SEED ACCESSMENT OF SOYBEAN (*Glycine Max*) ACCESSION

BY

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LSC1705824

A PROJECT THESIS SUBMITTED TO THE DEPARTMENT OF PLANT BIOLOGY AND BIOTECHNOLOGY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN, BENIN CITY, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE (B.Sc.) IN PLANT BIOLOGY AND BIOTECHNOLOGY

DECEMBER, 2022.

CERTIFICATION

This is to certify that this work was carried out by Preye G. BRASANA in the Department of Plant Biology and Biotechnology, Faculty of Life Sciences, University of Benin, Benin City.

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DEDICATION

This work is dedicated to my late mum (Agnes Brasana) for her immerse support while alive and even on her sick bed.

ACKNOWLEDGEMENT

I want to thank God Almighty for provision and enablement to complete this work. I appreciate my amazing project supervisor, Mrs. F. N. Egbenoma, for her guidance, patience, instructions and for her availability all through this period of this study, also Prof. B. Ikhajiagbe for his guidance and great support during the cause of this research. I also want to thank the HOD Prof. Akpaja. Special thanks to my adorable dad, Mr. Robert Brasana, Barr. Okungbowa Aihie and my wonderful siblings for their immerse contribution towards my academic pursuit. I also want to appreciate TREP family and my wonderful friends for always being there to support and encourage me. My colleagues are not left out, thank you all for making my stay in University of Benin memorable.

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ABSTRACT

Soybean (Glycine max [L.] Merr.) Is one of the most essential oil plant that is largely grown globally. Its domestic and industrial use has brought about increase in the economy of many countries. About 64 % of the world's supply of oil seed meal comes from soy, which also serves as the primary source of oil and contributes to about 28 % of output as a whole. Soybean which is a legume crop serves as food to humans and animals and other beneficial purpose. 10 different accessions of soybean were studied to check if there will be significant change in their morphological and physiological characteristics. The set of descriptors for the present morphological characterization of Soybean was produced using the *Sphenostylis stenocarpa* (Hochst ex. A. Rich.) Harms descriptor and the seed length, seed width and seed thickness of 10 seeds from each accession number were determined using a venire caliper. Accession number TGM-942 had the least length, 0.47 cm while Accession number TGM-944 had the highest length, 0.58 cm. Accession number TGM-540 seed weighed 1.45 g, which was the highest see weight. Their testa basal color ranged from black, reddish brown, light brown, black to purple.

CHAPTER ONE

INTRODUCTION

1.0 Background to study

1.1 The Soybean Plant

Soybeans (*Glycine max,*) is a variety of the legume family that was found for the first time in East Asia. The soybean is a kind of plant that belongs to the family Leguminosae. Although it is not known for certain where the soybean was first domesticated, China is generally regarded as the country of origin for this crop (Qiu and Chang, 2010). The edible seed of the soybean, a type of annual legume that also goes by the name soya bean and is a member of the Fabaceae family, is the primary reason for the plant's cultivation.

The soybean is the most significant bean in terms of economic importance because it provides ingredients for hundreds of chemical goods as well as vegetable protein for millions of people.

The soybean (*Glycine max* (L.) Merrill.), the most important source of both vegetable oil and high-quality, highly concentrated proteins, maintains a prominent position among agricultural crops. Soybean seeds have been used to make fresh, fermented, and dried foods throughout Asia and other areas of the world for many years (Tamang, 2015). The seeds of soybeans, the most important legume crop and an excellent source of both protein and oil, comprise around 40 % protein and 20 % oil. Soybeans are an important source of protein for human nutrition, animal feed, and fish food.

In recent years, the role of soybean as a biodiesel source has grown. Soybean roots improve the health of the soil through a symbiotic association with the rhizobacterium *Bradyrhizobia japonicum*. Soybean is a member of the families Leguminosae and subfamily Papilionaceae. Ricker and Morse proposed the proper designation for domesticated soybeans in 1948.

Soybean growth is particularly sensitive to environmental changes, and water is the primary factor that has a substantial effect on its production. In addition, temperature and photoperiod have a substantial effect in regulating the location and time of soybean production. Despite multiple biotic and abiotic stressors, productivity limitations, and other obstacles, this miracle crop has made significant progress over time. This chapter examines the soybean crop with an emphasis on its genetics and crop-improvement characteristics.

1.2 Scientific classification of soybeans

Soybeans, being members of the bean family, belong to the genus Glycine. Last but not least, this organism's scientific name is Glycine max. It distinguishes itself from other members of the Glycine genus since it is the only upright plant species. The remaining species of this genus climb or tangle (Scurek, 2006).

Soybean is a diploidized tetraploid (2n=40) that belongs to the Leguminosae family, subfamily Papilionoideae, tribe Phaseoleae, genus Glycine Wild., and subgenus Soja (Moench). It is an annual herbaceous plant that may reach a height of 1.5 meters and is erect and bushy. Soybean cultivars exhibit three distinct growth patterns: determinate, semi-determinate, and indeterminate (Kato *et al.,* 2019). Vegetative activity ceases when the terminal bud turns into an inflorescence at both the axillary and terminal racemes, indicating definite development. Mostly determined genotypes are created. Because they retain vegetative activity throughout the blooming period, indeterminate genotypes are commonly planted in the central and northern regions of North America. The vegetative development of semi-determinate and indeterminate stems abruptly ceases after the blooming season concludes. None of the soybean cultivars are frost-resistant and cannot sustain the severe winter temperatures.

1.3 Origin of soybeans

Although the history of the soybean plant is obscure, many botanists believe it was initially domesticated in central China about 7000 BCE. In China, Japan, and Korea, the soybean has been consumed and used as an ingredient in traditional medicines for countless centuries. After being introduced to the United States in 1804, soybeans rose to popularity in the South and Midwest throughout the mid-20th century. Brazil and Argentina are two major producers.

Many histories have been written of the soybean crop, which is cultivated across a vast area of the planet (Guo *et al.,* 2010). Evidence shows that soybean domestication originated in the eastern section of northern China between 1700 and 100 BC, during the Shang period (Lee *et al.,* 2011). It is one of the first cultivated edible legumes, having been known to humans for about 5,000 years. Due to this, it was imported and naturalized in Africa from China via Egypt in the late 19th century (Shurtleff *et al.,* 2009). Molecular diversity studies on populations of soybeans from the north and south of China indicate that this crop was also domesticated in South China (Ding *et al.,* 2008).

No earlier than 1100 B.C., bronze inscriptions and early writings contain the earliest descriptions of soybean farming. As the Shang dynasty flourished, soybean commerce expanded in South China, Korea, Japan, and Southeast Asia. In the first century after the Common Era, trade voyages likely delivered soybeans across China and later to other Asian states. Samuel Bowen, a marine for the East India Company who, in 1765, planted the first soybeans at "Greenwich," a few miles east of Savannah, Georgia, introduced soybeans to the United States.

The late type soybean from South China was discovered to be closer to the wild type, and it is anticipated that the wild soybean is an ancestor of the cultivated type of South China from which the early cultivated types emerged throughout the process of dispersal to North China (Gai *et al.,* 2000). The South Chinese origin of soybean was also supported by the population's greater genetic diversity as compared to the population of North China (Ding *et al.*, 2008).

1.4 Description of soybean plant

The initial soy plants were wild. It was a green, annual, three-leafed vine. It had short, slender leaves. It produced minuscule, rigid, roundish purple flowers and seeds ranging from dark brown to black in color. These seeds were fragile and easily broken when fully mature.

Domesticated soybean plants are now annual shrubs with tall stems. They have leaves, pods, and stems and are usually covered in fine brown hairs. Plants possess branched tap roots and trifoliate leaves with net-like veins. There are three distinct developmental stages: blooming, pod development, and maturation. As maturity approaches, the leaves begin to turn yellow and typically fall off prior to the pods (Scurek, 2006).

Soybean plants are typically tall, woody shrubs with oppositely arranged leaves. The leaves have three separate, oval- or lance-shaped leaflets with lengths between 3 and 10 cm. The curved seed pods of the soybean plant, which are 3–15 cm (1.2–6 in) long and contain one to five seeds, are adorned with small white or purple flowers. The seeds can be any of the following colors: yellow, green, brown, or black, or a mottled combination of these hues. The annual soybean plant grows between 0.2 and 1.5 meters tall and has a single growing season. Soybean, also known as Soybean or soya, is native to northeast China.

The flowering process moves rapidly from the plant's base to its tip, and the flowers are minute, white or violet. They are supported by short stems that arise from stem nodes. Small, straight or slightly curved, hair-covered pods containing one to four seeds develop from the flowers. These seeds' form and hue vary ranging from elliptical to circular (Scurek, 2006).

Fine trichomes are found on the leaves, stems, sepals, and pods. There are four types of leaves on soybean plants: prophylls, simple cotyledons or seed leaves, primary leaves, and foliar leaves. The pair of cotyledons are the first to form and are arranged oppositely. At the node above the cotyledons, the two largest leaves are unifoliate and positioned opposite one another. The subsequent stem foliage is composed of alternately arranged trifoliate leaves. Occasionally, compound leaves can contain four or more leaflets. Prophyll is found at the bottom of each flower's pedicel and at the base of its lateral branches. Two small pairs of simple leaves are visible. The self-pollinating flowers are either white or purple in color. Yellow, green, brown, black, or bicolored seeds are also possible; however, the vast majority of commercial varieties have brown or tan seeds, with one to four per pod.

When the seeds become hard or the leaves begin to fall, soybeans are ready for harvest. Typically, the harvest is postponed until the seeds have fully dried on their stalks.

1.5 Botany and cultivation

Taxon	Scientific name and common name
Kingdom	Plantae (plants)
Subkingdom	Tracheobionta (vascular plants)
Super division	Spermatophyta (seed plants)
Division	Magnoliophyta (flowering plants)
Class	Magnoliopsida (dicotyledons)
Subclass	Rosidae
Order	Fabales
Family	Fabaceae / Leguminosae (legume and pea family)
Tribe	Phaseoleae

Genus Glycine Willd. (Soybean)

Species *Glycine max*(L.) Merr. (Soybean)

Synonyms of *Soybean* include: *glycine hispida* (Moench) Maxim, Soja max (L) Piper.

Glycine max, have true nucleus with organelles attached to the membrane, they fall under the domain Eukarya. It belongs to the kingdom Plantae since it possesses the qualities of being multicellular, engaging in photosynthesis, and having cellulose.

1.6 Habitat

The stated salinity threshold for soybeans is approximately 5 decimeters per meter; however, the effect varies based on climate, exposure timing, and soybean type. Even though soybeans are considered warm-season crops, they are typically grown from the tropics to at least 52 degrees north latitude, at altitudes below 1,000 meters. The sensitivity of soybean plants is impacted by photoperiod and light intensity.

Even though water requirements vary greatly, a productive crop of soybeans requires 330 to 825 millimeters of precipitation during the growing season on average. The period between flowering and seed filling is the most water-intensive. They may be negatively affected by flooding and drought. Even though the soybean seed has a moisture content of less than 13 %, dry weather in July and August could result in the harvest of green soybean seed.

Soybeans grow best in neutral or slightly acidic soil, with a pH range of approximately 5.5-8.8. Although a range of well-drained soil types can be utilized for soybean cultivation, clay loam soils perform the best. Soybeans perform well once established, despite the fact that seeding and plant emergence after germination are challenging in heavy clay soils. Because they make plants more susceptible to drought stress, sandy or gravelly soils are not ideal for growing soybeans.

1.7 Soybean genome

During speciation, the genome of the ancient polyploid genus Glycine had two substantial duplication events, according to research (Schlueter *et al.,* 2004; Van et *al.* 2008). Studies on the haploid DNA also suggest that soybean is an ancient, diploidized tetraploid (Safari and Schlueter 2011). According to research, these duplication occurrences occurred between 14.5 and 45 MYA (Schlueter *et al.,* 2004; Blanc and Wolfe 2004). Numerous nested duplications on the soybean genetic map appeared to suggest an even more ancient episode of polyploidy at some time in the species' evolutionary history (Shoemaker *et al.,* 2006). According to one idea, the initial "diploid" genome donors of today's "allopoly-ploid" soybeans were stable paleopolyploids from an earlier round of genome duplication.

The origins of the soybean genome have been described as both allo- and autopolyploid.

On the basis of cytogenetic (Udall and Wendel, 2006) and molecular studies, an allopolyploid soybean genome was previously posited, however nuclear gene phylogenetic analysis showed an autopolyploid origin (Doyle *et al.,* 2003; Straub *et al.,* 2006). The revolutionary molecular cytogenetic technique fluorescence in situ hybridization (FISH) has successfully distinguished ten chromosomal pairs in soybean, indicating the presence of two separate and co-resident genomes with two types of centromeres that reflect divergence in its two diploid progenitors (Udall and Wendel, 2006).

Australia and Papua New Guinea both include several perennial diploid cousins of Glycine. Among these are reports of interbreeding between diploid species, which gave rise to various allopolyploid taxa (Doyle *et al.,* 2004). Doyle *et al.,* (2004) found and characterized the tomentella and tabacina complexes as naturally occurring allopolyploids. These were created by diverse combinations of diploid progenitors, supporting the notion that these polyploids were unquestionably derived from several origins.

1.7.1 Genetic diversity of soybean accession

An accession is a separate, individually identifiable sample of seeds that represents a cultivar breeding line or a population and is stored for use. Seed acquisition often involves collecting seed from many sites, combining them into a single seed lot, and then storing or planting the seed.

The genetic variety of crops may be evaluated at the phenotypic and genotypic levels, as well as via the use of statistical techniques that divide phenotypic or genetic descriptors into genetic or environmental components. Using morphological markers, the diversity of genotypes may be calculated; however, these markers are less efficient than DNA markers due to their limited quantity, subjectivity, and environmental sensitivity.

The soybean*, Glycine max (*L) Merrill, is the most important grain legume in the world due to its vast variety of adaptations to many climatic, soil, and growth conditions. For efficient plant breeding operations, it is essential to comprehend the genetic diversity across different genotypes (Rabbani *et al.,* 2010). Understanding genetic diversity will also aid in the development of breeding program strategies and the comprehension of the evolutionary links among accessions (Pervaiz *et al.,* 2010).

According to Bernard *et al.,* (1998), the degree of phenotypic and genotypic variability in germplasm is determined by differences in morphological and agronomic characteristics or pedigree data. Since the evaluation of agronomic data is heavily influenced by a number of environmental factors, biochemical markers, such as seed storage protein and isozyme, have been utilized for assessing genetic variability. Utilizing seed storage protein markers to classify soybean cultivars has been standard practice (Natarajan *et al.,* 2006)

Seed storage protein polymorphism has been successfully used to identify variation among soybean genotypes exhibiting significant regional variation.

Microsatellites and random amplified polymorphic DNA (RAPD) are two commonly used PCR-based markers for identifying soybean polymorphisms. Due to the simplicity of the method, RAPD markers are frequently employed in plant breeding.

They have been utilized effectively for soybean polymorphism and have been found to exhibit a high level of polymorphism.

1.7.2 Soybean Seed yield and biomass

Soybean (Soybean) yields have increased steadily over the course of the last century due to advances in breeding, better management practices, and higher atmospheric carbon dioxide concentrations. The United Nations has set a goal of doubling agricultural yields by 2050 to meet the needs of a growing population, but the current rate of growth is insufficient to meet this objective. Despite the fact that conventional breeding efforts have increased soybean yields, the physiological causes underlying earlier yield increases in the United States are largely unknown. By understanding the physiological mechanisms underlying past increases in soybean yield, it may be possible to devise strategies for future output increases. Yield potential (Yp) is the maximum yield that can be obtained from a crop when no biotic or abiotic stressors are present. Genetically improved soybean production is typically associated with a rise in dry matter accumulation rather than a higher harvest index.

In order to comprehend the high-yielding conditions for soybean, it is necessary to describe the Eco physiological variables responsible for dry matter accumulation. Therefore, we designed this study to focus on the absorption and utilization of light by soybean plants, as both are essential for the accumulation of dry matter.

Radiation use efficiency (RUE), which is the amount of biomass produced per unit of solar radiation intercepted, is a crucial factor in the accumulation of dry matter. The number of soybean seeds produced is determined by the number of pods produced per area. More than fifty percent of soybean flowers and early pods fail to mature into pods and seeds. In adverse weather and growth conditions, the percentage of aborted flowers and pods rises. Although the number of seeds per pod in soybeans can range from one to four, the average number of seeds per pod is quite stable. The average seed weight is influenced by growing conditions during the maturation phase.

1.8.0 Nutrition Details Of soybean

One cup of soybeans (186 grams) contains 830 calories and 56 grams of carbohydrates.

Following are the other major nutrients present:

67 grams of protein

37 grams of fat

17 grams of fiber

515 milligrams of calcium

29 milligrams of iron

521 milligrams of magnesium

3 grams of phosphorus

3 grams of potassium

698 micrograms of folate

41 IU of vitamin A (Tadimalla, 2022).

1.8.1 Health Benefits of Soybean

The following are benefits of Soybean

Soybeans have anti-inflammatory, collagen-stimulating, antioxidant, skin-lightening, and UV protection properties that aid to protect the skin.

It helps with digestion.

It regulates weight gain and cholesterol levels.

It prevents coronary heart disease

It relieves menopausal symptoms

It helps to manage diabetics

It improves blood circulation in the body

It helps to enhance protein intake while decreasing saturated fat consumption.

(Tadimalla, 2022).

1.8.2 Economic benefits of soybean

Economically and socially, the worldwide soybean crop is unquestionably of great significance. About 64 % of the world's supply of oil seed meal is derived from soy, which is also the leading source of oil and accounts for 28 % of total production (USDA, 2000). Soybeans produced 46 % of the world's soybeans in 1999, which were grown on approximately 30 million hectares of land and had a crop value of $12.3 billion. This represented 52 percent of global oilseed production. American soy exports accounted for sixty percent of the global trade in soybeans. Soybeans are the best available protein source in some developing countries, particularly rural areas, for enhancing the nutritional value of traditional foods (Rizzo, 2018). Additionally, the crop has transformed the rural economy by improving the living conditions of soybean farmers, particularly women and children (Paroda, 1999). In certain regions of Asia, the sale of soybean crops accounts for between 30 and 60 percent of the average cash revenue used to purchase crop inputs (Liu *et al.,* 2019). Tofu, soy milk, soy sauce, miso, and other nutritious soy-based foods have been developed for human consumption, while oil-extracted soy meal is used as a nutritious animal feed. Soy oil has numerous uses in the production of insecticides, cosmetics, plastics, papers, inks, paints, and varnishes in addition to pharmaceuticals.

Why then are soybeans grown?

• It is used in foods such as soy milk, soy flour, soy cheese, dawadawa, and Tom Brown (infant weaning food).

• It is a good source of (cholesterol-free) vegetable oil.

• It is utilized in the production of printing ink, alkyd resins, adhesives, wood veneer, and paper coatings.

•. It increases soil fertility and helps avoid the parasitic weed. *Striga hermonthica*

• Soybean cake is a great animal feed, particularly for poultry.

• Sheep and goats receive quality feed from the haulms.

1.8.3 Diseases of Soybean

Nematode diseases

i. Pin nematode caused by *Paratylenchusprojectus*
ii. Lance nematode caused by *Hoplolaimus Columbus*

Virus diseases

i. Soybean dwarf caused by *Luteovirus*
ii. Bean yellow mosaic caused by *Potyvirus*

Bacterial diseases

i. Bacterial wilt caused by *Flaccumfaciens*
ii. Bacterial blight caused by *Pseudomonas amygdali*

Fungal diseases

i. Black root rot caused by *Chalaraelegans*
ii. Black leaf blight caused by *Arkoolanigra*

1.9 Aim and Specific objective of study

1.9.1 Aim of Study

The aim of this research is to determine if there will be significant change in the morphology and physiology of the soybean accession cultivars.

1.9.2 Specific Objective of Study

To further research on how to improve the morphology of soybean seeds.

CHAPTER TWO

MATERIALS AND METHOD

2.1 Study Area

This research was carried out in the department of Plant Biology and Biotechnology lab at the University of Benin (Ugbowo campus), Benin City. The research began by getting materials, cleaning of the lab and equipment to be used.

2.1.1 Materials used

Measuring cylinder (50 ml and 100 ml), conical flask (100 ml), Ethanol, Venire caliper, Weighing balance, Ruler and Paper tape.

2.2 Research Methodology

2.2.1 Collection of seed sample

The seeds of Soybean (*Glycine max*) cumulated by **IITA** were gotten from the locations as shown in Table 2.1

Table 2.1: Selection of Soybean genotype used in this study

ACCESSION NUMBER	CULTIVAR NAME	COUNTRY OF ORIGIN	GRIN TAXA	ACCQUISITION DATE BY IITA
TGM-540	M79	Nigeria	GRIN:117711	31-1-1981
TGM-932	X2 S29	Nigeria	GRIN:117711	31-1-1981
TGM-933	ANAYELLES BLACK	Nigeria	GRIN:117711	31-1-1981
TGM-934	GUFULD 64044	Nigeria	GRIN:117711	31-1-1981
TGM-935	GILBERT	Nigeria	GRIN:117711	31-1-1981
TGM-941	X2 87	Nigeria	GRIN:117711	31-1-1981
TGM-942	X2 529	Nigeria	GRIN:117711	31-1-1981
TGM-943	M98 SHIKA	Nigeria	GRIN:117711	31-1-1981
TGM-944	ANAYELLES BLACK	Nigeria	GRIN:117711	31-1-1981
TGM-945	TRINIDARD	Nigeria	GRIN:117711	31-1-1981

2.2.2 Priming materials

Ethanol and water

2.3 Experimental Procedure

Two categories, quantitative qualities and qualitative traits, were used to analyze the morphological evaluations of the seeds.

2.3.1 Quantitative characteristics

The linear dimensions of 10 seeds from each accession number were determined using a venire caliper. The linear dimensions were measured in centimeters, and their mean values were calculated and recorded. A high-precision scale was used to determine the weight of the seeds by weighing 10 seeds from each accession. The 10-seed volume was produced with the water displacement technique. The volume of the seed was determined by placing 10 seeds in a 95 % ethanol and 5 % water-filled cylinder.

2.3.2 Qualitative characteristics

This comprises the seed's form, brightness, eye color, eye pattern, testa texture, color of variegation, pattern of variegation, color of the basal of variegated seeds, and splitting. Katie Dektar's 2013 application Color Namer was used to determine the testa basal color. The set of descriptors for the present morphological characterization of Soybean was produced using the *Sphenostylis stenocarpa* (Hochst ex. A. Rich.) Harms descriptor from Adewale and Dumet (2011).

Assessment of Experimental Parameters

Seed shape

1 = Round/globular

2 = Oval

3 = Oblong

4 = Rhomboid

Testa texture

Scored on the seeds by touching the testa surface as:

1 = Smooth

2 = Rough

3 = Wrinkled (folds on the testa)

Testa color variegation

0 = Absent

1 = Present

Testa basal color

Measured as varieties of colors without variegation

1 = White

2 = Grey

3 = Cream

4 = Light brown

5 = Reddish brown

6 = Dark brown

7 = Purple

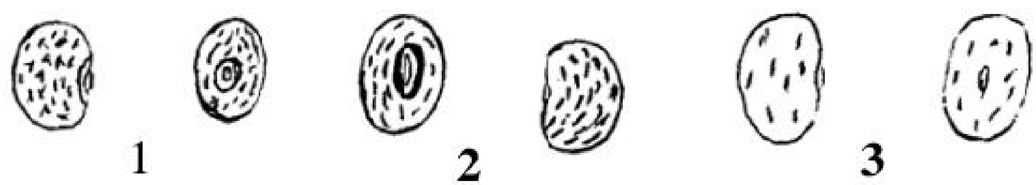
8 = Variegated (mosaic)

Pattern of testa variegation

1 = Dense black uneven spots/dots on brown background basal color with clean eye

2 = Sparse black dots on creamy brown background with a concentration around the hilum

3 = Patchy light brown dots on dark brown background



Basal color of variegated seed

0 = Non-variegated seeds

1 = Cream

2 = Brown

3 = Black

Eye color of white seed

Color around the hilum of white seeds

0 = Non-white seeds

1 = Clean (no color around the hilum)

2 = Brown

3 = Black

Eye color pattern

1 = Brown testa with continuous narrow black stripe around the hilum

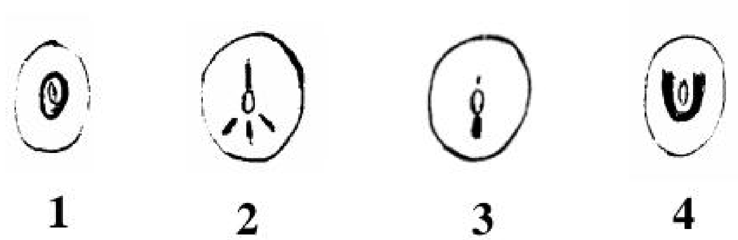
2 = Brown testa with dark brown fork-like eye pattern

3 = White/grey testa with incision-like eye pattern

4 = Brown testa with dark brown incision-like pattern below and parallel to the hilum

5 = White testa with reddish brown vase-like eye

6 = White testa with black vase-like eye



Brilliance of seed

1 = Matt

2 = Medium

3 = Shiny

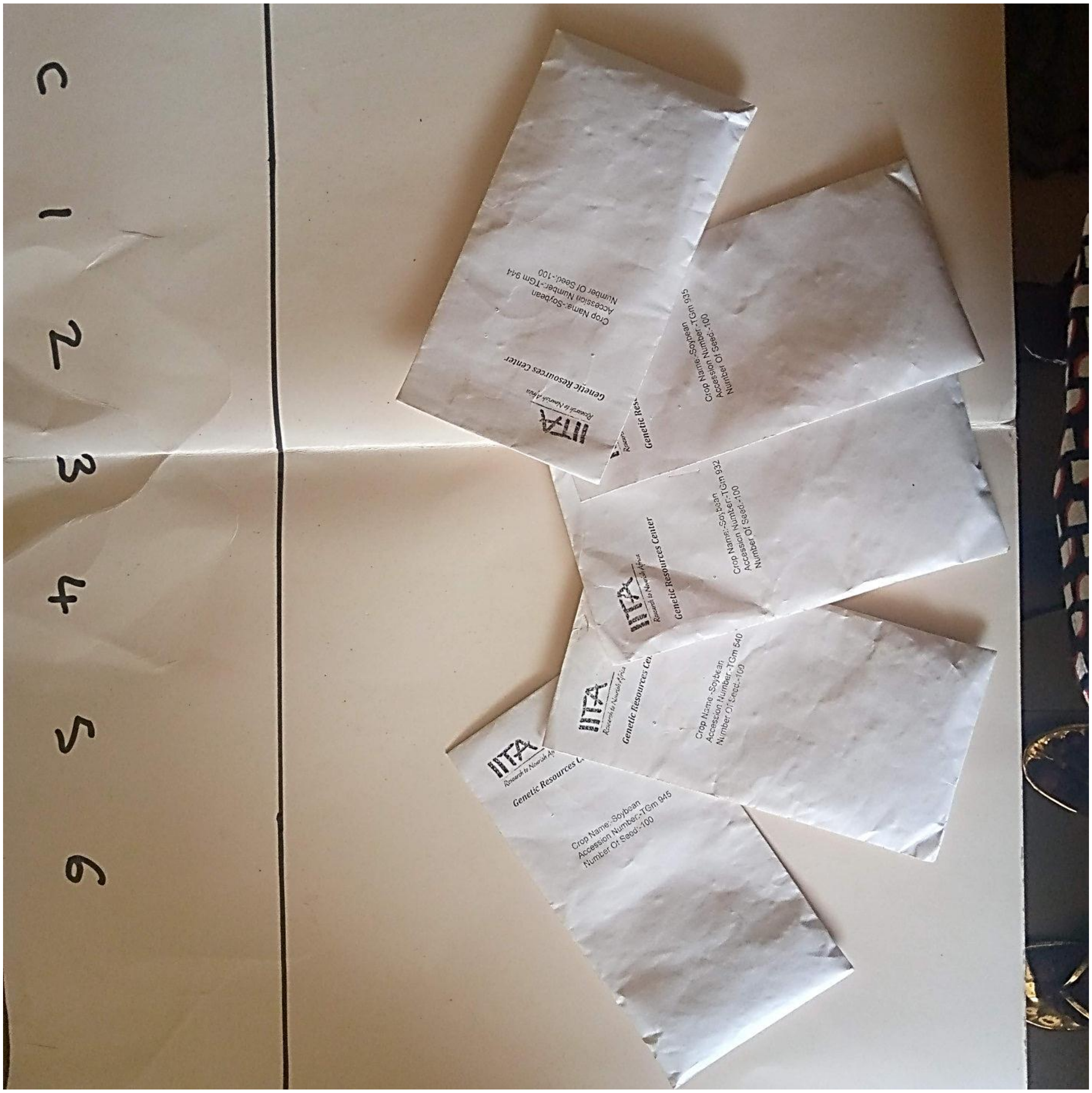


Plate 2.1A: Soybean samples collected from IITA

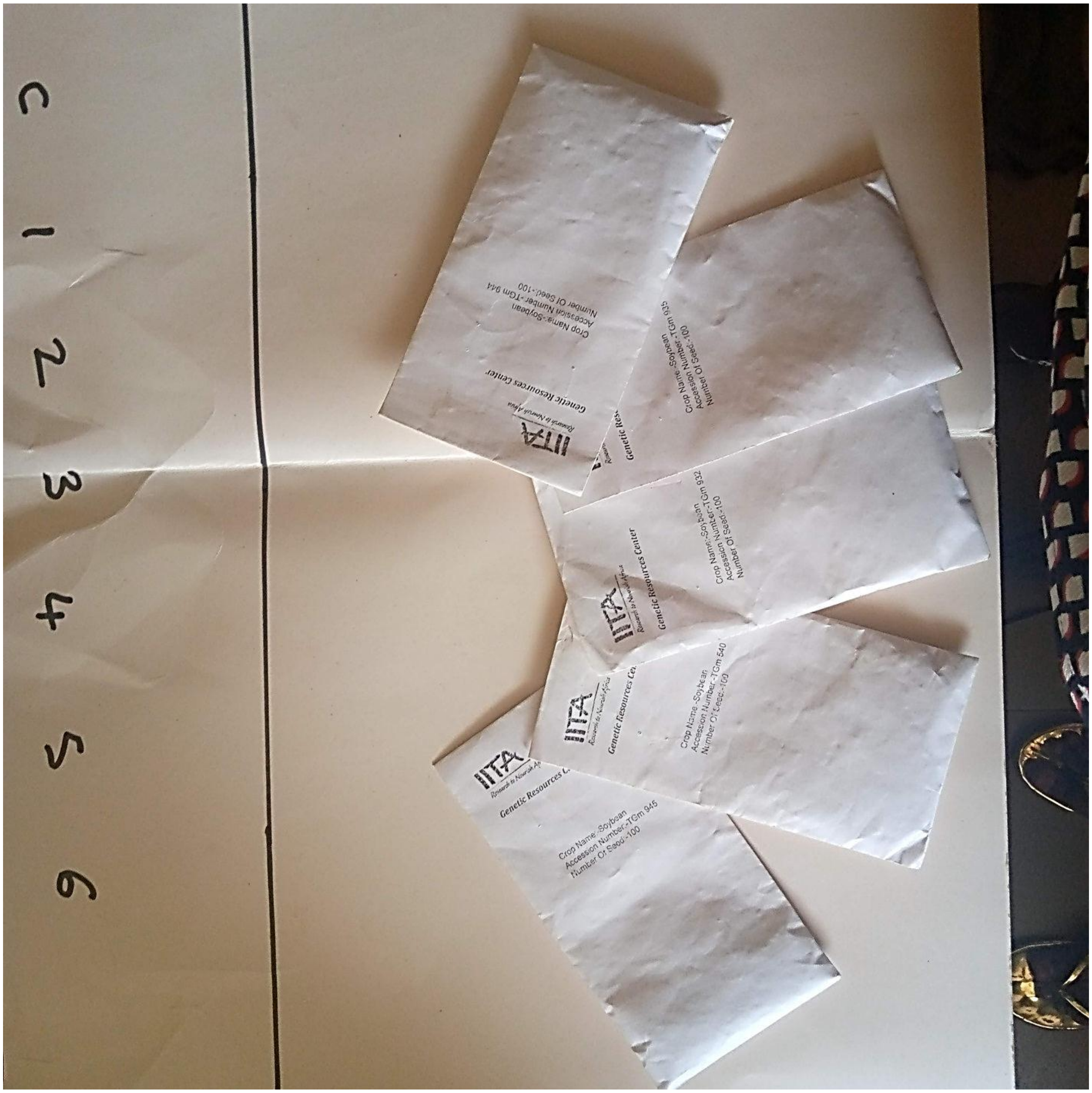


Plate 2.1B: Soybean samples collected from IITA

CHAPTER THREE

RESULTS

Accession number TGM-540

The quantitative parameters of the soybean variety with accession number TGM 540 did not show any visible signs of change at any time during the study. As a result, the length of the seed ranged anywhere from 0.6 to 0.75 centimeters. The seed width was between 0.5 and 0.6 centimeters, while the seed thickness was from 0.5 to 0.6 centimeters.

Table 3.1: Quantitative characteristic of accession number TGM-540

S/N	Length (cm)	Thickness (cm)	Width (cm)
Seed 1	0.75	0.5	0.5
Seed 2	0.6	0.5	0.5
Seed 3	0.75	0.6	0.6
Seed 4	0.7	0.55	0.55
Seed 5	0.65	0.5	0.5
Seed 6	0.69	0.6	0.6
Seed 7	0.7	0.6	0.6
Seed 8	0.6	0.5	0.5
Seed 9	0.65	0.55	0.55

Seed 10	0.69	0.59	0.59
mean	0.68	0.55	0.55

Accession number TGM-932

There were not substantial differences found in the length, breadth, or thickness of the seeds in the Soybean variety with accession number TGM 932, according to a quantitative examination of the seeds. Because of this, the length of the seeds ranged from around 0.5 to 0.7 centimeters. On the other hand, the width of the seed was between 0.49 and 0.55 centimeters, and its thickness was also between 0.49 and 0.55 centimeters.

Table 3.2: Quantitative characteristic of accession number TGM-932

S/N	Length (cm)	Thickness (cm)	Width (cm)
Seed 1	0.7	0.5	0.5
Seed 2	0.6	0.5	0.5
Seed 3	0.65	0.5	0.5
Seed 4	0.69	0.5	0.5
Seed 5	0.7	0.5	0.5
Seed 6	0.6	0.5	0.5

Seed 7	0.65	0.55	0.55
Seed 8	0.55	0.45	0.45
Seed 9	0.6	0.49	0.49
Seed 10	0.55	0.49	0.49
mean	0.63	0.55	0.55

Accession number TGM- 933

The quantitative characteristics of the TGM 933 variety of soybean were investigated, and the results suggest that there are no big differences in seed length, seed width, or seed thickness. Therefore, the length of the seed varied from 0.55 to 0.7 centimeters. On the other hand, the seed thickness ranged from 0.45 to 0.5 cm, while the seed width was somewhere from 0.45 to 0.5 cm.

Table 3.3: Quantitative characteristic of accession number TGM-933

S/N	Length (cm)	Width (cm)	Thickness (cm)
Seed 1	0.69	0.5	0.5
Seed 2	0.7	0.5	0.5
Seed 3	0.6	0.5	0.5
Seed 4	0.69	0.5	0.5
Seed 5	0.7	0.5	0.5

Seed 6	0.69	0.5	0.5
Seed 7	0.65	0.5	0.5
Seed 8	0.6	0.45	0.45
Seed 9	0.6	0.5	0.5
Seed 10	0.55	0.5	0.5
mean	0.65	0.50	0.50

Accession number TGM-934

There are no apparent differences in the length, width, or thickness of the seeds of the TGM 934 variety of soybean when compared to other varieties. Therefore, seed length varied from 0.5 cm to 0.7 cm. On the other hand, the seed thickness ranged from 0.49 cm to 0.55cm, while the seed width varied from 0.49 cm to 0.55 cm.

Table 3.4: Quantitative characteristic of accession number of TGM-934

S/N	Length (cm)	Thickness (cm)	Width (cm)
Seed 1	0.7	0.55	0.55
Seed 2	0.7	0.5	0.5
Seed 3	0.69	0.55	0.55
Seed 4	0.7	0.5	0.5
Seed 5	0.5	0.49	0.49
Seed 6	0.7	0.59	0.59

Seed 7	0.6	0.5	0.5
Seed 8	0.59	0.49	0.49
Seed 9	0.6	0.55	0.55
Seed 10	0.6	0.5	0.5
Mean	0.64	0.52	0.52

Accession number TGM-935

After measuring the length, width, and thickness of the seeds of the Soybean variety with the accession number TGM 935, there was statistically no changes. Therefore, the length of the seeds was between 0.5 cm and 0.6 cm. Conversely, the width of the seeds ranged from 0.39 cm to 0.5 cm, and the thickness also varied within the same range.

Table 3.5: Quantitative characteristic of accession number of TGM-935

S/N	Length (cm)	Thickness (cm)	Width (cm)
Seed 1	0.5	0.4	0.4
Seed 2	0.5	0.4	0.4
Seed 3	0.55	0.39	0.39
Seed 4	0.5	0.4	0.4

Seed 5	0.55	0.4	0.4
Seed 6	0.6	0.45	0.45
Seed 7	0.6	0.5	0.5
Seed 8	0.55	0.4	0.4
Seed 9	0.6	0.45	0.45
Seed 10	0.6	0.5	0.5
Mean	0.56	0.43	0.43

Accession number TGM-941

The quantitative characteristics of Soybean TGM 941 showed no significant changes in seed length, seed width, or seed thickness. Seed length was 0.59 cm to 0.7 cm. Seed width and thickness ranged from 0.45 cm to 0.59 cm.

Table 3.6: Quantitative characteristic of accession number of TGM-941

S/N	Length (cm)	Thickness (cm)	Width (cm)
Seed 1	0.7	0.5	0.5
Seed 2	0.7	0.59	0.59
Seed 3	0.69	0.5	0.5
Seed 4	0.6	0.5	0.5
Seed 5	0.6	0.5	0.5

Seed 6	0.6	0.5	0.5
Seed 7	0.7	0.5	0.5
Seed 8	0.59	0.45	0.45
Seed 9	0.6	0.45	0.45
Seed 10	0.55	0.45	0.45
Mean	0.63	0.50	0.50

Accession number TGM-942

The quantitative characteristics of the TGM 942 variety of soybean were studied, and the results reveal no significant changes in seed length, seed width, or seed thickness. As a result, seed length ranged from 0.5 cm to 0.6 cm. The seed width ranged from 0.4 cm to 0.5 cm, whereas the seed thickness ranged from 0.4 cm to 0.5 cm.

Table 3.7: Quantitative characteristic of accession number of TGM-942

S/N	Length (cm)	Thickness (cm)	Width (cm)
Seed 1	0.6	0.5	0.5
Seed 2	0.6	0.5	0.5

Seed 3	0.6	0.5	0.5
Seed 4	0.55	0.45	0.45
Seed 5	0.5	0.49	0.49
Seed 6	0.5	0.45	0.45
Seed 7	0.55	0.49	0.49
Seed 8	0.5	0.4	0.4
Seed 9	0.5	0.49	0.49
Seed 10	0.5	0.4	0.4
Mean	0.54	0.47	0.47

Accession number TGM-943

The quantitative characteristics of the Soybean variety with the accession number TGM 943 were studied, and the results reveal that there are no massive changes in the seed's length, seed's width, or seed's thickness. Therefore, the length of the seed varied between 0.6 cm and 0.7 cm throughout the board. On the other hand, the seed thickness and seed width was between from 0.49 cm to 0.55 cm.

Table 3.8: Quantitative characteristic of accession number of TGM-943

S/N	Length (cm)	Thickness (cm)	Width (cm)

Seed 1	0.69	0.5	0.5
Seed 2	0.7	0.5	0.5
Seed 3	0.7	0.5	0.5
Seed 4	0.69	0.5	0.5
Seed 5	0.7	0.5	0.5
Seed 6	0.69	0.5	0.5
Seed 7	0.6	0.49	0.49
Seed 8	0.7	0.55	0.55
Seed 9	0.7	0.5	0.5
Seed 10	0.7	0.55	0.55
Mean	0.69	0.51	0.51

Accession number TGM-944

There were no visible variations in the length, width, or thickness of the seeds of the TGM 944 variety of soybean when the quantitative characteristics of the plant were examined. Therefore, the length of the seeds varied from 0.6 cm to 0.8 cm. On the other hand, the seed width and thickness ranged from 0.5 cm to 0.6 cm respectively.

Table 3.9: Quantitative characteristic of accession number of TGM-944

S/N	Length (cm)	Thickness (cm)	Width (cm)

Seed 1	0.6	0.5	0.5
Seed 2	0.65	0.55	0.55
Seed 3	0.69	0.59	0.59
Seed 4	0.65	0.59	0.59
Seed 5	0.7	0.6	0.6
Seed 6	0.7	0.6	0.6
Seed 7	0.8	0.6	0.6
Seed 8	0.7	0.6	0.6
Seed 9	0.65	0.59	0.59
Seed 10	0.69	0.59	0.59
Mean	0.68	0.58	0.58

Accession number TGM-945

There were no statistically significant variations in the measured quantitative characteristics of soybean seeds of the TGM 945 variety. This meant that the length of the seeds may be anything between 0.6 cm and 0.75 cm. However, there was a wide range of variation in seed width, from 0.49 cm to 0.6 cm and seed thickness, also from 0.49 cm to 0.6 cm.

Table 3.10: Quantitative characteristic of accession number of TGM-945

S/N	Length (cm)	Thickness (cm)	Width (cm)

Seed 1	0.69	0.55	0.55
Seed 2	0.6	0.5	0.5
Seed 3	0.6	0.5	0.5
Seed 4	0.59	0.49	0.49
Seed 5	0.7	0.6	0.6
Seed 6	0.75	0.6	0.6
Seed 7	0.7	0.55	0.55
Seed 8	0.6	0.5	0.5
Seed 9	0.65	0.55	0.55
Seed 10	0.7	0.6	0.6
Mean	0.66	0.54	0.54

Accession number TGM-540

For *Soybean,* accession number TGM 540, the modal phenotypic and qualitative data are shown in Table 3.11. About six of the seeds had an oval shape, whereas four had a different shape (oblong). One of the 10 testa seeds had a rough texture; the other nine had smooth textures. The values for testa basal color, testa variegation pattern, eye color, and seed brilliance, among others, were consistent.

Table 3.11: Qualitative characteristic of accession number of TGM-540

	1	2	3	4	5	6	7	8	9	10
Seed shape	oval	Oval	Oval	Oblong	Oblong	oblong	oval	oval	oval	oblong
Testa texture	Rough	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Testa color variegation	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Testa basal color	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown
Pattern of testa variegation	3	3	3	3	3	3	3	3	3	3
Basal color of variegated seed	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown
Eye color of white seed	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown
Eye color pattern	4	4	4	4	4	4	4	4	4	4
Brilliance	Shiny	Shiny	Shiny	Shiny	Shiny	Shiny	Shiny	Shiny	Shiny	Shiny

Accession number TGM-932

For Soybean, accession number TGM 932, the modal phenotypic and qualitative data are shown in Table 3.12. About six of the seeds had an oval shape, whereas four had a different shape (oblong). The values for testa texture, testa basal color, testa variegation pattern, eye color, and seed brilliance, among others, were consistent.

Table 3.12: Qualitative characteristic of accession number of TGM-932

	1	2	3	4	5	6	7	8	9	10
Seed shape	Oval	Oval	Oblong	Oblong	Oval	Oblong	Oval	Oval	oval	oblong
Testa texture	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Testa color variegation	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Testa basal color	Black	Black	Black	Black	Black	Black	Black	Black	Black	Black
Pattern of testa variegation	None	None	None	None	None	None	None	None	None	None
Basal color of variegated seed	0	0	0	0	0	0	0	0	0	0
Eye color of white seed	1	1	1	1	1	1	1	1	1	1
Eye color pattern	None	None	None	None	None	None	None	None	None	None
Brilliance	Matt	Shiny	Shiny	Matt	Medium	Shiny	Matt	Shiny	Matt	Shiny

Accession number TGM-933

For *Soybean*, accession number TGM 933, the modal phenotypic and qualitative data are shown in Table 3.13. Only one of the seeds had an oval shape, whereas the nine others had a different shape (oblong). The seed brilliance, only one was matt while the others were medium and shiny. The values for testa texture, testa basal color, testa variegation pattern, eye color, among others, were consistent.

Table 3.13: Qualitative characteristic of accession number of TGM-933

	1	2	3	4	5	6	7	8	9	10
Seed shape	Oblong	Oblong	Oblong	Oblong	Oblong	Oval	Oblong	Oblong	Oblong	Oblong
Testa texture	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Testa color variegation	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Testa basal color	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown	Reddish brown
Pattern of testa variegation	None	None	None	None	None	None	None	None	None	None
Basal color of variegated seed	0	0	0	0	0	0	0	0	0	0
Eye color of white seed	1	1	1	1	1	1	1	1	1	1
Eye color pattern	None	None	None	None	None	None	None	None	None	None
Brilliance	Shiny	Medium	Medium	Medium	Shiny	Shiny	Medium	Shiny	Matt	Shiny

Accession number TGM-934

For Soybean, accession number TGM 934, the modal phenotypic and qualitative data are shown in Table 3.14. About eight of the seeds had an oblong shape, and only two had an oval shape. The values for testa texture, testa basal color, testa variegation pattern, eye color, and seed brilliance, among others, were consistent.

Table 3.14: Qualitative characteristic of accession number of TGM-934

	1	2	3	4	5	6	7	8	9	10
Seed shape	Oblong	Oblong	Oblong	Oblong	Oblong	Oblong	Oval	Oblong	Oblong	Oval
Testa texture	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Testa color variegation	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Testa basal color	Black	Black	Black	Black	Black	Black	Black	Black	Black	Black
Pattern of testa variegation	None	None	None	None	None	None	None	None	None	None
Basal color of variegated seed	0	0	0	0	0	0	0	0	0	0
Eye color of white seed	1	1	1	1	1	1	1	1	1	1
Eye color pattern	None	None	None	None	None	None	None	None	None	None
Brilliance	Medium	Shiny	Matt	Matt	Shiny	Matt	Medium	Matt	Medium	Shiny

Accession number TGM-935

For Soybean, accession number TGM 935, the modal phenotypic and qualitative data are shown in Table 3.15. About five of the seeds had an oval shape, while five others had an oblong shape. The values for testa texture, testa basal color, testa variegation pattern, eye color, and seed brilliance, among others, were consistent.

Table 3.15: Qualitative characteristic of accession number of TGM-935

	1	2	3	4	5	6	7	8	9	10
Seed shape	Oval	Oblong	Oblong	Oval	Oval	Oval	Oblong	Oblong	Oblong	Oval
Testa texture	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Testa color variegation	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Testa basal color	Light brown	Light brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown
Pattern of testa variegation	3	3	3	3	3	3	3	3	3	3
Basal color of variegated seed	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown
Eye color of white seed	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown
Eye color pattern	4	4	4	4	4	4	4	4	4	4
Brilliance	Medium	Shiny	Medium	Medium	Shiny	Shiny	Matt	Shiny	Shiny	Matt

Accession number TGM 941

For Soybean, accession number TGM 941, the modal phenotypic and qualitative data are shown in Table 3.16. Only two seeds had oblong shape, the other eight had oval shape. The values for testa texture, testa basal color, testa variegation pattern, eye color, and seed brilliance, among others, were consistent.

Table 3.16: Qualitative characteristic of accession number of TGM-941

	1	2	3	4	5	6	7	8	9	10
Seed shape	Oval	Oval	Oval	Oval	Oval	Oval	Oblong	Oval	Oblong	Oval
Testa texture	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Testa color variegation	Present	Absent	Absent	Present	Absent	Absent	Present	Present	Present	Present
Testa basal color	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown
Pattern of testa variegation	3	None	None	3	None	None	3	3	3	3
Basal color of variegated seed	Brown	0	0	Brown	0	0	Brown	Brown	Brown	Brown
Eye color of white seed	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown
Eye color pattern	4	4	4	4	4	2	4	4	4	4
Brilliance	Shiny	Medium	Shiny	Medium	Matt	Matt	Medium	Medium	Shiny	Matt

Accession number TGM-942

For Soybean, accession number TGM 942, the modal phenotypic and qualitative data are shown in Table 3.17. About eight seeds had oblong shape while the other two had oval shape. The values for testa texture, testa basal color, testa variegation pattern, eye color, and seed brilliance, among others, were consistent.

Table 3.17: Qualitative characteristic of accession number of TGM-942

	1	2	3	4	5	6	7	8	9	10
Seed shape	Oblong	Oblong	Oblong	Oblong	Oblong	Oval	Oblong	Oblong	Oblong	Oval
Testa texture	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Testa color variegation	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Testa basal color	Black	Black	Black	Black	Black	Black	Black	Black	Black	Black
Pattern of testa variegation	1	1	1	1	1	1	1	1	1	1
Basal color of variegated seed	0	0	0	0	0	0	0	0	0	0
Eye color of white seed	1	1	1	1	1	1	1	1	1	1
Eye color pattern	None	None	None	None	None	None	None	None	None	None
Brilliance	Shiny	Medium	Medium	Shiny	Matt	Medium	Shiny	Medium	Matt	Matt

Accession number TGM-943

For Soybean, accession number TGM 943, the modal phenotypic and qualitative data are shown in Table 3.18. Only two seeds had oval shape, the other eight had oblong shape. The values for testa texture, testa basal color, testa variegation pattern, eye color, and seed brilliance, among others, were consistent.

Table 3.18: Qualitative characteristic of accession number of TGM-943

	1	2	3	4	5	6	7	8	9	10
Seed shape	Oblong	Oblong	Oval	Oblong	Oblong	Oblong	Oblong	Oblong	Oval	Oblong
Testa texture	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Testa color variegation	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Testa basal color	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple
Pattern of testa variegation	None	None	None	None	None	None	None	None	None	None
Basal color of variegated seed	0	0	0	0	0	0	0	0	0	0
Eye color of white seed	1	1	1	1	1	1	1	1	1	1
Eye color pattern	None	None	None	None	None	None	None	None	None	None
Brilliance	Shiny	Medium	Matt	Medium	Medium	Matt	Matt	Medium	Matt	Matt

Accession number TGM-944

For Soybean, accession number TGM 944, the modal phenotypic and qualitative data are shown in Table 3.19. All the seeds had oblong shape. The values for testa texture, testa basal color, testa variegation pattern, eye color, and seed brilliance, among others, were consistent.

Table 3.19: Qualitative characteristic of accession number of TGM-944

	1	2	3	4	5	6	7	8	9	10
Seed shape	Oblong	Oblong	Oblong	Oval	Oblong	Oblong	Oblong	Oblong	Oblong	Oblong
Testa texture	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Testa color variegation	Absent	Absent	Present	Absent	Present	Present	Present	Absent	Present	Present
Testa basal color	Light brown	Light brown	Variegated (mosaic)	Light brown	Light brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown
Pattern of testa variegation	None	3	3	None	3	3	3	None	3	3
Basal color of variegated seed	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown
Eye color of white seed	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown
Eye color pattern	4	4	4	4	4	4	4	4	4	4
Brilliance	Medium	Matt	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

Accession number TGM-945

For Soybean accession number TGM 945, the modal phenotypic and qualitative data are shown in Table 3.20. The values for seed shape, testa texture, testa basal color, testa variegation pattern, eye color, and seed brilliance, among others, were consistent.

Table 3.20: Qualitative characteristic of accession number of TGM-945

	1	2	3	4	5	6	7	8	9	10
Seed shape	Oblong	Oblong	Oblong	Oblong	Oblong	Oblong	Oblong	Oblong	Oblong	Oblong
Testa texture	Rough	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Testa color variegation	Present	Absent	Absent	Present	Present	Present	Absent	Present	Present	Present
Testa basal color	Variegated	Purple	Black	Black	Reddish brown	Purple	Black	Black	Black	Black
Pattern of testa variegation	1	None	None	1	1	1	None	1	1	1
Basal color of variegated seed	Black	None variegated	0	Black	Brown	Black	0	Black	Black	Black
Eye color of white seed	Black	Black	Black	Clean	Clean	Clean	Clean	Clean	Clean	Clean
Eye color pattern	6	6	3	None	None	None	None	None	None	None
Brilliance	Matt	Matt	Matt	Matt	Matt	Matt	Matt	Matt	Matt	Matt

Table 3.21: Measurable mean and standard deviation of Soybean seeds collected at IITA.

Accession Number	Quantitative parameter	Mean	Standard Deviation
TGM540	Seed length (cm)	0.68	0.053
	Seed width(cm)	0.55	0.046
	Seed thickness(cm)	0.55	0.046
	Seed weight (g)	1.45	
TGM932	Seed length (cm)	0.629	0.057
	Seed width(cm)	0.50	0.024
	Seed thickness(cm)	0.50	0.024
	Seed weight (g)	0.94	
TGM933	Seed length (cm)	0.65	0.055
	Seed width(cm)	0.50	0.016
	Seed thickness(cm)	0.50	0.016
	Seed weight (g)	1.03	
TGM934	Seed length (cm)	0.64	0.070
	Seed width(cm)	0.52	0.035
	Seed thickness(cm)	0.52	0.035
	Seed weight (g)	1.02	
TGM935	Seed length (cm)	0.56	0.059
	Seed width(cm)	0.43	0.043
	Seed thickness(cm)	0.43	0.043
	Seed weight (g)	0.68	

TGM941	Seed length (cm)	0.63	0.058
	Seed width(cm)	0.50	0.041
	Seed thickness(cm)	0.50	0.041
	Seed weight (g)	1.07	
TGM942	Seed length (cm)	0.54	0.050
	Seed width(cm)	0.47	0.040
	Seed thickness(cm)	0.47	0.040
	Seed weight (g)	0.68	
TGM943	Seed length (cm)	0.69	0.031
	Seed width(cm)	0.51	0.022
	Seed thickness(cm)	0.51	0.022
	Seed weight (g)	1.04	
TGM944	Seed length (cm)	0.68	0.053
	Seed width(cm)	0.58	0.032
	Seed thickness(cm)	0.58	0.032
	Seed weight (g)	1.25	
TGM945	Seed length (cm)	0.66	0.057
	Seed width(cm)	0.54	0.045
	Seed thickness(cm)	0.54	0.045
	Seed weight (g)	1.28	

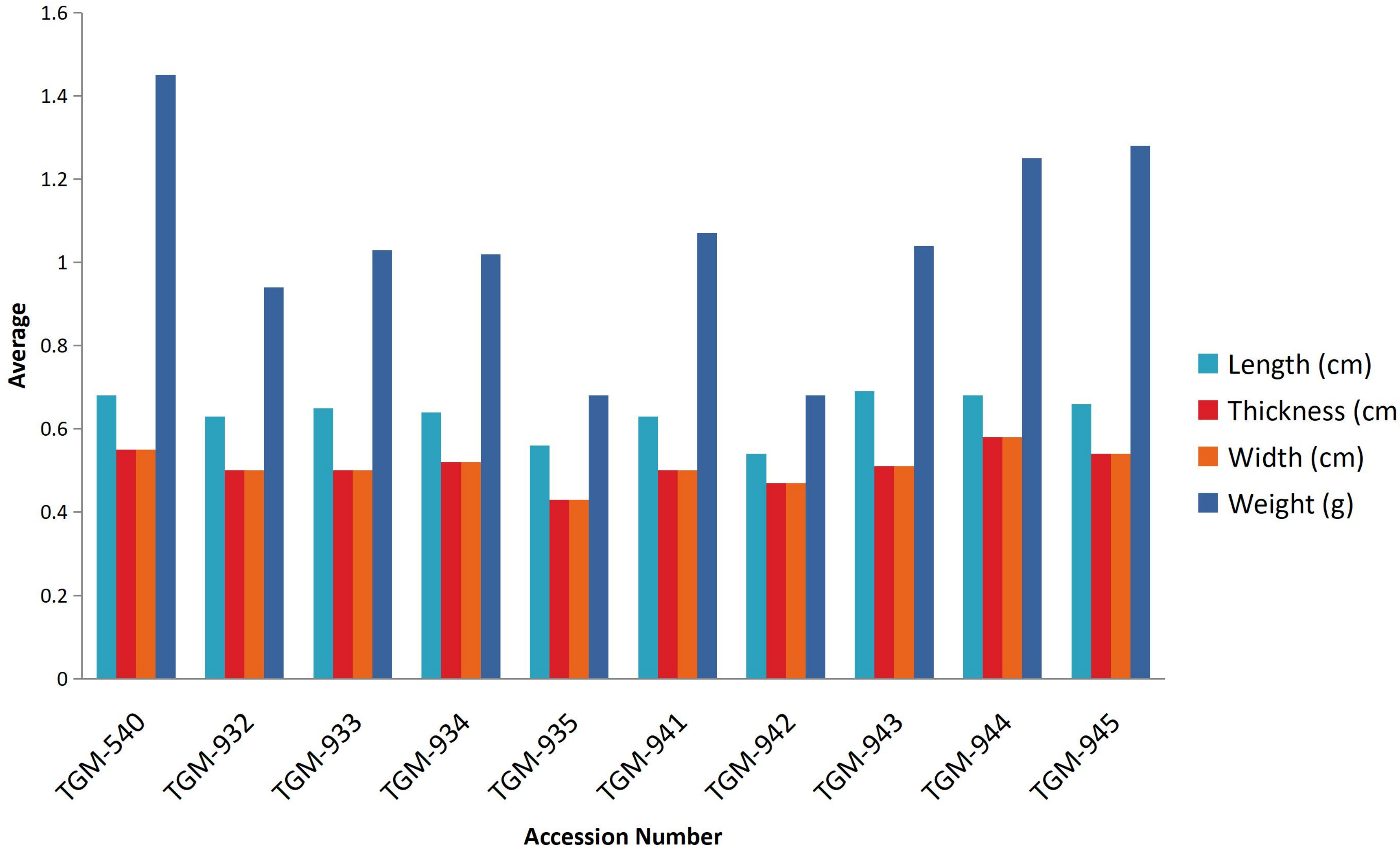


Figure 3.1: Quantitative characteristics of Soybean accessions used

CHAPTER FOUR

DISCUSSION AND CONCLUSION

5.1 Discussion

The research was carried out to check if there will be significant change in the morphology and physiology of soybean seeds with different accession numbers. Accession number TGM-540 weighed more, compared to the other accession numbers. Accession number TGM-942 had the least length while accession number TGM-935 had the least width and thickness of seeds. Harvest index was shown to be unrelated to seed yield by Liu *et al.* in 2005. Even tall statured soybean cultivars generated more leaves, which in turn provided more assimilates for seed development and led to a higher seed output, even if plant height had no direct impact on the ultimate seed production. Similar to taller plants, taller soybean types produced more pods and seeds during their course of growth. Furthermore, the fact that there was a positive correlation between seed yield and the quantity of pods and seeds was presumably a result of the fact that these are the key soybean production components.

In comparing the shape of the seeds, accession number TGM-945 and TGM-933 seeds all had an oblong shape, while the others had both oblong and oval shape respectively. They all had variably smooth testa texture while only a few seeds had a rough testa texture. Testa color variegation was present in all seeds of Accession number TGM-540and TGM-935, absent in Accession number TGM-934, TGM-942 and TGM-943 and was both present and absent in the seeds of the other accession numbers. The testa basal color ranged from purple in TGM-943, black in TGM-932, TGM-934, TGM-942 to reddish brown, light brown, dark brown and variegated (mosaic) in the other Accession numbers. Their testa basal color varies and it may be due to expression of many genes which can be linked to environmental, physiological, and genetic factors. The farmer's preferences for agricultural output are another factor in the environment. Therefore, these variables may have an impact on my results. In a range of plant species, including legumes like cowpea, bean, and soybean, the testa color feature is reportedly polygenic and controlled by numerous genes (Yildiz *et al*., 2016). The basal color of variegated seeds was mostly brown and 0. The observed color fluctuations in seed testa are explained by the expression of numerous genes, which causes variable quantities of different color pigments (Mavi, 2010). The generation of these pigments may be impacted by environmental conditions as well. Seed color has also reportedly been linked to seed germination and dormancy, according to Bhatt *et al*. (2016). As a result, more investigation is needed to determine how seed testa color affects both dormancy and germination. Additionally, a straightforward technique for enhancing seed quality for various crop species, including common bean and cowpea, has been developed using seed size and seed coat color (Yildiz Tiryaki *et al.,* 2016). Uncertainty is brought on by seed variations in the agricultural industry, where consistency is required (Mitchell *et al.,* 2016). The farmer will have problems if these variances have a detrimental effect on crop output. These seed variations might also work against the vendor, especially if customers find them to be unattractive.

5.2 CONCLUSION

Given the significance of soybean as a crop rich in protein and oil, its capacity to enhance soil quality, and its numerous applications in both household and industrial settings, there are sufficient justifications to focus greater research efforts on its genetic development. A variety of promising cultivars with strong yield potential have been produced in recent years, and there has been tremendous progress in the development of soybean types. Improvements to the crop's plant type, oil content and quality, protein content, and nutritional profile have all been the subject of substantial research.

However, there is still a sizable discrepancy between the crop's actual yield and its required production. This is increasingly significant in light of the rising demand for its oil caused by population growth, a variety of applications, and an improvement in people's purchasing power, particularly in emerging countries. Consequently, improving seed production as well as oil and protein content are problems. For this, a thorough soy improvement program is necessary, and sufficient genetic variety is needed for harvest.

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