3.9 Oil extraction

The seeds were sundried after which they were pounded in a mortal. After pounding they were then taken to the mill. The grounded samples were put in a muslin bag and placed in a jar, the extraction solvent (n-haxane) was poured into the jar. The oil was then extracted using Soxhlet apparatus

Weight after milling:

SAMSUN 1: 3.6kg

SAMSUN 2: 2.7kg

Oil yield

After the extraction process, SAMSUN 1 gave 400ml of oil and SAMSUN 2 gave 460ml of oil

Plate 6: Seeds in muslin bag in a jar

Plate 7: mixture of n-haxane and the oil after extraction.

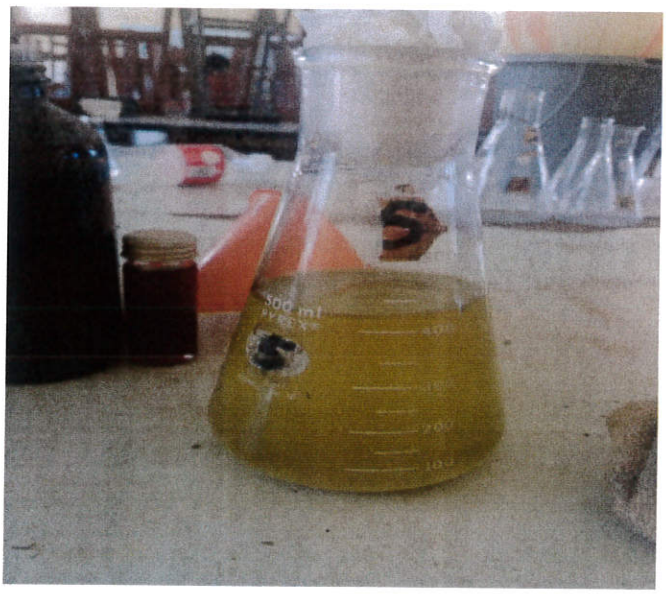
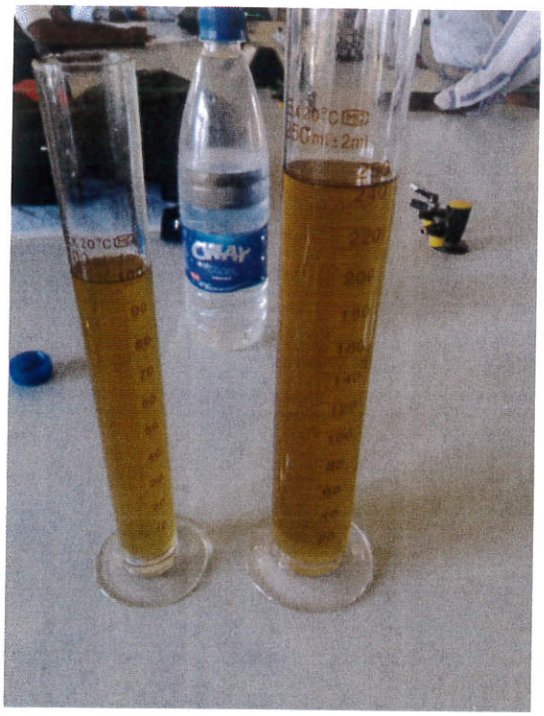


Plate 8: Soxhlet apparatus

Plate 9: extracted oil



3.10 Vitamin a protocol

A weighed sample of the oil containing not more than 1g fat and at least 240 unit of vitamin A was mixed with 30ml absolute ethanol and 3ml of 5% potassium hydroxide. The mixture was boiled gently under reflux for 30 minutes in a steam of oxygen free nitrogen. It was allowed to cool down and 30ml of water was added after which it was transferred to a separator. It was then washed with 3X 50ml ether and the vitamin A was extracted by shaking it for 1 minute, after complete separation, the lower layer was discarded and the extract was washed with 50ml water . The extract was washed and evaporated to 5ml and the remaining ether was removed in a steam of nitrogen at room temperature. The residue was dissolved in sufficient isopropyl alcohol to give a solution. The extinction was measured at 300, 310, 325 and 334nm and the wavelength of maximum absorption (Pearson, 1975).

Determination of vitamin e

One gram of the sample was weighed into a 100ml flask fitted with a reflux condenser, and then 10ml of absolute ethanol was added with 20ml of 1M alcoholic Sulphuric acid. It was then refluxed for 45minutes and allowed to cool down. 50ml of water was added and then transferred to a separating funnel of low actinic glass with additional 50ml of water. The unsaponifiable matter present was extracted with 5X 30ml diethyl ether, and the extract was evaporated at low temperature. While protecting from sunlight, the residue was dissolved in 10ml absolute alcohol, then the standard and the sample were transferred to a 20ml volumetric flask and 5ml of absolute alcohol was added followed by 1ml concentrated Nitric acid. The flask was placed in water bath at 900C for 3minutes. The flask was cooled under running water and the volume was made up to 20ml with absolute alcohol. The absorbance was measure at 470nm. (Pearson,1975)

Determination of vitamin c

The vitamin C content was determined using the ascorbic acid as the reference compound. 200µl of the extract was pipetted and mixed with 300µl of 13.3% trichloroacetic acid (TCA) and 75µl 2,4-dinitrophenylhydrazine (DNPH). The mixture was incubated at 370C for 3hrs and 500µl 65% H2SO4 was added and the absorbance was read at 520nm. (Benderitter*et al.*, 1998).

Determination of vitamin k

The procedure for color development as adopted from Menotti's procedure. The solution in which the concentration of vitamin K is being determined was placed in a flask and Sodium Pentacyanoamineferroate reagent was added. The solution was stirred and then allowed to stand for fifteen minutes to allow maximum color development. When the blue color has developed, the absorption of the solution was measured by means of a spectrophotometer at 650nm.

Standard vitamin K solution: The standard Vitamin K solution was prepared by dissolving 5 milligrams of crystalline Vitamin K in water and diluting to 100 milliliters. This solution was stabilized for 4 to 6 hours. The absorption of the solution was read on a spectrophotometer at 650nm, against a reagent blank.

3.11 Proximate analysis

Moisture: The moisture content of the sample was determined using air oven (AOAC, 2000). The petri dishes were washed and dried in air oven. The dishes were then transferred into the desiccator and allow to cool. The weights of the petri dishes were measured. 3g of sample was weighed into a dry petri dish and the contents were transferred into an oven maintaining a temperature of 105^0C. The content was allowed to dry at this temperature for 6hrs. The petri dish with its content was removed from the oven and placed in the desiccator. After cooling, the

weight was measured, after drying to constant weight. The percentage moisture was calculated using the following equation:

Original sample weight (g) – Dried sample weight (g) × 100 = Moisture %

Ash: clean crucibles were ignited at 350^0C for about 15mins, cooled in a desiccator and weighed. 1g of each sample was transferred into each of the appropriately labeled crucibles and then reweighed. Then, the crucibles with their contents were transferred into the muffle furnace at 5500C for about 5hours. After complete ashing, the crucibles were allowed to cool in a desiccator and then reweighed. The percentage of ash was then calculated using the formula:

$$\text{Ash content (\%)} = \frac{\text{Weight of crucible with ash(g)} - \text{Weight of empty crucible (g)x 100}}{\text{Weight of sample (g)}}$$

Crude Protein

Crude protein of the samples was estimated using Kjeldahl procedure. A sample of 0.5 g and a blank was estimated in the digestion tube. For digestion at high temperature, 10 ml of concentrated Sulfuric acid and 1.1 g digestion mixture were added in the tube. The digestion tubes were then set in digestion chamber fixing at 420^0C for 45 minutes ensuring water supply, easier gas outlets etc. After digestion the tubes were allowed to cool and 5ml of Sodium thio-sulphate ($Na_2S_2O_3$, 33%) and 30 ml Sodium hydroxide (NaOH) solution was added in each tube. Then the distilled extraction was collected with 25ml of Boric acid (4%) and titrated with standard Hydrochloric acid (0.2N). The Nitrogen values obtained was converted into percentage of crude protein by multiplying with a factor of 6.25 assuming that protein contains 16% nitrogen.

$$\% \text{ Nitrogen} = \frac{\text{Milliequivalent of Nitrogen (0.014) X titrant value (ml) X strength of HCL X 100}}{\text{Sample weight (g)}}$$

% Crude protein = % Nitrogen X 6.25

Crude Lipid

Crude lipid was determined by extracting a weighed quantity (3g) of samples with analytical grade acetone in ground joint Soxhlet apparatus. Extraction was allowed to continue by heating in the electric heater at the temperature 70^0C until clear acetone (without oil) was seen in siphon, which took about 3 hours. Then the round bottom flask of the apparatus was separated and the extract was transferred to a pre-weighed beaker and left for evaporation of acetone. After the evaporation of acetone, only the lipid was left in the beaker and the crude lipid was calculated in percentage thus:

$$\% \text{ Crude lipid} = \frac{\text{Weight of beaker with lipid– Weight of empty beaker x 100}}{\text{Weight of sample (g)}}$$

Crude Fibre

A small amount of finely grinded sample (2g) was taken into a filter crucible and was inserted into the hot extraction unit (Hot Extractor, Model-1017). Pre-heated 0.128M of sulfuric acid (H_2SO_4) was added into the reagent heating system and few drops of octanol ($C_8H_{18}O$) were added through the valves. The mixture was digested for 30 minutes. Acid was then removed from it by filtering and washing with boiling water. The residue in the flask was boiled with 0.223M of potassium hydroxide (KOH) for 30 minutes and then filtered with subsequent washing in boiling water and acetone. The residual content was then dried in an oven at 105°C

for a few hours and then ignited in muffle furnace at 550°C for 3 hours. The loss of weight represented the crude fibre. Then percent crude fibre was calculated by the following formula:

$$\text{Crude fibre (\%)} = \frac{\text{Oven dried weight of sample (g)} - \text{Ash weight of sample(g)} \times 100}{\text{Weight of sample (g)}}$$

Carbohydrate

Carbohydrate was calculated by subtracting the sum of the percentage contents of moisture, crude protein, lipid, ash and crude fibre from 100.

Cho % = {100- (moisture + crude protein + crude lipid + ash + crude fibre)}

Determination of minerals

The minerals were analyzed from the solution obtained by the first dry ashing. 1g of each sample was placed in a crucible and placed in a muffle furnace at 550^0C for 5hours to ash and then transferred into desiccators to cool. The cooled ash was dissolved in 10% hydrochloric acid (HCL), filtered into a clean graduated sample bottles and the solution was made up to 50ml with distilled water. The solution was aspirated into the atomic absorption spectrophotometer to obtain the mineral concentration.

CHAPTER 4

RESULTS

4.1 Specific description of SAMASUN 1

1. Plant type: shrubby, annual, erect
2. Photoperiod sensitivity: neutral
3. Plant height 61cm
4. Leaf shape: broad leaf
5. Stem thickness: 1.8cm
6. Number of leaves: 28
7. Flower colour: bright yellow
8. Head diameter:17cm
9. Seed size: 6g per 100 seeds
10. Seed colour at maturity: light ash
11. Seed texture: smooth
12. Number of head per plant: 1

4.2 Specific description of SAMSUN 2

1. Plant type: shrubby, annual, erect
2. Photoperiod sensitivity: neutral
3. Plant height: 46cm
4. Leaf shape: broad leaf
5. Stem thickness: 1.6cm
6. Number of leaves: 28

7. Flower colour: deep yellow
8. Head diameter:14cm
9. Seed size: 7g per 100 seeds
10. Seed colour at maturity: ash colour
11. Seed texture: rough
12. Number of head per plant: 1

4.3 Seed yield

The weights of the harvested Sunflower seeds are as follows:

For SAMSUN 1 (803)

Per 100 seeds - 6g

For SAMSUN 2 (806)

Per 100seeds – 7g

Total weight of harvested SAMSUN 1 seeds = 3.74Kg

Total weight of harvested SAMSUN 2 seeds = 2.96Kg

4.4 Agronomic data of SAMSUN 1 and 2 84 days after planting

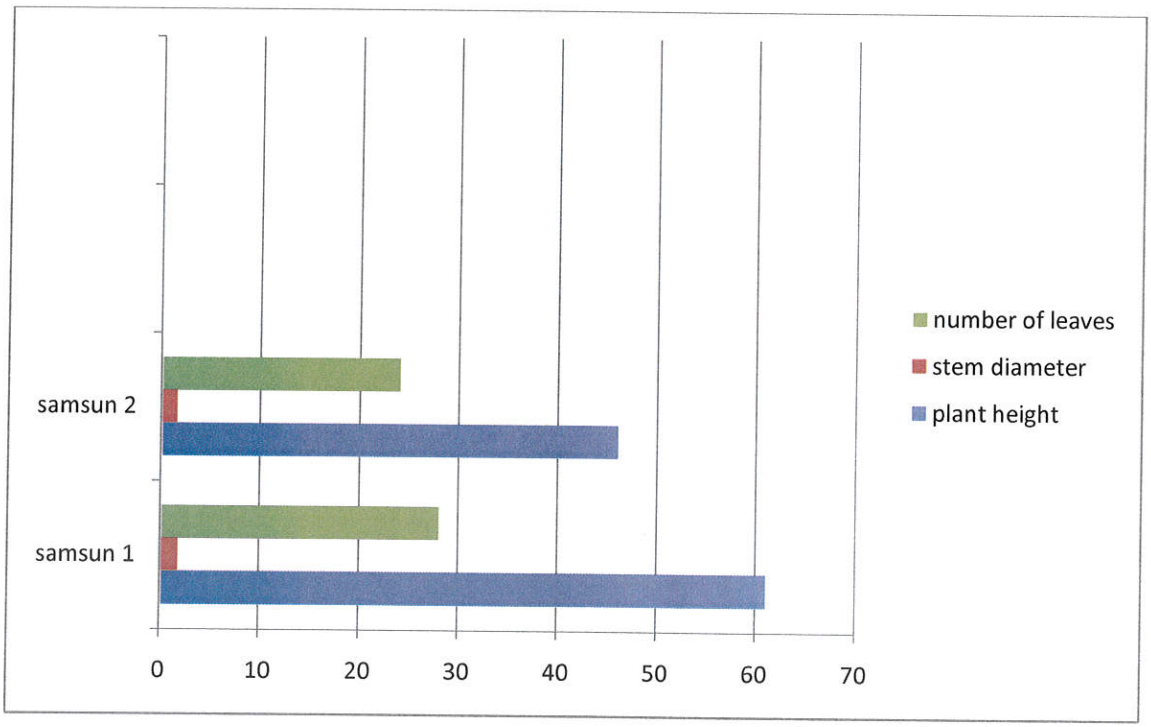


Figure 2: 84 days after planting

Table 2: overall paired sample test of the agronomic data after the vegetative stage

	Paired Differences					T	Df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Height_1 - Height_2	9.37222	9.21698	2.17246	4.78873	13.95572	4.314	17	.001
Leaf_1 - Leaf_2	-.77778	1.51679	.35751	-1.53206	-.02350	-2.176	17	.044
Stem_1 - Stem_2	.07778	.15168	.03575	.00235	.15321	2.176	17	.044

Table 2shows that the overall plant height of SAMSUN 1 and SAMSUN 2 were statistically significant as the probability level of 0.001 was lower than the critical value of 0.05. Likewise the number of leaves for both plants was significantly different with p-value of 0.004 lower than the critical value of 0.05. The same result goes for the size of the stem as the p-value of 0.044 was less than the critical value of 0.05

4.6 Laboratory analysis

Table 3: vitamins content of SAMSUN 1 and SAMSUN 2

VIT. C mg/g		
803	1.632515	1.745102
806	4.784958	4.559784
VIT. E mg/g		
803	2.736184	2.757264
806	3.882936	3.904016
VIT. K mg/g		
803	0.042106	0.041915
806	0.057967	0.058413
VIT.A unit/g		
803	1488.03	1484.99
806	1809.74	1811.35

Table 4: The pH and Nitrogen level of the Soil

	pH	Nitrogen
Soil sample	5.36	1.28

Table 5: Proximate analysis, oil composition and mineral composition of the Sunflower oil.

Plant type	Proximate analysis (%)					Oil composition (%)			Mineral (ppm)				
	Moisture	Ash Content	Crude protein	fat	Crude fibre	Moisture	ash	Crude protein	Sodium	potassium	Magnesium	iron	Zinc
SAMSUN 1	5.88	1.58	7.10	3.35	3.35	5.37	0.74	11.91	13.60	42.20	3.69	0.63	1.31
SAMSUN 2	4.29	2.16	6.45	4.67	4.67	6.98	0.73	12.37	15.10	37.80	1.97	0.37	0.96

CHAPTER 5

DISCUSSION AND CONCLUSION

An overall agronomic performance was conducted on two different Sunflower varieties between December 2017 and April 2018 to determine the effects of the environment on the growth of *Helianthus annuus* (Sunflower) in Ado Ekiti, Southwest Nigeria. The agronomy data showed that there was a significant variation among the two varieties evaluated. SAMSUN 1 matured faster and performed better during the vegetative stage when compared to SAMSUN 2. However, the performance observed in this study was not as good as that recorded in Zaria by Showemimo*etal.*, (2010) suggesting that the environment plays a significant role.

The Sunflower planted in Ado Ekiti had an average height of 61cm for SAMSUN 1 and 46cm for SAMSUN 2, with 28 and 24 as the average number of leaves for SAMSUN 1 and 2 respectively. This is significantly different from the average plant height recorded in Zaria 120cm for SAMSUN 1 and 125cm for SAMSUN 2 with 20 and 24 as the average number of leaves for SAMSUN 1 and 2 respectively (Showemimo*etal.*, 2010).

The crude proteinobtained from this work was 11.9% forSAMSUN 1and 13.92% for SAMSUN 2 and these values were considerably lower than the crude protein reported by Showemimo*et al.*, (2010); 17.2% and 19.72% for SAMSUN 1 and SAMSUN 2 respectively.

However, the ecological and environmental factors in the rainforest region may play a role by reducing the protein content of the oil.

The moisture content of the Sunflower seeds was 5.88% for SAMSUN 1 and 4.29% for SAMSUN 2. These figures are higher than those reported by Showemimo*et al.*, (2010),andthis difference in moisture content can be attributed to the amount of rainfall in the rainforest zone of Nigeria.

The oil extracted from the seeds contains vitamin E which is in line with the findings of Flagella *et al.*, 2002 and Qahar*et al.*, 2010. Vitamin E prevents dangerous free radicals from oxidizing the body's cholesterol.The shaft of the Sunflower contains 7.10% and 6.45% crude protein and 3.35% and 4.16% crude fat , thus it can be used as animal feed as previously suggested by BIO, (2005).

5.1 Conclusions

This research study has shown that Sunflower will grow in Ekiti State a rainforest zone in Southwest Nigeria. Since the plant is prone to logging if planted during rainy season, the best time to plant Sunflower would be the dry season to avoid yield loss.

The result of the study showed that Sunflower seeds are rich in protein, fibre but low in fat content and this is responsible for its reported uses in food preparation in different parts of the world. The presence of vitamin E a very powerful antioxidant also confirms its use in preventing asthma.

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