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VARIATION IN AGRONOMICS CHARACTERISTICS OF TEN ACCESSIONS OF SESAME (*Sesamum indicum* L.) CULTIVATED IN NORTH CENTRAL STATES, NIGERIA

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Abstract

This study was carried out to assess agronomic characteristics of ten accessions of sesame (Sesamum indicum L.) cultivated in north central states, Nigeria. A total of ten accessions of sesame were collected from National Centre for Genetic Resources and Biotechnology (NACGRAB) Ibadan, Nigeria. The seeds were grown to maturity in pots arranged in experimental layout to assess agronomic characteristics. Ten accession of sesame were evaluated for agronomic traits at the at the landscape garden, Modibbo Adama University (MAU), Yola during 2017/2018 and 2018/2019 growing seasons, using a complete Randomized Block Design (CRBD) with three replicates. The agronomic parameters were investigated using standard procedures. The results on the agronomic characteristics showed significant difference (p≤0.05) in the leaf lengths and leaf areas, number of leaves, plant heights, internodes flowers emergence, bud opening. The accessions showed variations in the leaf length at 4, 6, and 8 weeks after planting (WAP). NGB943 had significantly highest in leaf lengths at 4, 6, and 8 WAP with the values of 10.07 cm, 20.67 cm, and 50.50 cm respectively. Similarly, the significant highest in leaf area was recorded at 4, 6, and 8 WAP for NGB943 with the values of 66.63 cm^2, 134.0 cm^{2,} and 199.80 cm^2 respectively. The number of leaves and plant heights of sesame plants at 4WAP, NGB1336 recorded the highest number of leaves with the value of 12 leaves. Plant height of sesame accessions significantly varied at 4, 6, and 8 WAP. NGB 1336 produced the tallest plant with the values of 20.33, 40.33, and 60.33 at 4, 6, and 8 WAP respectively. The variations of accessions on internodes flower, bud emergence, and bud opening were significantly different (P≤ 0.05) at both 6 and 8WAP respectively. NGB380 produced the highest number of internodes flower at both 6 and 8WAP. The variations of accessions on internodes flower, bud emergence, and bud opening were significantly different at both 6 and 8WAP respectively. NGB380 produced the highest number of internodes flower *at both 6 and 8WAP. Also, NGB454 and NGB943 recorded the highest bud emergence at 6WAP. Bud emergence at 8WAP indicated that NGB380 had a significantly highest value of 20 compared to other accessions. Also, NGB419 recorded significantly highest in bud opening at 6WAP with the values of 13.00 buds while NGB454 was significantly higher in the number of bud opening at 8WAP with the value of 18.00 buds. The study revealed that all of the agronomic characteristics were influenced by genetic factors such characteristics are suitable for selection. Therefore, combination of high heritability estimates with genetic advance in the selection program is vital for selection of the crop in the future. Emphasis should be made on those agronomic characteristics that show greater genetic importance for selection and improvement of the crop in Nigeria.*

Keywords: Accession, CRBD, NGB, Variation and WAP

Introduction

Sesame is one of the most ancient oil-producing crops known to humanity. It is a rain-fed crop grown throughout the tropics and subtropics. It is a short-day plant but also grows well in long-day areas. It belongs to the family Pedaliaceae, domesticated well over 3000 years ago (Ashri, 2017). The genus *Sesamum* consists of about 20 species and it is a diploid species, n =13 and 2n = 26 (Nimmakayala *et al*., 2011). It is an annual plant growing 50 to 100 cm (1.6 to 3.3 ft) tall, with opposite leaves 4 to 14 cm (1.6 to 5.5 in) long with an entire margin; they are broad lanceolate, to 5 cm (2 in) broad, at the base of the plant, narrowing to just 1 cm (0.4 in) broad on the flowering stem (Ashri, 2017). The flowers are yellow, tubular, 3 to 5 cm (1.2 to 2.0 in) long; with a four-lobed mouth, the flowers may vary in colour with some being white, blue, or purple. Sesame fruit is a capsule, normally pubescent, rectangular in section and typically grooved with a short triangular beak. The length of the fruit capsule varies from 2 to 8 cm; its width varies between 0.5 to 2 cm, and the number of loculi from 4 to 12 (Tunde-Akintunde *et al*., 2010). Sesame seeds are an important seed crop. They are sprinkled on loaves of bread, cakes, cookies, and candies and are the source of valuable oil. The seed coat (testa) may be smooth or ribbed. Sesame seeds come in many colours depending on the accessions harvested. The most-traded variety of sesame is off-white coloured. Other common colours are buff, tan, gold, brown, reddish, gray, and black. Sesame seed is considered to be the oldest oilseed crop known to humanity. Sesame has many species, and most are wild. The fruit naturally splits open (dehisces) to release the seeds by splitting along the septa from top to bottom or using two apical pores (Anthony *et al*., 2015). Sesame seed viability is the ability of the seed to germinate and the ability of the seedling to establish itself in the environment in which seed finds itself. Sesame seeds can be stored in an airtight container in a cool, dark place in the pantry. The best method to store sesame seed is in the freezer, the cold temperature prevents the natural oils in the seed from spoiling and last a longer period of time. Sesame seeds are viable for at least a year. Sesame seeds are small in size and almost oblate in shape. *Sesame indicum* is the cultivated species, originated in India. Sesame is very drought-tolerant, in part due to its extensive root system. Sesame plant grows well on loamy soil and rainfall ranges from 200-1000 mm. late rainfall in the season prolongs growth and increases high harvest-shattering losses (Abdou *et al*., 2015). The high yielding sesame plant thrives best on well drained fertile soil of medium texture and neutral pH. However, it has a low tolerance for water logged condition. The sesame plant is sensitive to photoperiod and photoperiod affects the oil content in sesame plant. Sesame is drought tolerant plant and it requires adequate moisture for germination and early growth.

Today it has become one of the most patronized and most important oilseed crops in Nigeria. The sesame plant is an annual herb in the family Pedaliaceae, which grows extensively in Nigeria, Asia, particularly in Burma, China, and India. It is also one of the chief commercial crops in Nigeria, Sudan, and Ethiopia. The crop thrives best on moderately fertile, well-drained soils with a pH ranging from 5.5 to 8.0 and is sensitive to salinity (Ali, 2015). It has high ecological aptitude being highly tolerant to drought and can grow where other crops fail. The local names are ridi in Hausa, isasa in Yoruba and ekuku in Igbo. Sesame seeds are considered to have the highest oil contents 44-60 percentage among major oilseed crops including peanut, soybean, rapeseed, and also rich in proteins, vitamins, and antioxidants such as sesamin. The outstanding characteristic of sesame oil is its stability and keeping quality as well as resistance to rancidity. Nigeria is one of the most important sesame-producing countries that contributes over 20% and consumes ~30% of the world's production, with the highest yield level around the world (UNFAO, 2010).

Nigeria is the second-largest producer of sesame in Africa, with about 84 millions hectare of arable land under cultivation. The production of sesame is highly promising with high returns on investment. According to Food and Agriculture Organization (FAO, 2015) reported that Nigeria has the potential of producing about 180 billion tonnes of sesame in four months if fully tapped and about 95% of the output in Nigeria is exported. Also, the Nigeria Bureau of Statistics in 2016 reported that sesame seeds worth 16.46 billion were exported during the period, representing 39.4 percentages of agricultural exports between October and November 2016. Nigeria is the second-largest in agro-export earner with the capacity of generating billions of naira in foreign exchange yearly. Jigawa state has the highest area of production of about 22.3% in Nigeria. The yield per hectare in Nigeria is 0.5-1.0 tonnes. The white seed sesame is most cultivated in Nigeria. Sesame presents huge opportunities for Nigeria in terms of generating export revenue and employment (Agele *et al.*, 2015). Aside from the fact that it has numerous healths, industrial benefits and widely used for baking, medicine and animal feeds. It has a high oil content of about 44-60%. Sesame is cultivated majorly in the Northern part of Nigeria. Sesame seeds and oil are being used extensively in Nigeria. In most parts of the country, sesame seeds mixed with heated jaggery, sugar which is made into balls (Adebowale *et al.*, 2010). Sesame is an important oilseed crop of tropical and subtropical regions, renowned for its high oil content. The seeds contain 44-60% oil, hence sesame is known as the king of oil seeds. Generally, the oil is used as active ingredients in antiseptics, bactericides, viricides, disinfectants, moth repellants, anti-tubercular agents, and a considerable source of calcium, tryptophan, methionine, and many minerals (Ashri, 2017).

Nigeria was the largest supplier to the Japanese market, the world's largest import market for sesame. Nigeria can generate 540 billion naira from sesame seed production annually (FAOSTAT, 2015). Thus, the potentials for beniseed production in Nigeria is high and sesame was widely grown in Middle Belt, Northern, and Central Nigeria as a minor crop initially in 1974 when it became a major cash crop in the many Northern States e.g. Benue, Kogi, Gombe, Jigawa, Kaduna, Kano, Nasarawa, Katsina, Plateau, Yobe and Federal Capital Territory. The major producing states in order of priority are Nasarawa, Jigawa, Taraba and the Benue States. Other important states of production are found in Yobe, Borno, Adamawa, Niger, Kano, Katsina, Kogi, Gombe, and the Plateau States (RMDC, 2004). The map of Nigeria showing sesame-producing states as shown (Figure 1).

Harvesting begins in late December and continues through July. Each producing area has only one season (Woldesenber *et al.,* 2015). There two types of sesame produced in Nigeria, the white/raw = Food-grade used in the bakery industry. 98-100% whitest grade seeds and the brown/mixed = primarily oil-grade. The white (Food Grade) seed is grown around the towns of Keffi, Lafia, Makurdi, Doma, and in Nassarawa, Taraba, and the Benue States. The brown/mixed grows in the North, in Kano State, and Jigawa State near Hadejia, and in the southern part of Katsina State (Patel, *et al*., 2015).

Sesamum indicum is the sole cultivar in the *Sesamum* genus and evolved from wild populations. Sesame is an herbaceous annual plant belonging to the Pedaliaceae family and is one of the oldest oilseed herbs which is adapted to the arid and semi-arid areas and known as the queen of the oilseed plants (Roul *et al.,* 2017). Falusi *et al*., (2007) observed that the nature of sesame leaf varies from one species to another. According to him, the leaves are ovate to wavy entire in *S. indicum,* pentalobed entire in *Sesamum alatum,* heteromorphic linear to three-lobed entire leathery in *Sesamum malabaricum,* deeply dissected coarse in *Sesamum laciniatum,* coarse leathery with serrated margin in *Sesamum occidentalis* and coarse broad in *Sesamum radiatum.* According to Food and Agriculture Organization (FAO, 2011), Ethiopia is ranked sixth in sesame production with 327,741 tons (10%) of production per year. Falusi *et al*. (2001) reported that sesame plant is grown in different parts of Nigeria and the sesame seeds yield a quantity of the oil that is half their weight. The oil is commonly used in making soup while the young leaves are used as a soup vegetable. Various parts of the plant are also used in native medicine. Alege *et al.* (2009a) reported that the stems are usually burned to provide fuel where firewood is scarce and the ash is commonly used for local soap production.

The potentials for sesame production in Nigeria were high. This has led to the growth in demand for sesame and its products both at the national and international levels. S*esamum indicum* is considered the queen of oil seeds for its high oil content and quality. It is grown widely in tropical and subtropical areas as an important source of oil and protein. According to Muhamman and Gungula (2008), the plant is gaining significance in Nigerian agriculture because of the economic importance of its seeds as well as the nutritional value of the leaves when used as a vegetable. Morphology has been a primary tool in estimating genetic variability among sesame genotypes and agro-morphological characterization of any plant have been reported to be an important tool in the determination of quality and the present state of the plant. To date, limited information is available about the characteristic traits of sesame particularly as it regards the North Central States, Nigeria. However, this increase in production of the plant is hampered by several factors such as lack of improved varieties and low fertilization rate with little or no concern from both government and sesame breeders. Therefore, there is need to enhance the productivity of the crop by developing high-yielding genotypes that could stand the test of time. Improvement of any plant depends on the degree of characterization and variability present in the gene pool of that plant. Unfortunately, there is little research on the characterization of the plant at a agro-morphological. Hence, this research is designed to evaluate the genetic diversity of sesame (*Sesamum indicum*) cultivated in North Central States, Nigeria using morphological characteristics.

Materials and Methods

Experimental Site and Planting Materials

Cultivation and phenotype evaluations were carried out at the Landscape Garden, Modibbo Adama University, Yola, Adamawa State between July and October 2018 sowing season. The study area at GPS locations lie within the Northern Guinea Savanna of Nigeria between latitudes 8^{0} ^{N} and $11^{0\,N}$ of the equator and longitudes 11.5^{0} E and 13.5^{0} E of the Greenwich meridian, with a land area of about 42,159 square kilometers. The vegetation is a sub-Sudan Savannah type consisting of short grasses with short trees. The tropical climate of the region is marked by wet and dry seasons. The wet season is from May to October with maximum rainfall around August while the dry season is from November to April. On average, the minimum temperature is 35^0 C while the maximum temperature is 44^0 C in October 2018. Mean annual temperature ranges between 26.9 and 27.8^0 C (Adebayo *et al*., 2012). Rainfall is the most variable element of the tropical climate. Most of its characteristics such as amount and frequency vary with time. The amount of rainfall ranges between 600-1000mm and amount of humidity varies from $20\text{-}30^0$ C. The state is located at an altitude of 185.9 m above sea level and lies within the northern guinea savanna zone of Nigeria.

Collection of Sesame Seeds (*Sesamum Indicum)*

Ten accessions of sesame seeds were obtained from the National Centre for Genetic Resources and Biotechnology, (NACGRAB) Ibadan, the seeds were kept separately in properly labeled envelopes and tied in white polythene bags. Healthy seeds were determined using the floatation method. Sesame accessions obtained were NGB380, NGB419, NGB454, NGB627, NGB935, NGB939, NGB943, NGB967, NGB1335 and NGB1336. The characteristics, local names, sources and description of ten accessions of sesame were shown (Table 1).

Measurement of Agronomic Characteristics

The agronomic parameters were investigated using standard procedures after the techniques of Akinyele and Osekita (2006). Specifically, the number of leaves per plant (NL) at maturity was determined by counting the number of leaves attached to the plants. The length of vine of the plants at two weeks interval up to maturity was measured in centimetres (cm) using a metre rule. Leaf area (cm^2) was determined per plant using a graphical method at 4, 6, and 8 weeks after planting. The outline of the leaf was traced on a graph sheet and the area of each square covered by the leaf was added to give an estimate of the surface area. Squares that were not covered up to half were not counted. The number of leaves per plant was determined by direct counting at 4, 6, and 8 weeks after planting. Plant height (cm): The distance from ground level up to the apex per plant was measured at 4, 6, and 8 weeks using a measuring tape. The number of internodes flower per plant was counted along the shoot at 6 and 8 weeks after planting. The number of bud emergence per plant on the main stem was assessed by counting the total number of buds emergence at 6 and 8 weeks after planting. The number of bud openings per plant was determined by counting the total number of buds opening on a plant at 6 and 8 weeks after planting (Akinyele *et al*. 2006).

Experimental Design and Sowing Seeds

Abdullahi's (2015) method was adopted with little modification for the experimental design. The sowing of the seeds was done in five-liter size pots filled with rich loamy soil were arranged in experimental layout with ten replicates in each accession as shown in Table 3.2. Ten seeds were sown at the depth of 1-2cm for each accession. At two weeks after sowing, the emerging seeds (seedlings) were thinned out to two per pot to reduce competition. The pots were placed in open sunlight. These plants were monitored for agro-morphological variables up to budding and flowering stages of development. The data collection and analysis observation on morphological and reproduction characteristics in the phenotype parameters such as leaf length, leaf area, number of leaves, the height of plant, internodes flower emergence of sesame and duration of reproductive events such as the age of plant at bud emergence, bud opening were subjected to statistical analysis using analysis of variance (ANOVA) to test the significance difference (P < 0.05) (Kindeya, 2017).

Results

The result revealed considerable agronomic characteristics among the various accessions for the characters under consideration. The result revealed consistency in the, characteristics, local name, source and description of ten of accessions of sesame. (Table 1).

Leaf Lengths and Leaf Areas of Ten Sesame Accessions

The leaf length and leaf area of sesame plants are presented in Table 2. The accessions showed variations in the leaf length at 4, 6, and 8 weeks after planting (WAP). NGB943 had significantly highest in leaf lengths at 4, 6, and 8 WAP with the values of 10.07 cm, 20.67 cm, and 50.50 cm respectively. Similarly, the significant highest in leaf area was recorded at 4, 6, and 8 WAP for NGB943 with the values of 66.63 cm^2, 134.0 $cm^{2,}$ and 199.80 cm^2 respectively. While, NGB1335 had the least in leaf areas at 4, 6, and 8WAP with the values of 38.03cm2, 76.5$cm^{2,}$ and 114 .00cm^2 respectively. These values were significantly different from the values of all other accessions.

Number of Leaves and Plant Height of Ten Sesame Accessions

The number of leaves and plant heights of sesame plants are shown in Table 3. At 4WAP, NGB1336 recorded the highest number of leaves with the value of 12 leaves but was not significantly different (P≥0.05) from the value of 11 leaves in NGB454. Also, NGB1336 had a significantly higher (P≤ 0.05) number of leaves at 4, 6, and 8 WAP with the values of 12, 24, and 48 leaves respectively. Also, NGB1335 recorded the least number of leaves at 4, 6, and 8 WAP with the values 7, 14, and 28 leaves respectively. Plant height of sesame accessions significantly varied at 4, 6, and 8 WAP. NGB 1336 produced the tallest plant with the values of 20.33, 40.33, and 60.33 at 4, 6, and 8 WAP respectively. These values were significantly (P≤ 0.05) different from the values of other accessions except NGB967 at 6WAP. However, NGB627 recorded the shortest plant height at 4 and 8 WAP with significant values of 12.67 and 39.00 respectively.

Variation in Internodes Flower, Bud Emergence, and Bud Opening Among Ten Sesame Accessions

The variations in internodes flower, bud emergence, and bud opening of the sesame plants were represented in Table 4. The variations of accessions on internodes flower, bud emergence, and bud opening were significantly different (P≤ 0.05) at both 6 and 8WAP respectively. NGB380 produced the highest number of internodes flower at both 6 and 8WAP. These values were significantly (P≤ 0.05) different from NGB419 and NGB1336 at 6WAP. Also, NGB454 and NGB943 recorded the highest bud emergence at 6WAP but not significantly different from NGB380, NGBH419, and NGB627. Bud emergence at 8WAP indicated that NGB380 had a significantly highest value of 20 compared to other accessions. Also, NGB419 recorded significantly highest in bud opening at 6WAP with the values of 13.00 buds while NGB454 was significantly higher in the number of bud opening at 8WAP with the value of 18.00 buds.

Discussion

The significant variation of agronomic characteristics in ten accessions due to genotypes for some of the traits implied that there was large genetic variation among the evaluated sesame accessions and thus underscored the potential to make selection for genetic advancement in sesame breeding program (Olaniran *et al*., 2020).

There was variation in agronomic traits observed among the ten accessions of sesame in this study (Table 2). The variation in agronomic traits observed among the accessions indicated that a high level of variability exists in the collection of accessions studied. This result agreed with that of Joshi *et al*. (2009) and Reema (2015) who reported high variation in agronomic parameters among all the sesame accessions studied. The consistent variation observed in the traits could be due to the differences in the genetic constituents of the accessions. The clear distinctiveness observed in agronomic parameters of the ten accessions of sesame was probably indications of significant differences in their genetic bases and high genetic variabilities. This assertion conformed to the report of Rajib *et al.* (2011), who reported that genetic variability is largely due to the genetic constituents and the environment plays a vital role in the expression of different traits. Also, Sammour *et al.* (2012) had earlier observed variations in agro-morphological traits of sesame plant such as leaf length, leaf area, and numbers of leaves, the heights of the plant, internodes flower, bud emergence and bud opening. An increase was observed in the number of leaves with an increase in weeks of planting among the accessions of sesame examined in this study. The increase in the number of leaves with the increase in weeks observed in this study is similar to the findings of Nura *et al.* (2013) who reported an increase in leaf number of sesame variety with an increase in weeks of growth. Also, variations in the number of leaves and leaf areas among sesame have been previously reported by Pham *et al*. (2010). The number of leaves and leaf area play important roles in the yield ability as leaves serve as a site of nutrient synthesis in the plant.

Plant heights (Table 3) of sesame significantly varied among accessions studied. The variation in plant height observed among the accessions in this study is supported by the earlier findings of Veasey *et al.* (2007) who reported that there was a variation in plant height among sesame plants in their study. The variations in plant height of sesame could be due to different temperatures and moisture levels. There was significant variation in internodes flower, bud emergence, and bud opening among sesame accessions studied (Table 4). The significant variations observed in internodes flower, bud emergence, and the number of buds produced in the study might be due to certain environmental factors and frequent pollination that occurred among closely related accessions. In agreement with this study, Pham *et al.* (2010) reported that the high number of buds produced in plants strongly depends on the environment of the study. Similarly, Tindal (2010) opined that high bud production in sesame plants is primarily brought about by soil organic content and mineral nutrient. The variation based on the genetic makeup of the organisms according to Alege *et al*. (2011) is more reliable than variation induced by changes in environmental factors. In addition to that, any showed significant variation is most likely to have a genetic impact on the plants.

Conclusion

In conclusion, broad genetic variability was observed among the sesame accessions that could be useful for future breeding purposes. The results of this study indicate that there is considerable genetic variation present in most of the traits to warrant selection for better genotypes. These traits can therefore be given special attention in selections aimed at sesame improvement.

Declaration of Interest

I hereby declare this research was written by me and it is a record of my research work. All references cited have been duly acknowledged.

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References

Abdou, R. I. Y., Moutari, A., Ali, B., Basso, Y., and Djibo, M. (2015). Variability Study in Sesame (*Sesamum indicum* L.) Cultivars Based on Agro-morphological Characters. *International Journal of Agriculture, Forestry and Fisheries,* 3 (6): 237-42.

Abdullahi, I.A. (2015). Estimation of genetic diversity of some *Sesamum indicum* genotypes. *Research Journal of Agriculture and Biological Sciences*, 4(6): 761-766.

Adebayo, A.A., Onu, J.I., Adebayo, E.F and Anyanwu, S.O. (2012). Farmers awareness, vulnerability, and adaptation to climate in Adamawa State, Nigeria. *British Journal of Arts and Social Science,* 9(2): 104-115.

Adebowale, A.A, Sanni, S.A. and Falore, O.A. (2010). Varietal differences in the Physical properties and proximate composition of elite sesame seeds. *International Journal of Libyan Agricultural Research,* 1(2), 103-107.

Alege, G.O., Akinyele, B.O., Aremu, A.K. and Ayodele, S. M. (2009a) Taxonomic Importance of the Vegetative and Pollen Characteristics in Nigerian Species of Sesame, *African Journal of Plant Science*, 5 (3): 213-317.

Alege, G.O., Akinyele, B.O., Ayodele, S. M. and Ogbode, A.V. (2011). Taxonomic Importance of the Vegetative and Pod Characteristics in Nigerian Species of Sesame, *African Journal of Plant Science,* 5 (3): 213 – 317.

Alege, G.O. and Mustapha, O.T. (2015). Assessment of genetic diversity in Nigeria sesame using morphological markers. *Proceedings of Genetic Society of Nigeria (GSN).* Federal University, Lafia Nasarawa State, Pp 78-88.

Agele, S. O., Oladitan, T. O., and Olarewaju1, A. T. (2015). "Growth and Yield Performance of Sesame (*Sesamum indicum* L.) in the Rainforest and Derived Savanna Agro-ecologies of Nigeria." *International Journal Agricultural Policy and Research* 3(6): 279-86.

Akinyele, B.O. and Osekita, O.S. (2006). Correlation and path coefficient analyses of seed yield attributes in okro (*Abelmoschus esculentus* L). *African Journal Biotechnology*, 5(14):1330-1336.

Ali, K. A. (2015). Generation Mean Analysis for Yield and Yield Components in Sesame (*Sesamum indicum* L.). *International Journal of Environment,* 4 (3): 111-20.

Anthony, O., Ogunshakin, R., Vaghela, S., and Patel, B. (2015). Towards sustainable intensification of sesame-based cropping systems diversification in northwestern. *India Journal of Food Security,* 3(1):1–5.

Ashri, A. (2017). Sesame (*Sesamum indicum* L.). Genetic Resource Chromosome Engineering and Crop Improvement. CRC press USA. *Journal of Oilseed crop,* 4: 231-289.

Falusi, O.A., Salako, E.A. and Ishaq, M.N. (2001). Interspecific hybridization between (*Sesamum indicum* L) and *Ceratotheca sesamoides*. *Endl Tropiculturae*, 19(3), 127-130.

Falusi, A.O. and Salako, E.A. (2007). Assemblage of sesame germplasm for conservation and genetic improvement in Nigeria. *Plant Genetic Resources,* Newsletter. 127:25-38

FAOSTAT (2008). Food and Agricultural Organization of the United Nations. Statistical Database.

FAO (2011). Food and Agricultural Organization of the United Nations (2011). FAO statistical Databases. *Food Agricultural Nutrition and Development,* 8(2), 133-150.

FAO (2015). Food and Agricultural Organization of the United Nations. Statistical Database Kindeya, Y. B. (2017). "Correlation and Cluster

Analysis of White Seeded Sesame (*Sesamum indicum* L.) Genotypes Oil Yield in Northern Ethiopia." *African Journal of Agricultural Research.* 12 (12): 970-8.

Joshi, A., De'smet, R., Marchal, K., and Michoel, J. (2009). Computational morphological assessment. Bioinformatics,25(4) : 490-492

Muhamman, M. A. and Gungula, D.T. (2008). Growth Parameters of Sesame (*Sesamum indicum* L.) as affected by Nitrogen and Phosphorus level in Mubi. Nigeria Journal

Sustainable Development Agriculture and Environment 3(2):80-86.

National Bureau of Statistic (2016). Production statistics of crops and crops processed in Nigeria. *Statistics database*.

National Centre for Genetic Resource and Biotechnology *Newsleter*, 2016 No 127: 35-37

Nimmakayala, P, Perumal, R., Mulpuri, S. and Reddy, U.K (2011). Wild Crop Relatives: Genomic and Breeding Resources Oilseeds. Kole C, editor. *Berlin Heidelberg*: Springer-Verlag, Sesamum. Pp. 261–273.

Nura, S., Adamu, A.K., Mu'azu, S., Dangora, D.B. and Fagwalawa, L.D. (2013). Morphological characteristics of colchicines-induced mutant in sesame *(Sesamum indicum L.). Journal of Biological Sciences*, 13:277-282.

Olaniran, D.D., Olayiwola, M.O., Nassir, A.L. and Ariyo, O.J. (2020). Genetic variation among progenies in Okra using Coefficient of Racial Likeness and Mahalanobis D. statistics. *Electronic Journal of Plant Breeding* 11(3); 814 - 821

Patel, B. Anthony, O., Ogunshakin, R., and Vaghela, S. (2015). Towards sustainable intensification of sesame-based cropping systems diversification in India. *Journal of Food Security,* 3(1):4-5.

Pham, T.D., Nguyen, T.T., Carlsson, A.S. and Bui, T.M. (2010). Morphological evaluation of sesame *(Sesamum indicum* L.*)* varieties from different origins. *Austria Journal of Crop Science,* 4(7):498-504.

Rajib, R. and Jagatpati, T. (2011). Evaluation of genetic parameters for agro-metrical characters in carnation genotypes. *African Crop Science Journal, 19*(3):183-188.

Reema, S. (2015). Assessment of morphological diversity of selected *Amaranthus* species. *Journal of Globa Bioscience,* 4(8):3044-3048.

Roul. B., Mishra, B.K. and Prusty, N. (2017). 'Natural effect of micronutrient on growth and growth parameter of sesame oilseed crop'. *Pharmacognosy and Phytochemistry*, 6(5): 26- 28.

Sammour, H. R., Radwan, S.A. and Mira, M. (2012). Genetic diversity in genus *Amaranthus*: from morphology to genomic DNA. *Trade science incision*, 6: 351-360.

Tindall, H.D. (2010). Commercial vegetable growing: *Oxford Tropical Handbook. Oxford University Press.*

Tunde-Akintunde, T.Y. and Akintunde, B.O. (2010). Some physical properties of Sesame seed. *Biosystems Engineering* 88 (1), 127 – 129.

UNFAO (2015). United Nation Food and Agriculture Organization Data 2010.

Veasey, E.A, Silva, J.R, Rosa, M.S, Borges, A and Peroni, N. (2007). Phenology and Morphological diversity of sweet potato (*Ipomoea Batatas*) Landrances of the Vace Do Ribeira. *Science Agricultural (Piracicaba Brazil)*, 64 (4):416-427.

Woldesenber, D.T., Tesfaye, K. and Bekele, E. (2015). Genetic diversity of sesame germplasm collection (*Sesamum indicum* L.). Implication for conservation, improvement and use. *International Journal of Biotechnology and Molecular Biology Research*, 4:7-18.

Table 1: Characteristics and Sources of Ten Accessions of Sesame (*Sesamum indicum* L.) Studied

Accessions number	Local Name	Source	Description of the Sesame Accessions
NGB380	Ridi	Otukpo (Benue)	Stem erect, green, branched, whitish pink flower with light brown seeds.
NGB419	Ridi	Kafanchan (Kaduna)	Stem erect, green branched, whitish pink flower with creamy white Seeds
NGB454	Ridi	Lafia (Nassarawa)	stem erect, green, branched, whitish pink flower with light brown seeds
NGB627	Ridi	Lafia (Nassarawa)	Stem erect, green, branched whitish pink flower with white seeds
NGB935	Ishwa	Saminaka (Niger)	Stem erect, green, branched, whitish pink flower with light brown seeds
NGB939	Ridi	Kafanchan (Kaduna)	Stem erect, green, branched, whitish pink with dark brown seeds
NGB943	Ridi	Aliade (Benue)	Stem, erect, green, branched, pink flower, white seeds
NGB967	Ridi	Doma (Nassarawa)	Stem erect, green, branched, whitish pink flower with light brown seeds
NGB1335	Gogorigo	Okene (Kogi)	Stem, erect, green, branched, whitish pink flower with creamy white seeds
NGB1336	Esso	Katcha (Niger)	Stem erect, purple, branched, purple flower with whiteseeds.

Source: National Centre for Genetic Resource and Biotechnology Newsletter, 2016 No 127: 35-37

Table 2: Leaf Lengths and Leaf Areas of Ten Sesame Accessions

Sesame Accession	Leaf Length (cm)			Leaf Area (cm^2)		
	4WAP	6WAP	8WAP	4WAP	6WAP	8WAP
NGB380	8.26^{e}	16.67^{de}	41.53^{c}	43.91^{g}	88.0^{g}	130.10^{h}
NGB419	9.87^{b}	17.33^{d}	49.43^{b}	61.37^{c}	122.7^{c}	185.23^{c}
NGB454	9.73^{bc}	20.33^{a}	38.80^{d}	56.43^{d}	113.3^{d}	170.07^{d}
NGB627	7.87^{f}	18.67^{c}	31.60^{g}	40.29^{h}	82.5^{h}	120.50^{i}
NGB935	9.83^{b}	16.33^{e}	30.20^{i}	64.68^{b}	130.3^{b}	194.05^{b}
NGB939	8.43^{d}	20.33^{a}	25.50^{j}	46.17^{f}	94.0^{f}	138.70^{f}
NGB943	10.07^{a}	20.67^{a}	50.50^{a}	66.63^{a}	134.0^{a}	199.80^{a}
NGB967	8.57^{d}	17.27^{d}	34.50^{f}	43.86^{g}	88.1^{g}	131.50^{g}
NGB1335	7.63^{g}	15.27^{f}	30.50^{h}	38.03^{i}	76.5^{i}	114.00^{j}
NGB1336	9.63^{c}	19.47^{b}	38.50^{e}	53.76^{e}	108.0^{e}	161.27^{e}
SE±	0.16	0.34	1.46	1.83	3.66	5.58

Means followed by the same letter(s) in a column are not significantly different at P≤0.05 using DMRT, SE = Standard error; WAP = Weeks after planting

Table 3: Number of Leaves and Plant Heights of Ten Sesame Accessions

Sesame accession	Number of Leaves/Plant			Plant height (cm)/Plant		
	4WAP	6WAP	8WAP	4WAP	6WAP	8WAP
NGB380	9^{b}	17^{e}	32^{d}	13.00^{e}	26.67^{f}	39.33^{h}
NGB419	9^{b}	18^{de}	36^{c}	16.33^{cd}	32.33^{c}	48.00^{e}
NGB454	11^{a}	23^{b}	44^{b}	15.33^{d}	30.33^{d}	45.00^{f}
NGB627	9^{b}	18^{ed}	36^{c}	12.67^{e}	25.67^{g}	39.00^{h}
NGB935	8^{c}	16^{f}	32^{d}	13.67^{e}	28.33^{e}	42.00^{g}
NGB939	9^{b}	18^{ed}	36^{c}	16.67^{c}	35.33^{b}	51.33^{d}
NGB943	9^{b}	19^{d}	36^{c}	18.33^{b}	20.33^{h}	54.00^{c}
NGB967	10^{b}	20^{c}	44^{b}	18.67^{b}	40.33^{a}	57.33^{b}
NGB1335	7^{d}	14^{g}	28^{e}	13.33^{e}	25.33^{g}	39.33^{h}
NGB1336	12^{a}	24^{a}	48^{a}	20.33^{a}	40.33^{a}	60.33^{a}
SE±	0.28	0.52	1.11	0.48	1.17	1.39

Means followed by the same letter(s) in a column are not significantly different at P≤0.05 using DMRT, SE = Standard error; WAP = Weeks after planting

Table 4: Variation in Internodes Flower, Bud Emergence and Bud Opening Among Ten Sesame Accessions Per Plant

Sesame	Internodes Flower		Bud Emergence		Bud Opening	
accession	6WAP	8WAP	6WAP	8WAP	6WAP	8WAP
NGB380	16.33[a]	21[a]	15.00[ab]	20[a]	12.33[a]	15.33[c]
NGB419	15.33[ab]	20[b]	15.00[ab]	19[b]	13.00[a]	17.00[b]
NGB454	12.33[de]	17[d]	15.33[a]	19[b]	12.00[a]	18.00[a]
NGB627	11.33[e]	16[e]	13.67[ab]	18[c]	9.33[b]	14.00[d]
NGB935	11.67[e]	17[d]	11.33[c]	15[f]	9.33[b]	13.00[e]
NGB939	14.33[bc]	17[d]	13.33[b]	17[d]	11.33[ab]	12.00[f]
NGB943	11.33[e]	16[e]	15.33[a]	19[b]	11.00[ab]	14.00[d]
NGB967	12.33[de]	18[c]	10.33[c]	16[e]	9.00[b]	14.00[d]
NGB1335	13.33[cd]	17[d]	11.33[c]	15[f]	9.00[b]	11.00[g]
NGB1336	15.33[ab]	20[b]	13.33[b]	18[c]	8.67[b]	14.00[d]
SE±	0.34	0.31	0.36	0.31	0.35	0.37

Means followed by the same letter(s) in a column are not significantly different at P≤0.05 using DMRT, SE = Standard error; WAP = Weeks after planting.

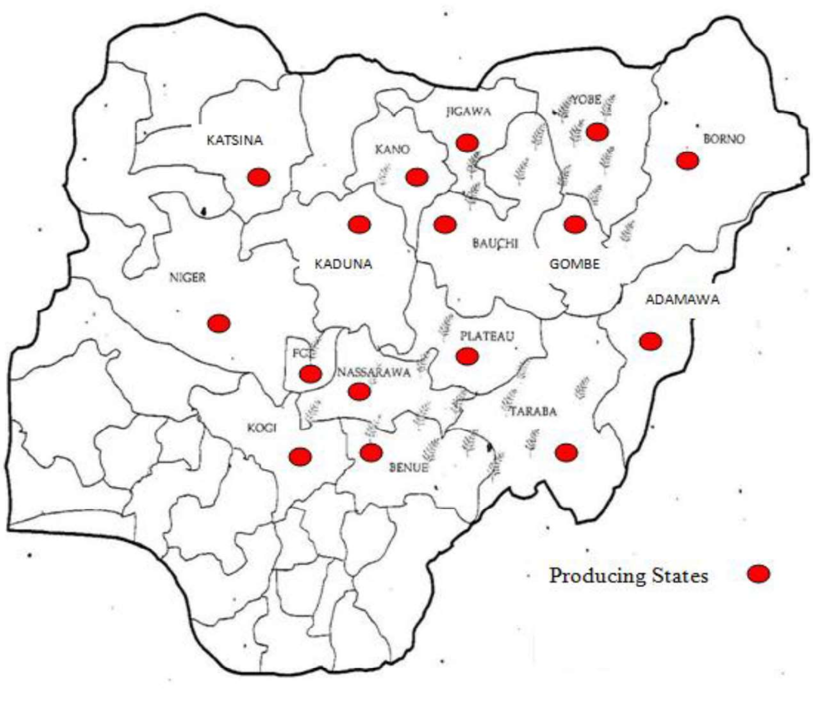

Figure 1: Map of Nigeria Showing Sesame Producing States (FAOSTAT, 2008)