

**CORRELATION BETWEEN OIL CONTENT AND YIELD PARAMETERS OF  
SOME SOYBEAN (*Glycine max* (L.) Merrill) GENOTYPES IN KEFFI, NASARAWA  
STATE**

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**DECEMBER, 2016.**

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE  
REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (HONS)  
DEGREE IN PLANT GENETICS AND BREEDING DEPARTMENT OF  
BIOLOGICAL SCIENCES, NASARAWA STATE UNIVERSITY, KEFFI**

**DECEMBER, 2016**

## DECLARATION

I hereby declare that this dissertation has been written by me and it is a report of my research work, all quotations are indicated and source of information specially acknowledged by means of references.

.....

Adeshina, Dolapo Adetokunbo

NSU/NAS/M.Sc/PGB/773/12/13

## CERTIFICATION

This dissertation titled, “Correlation of Oil Content and Yield Parameters in some Soybean (*Glycine max* (L.) Merrill) Genotypes in Keffi, Nasarawa State” meets the regulations governing the award of the degree of Master of Science in Plant Genetics and Breeding, Faculty of Natural and Applied Sciences of the School of Postgraduate Studies, Nasarawa State University, Keffi, Nigeria for its contribution to scientific knowledge and literary presentation.

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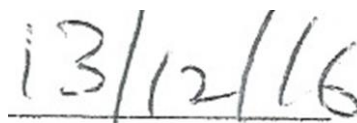
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## **DEDICATION**

This dissertation is dedicated first to God Almighty, to my husband, children and family for their support.

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## ABBREVIATIONS

ANOVA	Analysis of Variance
GLM	General Linear Model
SAS	Statistical Analysis System
RCBD	Randomized Complete Block Design
OC	Oil Content
WWP	Weight With Pods
NSP	Number of Seeds Per Pod
NP	Number of Pods
WWTP	Weight Without Pods
GY	Grain Yield
CV	Correlation of Variation
DMRT	Duncan's multiple range test

## ABSTRACT

Soybean meals and oils are very essential for human and animal health. Twelve varieties of Soybeans were evaluated to determine their variability in oil content as well as the correlation between oil content and yield parameters. The study was carried out during the rainy season of 2015 at the Botanical garden of the Department of Biological Sciences, Plant science and Biotechnology unit farm of Nasarawa State University, Keffi. Randomized complete block design (RCBD) was used and replicated three times. Data was collected on agronomic characters such as days to emergence, days to 50% flowering, plant height, number of leaves, stem diameter, grain yield, seed weight, number of flowers, leaf area and oil content per a hundred grams of seeds. The results from these data were analyzed using ANOVA and correlation analysis. All of the analyzed traits varied significantly ( $P < 0.05$ ) between varieties. The variety TG  $\times$  1989 – 45F had the highest weight per plot with a mean of 3733 while TG  $\times$  1990 – 21F had the lowest mean as 1000g. It was observed that Variety TG $\times$ 1989 – 42F had the highest mean for oil content (17.0ml). Oil content showed a positive correlation with number of pods  $r = 0.410$ , weight with pods  $r = 0.3406$ , weight without pods  $r = 1$ , number of seeds per pod  $r = 0.9162^*$  and Grain yield  $r = 0.215^*$ . Based on this study soybean varieties TG  $\times$  1989 – 45F and TG  $\times$  1989 – 42F are recommended for farmers in Keffi area interested in grain and oil content, respectively.

## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background of study

Soybean (*Glycine max* (L.) Merrill) is a species of legume native to Eastern Asia and introduced into Nigeria in 1908 (Seyi, 2014). Soybean is among the major industrial and food crops grown in every continent. The crop can be successfully grown in many states in Nigeria using low agricultural input. Soybean cultivation in Nigeria has expanded as a result of its nutritive and economic importance and diverse domestic usage. It is also a prime source of vegetable oil in the international market (Dashiel, 1993). With improvement in breeding and processing research, soybean cultivation, domestic market, processing and utilization have grown considerably in Nigeria. Approximately 98 percent of the soybean meal that is crushed is further processed into animal feed with the balance used to make soy flour and proteins. Of the oil fraction, 95 percent is consumed as edible oil; the rest is used for industrial products such as fatty acids, soaps and biodiesel (Ashraf *et al.*, 2012).

Soybean has been recognized in the country as an important food crop that contains about 40 percent high quality protein and about 20 per cent oil. Industrial and domestic processing of soybean has given rise to numerous products utilized for both human and animal consumption. The importance of soybean in food security especially for the poor in Nigeria cannot be overemphasized. It is the best source of plant protein, substituting the animal-protein sources, which are usually inadequate in supply for poor households (Seyi, 2014). Most soybean breeding programs have regional testing efforts to evaluate genotypes across a wide array of environments, a genotype is selected from these tests on the basis of

ability to perform well in most environments. Evaluation and selection of stable cultivars is the most common way that environmental influence is moderated by genetics. The other way is to attempt to tailor a variety for a particular environment. This can be quite successful if the environment can be defined (Jagdish *et al.*, 2000). The average lifetime of a soybean cultivar in the United States is five to nine years in part because of the dynamic nature of the agro ecosystem. The sudden appearance of a disease, change in climate, global warming, water or soil conditions or changing cultural practices can necessitate the replacement of a cultivar which is more adapted to the new environment (Jagdish *et al.*, 2000).

Different genotypes will have variabilities in their yield parameters as their response to the environment will vary. These yield parameters include days to 50% emergence, days to 50% flowering, plant height, number of leaves, stem diameter, 100 seed weight, number of flowers, Leaf area amongst others (Abdullah *et al.*, 2009). Correlation studies is initiated with the objective of observing the mutual relationship of different morphological characters and also their contribution to yield parameters (Amsalu *et al.*, 2014).

## **1.2 Statement of the problem**

Previous studies in different parts of the world suggest various plant traits which should be considered to be most important while selecting soybean genotypes for higher seed yield and oil content (Ashraf *et al.*, 2012). Drought stress is a major constraint to the production and yield stability of soybean [*Glycine max* (L.) Merrill]. For developing high yielding varieties under drought conditions, the most widely employed criteria has traditionally been

direct selection for yield stability over multiple locations (Guttikonda *et al.*, 2009). Soybean breeders suspect that oil content is negatively correlated with yield (Babka *et al.*, 2003).

An understanding of the relations among various characters with seed yield is essential so as to find appropriate selection criteria. Quite often, characters are correlated and selection for one character may lead to either positive or negative response in the other characters. This response can be predicted if the correlation and heritability of the characters are known (Morakinyo, 1996). It is a challenge to farmers and breeders to select specific varieties to use when planting for either seed yield, oil content or both. This serves as a problem and a foundation for undergoing this research.

### **1.3 Justification of the study**

Nigeria's soybean production is rising steadily spurred by favorable grower prices and sustained high demand for soy meal by the poultry sector over the past five years however growth in domestic production lags behind rapid growth in demand by the poultry sector and other sectors. As a result, the price of soybeans has almost doubled to the current \$670 in early 2014 (USDA, 2014). The quantity of oil and seed yield varies amongst genotypes. Varieties of testing are very important so we could evaluate which varieties are the best solutions for the specific growing region (Djekic *et al.*, 2013).

Adequate choice of soybean cultivar is of great importance for attaining high and stable yields to meet and surpass local needs. Soybean is a legume that has been in use centuries ago and recently gained entry into the Nigeria farming circle. Annually, a good number of the world's total soybean production is processed into different types of soybean meal and oil (Djekic *et al.*, 2013). These meals and oils are very essential for child and adult health

alike. Apart from human consumption, soybean is used for the production of nutritious animal feeds of different kinds in the market.

For the proper understanding of seed yield performance and oil content of any crop cultivar under specific set of environmental conditions, it is necessary to study the contribution of various yield and oil determining parameters towards final seed and oil yield. It will not only help in selecting suitable variety for an agro-ecological zone but also provide guideline for breeder to develop improved variety of the crop. Therefore correlation and regression studies among yield and yield contributing traits, oil and oil increase of soybean will provide knowledge which will be of greater significance for agronomists and plant breeders in manipulation in any crop improvement programme as these traits would lead to higher economic yield.

#### **1.4 Aim of the study**

This study is aimed at evaluating the correlation between oil content and seed yield parameters of soybean (*Glycine max* (L.) Merrill) in Keffi, Nasarawa State, Nigeria.

#### **1.5 Objectives of the study**

The objectives of this study are to:

- i) Determine the variability of oil content among the selected genotypes of soybean
- ii) Determine the yield performances of the selected genotypes of soybean.
- iii) Estimate the relationship between the oil content and grain yield parameters among the selected soybean genotypes.

## **1.6 Research Hypothesis**

The following research hypothesis were proposed to guide this study:

- i) There is no significant relationship between oil content and genotypes of soybean in Keffi, Nasarawa State.
- ii) There is no significant relationship between yield parameters and genotypes of soybean in Keffi, Nasarawa State.
- iii) There is no significant relationship between oil content and yield parameters of genotypes of soybean in Keffi, Nasarawa State.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Botany of soybean

The soybean is a legume; like all other peas and beans, lentils and peanuts, it belongs to the large botanical family Leguminosae (which includes some 500 genera and more than 12,000 species), in the subfamily Papilionideae. The genus *Glycine* has had a stormy taxonomic history. All food legumes (also called "edible grain legumes") can be divided into two types: oilseeds and pulses. Soybeans, like peanuts, are oilseeds (Aoyagi and Shurtleff, 2004). Soybean is from Kingdom-Plantae, Phylum-Magnoliophyta, Class - Magnoliopsida, Order-Fabales, Family-Fabaceae, Genus-*Glycine*, Species - *max* (Arnarson, 2016).

##### 2.1.1 Origin and distribution of soybean

The first domestication of soybean has been traced to the eastern half of North China in the eleventh century B.C. or perhaps a bit earlier (Benson and Gibson, 2005). Soybean has been one of the five main plant foods of China along with rice, soybeans, wheat, barley and millet (Arnarson, 2016). According to early authors, soybean production was localized in China until after the Chinese-Japanese war of 1894-95, when the Japanese began to import soybean oil cake for use as fertilizer. Shipments of soybeans were made to Europe about 1908, and the soybean attracted world-wide attention (Arnarson, 2016). Europeans had been aware of soybeans as early as 1712 through the writing of a German botanist. Some

soybean seed may have been sent from China by missionaries as early as 1740 and planted in France (Benson and Gibson, 2005).

It derives from *Glycine ussuriensis* species that grows wild in China and Japan. Soybeans originated in Southeast Asia. We have traces of their existence in China for over 5000 years and their use as food is documented in this country in 2800 BC. Since the Eastern religions prohibit the consumption of animal meat, soybeans were imposed from the beginning as a crop in the East to supply essential proteins for people who could not afford meat. In fact, in these regions is known as "flesh of the fields" or "beef in China." From there, it was taken to Europe in the eighteenth century and to U.S.A. in the early nineteenth century (Fennel, 1966).

Soybeans were first introduced into Nigeria in 1908 (Fennel, 1966), but the first successful cultivation was in 1937 with the Malayan variety, which was found suitable for commercial production in Benue State in Central Nigeria (Adegbite *et al.*, 2007). Soybean is valued as a productive and adaptable crop which fits well into the cropping patterns of varying agro-climatic conditions. Soybean is generally considered as a highly versatile grain which has about 365 applications in the formulation of both human and animal foods and other industrial uses (Adegbite *et al.*, 2007).

### **2.1.2 Phytochemical characteristics of soybean**

Soybeans contains antioxidants and phytonutrients that have been linked with various health benefits, while concerns have also been raised about adverse effects. Together for the chemical composition protein and soybean oil content account for 56% of dry soybeans

by weight (36% protein and 20% fat).The remainder consists of 30% carbohydrates, 9% water and 5% ash (Arnarson, 2016).

## **2.2 Production of soybean in Nigeria**

Nigeria presently produces about 500,000 MT of Soybean annually making it the largest producer of the product on the African continent. Soybean is a legume which is produced in mostly the middle belt of the country with Benue State accounting for about 45% of the total production in the country. Benue state accounts for over 70% of the production in the middle belt region. Some of the states producing Soybeans in Nigeria include Kwara, Kogi, Oyo, Ondo, Nasarawa, Kaduna, Niger, Bauchi, Ogun and Taraba states. Others are Adamawa, Abia, Enugu, Anambra, Jigawa, Lagos, Plateau, Ekiti and the Federal capital Territory, Abuja (Adegbite *et al.*, 2007).

## **2.3 Economic importance of soybean**

Soybean is a cheap source of quality protein that is superior to all other plant foods because it has good balance of the essential amino acids. Its seed has a close protein content and fairly close amino-acids with cow milk (Belewu and Belewu, 2007). The fat from the soybean is unsaturated type unlike saturated fats from animal origin and hence is good for heart disease patients (Fabiya, 2006). Various soy products are available such as soyflour, soyprotein, Tofu, soymilk, soysauce and soybean oil (Arnarson, 2016). According to UN food and Agriculture Organization FAO, (1999) the plant soybean is classed as an oilseed rather than a pulse it produces significantly more protein per acre than most other uses of

land. Fat free (defatted) soybean meal is a significant and cheap source of protein for animal feeds and many pack aged meals for example soybean products such as textured vegetable protein (TVP), are ingredients in many meat and dairy substitutes. The beans contain significant amounts of phytic acid, dietary minerals and B vitamins (FAO, 1999). Soy vegetable oil, used in food and industrial applications is another product of processing the soybean crop. The plant is known as the "large bean" in Chinese, Japanese, and Korean or "yellow bean" Both the immature soybean and its dish are called edamame in Japan, but in English, edamame refers only to a specific dish. Other than the high protein content, it also has good amount of calories and fat. It contains the eight essential amino acids and is a rich source of polyunsaturated fatty acids (including the good fat-omega 3) and is free of cholesterol (FAO, 1999).

Soybean contains 43 grams of protein per 100gms, which is the highest among the pulses. It also contains 19.5gms of fat, 21gms carbohydrate and provides 432 kcal per 100gms (Akiko and William, 2000). It is one of the best vegetarian food items as far as protein content is concerned, with an average production cycle of 90-110 days from planting to harvesting (Fabiya, 2006). Research has it that one kilogram of soybean contained as much protein as 2kg of boneless meat or 45cups of cow's milk or 5dozen of eggs (Dashiell, 1993). Soybean seed contains about 40% protein, 30% carbohydrates, 20% oil and 10% mineral (Dashiell and Osho, 1998).

Nigeria's soybean production is rising steadily spurred by favorable grower prices and sustained high demand for soy meal by the poultry sector over the past five years. Growth

in domestic production lags behind rapid growth in demand by the poultry sector, averaging about 25 percent per annum the last five years. As a result, the price of soybeans has almost doubled to the current \$670 in early 2014. Soybean meal remains a vital and preferred source of protein in compound feed by the Nigerian poultry industry (USDA, 2014). The beans can be utilized in the liquid, powdery and curd forms for human consumption. The oil could be converted to margarine and salad oil. In most cases, soybean has found wide application in the reduction of malnutrition related problems. Owing to its nutritional value there is a growing demand for soy products such as soymilk, soy oil, soy cake, and soy cheese like soybean curd rich in protein (George, 2015).

The medicinal nature of soybean is extremely essential in building body immune system. Soy food has been reported to provide significant, but not total protection against heart disease, high blood pressure, stroke, ulcer, menopause, diabetes and cancer (George, 2015). Recently, soybean is found to be an industrially important crop used as anti-corrosion agent, core oil, and bio-fuel due to less or no nitrogen element in the oil, and as disinfectant, in pesticides, printing inks, paints, adhesives, antibiotics and cosmetics (Ashraf *et al.*, 2012)

### **2.3.1 Soybean uses in the cosmetic industry**

Traditional Chinese medicine professes that topical soy provides skin care benefits. There are accounts from scientists that Asian workers in Soybean factories who handled soy regularly had hands that were especially smooth, and even toned and that women working in the tofu industry had beautiful skin. This observations led to the use of Soybean by the cosmetic industry (United Soybean Board, 2016). Within the past ten years, the cosmetic

industry with a worldwide sale reportedly about \$ 170 billion dollars a year and almost 25% of the amount which occurs in United States) has tapped the soybean and its components for use in a wide range of products from shampoos and conditioners to creams aimed at evening skin tone and reducing blotchiness. Some other school of thought are adopting the “beauty from within” concept that is are interested in the effects of soy product ingestion on skin health they observe that there are multiple components in the soybean that appear to beneficially affect various aspects of skin health (United Soybean Board, 2016). Clinical and scientific studies both show that soy works to reduce blotchiness and discoloration by evening out the appearance of pigments within the skin’s surface. Soy proteins can also work to moisturize skin and reduce the appearance of fine lines it is excellent for women who want an all-natural beauty routine (Beauty news, 2012).

According to Beauty news, (2012) their dermatologists suggests that soybean oil is rich in vitamins and has a small molecular structure which enables it to penetrate the epidermis - which is the top layer of the skin well it can nestle into the cellular structure and stimulate the synthesis of collagen, elastin and other proteins. This encourages cell growth and regeneration by reversing abnormal cell formations. Soy is naturally rich in Vitamin E which promotes healing and regeneration through its antioxidant properties (United Soybean Board, 2016).

Essential fatty acids can help moisturize the collagen below the skin surface, lecithin is known to help maintain the elasticity of the skin Soy based skin care products can even out skin tone and can correct pigmentation brought about by hormonal changes and damaging sun exposure thereby smooth out fine lines and prevent premature aging Soya contains a

substance called genistein a natural plant hormone which boosts collagen production collagen gives skin its strength and elasticity which depletes with age this could be the answer to youthful, wrinkle free skin (United Soybean Board, 2016). In trials about two thousand women aged between 50 and 65 took part in a clinical trial in 2011 photographs were taken of wrinkles around their left eye area and they were asked to apply two or three drops of genistein to the area twice daily 53% of women who applied genistein extract reported firmer skin and has been included in some face serums it was so successful at reducing wrinkles that users dubbed it a “facelift in a bottle” (Beauty news, 2012). Recent studies have also found genistein to be an inhibitor of both breast and prostate cancer. It stops an enzyme that switches on cancer genes and also inhibits angiogenesis, the growth of new blood vessels needed to feed growing cancers in the laboratory (United Soybean Board, 2016).

It has been proven to curb the growth of all types of cancer cells, including those affecting the breast, lung, colon, prostate and skin including leukaemia. Genistein is also thought to be useful in the fight against heart disease by preventing fatty plaque buildup in arteries. It also deters the activity of thrombin, which promotes blood clotting, this in turn helping to prevent heart attacks and strokes (Beauty news, 2012). Beauty news, 2012 contributes that soybeans is known as the snack that have great nutritional value, they are classified as oilseeds and it is a complete protein because of the amount of essential amino acids below are some of the itemized benefits of the soy for beauty.

1. **Moisturizing:** it is a very good moisturizer for combination skin ( this is skin that can be dry or normal in some areas and oily in others such as the T zone which is

the nose, forehead and chin, many people have this skin type It may need slightly different care in different areas). Combination skin can have pores that look larger than normal because they are more open, blackheads and shiny skin because it can moisturize the dry skin parts as well as scrape the excess oil in oily skin. It helps reduce the signs of aging such as skin discoloration, dark spots, fine lines and even handcuffs (Beauty news, 2012).

2. **Strengthen nails:** It helps in strengthening brittle nails. Eating soy regularly for up to six months will make nails strong and shine. It can help treat nail fungus infection as well by dipping the nail in soy sauce the nail will be free of the fungus this is a homemade tip (Beauty news, 2012).
3. **Hair Shine:** It can be used as hair care product. Its benefit is making hair smooth, soft and shiny to do this soybean juice is applied on the hair. If done consistently for up to three months desired results would be seen (Beauty news, 2012).

### **2.3.2 Nutritional values of soybean**

The nutritional benefits of soybean are numerous. In Asia, soybeans are often eaten whole, but in Western countries including Nigeria processed soy products are much more common. Soybeans contain antioxidants and phytonutrients that have been linked with various health benefits, while some concerns have also been raised about adverse effects (Arnason, 2016). Dramatic increase in soyfood sales is largely credited to the Food and Drug Administration's approval of soy as a cholesterol- lowering food, along with other heart and health benefits. Asides from water,soybeans are mainly composed of protein,but they also contain good amounts of carbs and fat (Morakinyo, 1996). The tables 2.1, 2.2 2.3

and 2.4 contains information on all the basic nutrients in soybeans when boiled, roasted and raw as documented by Arnanson, (2016). Most soy protein are relatively heat stable storage protein. This makes soyfood require high temperatures for cooking such as soymilk and tofu as it is considered as a source of complete protein (Henkel, 2000). A complete protein contains significant amounts of all the essential amino acids that must be provided to the human body. According to US Food and Drug Administration this makes soybean a good source of protein amongst others for vegeterians,Vegans and for people who want to reduce their meat consumption (Henkel, 2000). Soybean can produce at least twice as much protein per acre than any other vegetable or grain crop,five to ten times more protein per acre than land set aside for grazing animals to make milk,and up to fifteen times more protein per acre than land set aside for meat production (NSRL, 2012). After fat has been extracted from soybean what remains is called soybean meal which is about 50% protein.

The majority of soybean meal is used to feed livestock but it can also go through further processing to produce isolated soy protein because it is cheap and has certain functional properties (NSRL, 2012). Soybean oil and soy protein have found their way into all sorts of processed foods such that for example most people in the United States of America are consuming significant amounts of soy without even knowing it. Soy protein is also the major ingredient in soy based infant formulas which is good for lactose intolerant infants (Gunnars, 2012).

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<b>Cooked soybean (100g serving)</b>	<b>Nutritional benefits(Vitamins and minerals)</b>
Calories	173
Water	63 %
Protein	16.6 g

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Carbs	9.9 g
Sugar	3 g
Fiber	6 g
<b>Roasted soybean (100g serving)</b>	<b>Nutritional benefits (Vitamins and minerals)</b>
Fat	9.6 g
Saturated	1.3 g
Monounsaturated	1.98 g
Polyunsaturated	5.06 g
Omega-3	0.6 g
Omega-6	4.47 g
Trans fat	~
Carbohydrate	9.9 g
Fiber	6 g
Sugars	3 g
Sucrose	~
Glucose	~
Fructose	~
Lactose	~
Maltose	~
Galactose	~
Starch	~

**Table 2.1: Basic nutrients in cooked soybean**

Source: Arnanson, (2016).

**Table 2.2: Basic nutrients in roasted soybean**

Calories	471
Water	2 %
Protein	35.2 g
Carbs	33.6 g
Sugar	~
Fiber	17.7 g
Fat	25.4 g
Saturated	3.67 g
Monounsaturated	5.61 g
Polyunsaturated	14.34 g
Omega-3	1.69 g
Omega-6	12.64 g
Trans fat	~
Carbohydrate	33.6 g
Fiber	17.7 g
Sugars	~
Sucrose	~
Glucose	~
Fructose	~
Lactose	~
Maltose	~
Galactose	~
Starch	~

Source: Arnanson, (2016).

**Table 2.3: Basic nutrients in raw soybean**

Raw mature seeds ( 100g serving)	Nutritional benefits(Vitamins and minerals)
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Energy	1,866 kJ (446 kcal)
Carbohydrates	30.16 g
Sugars	7.33 g
Dietary fiber	9.3 g
<b>Fat</b>	19.94 g
Saturated	2.884 g
Monounsaturated	4.404 g
Polyunsaturated	11.255g
Omega 3	1.330g
Omega 6	9.925g
<b>Protein</b>	36.49 g
Tryptophan	0.591 g
Threonine	1.766 g
Isoleucine	1.971 g
Leucine	3.309 g
Lysine	2.706 g
Methionine	0.547 g
Cystine	0.655 g
Phenylalanine	2.122 g
Tyrosine	1.539 g
Valine	2.029 g
Arginine	3.153 g
Histidine	1.097 g
Alanine	1.915 g
Aspartic acid	5.112 g
Glutamic acid	7.874 g
Glycine	1.880 g
Proline	2.379 g
Serine	2.357 g
Vitamin A equiv.	(0%) 1 µg
Thiamine (B1)	(76%)0.874 mg
Riboflavin (B2)	(73%)0.87 mg
Niacin (B3)	(11%)1.623 mg
Pantothenic acid (B5)	(16%)0.793 mg
Vitamin B6	(29%)0.377 mg
Folate (B9)	(94%)375 µg
Vitamin B12	(0%)0 µg
Choline	(24%)115.9 mg
Vitamin C	(7%)6.0 mg
Vitamin E	(6%)0.85 mg
Vitamin K	(45%)47 µg

Source: Arnanson, (2016).

**Table 2.4: Basic mineral and other constituents in raw soybeans**

<b>Raw mature seeds(100g serving)</b>	<b>Nutitional benefits(Vitamins and minerals)</b>
	<b>MINERALS</b>
Calcium	(28%)277 mg
Iron	(121%)15.7 mg
Magnesium	(79%)280 mg
Manganese	(120%)2.517 mg
Phosphorus	(101%)704 mg
Potassium	(38%)1797 mg
Sodium	(0%)2 mg
Zinc	(51%)4.89 mg
	<b>OTHER CONSTITUENTS</b>
Water	8.54 g
Cholesterol	0 mg

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Source : Arnanson, (2016).

### **2.3.3 Health values of soybean**

According to the American Cancer Society, “Studies in humans have not shown harm from eating soy foods. Moderate consumption of soy foods appear safe for both breast cancer survivors and the general population and may lower breast cancer risk. They caution however that soybean supplements should be avoided ( McCullough, 2012). Some people are allergic to soybean like any other crop for example nuts some reactions may include hypersensitivity allergic skin problems like urticaria, hives, eczematous dermatitis. In severe cases symptoms may include vomiting, gastritis, pain in the abdomen, swelling of lips and throat leading to difficulty in breathing such people may be advised to avoid products that contain soy food stuffs (Gunnars, 2012). Research , however suggests that highly refined soybean oil, which has all the allergic proteins removed and impurities does not cause a hypersensitive- response even in severely allergic individuals (Gunnars, 2012).

Soybean happens to be an excellent source of the minerals calcium and iron. While calcium builds and maintains strong bones and teeth Iron is used to carry oxygen to tissues and muscle cells (Dieticians of Canada, 2015). It also contains isoflavones which are antioxidants that may have health benefits the Canada’s Food Guide recommend soy foods as part of a healthy diet. They are of the opinion that two to three servings of traditional soy foods a day is beneficial this should provide about 15-20 grams of soy protein and approximately 50 to 75mg of isoflavones this is as seen in Asian diet (Dieticians of Canada, 2015). Soymilk is also a great source of high quality soy protein, frequently fortified with calcium and Vitamin D for bone health and as such serves as an option for people who are lactose intolerant this can be added to daily diet (Organic facts, 2016). In the past fifteen

years, soyfoods have attracted the attention of research scientists around the world for health properties beyond basic nutrition. The Food and Drug Administration (FDA) officially recognized the cholesterol lowering effects of soy protein with a claim stating that 25 grams of soy protein per day may reduce the risk of heart disease. Most soyfoods are also low in saturated and trans fats, one reason why the American Heart Association has recognized soyfoods role in an overall heart health diet (United Soybean Board, 2016). Recent research suggests that soy may also lower risk of prostate, colon and breast cancers as well as osteoporosis and other bone health problems and alleviate hot flashes associated with menopause (United Soybean Board, 2016).

It may help men lower the risk of prostate cancer, heart disease and more and the men have no need to fear the risk of feminization, as there is no credible clinical evidence that suggests soy protein lowers testosterone levels or exerts any estrogen-like or feminizing effects (United Soybean Board, 2016). The U.S. Food and Drug Administration states that 25 grams of soy protein per day, as part of a diet low in saturated fat and cholesterol, may decrease the risk of heart disease. To help lower cholesterol, replace foods higher in saturated fats with protein packed foods lower in saturated fat, like soyfoods (United Soybean Board, 2016). Soybean also has a number of extra benefits including the ability to improve metabolism, help people gain weight in a healthy way, protect heart health, defend against cancer, reduce the effects of menopause, improve digestive health, promotes bone health, protect against birth defects, increase circulation, decrease the risk of diabetes, and generally tones up the body (Organic facts, 2016).

These benefits are explained better below :

**Metabolic Activity** : When there is enough protein in your body then your metabolic functioning and overall system will get a major boost this is because proteins are the building blocks of cells and blood vessels and basically every essential part of the human body. Soybean protein ensures the proper health and regrowth of cells if there is need to be repaired or replaced. For vegetarians and vegans it serves as an excellent replacement for the proteins normally acquired in red meat, chicken, eggs, dairy products and fish (Organic facts, 2016).

**Healthy Weight** : Soybeans can work in two ways either to loose weight because soy based products have been associated with appetite suppression, which can help people eliminate overeating which leads to obesity and all of the related risks. For weight gain as well if eaten in larger quantities it provides a decent amount of fiber and protein and the weight it provides your body is not unhealthy high fat or high cholesterol in nature, which protects you from dangerous conditions like diabetes and cardiovascular diseases (Organic facts, 2016).

**Cancer Prevention** : The levels of antioxidants in soybean make it generally good for preventing the onset of various cancers. Antioxidants seek out and neutralize free radicals which are the dangerous by products of cellular metabolism. These free radicals can cause healthy cells to mutate into deadly cancer cells. Furthermore, the high fiber content in soybeans has been connected to a reduction in colorectal and colon cancer, since fiber helps to ease the digestive process and put far less strain on the gastrointestinal system. Soya contains Phytoestrogens the specific one found in soya are called isoflavones.

Soyaisoflavones (daidzein and genistein) have attracted a great deal of research and some studies suggest that women with a soya rich diet may have a lower risk of breast cancer (Organic facts, 2016).

**Heart Health** : soybeans are a source of healthier, unsaturated fat, which helps you lower your total cholesterol. Some fatty acids are necessary for a healthy system two of those fatty acids are linoleic acid and linolenic acid.They are found in significant amounts in soybeans they regulate smooth muscle function in the body, and help to maintain appropriate blood pressure levels.Soybean has also shown to regulate cholesterol in the body by scraping that excess off the walls of blood vessels and arteries (United Soybean Board, 2016).

It is also seen that soybean protein are processed in the body differently to animal proteins. Experimental studies have shown that soya protein isolates as a result lowers cholesterol levels. Animal proteins sources can raise cholesterol levels. Phytosterols which are compounds present in soybeans are structurally similar to cholesterol and steroid hormones. They function to inhibit the absorption of cholesterol by blocking absorption sites are well documented and is very useful for the general heart health (Organic facts, 2016).

**Menopause** : Soybeans are a very good source of isoflavones,which are essential components of the female reproductive system.During menopause,estrogen levels drop significantly. Isoflavones are able to bind to estrogen receptor cells,so that the body doesn't feel as though it is going through such a dramatic decrease.This can ease many of the symptoms of menopause such as mood swings,hot flashes,and hunger pains which can be a

difficult tie of life for many women but soybeans are a great way to ease that major life transition (Organic facts, 2016).

**Digestive Health** : Fiber is an essential required for a healthy body especially for the digestive system as it makes the bulk of stool,thus making it move through your digestive system smoothly.Soybeans provides this fibre and as such constipation is prevented (Organic facts, 2016)..

**Bone Health** : There is impressive levels of calcium,magnesium,copper,selenium, and zinc in Soybeans which is needful for a variety of functions in the body especially for bone health.All these elements are essential for promoting osteotrophic activity which allows for new bones to grow and also speeds up the healing process of bones. Eating Soybeans can be a long term solution for problems like osteoporosis which commonly occurs as we age (Organic facts, 2016).

**Birth Defects** : The vitamin B complex levels in soybeans is impressive and the high levels of folic acid are very important for pregnant women.Folic acid ensures the prevention of neural tube defects in infants,which ensures a happy and healthy baby (Organic facts, 2016).

**Circulation and Oxygenation** : Copper and iron are minerals found in abundance in soybeans,and are both essential for the formation of red blood cells in the body as a result essential organs and all parts of the body can get the blood flow and oxygen they need to function efficiently.This maximised metabolic activities increases energy levels as such dangerous conditions like anemia is avoided (Organic facts, 2016).

**Diabetes** : In the Asian population research is ongoing on the specific relationship of soy products to a decrease in Type 2 diabetes because soybeans have shown an ability to increase insulin receptors in the body thereby helping to manage the disease effectively or prevent it from occurring in the first place (Organic facts, 2016).

**Sleep Disorders** : Soybeans help to regulate a number of aspects of the metabolism, which should be able to help in reducing sleep disorders and the occurrence of insomnia. It also contains a high content of magnesium, which is a mineral that is directly linked to increasing the quality, duration and restfulness of your sleep (Organic facts, 2016).

#### **2.3.4 Soybean oil benefits**

Soybean dry seeds compose about 18-19% of oil to extract oil from seed, the soybeans are cracked, adjusted for moisture content, rolled into flakes and solvent- extracted with commercial hexane. The oil is refined, blended for different applications and sometimes hydrogenated. Soybean oils both liquid and partially hydrogenated are exported and sold as vegetable oil or end up in a wide variety of processed foods (FAO, 1999). Crude soybean oil is deep yellow in colour and contains impurities such as moisture, lecithin, free fatty acids, and volatile compounds these impurities are removed through further refinement to obtain acceptable standard oil. Refined oil is clear light yellow liquid, has neutral odor and taste (Rudrappa, 2009).

Some of the benefits of Soy oil are summarized below according to Rudrappa, ( 2009).

- (i) Soybean oil is one of the poly unsaturated cooking oil currently in use 100g oil provides 884 calories.

- (ii) It has a high smoke point 495°F this property can be useful in setting oil temperature while deep frying food items.
- (iii) Soybean oil has a very good lipid profile. Has saturated, monosaturated and polyunsaturated fats in healthy proportions. It is low in saturated fats and free from cholesterol, making it one of the healthiest oils.
- (iv) It is one of the stable cooking oils having a long shelf life
- (v) Soybean oil is a moderate source of antioxidant vitamin E. Vitamin E is a powerful lipid soluble antioxidant, required for maintaining the integrity of cell membrane of mucus membranes and skin by protecting it from harmful oxygen- free radicals.
- (vi) The oil has Vitamin K in high concentrations;100g of oil compose of 183.9mcg.Vitamin K has potential role in bone health by promoting bone formation strengthening activity (Osteotropic) Adequate vitamin K levels in the diet help limit neuronal damage in the brain thus has established role in the treatment of patients suffering from Alzheimer's disease.

### **2.3.5 Other uses of soybean**

Some other uses of soybean asides from the ones discussed previously are itemized below:

- 1. Feed for animals:** the high protein fiber which remains after processing has removed the oil is toasted and prepared into animal feed for poultry, pork, cattle, other farm animals and pets. The poultry and swine industries are major consumers of soybean meal. It can be found also in fish food (North Carolina Soybean Production Association, 2014).

2. **Biodiesel:** biodiesel fuel for diesel engines can be produced from soybean oil by a simple process called transesterification. This process removes the glycerine from oil, leaving soy biodiesel this biodiesel is cleaner burning than petroleum- based diesel oil. Its use reduces particulate emissions, and it is non- toxic, renewable and environmentally friendly (North Carolina Soybean Production Association, 2014).
3. **Bio composites:** these are building materials made from recycled newspaper and soybeans they replace other products traditionally made from wood, such as furniture, flooring and countertops. Particleboard, laminated plywood and finger-jointed lumber are made with soy based wood adhesives (North Carolina Soybean Production Association, 2014). Soy products are also found in many popular brands of home and commercial carpet and in auto upholstery applications. Soy oil produces an environmentally friendly solvent that safely and rapidly removes oil from creeks, streams and shorelines without harming people, animals and the environment. Soy is an ingredient in many industrial lubricants, solvents, cleaners and paints, candles made with soybean oil burn longer but with less smoke and soot (North Carolina Soybean Production Association, 2014).

Soy ink is superior to petroleum – based inks because soy ink is not toxic, renewable and environmentally friendly, and it cleans up easily. Soy crayons made by the Dixon Ticonderoga company replace the petroleum used in regular crayons with soy oil making them non –toxic and safer for children. Soy based lubricants are as good as petroleum – based lubricants, but can withstand higher heat. More importantly, they are non – toxic, renewable and environmentally friendly. Soy

based hydraulic fluid and rail flange lubricants are among the recent products developed with check off funds (North Carolina Soybean Production Association, 2014). Soy based foams are currently being developed for use in coolers, refrigerators, automotive interiors and even footwear. Beginning in 2007, Ford Mustangs and other vehicles rolled off the production line with soy foam in the seats. New uses in the automotive and equipment industry followed, including lubricants, body parts, interiors and seating (North Carolina Soybean Production Association, 2014).

## **2.4 Growth of Soybean**

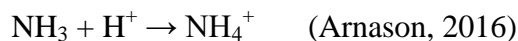
The first stage of growth is germination, a process that becomes apparent as the seed's radicle emerges. This is the first stage of root growth and occurs within the first 48 hours under ideal growing conditions. The first photosynthetic structures, the cotyledons, develop from the hypocotyl, the first plant structure to emerge from the soil (Ashraf *et al*, 2012). These cotyledons both act as leaves and as a source of nutrients for the immature plant, providing the seedling nutrition for its first 7 to 10 days.

As it matures the first true leaves develop as a pair of single blades, subsequent to this first pair, mature nodes form compound leaves with three blades. Mature trifoliate leaves, having three to four leaflets per leaf are formed (Ashraf *et al*, 2012). Under ideal conditions stem growth continues, producing new nodes every four days before flowering occurs. The fruit is a hairy pod that grows in clusters of three to five, each pod is 3-8 cm long and usually contains two to four (rarely more) seeds.

Soybeans occur in various sizes and in many hull or seed coat colours, including black, brown, brown, blue, yellow, green and mottled. The final characteristics of a soybean plant are variable, with factors such as genetics and climate affecting its form (Ashraf *et al*, 2012). Many legumes such as beans, Soybeans, peanuts and others contain symbiotic bacteria called Rhizobia within nodules of their root systems. These bacteria have the special ability of fixing nitrogen from atmospheric, molecular nitrogen (N<sub>2</sub>) into ammonia (NH<sub>3</sub>) the chemical reaction is:



Ammonia is then converted to another form, ammonium (NH<sub>4</sub><sup>+</sup>), which is now usable by some plants by the following reaction:



## **2.5 Selection, storage and post-harvest operations**

Soybean matures within 3- 4 months after planting and it requires timely harvesting to prevent excessive yield losses. At maturity the pod is straw- colored. Its best to harvest when the seed moisture content is between 14 and 16 % harvesting should not be delayed for too long. The mature plant should be cut at the ground level pulling by hand is not encouraged because this may remove the nutrient that the soybean has added to the soil (Bandyopadhyah *et al.*, 2009). Allow to dry in the open for two weeks before threshing. In Nigeria threshing is usually done manually by small scale producers this involves putting the dry soybean in a bag and beating with a stick it is then winnowed. However for large

scale production mechanical threshers are used and then blowers used to separate the grains from the chaff and it is then packed in bags (Bandyopadhyah *et al.*, 2009).

Across the world dry soybeans are generally available in prepackaged containers as well as bulk bins. It is important to make sure that the bins are covered and stored in good conditions to maintain its maximum freshness. It is important that no evidence of moisture or insect damage. Canned soybean can also be found in many markets (Bandyopadhyah *et al.*, 2009). It has been observed that there is less loss of nutrients with canned soybean as compared to other vegetables. If you purchase soybean at different times its best to store them separately since they may feature varying stages of dryness and therefore will require different cooking times (George, 2015). Soybean should be stored at a moisture content of 10 % or less a soybean is sufficiently dry when it cannot be dented with the teeth or fingernails.

At harvest the grains usually contain about 14% moisture dry to 13% moisture for storage of 6-12 months and 10 – 11% for longer storage. This is because high moisture content in stored soybean encourages the development of various agents of deterioration such as insects and microorganisms. Open air drying is the most practical way in Nigeria to protect soybean in storage place 50 or 100kg bags of clean soybean in the cold room or in a shade if it is exposed to high temperatures it will increase the deterioration and reduce seed viability. Good storage management can greatly influence the storability of soybean and subsequent germination when planted in the field (Bandyopadhyah *et al.*, 2009).

## **2.6 Breeding of soybean**

Soybean is bred for different purposes for this study oil content and yield were considered.

### **2.6.1 Breeding of soybean for oil content**

The protein content in soybean (*Glycine max* (L.) Merrill) seed is approximately 40% and the oil content is approximately 20%. This crop has the highest protein content and the highest gross output of vegetable oil among the cultivated crops in the world. In 2007, the total cultivated area of soybean in the world was 90.19 million ha and the total production was 220.5million tonnes (FAO, 1999). In soybean breeding, special attention is given to developing cultivars with high contents of protein and oil, apart from high and stable yields (George, 2015). Besides individual soybean grain components, processing industry finds the ratio between protein and oil content in soybean grain equally significant (Djekic *et al.*, 2013).

### **2.6.2 Breeding of soybean for grain yield**

China has a long history of growing soybean and a rich array of soybean germplasm has been bred through long-term natural and artificial selection, this provides a rich base for the selection and breeding of soybean varieties and for making a great contribution to soybean production and breeding in the world (Djekic *et al.*, 2013). China has made extensive improvements in soybean varieties and the high-yield culture techniques of soybean continue to improve. There is still, however, great potential for further improvements in soybean yields Primary gene center of soybean origin is in north-eastern China (Djekic *et al.*, 2013).

Knowledge of the extent and pattern of variability, particularly of genetic variability present in a population of a given crop is absolutely essential for further improvement of the crop (Djekic *et al.*, 2013). Similarly, information on the extent and nature of interrelationship among characters help in formulating efficient scheme of multiple trait selection. Besides this, knowledge of the naturally occurring diversity in a population helps to identify diverse groups of genotypes that can be used for hybridization program (Amsalu *et al.*, 2014). Selection of suitable cultivar for an agro-climatic zone is of prime concern for soybean growers. Moreover, identification of suitable plant traits showing maximum contribution to final seed yield is important for plant architects (Ali *et al.*, 2013).

## **2.7 Variability of soybean**

Variability exists in different genotypes of soybean for yield parameters.

### **2.7.1 Variability of soybean for oil content**

Soybean seed protein is negatively correlated with seed oil and often with yield (Babka *et al.*, 2003). The chemical composition of soybean seed is one of the most important factor for processing industry (Creaver *et al.*, 2009). The importance of this crop is primarily due to its chemical grain composition 40% protein and 20% oil, amounting to more than 60% of nutrients. Yield grain, protein and oil content in soybean seed are determinate by genetic and environmental factors (Djekic *et al.*, 2013). It can therefore be said that as a result there is variability in Oil content across various genotypes and environments.

### **2.7.2 Variability of soybean for grain yield**

The quantity of oil and yield varies amongst genotypes. Varieties of testing are very important so that it could be determined which varieties are the best solution for the specific growing region (Djekic *et al.*, 2013). Adequate choice of soybean cultivar is of great importance for attaining high and stable yields. An important feature of contemporary agriculture is growing high-yielding cultivars and hybrids that are resistant to diseases, pests and other adverse environmental conditions (Djekic *et al.*, 2013). These cultivars have been created primarily by using plant breeding methods based on selection of favorable genotypes and gene recombination in crossing and reselection. In soybean breeding, the focus of attention has been on yield increase and stability, that is, developing cultivars that are well-adapted to various growing conditions (Djekic *et al.*, 2013). Soybean has many uses. It is mainly pressed to extract soybean oil, after which a soybean meal remains, which is a rich source of protein. Soybean oil can be used for the production of edible oils such as kitchen oil, salad oil and others through refining and deep processing. Soybean oil is also used for the production of printing ink and biodiesel (Djekic *et al.*, 2013). Lecithin, a product extracted from soybean oil, is a natural emulsifier and lubricant used in many foods, commercial, and industrial applications. As an emulsifier, it can make fats and water compatible with each other (Chandel *et al.*, 2013). For example, it helps keep the chocolate and cocoa butter in a candy bar from separating.

It is also used in pharmaceuticals and protective coatings (Benson and Gibson, 2005). Previous studies in different parts of the world suggested various plant traits which should be considered to be most important while selecting soybean genotypes for higher seed yield. Plant height at harvest, number of pods per plant, weight of 100 seeds and seed yield were used to assess the performance of improved varieties of soybean (Ali *et al.*, 2013).

The newly recommended improved varieties of soybean have a wide range of maturity and diverse morphology (Henkel, 2000). Similarly it was reported by Khanghah and Sohani (1999) that the yield increase is correlated with increasing pod number, while seed size and seeds per pod does not change greatly over time Khanghah and Sohani (1999) studied heritability and correlation among yield determining components of 86 genotypes in Pakistan and reported that seed yield had a significant positive relationship with all yield components except pod height.

## **2.8 Correlation between oil and yield component**

Correlation Studies measures the degree of association among traits. The knowledge of correlation is useful in plant breeding for taking decisions by using appropriate selection indices. Correlation between characters can be said to reflect the degree of association between them. Usually in breeding programs, besides looking for the improvement of a main character, others are as well maintained constant or improved together (Khanghah and Sohani, 1999). Therefore, estimating correlation coefficients among the traits becomes particularly important because it makes possible to know how the selection for a certain character influences the expression of another (Khanghah and Sohani, 1999). According to Falconer (1989), in genetic studies it is necessary to distinguish two causes of correlation between characters, genetic and environmental.

The genetic cause of correlation is chiefly pleiotropy, though linkage is a cause of transient correlation particularly in populations derived from crosses between divergent strains. Environmental correlation among characters occurs when they are influenced by the same differences of environmental conditions. In soybean, like in any other crop species, genetic

variation for agronomic character is a vital measuring tool in improvement programme for widening the genomic base of cultivated crop plants. However, genetic variability for many characters is limited (Abdullah *et al.*, 2009).

Abdullah *et al.* (2009) reported that genetic improvement of crops for quantitative characters require reliable estimates of genetic diversity, heritability and genetic advance. Akiko and William (2000) reported high variability in plant height of soybean varieties. Similarly, pods per plant, revealed high significant diversity among genotypes. Both moderate and high heritability were reported for pods per plant, branches per plant, days to maturity, days to flowering and seed weight respectively (Belewu and Belewu, 2007). An understanding of the relations among various characters with seed yield is essential so as to find appropriate selection criteria (Burton, 2013). Quite often, characters are correlated and selection for one character may lead to either positive or negative response in the other characters. This response can be predicted if the correlation and heritability of the characters are known (Morakinyo, 1996).

## **2.9 Path analysis in soybeans**

Path Coefficient analysis permits the separation of correlation coefficients into direct and indirect effects. The direct effects are the direct causes between the causes and the effect, while the indirect effects are the interrelations between the causes themselves (Abdullah *et al.*, 2009). Amsalu *et al.* (2014), used Correlation and Path Coefficient Analysis Study among seed yield and oil content in Ethiopian Coriander (*Coriandrum sativum* L.) genotypes in Ethiopia.

They concluded that seed yield per plant was highly and positively correlated with umbel number per plant, biomass yield per plant and number of seeds per plant, while it was negatively correlated with days to start of flowering, days to 50% flowering and plant height at flowering at both genotypic and phenotypic level (Boroomandan *et al.*, 2012). Fatty oil content was highly and positively correlated with thousand seed weight, number of primary branch and harvest index per plant, while it is negatively correlated with days to 50% flowering, days to start of flowering and plant height at flowering at both genotypic and phenotypic levels.

High positive indirect effect were exerted by fatty oil content via harvest index, days to maturity via plant height at flowering and thousand seed weight via days to start of flowering at both phenotypic and genotypic levels (Amsalu *et al.*, 2014). Furthermore, the correlation coefficient between two variables is the sum of the entire path connecting them (Idahosa and Okonkwo, 2003). It appears to provide a clue to the contribution of various components of yield (Falconer, 1989). It was found in pepper that if other variables are held constant, increasing fruit size will increase yield, also increasing the number of fruits and plant height will increase yield per plant (Moradi and Salimi 2012).

## CHAPTER THREE

### MATERIALS AND METHODS

#### 3.1 Study area

The field experiment was carried out during the rainy seasons of 2015 at the Botanical garden of the Department of Biological Sciences, Plant Science and Biotechnology unit farm of Nasarawa State University, Keffi. Nasarawa state is located 8°32'N 8°18'E in the Guinea Savannah Zone of Nigeria and annual rainfall figures range from 1100 mm to about 1600 mm. It shares boundaries with Benue state to the south, Kogi state to the west, the Federal Capital Territory (FCT) to the north-west; Kaduna and Plateau states to the South-East (Attah and Salau, 2012). There are thirteen local Government areas in Nasarawa State (Fig 3.1).



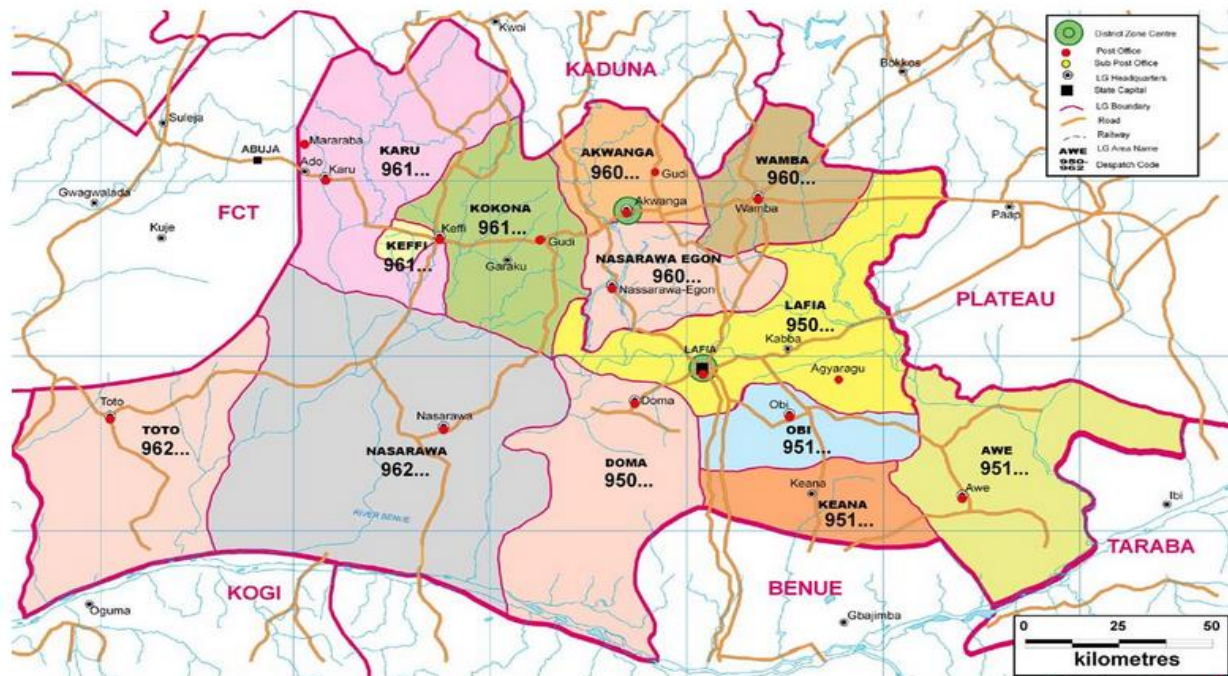


Figure 3.1: Map of Keffi, Nasarawa state

### 3.2 Sample collection

Twelve varieties comprising of Seven early maturing varieties of maturity dates ranging between 100 to 115days ( TG × 1990 – 21F, TG × 1987 – 62F, TG × 1990 – 40F, TG × 1990 – 52F, TG × 1835 – 10E , TG × 1485 – 1D , TG × 1987 – 10F) and five medium maturing varieties with maturity dates ranging between 115 – 130 days (TG × 1990 - 106FM, TG × 1990 - 106FM, TG × 1989 – 45F, TG × 1989 – 42F, TG × 1990 – 78F) were used for the study. All of these varieties were sourced from International Institute of Tropical Agriculture, Ibadan (I.I.T.A).

### 3.3 Experimental design

Randomized complete block design (RCBD) was used (Gerald, 2012). The varieties were planted in three blocks and the treatments were the twelve different varieties. It was arranged such that each block had a different arrangement of treatments. This was to ensure no bias and to check the performance of varieties on different blocks (Gerald, 2012). The experimental layout is illustrated (Table 3.1).

### 3.4 Site preparation

The land was prepared by manual tillage to ensure good germination and reduce weed infestation (Plate 3.1). NPK 15:15:15 was incorporated into the soil at preparation. The spacing used was 50cm between rows and 10cm between stands. The plot size was 2.5m × 1.5m. Thinning was done two weeks after sowing to one plant per hill. At two weeks weeding was done manually and it was repeated at six weeks. At flowering a single spray of Cypermethrin + Dimethoate 10EC at the rate of 100ml in 15 liters of water was used the spraying was repeated after two weeks (Plate 3.2).

**Table 3.1 Experimental layout (Blocks and Plots)**

<b>Block 1</b>	<b>V1</b>	<b>V2</b>	<b>V3</b>	<b>V4</b>	<b>V5</b>	<b>V6</b>	<b>V7</b>	<b>V8</b>	<b>V9</b>	<b>V10</b>	<b>V11</b>	<b>V12</b>
<b>Block 2</b>	<b>V5</b>	<b>V6</b>	<b>V7</b>	<b>V8</b>	<b>V9</b>	<b>V10</b>	<b>V11</b>	<b>V12</b>	<b>V1</b>	<b>V2</b>	<b>V3</b>	<b>V4</b>
<b>Block 3</b>	<b>V9</b>	<b>V10</b>	<b>V11</b>	<b>V12</b>	<b>V1</b>	<b>V2</b>	<b>V3</b>	<b>V4</b>	<b>V5</b>	<b>V6</b>	<b>V7</b>	<b>V8</b>

Key

- V1 variety TG × 1990 – 21F
- V2 variety TG × 1987 – 62F
- V3 variety TG × 1990 – 40F
- V4 variety TG × 1990 – 52F
- V5 variety TG × 1835 – 10E
- V6 variety TG × 1485 – 1D
- V7 variety TG × 1987 – 10F
- V8 variety TG × 1990- 106FM
- V9 variety TG × 1989 – 45F
- V10 variety TG × 1448 – 2E
- V11 variety TG × 1989 – 42F
- V12 variety TG × 1990 – 78F

### **3.5 Data collection**

Data was collected for the following characters.

#### **3.5.1 Determination and measurement of yield**

1. **Days to 50% emergence:** The number of days from sowing to when half of the plant in each plot emerged was collected for all the plots studied in accordance with method adopted by Dashiell, 1993.

2. **Days to 50% flowering:** Number of days between sowing and 50% flowering was taken for the samples studied in accordance with method adopted by Dashiell, 1993.

3. **Plant height (cm):** Average height of three plants measured from the ground to the point of attachment of the upper most (flag) leaf in centimeters was taken on a weekly basis until the plants attained 50% flowering. This measurement was taken for all the plot studied in accordance with method adopted by Dashiell and Osho, 1998

4. **Number of leaves:** Average number of leaves per plant in each plot was recorded on a weekly basis until the plants attained 50% flowering this was done by manual counting in accordance with method adopted by Dashiell and Osho, 1998

5. **Stem Diameter (cm):** Thickness of the stem of three plants was measured with a tape the average was obtained and recorded this exercise was done on a weekly basis for each of the plots until 50% flowering was reached for the plants in accordance with method adopted by Dashiell and Osho, 1998

6. **Yield (g):** The total weight for all the pods at maturity for each plot was taken using a weighing balance in accordance with method adopted by Dashiell and Osho, 1998

7. **Seed weight (g):** The total seed weight was taken per plot this was done in the following process according to the process adopted by Dashiell and Osho, 1998.

(i) After the pods were harvested per plot at maturity. It was further dried for two weeks.

(ii) Each plot sample was appropriately labelled and spread separately to avoid mix up.

(iii) They were individually kept in sacks at the end of the two weeks and threshed manually by beating with a stick.

(iv) The seeds were winnowed and the chaff separated from the seeds.

(v) The seeds for each plot was appropriately labelled.

(vi) 100 seeds were selected from each sample and weighed using the weighing balance.

(vii) The 100 seed weight in grams for each of the plots was then recorded.

8. **Number of flowers:** three plants on each plot was selected and manually counted the average number of the flowers for each plot was then recorded.

9. **Leaf Area (cm<sup>2</sup>):** the process for determining leaf area was done in this manner in accordance to the method used by Dashiel and Osho, 1998.

(i) Three leaves from three plants on each plot was used.

(ii) The leaf length and breadth in cm was measured using a ruler.

(iii) Each leaf used was drawn on a graph sheet.

(iv) This process was repeated weekly until 50% flowering of the plants was reached.

(v) For all the leaves measured the area was estimated by counting the boxes in the graph sheet.

(vi) To calculate for each leaf the formula used was:

$$\lambda_1 = \text{length of leaf} \times \text{breadth of leaf} / \text{Area of drawn leaf on graph sheet}$$

Where  $\lambda_1$  is the calculated area for leaf 1

(vii) The average of all the calculated areas were obtained to get the leaf area index.

(viii) The leaf area index is the constant factor used to get the leaf areas.

(viii) The length and breadth previously recorded for each leaf was then multiplied by the leaf area index to get the correct leaf area for all the plots.

$$\text{Length of leaf (cm)} \times \text{Breadth of leaf (cm)} \times \text{Leaf area index} = \text{Leaf area (cm}^2\text{)}$$

### 3.5.2 Determination and measurement of oil content

The oil content in milliliters per 100 gram of seed was taken in accordance with the method by Kettle, 2013.

The principle: The fat (oil) was extracted with ether (petroleum ether was used instead of ether because of risk of explosion). The solution was distilled and the ether extract was derived and weighed in accordance with the method of Kettle, 2013.

### **Reagents and Equipment**

1. Petroleum ether (b.p 60 – 80°C)
2. Extraction thimbles
3. Soxhlet extraction apparatus and accessories.
4. Analytical balance.

### **Method.**

- (i) Sample was weighed into an extraction thimble 2g of the dried sample (residue from dry matter determination was used).
- (ii) The thimble was placed inside the soxhlet apparatus. A dry tared solvent flask was placed in position beneath, the required quantity of solvent and connects to condenser. The heating rate was adjusted to give a condensation rate of 2 to 3 drop/second and extract for 16 hours (the extraction time was reduced to a minimum of six hours by increasing the condensation rate).
- (iii) On completion the thimble was removed and reclaimed ether using the apparatus. The removal of ether was completed on a boiling water bath and dry flask at 105°C for 30 minutes. It was cooled in a desiccator and weighed.

$$(iv) \text{Crude fat (\% of DM)} = \frac{\text{Weight of fat} \times 100}{\text{Weight of sample}}$$

This formula was used for the calculation.

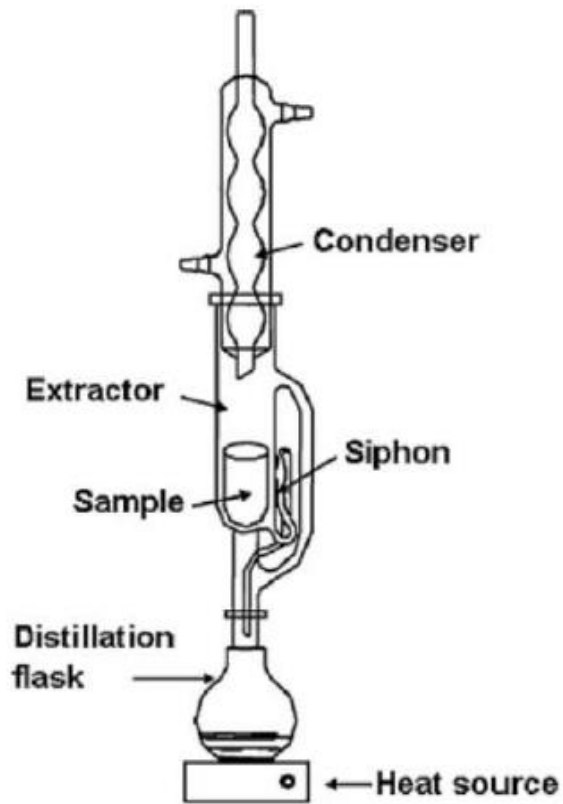


Figure 3.2: The process of oil extraction in the laboratory

Source: Bandyopadhyah *et al*, (2009).

### 3.6 Statistical analysis

The data collected was subjected to statistical analysis with the help of various standard statistical procedures.

### 3.6.1 Analysis of variance (ANOVA)

Analysis of Variance was conducted using the General Linear Model (GLM) procedure of the Statistical Analysis System (SAS) version 9.0 Software to test pre-harvest and post-harvest traits. Duncan's multiple range test (DMRT) was used to separate the means of all yield parameters studied where significant differences exist.

The standard linear model for an RCBD is as follows:  $y_{ij} = \mu + \alpha_i + \beta_j + e_{ij}$

$$i = 1, \dots, a, \quad j = 1, \dots, b$$

Where:  $y_{ij}$  = An observation in treatment  $i$  and block  $j$

$\mu$  = The overall mean

$\alpha_i$  = The effect of treatment  $i$

$\beta_j$  = The effect of block  $j$

$e_{ij}$  = Random error with mean 0 and variance  $\sigma^2$

$a$  = The number of treatments;

$b$  = the number of blocks

**Table 3.2: Form of ANOVA for RCBD**

Sources of variation	Df	MS	EMS
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Replication	$(r-1)$		
Genotypes	$(g-1)$	$MS_g$	$\sigma_e^2 + r\sigma_g^2$
Error	$(r-1)(g-1)$	$MS_e$	$\sigma_e^2$

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Where:  $\sigma_g^2$  = genotypic variance

$\sigma_e^2$  = error variance

$g$  = Number of genotype

$r$  = Number of replications

$MS_g$  = Mean square due to genotype

$MS_e$  = Error mean square

### 3.7 Correlations

Correlation coefficients was worked out to determine the degree of association of characters with yield and also among the yield components, using statistical analysis system (SAS) programme.

### **3.7.1 Estimate of correlations**

Correlation coefficients were estimated using the Pearson correlation coefficient formula given by Singh and Chaudhary, (1985), Bozokalfa *et al* (2010)

$$r_{xy} = \frac{\text{cov}(xy)}{\sqrt{\text{var}(y) \text{var}(x)}}$$

Where:  $\text{cov}(xy)$  = covariance of trait x and y

$\text{Var}(y)$  =variance of y

$\text{Var}(x)$  = variance of x

## **CHAPTER FOUR**

### **RESULTS**

#### **4.1 Analysis of variance for different pre-harvest yield traits**

Analysis of variance was conducted for four (4) pre –harvest yield traits (plant height, leaf area, stem diameter and number of leaves) in 8 weeks for the twelve varieties. The result (Table 4.1) showed the following results.

There was significant difference (66.60 cm) in plant height between varieties of soybean observed at ( $P < 0.05$ ) and no significant difference between replicates (4.00) (Table 4.1).

There was a significant difference between number of leaves between the twelve different varieties (125.75) at ( $P < 0.05$ ) and no significant difference (466.16) between replicates (Table 4.1).

There was significant differences in stem diameter (cm) for all the different varieties (0.26 cm) at ( $P < 0.05$ ) (Table 4.1).

There was significant difference in leaf area for the twelve varieties ( $9.97 \text{ cm}^2$ ) at ( $P < 0.05$ ), no significant difference (26.83) between replicates at ( $P < 0.05$ ) (Table 4.1).

**Table 4.1: Analysis of variance for pre- harvest traits**

Source of variation	Degree of freedom	Plant height(cm)	Number of leaves	Stem diameter(cm)	Leaf area(cm <sup>2</sup> )
Varieties	11	66.60*	125.98*	0.283*	9.97*
Replicate	2	4.00	466.16	0.022	26.83
Error	267	20.40	93.39	0.054	0.819

Key

\* 0.05 significant difference

#### **4.2 Analysis of variance for different post-harvest yield traits**

Analysis of variance was also carried out for five (5) post-harvest yield traits (number of pods per plot, pods weight per plot (kg), 100 seed weight (kg), number of seeds in pods and oil content (ml) in all varieties). These were presented in (Table 4.2) and it showed the following results.

There was significant difference for all the different varieties (15651.25) at ( $P < 0.05$ ), no significant difference within replicates was observed (Table 4.2).

There was significant difference for pods weight per plot for all the different varieties (19.735Kg) at ( $P < 0.01$ ), no significant difference within replicates was observed (Table 4.2).

There was significant difference for all the different varieties (0.07 Kg) at ( $P < 0.05$ ), no significant difference within replicates was observed (Table 4.2).

There was significant difference for all the different varieties (15651.25) at ( $P < 0.05$ ), no significant difference within replicates was observed (Table 4.2).

There was significant difference for all the different varieties (311.648ml) at ( $P < 0.05$ ), no significant difference within replicates was observed (Table 4.2).

**Table 4.2: Analysis of variance for post-harvest traits**

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Source of variation	Degree of freedom	Number of pods	Pods weight per plot(kg)	100 seed weight (kg)	Number of seeds in pods	Oil content(ml)
Varieties	11	15651.25*	19.735*	0.07*	15651.25*	311.648*
Replication	2	2019.92	24.38	0.44	2019.92	0.001
Error	22	105.44	0.16	0.05	0.03	0.002

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Key

\* 0.05 Significant difference

### **4.3 Mean performances and ranges for post-harvest traits**

Mean performances and ranges was also carried out for five (5) post-harvest yield traits (number of pods per plot, pods weight per plot (kg), 100 seed weight (kg), number of seeds in pods and oil content (ml) in all varieties). The details are presented on Tables 4.3 and 4.4. In all cases the means were much larger than their respective standard errors.

The following means for these varieties did not vary significantly amongst themselves at ( $P < 0.05$ ) for number of pods. Varieties TG  $\times$  1990 – 21F, TG  $\times$  1485 – 1D and TG  $\times$  1989 – 42F, Varieties TG  $\times$  1987 – 62F and TG  $\times$  1989 – 45F, Varieties TG  $\times$  1990 – 40F, TG  $\times$  1990 – 52F and TG  $\times$  1835 – 10E, Varieties TG  $\times$  1448 – 2E and TG  $\times$  1990 – 78F. The variety TG  $\times$  1987 – 10F had the lowest mean for number of pods per plant with a mean of 94 while variety TG  $\times$  1989 – 45F had the highest mean of 173.67 per plant (Table 4.3).

The following means for these varieties did not vary significantly amongst themselves at ( $P < 0.05$ ) for number of seeds in pods. Varieties TG  $\times$  1990 – 40F, TG  $\times$  1485 – 1D and TG  $\times$  1989 – 45F. While varieties TG  $\times$  1990 – 21F, TG  $\times$  1987 – 62F, TG  $\times$  1990 – 52F, TG  $\times$  1835 – 10E, TG  $\times$  1987 – 10F, TG  $\times$  1990- 106FM, TG  $\times$  1448 – 2E, TG  $\times$  1989 – 42F and TG  $\times$  1990 – 78F also did not vary significantly amongst themselves (Table 4.3).

There was variation in the means for total pod weight for all the varieties the following varieties did not vary significantly amongst themselves at ( $P < 0.05$ ). TG  $\times$  1990 – 21F, TG

× 1990 – 40F, TG × 1990 – 52F, TG × 1835 – 10E and TG × 1987 – 10F, Varieties TG × 1987 – 62F and TG × 1990- 106FM, Varieties TG × 1989 – 45F and TG × 1990 – 78F. The variety TG × 1989 – 45F had the highest weight of seeds per plot in kilograms before shelling per plot with a mean of 3.73kg while variety TG × 1990 – 21F had the lowest weight of seeds per plant before shelling with a mean of 1.0kg (Table 4.3).

The following means for these varieties did not vary significantly amongst themselves at ( $P < 0.05$ ) for 100 seed weight. Varieties TG × 1987 – 62F, TG × 1990 – 40F, TG × 1990 – 52F, TG × 1835 – 10E, and TG × 1485 – 1D, Varieties TG × 1989 – 45F, TG × 1448 – 2E and TG × 1989 – 42F, Varieties TG × 1987 – 10F, TG × 1990- 106FM and TG × 1989 – 45F. The variety with the lowest 100 seed weight after shelling was TG × 1990 -21F with a weight of 0.783 kg while variety had the highest weight is TG × 1989 -42F with a weight of 1.3kg (Table 4.3).

**Table 4.3: Mean performance for number of pods (no), number of seeds per pod (no), weight of pods per plot and 100 seed weight.**

<b>Varieties</b>	<b>Mean number of pods</b>	<b>Mean for number of seeds in pods</b>	<b>Mean weight pods(kg) per plot</b>	<b>100 seed weight in kg</b>
TG × 1990 – 21F	136bc±0.614	2.667ab±0.0983	1a±0.059	0.783c±0.064
TG × 1987 – 62F	168.33abc±1.300	3ab±0.0001	1.633c±0.171	1.0667a±0.087
TG × 1990 – 40F	106.96b±3.800	3b±0.0001	1.367a±0.129	0.963a±0.056
TG × 1990 – 52F	106.67b±4.368	3ab±0.0001	1.333a±0.109	0.9a±0.074
TG × 1835 – 10E	104b±1.802	3ab±0.0002	1.3a±0.192	0.8a±0.068
TG × 1485 – 1D	144bc±2.787	2b±0.0003	1.433abc±0.084	0.9a±0.034
TG × 1987 – 10F	94ac±0.614	3ab±0.0001	1.3a±0.090	0.967bc±0.035
TG × 1990- 106FM	114.33a±2.999	2.667ab±0.0983	1.867c±0.069	1.033bc±0.026
TG × 1989 – 45F	173.667abc±0.938	2b±0.0001	3.733b±0.064	1.2ab±0.0295
TG × 1448 – 2E	125.33c±1.040	2ab±0.00001	2.233bc±0.069	1.083ab±0.024
TG × 1989 – 42F	146bc±0.681	2ab±0.0002	2.867ab±0.147	1.3ab±0.017
TG × 1990 – 78F	126.67c±0.423	3ab±0.00001	3.4b±0.133	0.967bc±0.0098
GRAND MEAN	128.83	2.61	1.96	1.00
LSD	11.86	0.21	0.46	0.22
CV%	7.97	6.99	20.49	18.74

Means with the same letter(s) for each column are not significantly different at  $p= 0.05$  using Duncan Multiple Range Test (DMRT).

#### 4.4 Mean performance and ranges for some pre – harvest traits

Mean performance and ranges for plant height and number of leaves was collected and presented in (Table 4.4) oil content (ml) for all the varieties is also presented (Table 4.4) it showed the following results.

The oil content measurement was taken in ml from a 100 gram sample for all the varieties. In variety TG × 1990 -21F it ranged from 7.0 - 8.0 with a mean of 7.50, while in variety TG ×1987 -62F it ranged from 5.0 – 6.5 with a mean of 6.00, and variety TG × 1990 - 40F had a range from 5.0 – 6.5, with a mean of 5.50 .The oil content in TG × 1835 – 10E ranged from 4.0 - 5.5 with mean of 4.5 and in TG ×1485 – 1D it ranged from 12.0 - 12.5 with mean of 12.16.

TG ×1987 –10F ranged from 7.0 - 8.0 with a mean of 7.50, for variety TG × 1990 – 106FM it ranged from 6.0 – 6.5 with a mean of 8.33.Variety TG × 1989 – 45F oil content ranged from 8. 0 - 8.5 with a mean of 8.33.Variety TG × 1448 – 2E oil content ranged from 10.0 - 10.5 with a mean of 10.33, for variety TG × 1989 – 42F oil content ranged from 16.5 - 17.5 with a mean of 17.00. TG × 1990 – 78F oil content ranged from 5.8 - 6.5 with mean of 6.10.It was observed that Variety TG × 1989 – 42F had the highest mean (17.0) with a range of (16.5-17.5). While TG × 1835 – 10E had the lowest mean as 4.5 with a range of 4.0 - 5.5. Grand mean was 8.01ml, and CV% is 0.005 (Table 4.4).

Despite the variances in means for these varieties they did not vary significantly amongst themselves at ( $P < 0.05$ ) for oil content. Varieties TG × 1990 – 21F, TG × 1990 – 52F, TG × 1835 – 10E, TG × 1987 – 10F, TG × 1448 – 2E, TG × 1990 – 78F ,and Varieties

TG × 1987 – 62F, TG × 1990 – 40F, TG × 1485 – 1D, TG × 1990- 106FM, TG × 1989 – 45F and TG × 1989 – 42F had insignificant differences.

The following means for these varieties did not vary significantly amongst themselves at ( $P < 0.05$ ) for plant height. Varieties TG × 1990 – 21F, TG × 1987 – 62F, TG × 1990 – 52F, TG × 1990- 106FM, TG × 1989 – 45F, and TG × 1989 – 42F, Varieties TG × 1990 – 40F, TG × 1987 – 10F and TG × 1990 – 78F, varieties TG × 1835 – 10E and TG × 1485 – 1D. The variety TG × 1987 – 10F had the highest mean for plant height (50.17cm) with a range of 13.0 - 86.0 cm. While the lowest plant height is TG × 1835 – 10E which had a mean of 45.04cm and ranged from 13.0 – 79.0 cm (Table 4.4).

The following means for these varieties did not vary significantly amongst themselves at ( $P < 0.05$ ) for number of leaves TG × 1990 – 21F, TG × 1987 – 62F, TG × 1990 – 40F, TG × 1990 – 52F, TG × 1485 – 1D, TG × 1987 – 10F, TG × 1990- 106FM, TG × 1989 – 45F, TG × 1448 – 2E and TG × 1989 – 42F, varieties TG × 1835 – 10E and TG × 1990 – 78F. The variety TG × 1990 – 52F had the lowest mean for number of leaves with a mean of 55.13 and ranged from 10.0 -137.0. The variety that had the highest number of leaves among all the varieties studied is TG × 1448 – 2E with a mean of 63.42 and ranged from 12.0 – 86.0 leaves per plant (Table 4.4).

#### **4.5 Distribution in weeks for plant height, number of leaves, leaf area and stem diameter**

The distribution of plant height (cm) for all twelve varieties taken from week 1 to 8 is illustrated (Fig. 4.1). The distribution of number of leaves for all twelve varieties taken from week 1 to 8 is illustrated (Fig 4.2). The distribution of leaf area (cm<sup>2</sup>) for all twelve varieties taken from week 1 to 8 is illustrated (Fig 4.3). The distribution of stem diameter (cm) for all twelve varieties taken from week 1 to 8 is illustrated (Fig 4.4).

**Table 4.4: Mean performance and ranges for oil content (ml), plant height (cm), no of leaves.**

Varieties	Oil content		Plant height		No of leaves
	Mean	Range	Mean	Range	Mean
TG × 1990 – 21F	7.50ac±0.289	7.0-8.0	46.53ab±4.059	13.0-72.0	61.04b±8.662
TG × 1987 – 62F	6.00abc±0.500	5.0-6.5	47.46ab±5.280	10.0-81.0	60.17b±8.815
TG × 1990 – 40F	5.50abc±0.500	5.0-6.5	49.97bc±5.377	1.27-11.32	58.5b±8.303
TG × 1990 – 52F	5.0abc±0.289	4.5-5.5	46.63ab±4.921	13.0-79.0	55.13b±8.121
TG × 1835 – 10E	4.5a±0.500	4.0-5.5	45.04b±3.998	13.0-69.0	57.83a±8.806
TG × 1485 – 1D	12.16ab±0.166	12.0-12.5	46.08b±4.081	12.0-69.0	59.75b±8.653
TG × 1987 – 10F	7.50ac±0.289	7.0-8.0	50.17bc±4.978	13.0-86.0	59.33b±8.142
TG × 1990- 106FM	6.16abc±0.167	6.0-6.5	46.67ab±4.678	12.0-86.0	62.88b±9.521
TG × 1989 – 45F	8.33ac±0.167	8.0-8.5	47.88ab±4.787	11.0-79.0	60.38b±8.388
TG × 1448 – 2E	10.33ab±0.167	10.0-10.5	49.54abc±5.048	12.0-86.0	63.42b±9.632
TG × 1989 – 42F	17.00ab±0.289	16.5-17.5	47.34ab±4.971	11.5-80.0	61.38b±9.079
TG × 1990 – 78F	6.10abc±0.208	5.8-6.5	49.04bc±4.932	12.0-82.0	58.21a±7.870
GRAND MEAN	8.01		47.70		59.84
CV%	0.005		9.46		16.15

Means with the same letter(s) for each column are not significantly different at p =0.05 using Duncan's multiple range test (DMRT)

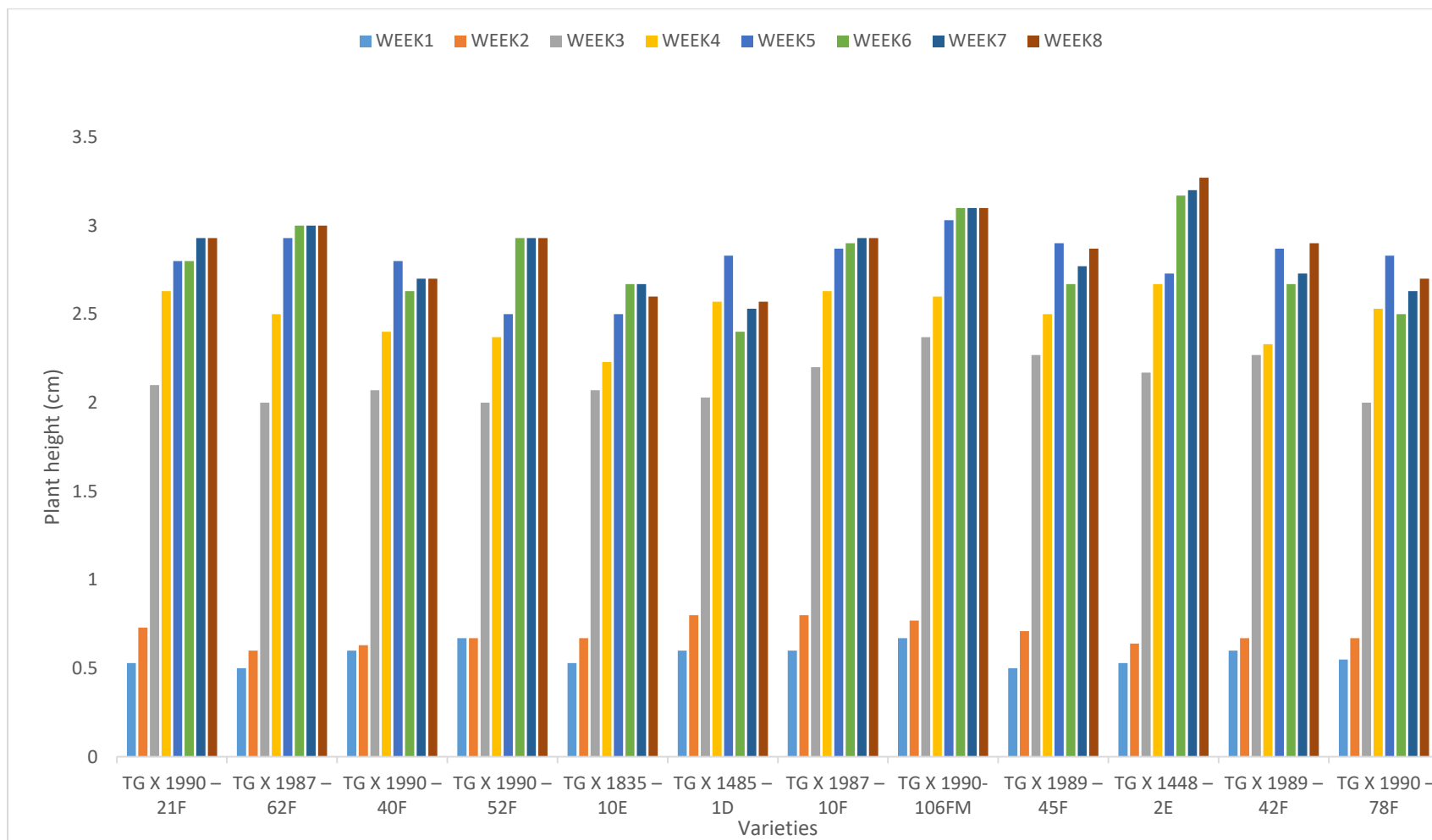


Figure 4.1 Plant height (cm) distribution for the twelve varieties from week 1 to 8

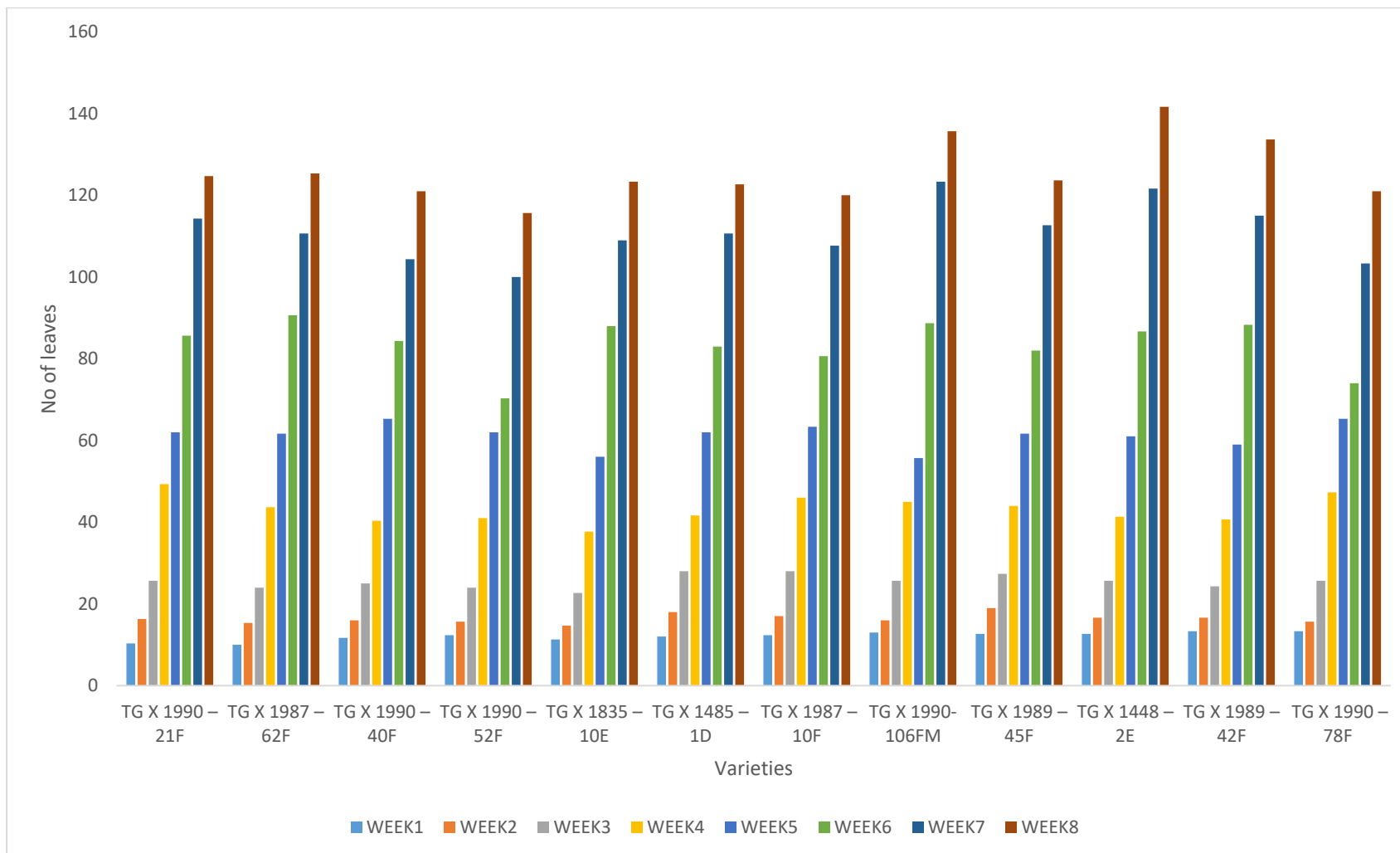


Figure 4.2 Number of leaves distribution for the twelve varieties from week 1 to 8

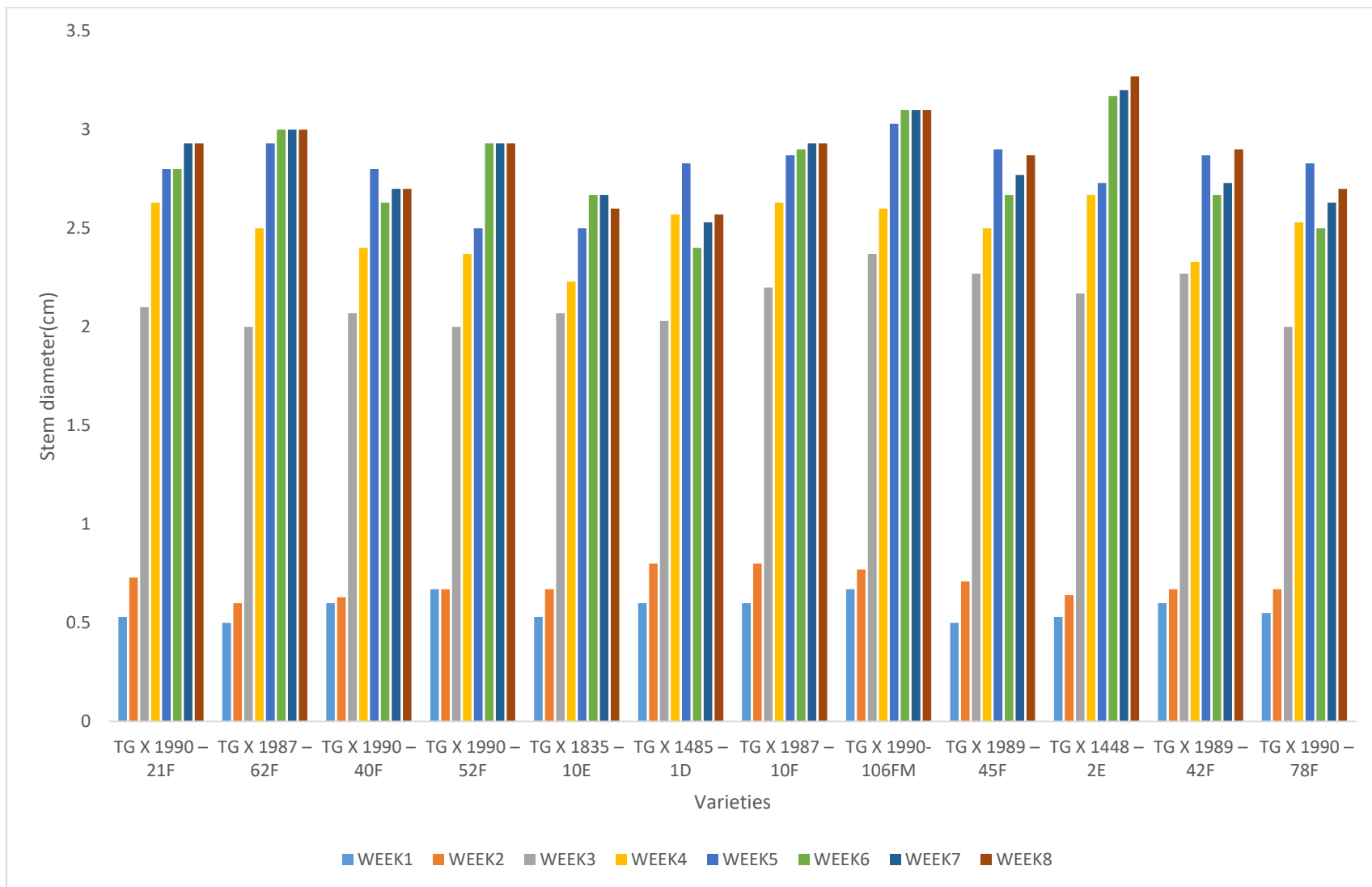


Figure 4.3 Stem diameter (cm) distribution for the twelve varieties from week 1 to 8

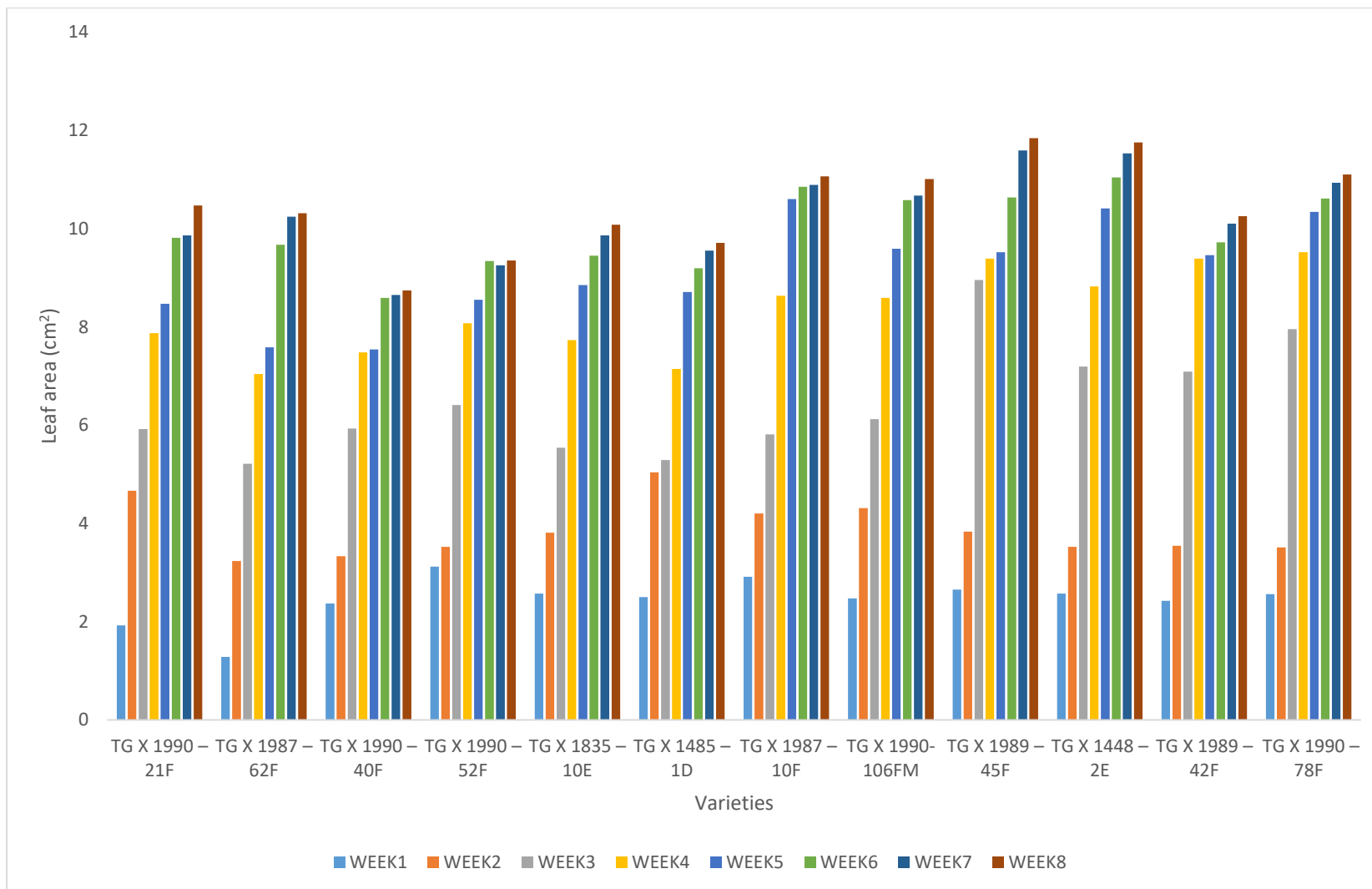


Figure 4.4 Leaf area (cm<sup>2</sup>) distribution for the twelve varieties from week 1 to 8

#### 4.4 Correlations

Plant height was significantly correlated with number of pods  $r = 0.895^*$  and significantly correlated with number of seeds in pods  $r = 0.50^*$ , Number of pods was also significantly correlated with number of seeds in pod  $r = 0.703^*$  (Table 4.5).

Significant correlation between leaf area and Oil content  $r = 0.623^*$  and grain yield  $r = 0.853^*$  respectively were observed (Table 4.6). There was also a significant correlation between Oil content and grain yield  $r = 0.853^*$  (Table 4.6).

Correlation was observed between oil content, number of pods, pods weight per plot(kg),100 seed weight (kg),number of seeds per pod and grain yield ( $r = 0.4104$ ,  $r = 0.3406$ , $r = 1$ ,  $r = 0.9162^*$  and  $r = 0.215$ ) respectively (Table 4.7).

There was also a significant correlation between number of pods and pods weight per plot (kg), 100seed weight (kg), number of seeds per plant and grain yield(kg) ( $r = 0.5565$ ,  $r = 1$ ,  $r = 0.4603$ ,  $r = 0.5526$ ) respectively (Table 4.7).

Pods weight per plot (kg) was also significantly correlated with number of seeds per pod and grain yield (kg) ( $r = 0.5761$ ,  $r = 0.4655$ ) respectively (Table 4.7).

100 seed weight (kg) was also significantly correlated with number of seeds per pod and grain yield (kg) ( $r = 1$ ,  $r = 0.462$ ) respectively (Table 4.7).

Number of seeds per pod was significantly correlated with grain yield (kg)  $r = 0.4594$  (Table 4.7).

**Table 4.5: Correlation between plant height (cm), number of pods and number of seeds in pod**

	<b>Plant height(cm) (PH)</b>	<b>Number of pods(NP)</b>	<b>Number of seeds in pod(NSP)</b>
<b>Plant height(cm) (PH)</b>	1	0.895*	0.50*
<b>Number of pods (NP)</b>		1	0.703*
<b>Number of seeds in pod(NSP)</b>			1

\* 0.05 significant difference

**Table 4.6: Correlation between oil content (ml), leaf area (cm<sup>2</sup>) and grain yield (Kg)**

	<b>Leaf area(cm<sup>2</sup>) (LA)</b>	<b>Oil content (ml) (OC)</b>	<b>Grain yield (Kg) (GY)</b>
<b>Leaf area (cm<sup>2</sup>) (LA)</b>	1	0.623*	0.853*
<b>Oil content (ml) (OC)</b>		1	0.715*
<b>Grain yield (kg) (GY)</b>			1

\* 0.05 significant difference

**Table 4.7: Correlation between oil content (ml) and all yield traits**

	<b>oc</b>	<b>np</b>	<b>Wwp</b>	<b>wwtp</b>	<b>nsp</b>	<b>gy</b>
<b>Oc</b>	1	0.4104	0.3406	1	0.9162*	0.215*
<b>Np</b>		1	0.5565	1	0.4603	0.5526
<b>Wwp</b>			1	1	0.5761	0.4655
<b>Wwtp</b>				1	1	0.462
<b>Nsp</b>					1	0.4594
<b>Gy</b>						1

\* 0.05 significant difference

Key for table

oc- oil content (ml)

np – number of pods

wwp – weight of pods per plot (kg)

wwtp – 100 seed weight per plant (kg)

nsp – number of seeds per pod

gy – grain yield (kg)

## CHAPTER FIVE

### DISCUSSION, CONCLUSION AND RECOMMENDATION

#### 5.1 Discussion

The quantity of oil and seed yield varied amongst genotypes. Varieties of testing were very important so we could evaluate which varieties were the best solutions for the specific growing region (Djekic *et al.*, 2013). Adequate choice of soybean cultivar is of great importance for attaining high and stable yields to meet and surpass local needs.

Among the twelve varieties studied, significant difference was observed for plant height, leaf area and stem diameter, except number of leaves among varieties. Significant differences ( $P < 0.05$ ) was also observed for pods weight per plot, 100 seed weight , number of seeds per pods and total number of pods per variety. This is so in this study as the different genetic properties of the varieties can be said to be responsible for the significant differences in all the parameters studied.

Ali *et al.* (2006) had a similar result when experimenting with different genotypes of soybean they reported that analysis of variance and mean performance for yield and its components revealed significant differences among all the genotypes for all the characters studied. These results were also in conformity with that of Khanghah *et al.* (2000) which showed significant differences for days to maturity, plant height and seed yield.

The 100 seed weight (Kg), number of pods per plot, plant height of the twelve different varieties had different means but the DRMT ( $P < 0.05$ ) was able to narrow varieties that even though had different means there was no significant difference between them this may be attributed to the environmental factors as they possess different genetic materials are expected to be different. This is different from results obtained by Muhammed *et al.* (2003) who had significant differences among all varieties in terms of traits like pod per plant, number of seeds per plant, plant height, 100 seed weight, grain yield per plant and seeds per pod.

Plant height was positively correlated with number of pods and positively correlated with number of pods. The number of pods was also positively correlated with number of seeds in pod. Positive correlation between leaf area and Oil content and grain yield respectively were observed. There was also a positive correlation between Oil content and grain yield. Positive correlation was observed between oil content, number of pods, pods weight per plot (kg), 100 seed weight (kg), number of seeds per pod and grain yield respectively.

There was also a significant correlation between number of pods and pods weight per plot (kg), 100seed weight (kg), number of seeds per plant and grain yield (kg) respectively. Pods weight per plot (kg) was also significantly correlated with number of seeds per pod and grain yield (kg) respectively. 100 seed weight (kg) was also significantly correlated with number of seeds per pod and grain yield (kg) respectively. Number of seeds per pod was significantly correlated with grain yield (kg). The positive correlation between all these parameters studied shows that an increase in each trait will also lead to an increase in the

other trait it is correlated to that is if all required conditions for proper growth and environment are met. This findings was in line with that of Moradi and Salimi (2012) who observed significant variations in all the parameters studied and showed significantly positive correlation of plant height, pods per plant, dry matter, branches per plant with grain yield. Similarly, Jagdish *et al.* (2000) reported that seed yield per plant showed significant positive association with days to maturity, plant height, number of pods per plant, seed pods and 100 seed weight. They further reported that pods per plant contributed directly towards seed yield.

Since all the varieties studied have been exposed to the same ecological and environmental factors they all showed the same positive significant correlation inspite of varying genetic components. Ali *et al.* (2003) reported interrelationships between yield and its components in different soybean genotypes and reported that seed yield per plant was positively and significantly associated with all parameters studied which is same as observed in this work. They reported that pods per plant has maximum positive direct effect on yield per plant followed by 100 seed weight and pods per plant, seeds per pod and 100 seed weight were the main yield components.

Leaf area showed a positive correlation with oil content and significant correlation with grain yield. This findings was in line with that of Ashraf *et al.* (2012) who reported significant and positive correlation of leaf area with pods per plant and oil content he suggested that the characters can be considered as selection criteria in improving the bean yield of soybean genotypes. Therefore from the obtained results varieties with larger amounts of grain yield would produce higher oil content. This can be explained that higher

quantities of soybean would produce more oil. Similarly Siahisar and Rezai (1999) also reported that the number of pod per plant had the greatest genotypic correlation with seed yield in soybean which is similar with results obtained from this study Jagdish *et al.* (2000) reported that improvement can be done on the basis of pods per plant, 100 seed weight and seed quality. Ashraf *et al.* (2012) also lends support to this result as he reported that correlation coefficient of yield was significant and positive with leaf area, pods per plant and oil content. In soybean, seed yield, as in other crops, is a complex character, which is dependent on a number of variables. Thus, to make effective selection for high seed yield a thorough understanding of yield contributing characters and their interrelationships among themselves and with yield is necessary. Therefore, knowledge of relationship between yield and its components obtainable through correlation and regression analysis helps a great deal to formulate selection. Correlation coefficient ( $r$ ), measures the degree (intensity) and nature (direction) of association between characters (Moradi and Salimi 2012).

## **5.2 CONCLUSION**

This study is one of such efforts in which twelve soybean varieties were studied, the genetic variability was observed to evaluate their performance. Results obtained from the study show significant variability in the seed yield and oil content of the twelve soybean varieties. The study is therefore very important for guiding selection of genotypes that are suitable for Keffi for high seed yield and high oil content. TG  $\times$  1989 – 45F had the highest weight (Kg) per plot with a mean of 3733g while TG  $\times$  1990 – 21F had the lowest mean as 1000g. It was observed that Variety TG  $\times$  1989 – 42F had the highest mean for oil content 17.0ml. While TG  $\times$  1835 – 10E had the lowest mean as 4.5ml. Varieties which should be

considered for high oil content are TG × 1989 – 42F, TG × 1448 – 2E and TG × 1485 – 1D while those to be considered for grain yield include TG × 1990 – 78F, TG × 1989 – 45F, TG × 1989 – 42F and TG × 1448 – 2E. Relationship between oil content and all grain yield parameters studied showed a positive significant correlation.

### **5.3 RECOMMENDATIONS**

Since genotypic and phenotypic variation has been observed in soybean genotypes from this study the recommendations are:

1. For further improvement in breeding works Variety TG × 1989 – 45F, TG × 1989 – 42F, TG × 1990 – 78F which has considerable higher grain yield, while TG × 1989 – 42F, TG × 1485 – 1D, TG × 1448 – 2E and TG × 1989 – 45F with higher oil content respectively among all varieties studied are recommended as sources of genetic material .
2. National and International research institutions should collaborate to exploit this genotypic variation to suit the needs of the major purpose for growing the crop in the environment considered.
3. Variety TG × 1989 – 45F which has the highest grain yield is recommended for adoption by farmers interested in grain yield while variety TG × 1989 – 42F with the highest oil content is recommended for farmers interested in oil content.

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## APPENDICES

### APPENDIX 1

**Mean Plant height (cm) for all varieties for the 8 weeks**

	<b>TG × 1990 – 21F</b>	<b>TG × 1987 – 62F</b>	<b>TG × 1990 – 40F</b>	<b>TG × 1990 – 52F</b>	<b>TG × 1835 – 10E</b>	<b>TG × 1485 – 1D</b>	<b>TG × 1987 – 10F</b>	<b>TG × 1990- 106FM</b>	<b>TG × 1989 – 45F</b>	<b>TG × 1448 – 2E</b>	<b>TG × 1989 – 42F</b>	<b>TG × 1990 – 78F</b>
<b>week1</b>	15.2	11.67	13.1	14.67	15.33	14.33	15.17	13.43	13.33	13.67	13.03	10
<b>week2</b>	22.67	17	20	19.67	22.33	22	22.67	21.33	22.67	21	20.33	23.33
<b>week3</b>	31	26.67	31.33	26.67	29	34	34.33	29	29.67	31.33	28.33	33
<b>week4</b>	51.33	44.67	43.67	39	44.67	45.67	43	43.67	43.67	45.67	41.33	47
<b>week5</b>	55	53.33	53.67	52.33	57.67	60.67	58.67	55.67	55	58.33	55	59
<b>week6</b>	62.67	72.33	75	70.33	60.67	59.33	71	63.67	67.33	68.33	66.33	64.33
<b>week7</b>	66.63	76.67	81	74.67	64.33	65	78.33	72	75	78	76.33	77.33
<b>week8</b>	68	77.33	82	75.67	66.33	67.67	79	74.33	76.33	80	78	78.33

## APPENDIX 2

**Mean number of leaves (no) for all varieties for the 8 weeks.**

	<b>Varieties</b>											
	<b>TG × 1990 – 21F</b>	<b>TG × 1987 – 62F</b>	<b>TG × 1990 – 40F</b>	<b>TG × 1990 – 52F</b>	<b>TG × 1835 – 10E</b>	<b>TG × 1485 – 1D</b>	<b>TG × 1987 – 10F</b>	<b>TG × 1990- 106FM</b>	<b>TG × 1989 – 45F</b>	<b>TG × 1448 – 2E</b>	<b>TG × 1989 – 42F</b>	<b>TG × 1990 – 78F</b>
<b>week1</b>	10.33	10	11.67	12.33	11.33	12	12.33	13	12.67	12.67	13.33	13.33
<b>week2</b>	16.33	15.33	16	15.67	14.67	18	17	16	19	16.67	16.67	15.67
<b>week3</b>	25.67	24	25	24	22.67	28	28	25.67	27.33	25.67	24.33	25.67
<b>week4</b>	49.33	43.67	40.33	41	37.67	41.67	46	45	44	41.33	40.67	47.33
<b>week5</b>	62	61.67	65.33	62	56	62	63.33	55.67	61.67	61	59	65.33
<b>week6</b>	85.67	90.67	84.33	70.33	88	83	80.67	88.67	82	86.67	88.33	74
<b>week7</b>	114.33	110.67	104.33	100	109	110.67	107.67	123.33	112.67	121.67	115	103.33
<b>week8</b>	124.67	125.33	121	115.67	123.33	122.67	120	135.67	123.67	141.67	133.67	121

### APPENDIX 3

Mean stem diameter (cm) for all varieties for the 8 weeks.

	Varieties											
	TG × 1990 – 21F	TG × 1987 – 62F	TG × 1990 – 40F	TG × 1990 – 52F	TG × 1835 – 10E	TG × 1485 – 1D	TG × 1987 – 10F	TG × 1990 – 106FM	TG × 1989 – 45F	TG × 1448 – 2E	TG × 1989 – 42F	TG × 1990 – 78F
<b>week1</b>	0.53	0.5	0.6	0.67	0.53	0.6	0.6	0.67	0.5	0.53	0.6	0.55
<b>week2</b>	0.73	0.6	0.63	0.67	0.67	0.8	0.8	0.77	0.71	0.64	0.67	0.67
<b>week3</b>	2.1	2	2.07	2	2.07	2.03	2.2	2.37	2.27	2.17	2.27	2
<b>week4</b>	2.63	2.5	2.4	2.37	2.23	2.57	2.63	2.6	2.5	2.67	2.33	2.53
<b>week5</b>	2.8	2.93	2.8	2.5	2.5	2.83	2.87	3.03	2.9	2.73	2.87	2.83
<b>week6</b>	2.8	3	2.63	2.93	2.67	2.4	2.9	3.1	2.67	3.17	2.67	2.5
<b>week7</b>	2.93	3	2.7	2.93	2.67	2.53	2.93	3.1	2.77	3.2	2.73	2.63
<b>week8</b>	2.93	3	2.7	2.93	2.6	2.57	2.93	3.1	2.87	3.27	2.9	2.7

#### APPENDIX 4

Leaf area (cm<sup>2</sup>) for all varieties for the 8 weeks.

	TG × 1990 – 21F	TG × 1987 – 62F	TG × 1990 – 40F	TG × 1990 – 52F	TG × 1835 – 10E	TG × 1485 – 1D	TG × 1987 – 10F	TG × 1990- 106FM	TG × 1989 – 45F	TG × 1448 – 2E	TG × 1989 – 42F	TG × 1990 – 78F
<b>week1</b>	1.92	1.28	2.37	3.12	2.57	2.5	2.91	2.47	2.65	2.57	2.42	2.56
<b>week2</b>	4.66	3.23	3.33	3.52	3.81	5.04	4.2	4.31	3.83	3.52	3.54	3.51
<b>week3</b>	5.92	5.21	5.93	6.41	5.54	5.29	5.81	6.12	8.95	7.19	7.09	7.95
<b>week4</b>	7.87	7.04	7.48	8.07	7.73	7.14	8.63	8.59	9.39	8.82	9.39	9.52
<b>week5</b>	8.47	7.58	7.54	8.55	8.85	8.71	10.6	9.59	9.52	10.41	9.46	10.34
<b>week6</b>	9.81	9.67	8.59	9.34	9.45	9.19	10.85	10.58	10.63	11.04	9.72	10.61
<b>week7</b>	9.86	10.24	8.65	9.25	9.86	9.55	10.89	10.67	11.59	11.53	10.1	10.93
<b>week8</b>	10.47	10.31	8.74	9.35	10.08	9.71	11.06	11.01	11.84	11.75	10.25	11.1

## APPENDIX 5

**Mean oil content (ml), stem diameter (cm), plant height (cm), no of leaves, no of pods,  
weight in (kg) with pods, weight in (kg) without pods**

Variety	Mean oil content (ml)	Stem diameter (cm)	Plant height (cm)	No of leaves	Leaf area (cm <sup>2</sup> )	No of pods	Pods weight per plot	100 seed weight(kg)
TG × 1990 – 21F	7.5	2.18	46.53	61.04	7.37	136	1	0.78
TG × 1987 – 62F	6	2.19	47.46	60.17	6.82	168.33	1.63	2.67
TG × 1990 – 40F	5.5	2.07	49.97	58.5	6.58	117	1.37	1
TG × 1990 – 52F	5	2.07	46.63	55.13	7.2	106.67	1.33	0.9
TG × 1835 – 10E	4.5	1.99	45.04	57.83	7.24	104	1.3	0.8
TG × 1485 – 1D	12.16	2.04	46.08	59.75	7.14	144	1.43	0.9
TG × 1987 – 10F	7.5	2.23	50.17	59.33	8.11	94	1.3	2.67
TG × 1990 - 106FM	6.16	2.34	46.67	62.88	7.92	114.33	1.87	2.67
TG × 1989 – 45F	8.33	2.15	47.88	60.38	8.55	173.67	3.73	1.03
TG × 1448 – 2E	10.33	2.3	49.54	63.42	8.35	125.33	3.23	1.2
TG × 1989 – 42F	17	2.13	47.34	61.38	7.68	146	2.8	1.3
TG × 1990 – 78F	6.1	2.05	49.04	58.21	8.32	126.37	3.4	0.97

## APPENDIX 6

**Number of pods, pods weight per plot (kg), 100 seed weight (kg) , number of seeds in pods for all the replicate 1 of varieties**

variety	replicate	number of pods	Pods weight per plot	100 seed weight	number of seeds in pods
<b>TG × 1990</b> - 21F	1	135.0	0.6	0.4	3.0
<b>TG × 1987</b> - 62F	1	170.0	0.5	0.5	3.0
<b>TG × 1990</b> - 40F	1	95.0	0.5	0.6	3.0
<b>TG × 1990</b> - 52F	1	85.0	0.6	0.4	3.0
<b>TG × 1835</b> - 10E	1	100.0	0.6	0.4	3.0
<b>TG × 1485</b> - 1D	1	130.0	1.1	0.7	3.0
<b>TG × 1987</b> - 10F	1	90.0	0.9	0.8	2.0
<b>TG × 1990</b> - 106FM	1	109.0	1.8	1.0	3.0
<b>TG × 1989</b> - 45F	1	170.0	3.3	1.1	2.0
<b>TG × 1448</b> - 2E	1	132.0	2.3	1.2	2.0
<b>TG × 1989</b> - 42F	1	142.0	2.1	1.3	2.0
<b>TG × 1990</b> - 78F	1	129.0	2.5	1.0	3.0

## APPENDIX 7

**Number of pods, pods weight per plot (kg), 100 seed weight (kg), number of seeds in pods for all the replicate 2 of varieties**

Variety	Replicate	Number of pods	Pods weight per plot	100 seed weight	Number of seeds in pods
TG × 1990 – 21F	2	140.0	1.2	1.0	2.0
TG × 1987 – 62F	2	175.0	2.4	1.5	3.0
TG × 1990 – 40F	2	96.0	1.9	1.2	3.0
TG × 1990 – 52F	2	100.0	1.6	1.1	3.0
TG × 1835 – 10E	2	96.0	0.7	0.8	3.0
TG × 1485 – 1D	2	140.0	1.2	0.9	2.0
TG × 1987 – 10F	2	95.0	1.1	0.9	3.0
TG × 1990 - 106FM	2	134.0	1.5	0.9	2.0
TG × 1989 – 45F	2	171.0	4.0	1.4	2.0
TG × 1448 – 2E	2	124.0	1.8	1.0	2.0
TG × 1989 – 42F	2	150.0	3.8	1.2	2.0
TG × 1990 – 78F	2	124.0	3.8	0.9	3.0

## APPENDIX 8

**Number of pods, pods weight per plot (kg), 100 seed weight (kg), number of seeds in pods for all the replicate 3 of varieties**

Variety	Replicate	Number of pods	Pods weight per plot	100 seed weight	Number of seeds in pods
TG × 1990 – 21F	3	133.0	1.2	1.0	3.0
TG × 1987 – 62F	3	160.0	2.0	1.2	3.0
TG × 1990 – 40F	3	160.0	1.7	1.1	3.0
TG × 1990 – 52F	3	135.0	1.8	1.2	3.0
TG × 1835 – 10E	3	116.0	2.6	1.2	3.0
TG × 1485 – 1D	3	162.0	2.0	1.1	2.0
TG × 1987 – 10F	3	97.0	1.9	1.2	3.0
TG × 1990 - 106FM	3	100.0	2.3	1.2	3.0
TG × 1989 – 45F	3	180.0	3.9	1.1	2.0
TG × 1448 – 2E	3	120.0	2.6	1.0	2.0
TG × 1989 – 42F	3	146.0	2.7	1.4	2.0
TG × 1990 – 78F	3	127.0	3.9	1.0	3.0

**APPENDIX 9**  
**Site preparation**



## APPENDIX 10

### Spraying of field against insect pests

