IMPROVEMENT OF SELECTED OKRA (*Abelmoschus* spp.*)* VARIETIES FOR FRUIT YIELD AND PRODUCTIVITY

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TITLE PAGE

IMPROVEMENT OF SELECTED OKRA (*Abelmoschus* spp.*)* VARIETIES FOR FRUIT YIELD AND PRODUCTIVITY

A DISSERTATION SUBMITTED TO THE DEPARTMENT OF CROP SCIENCE IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN PLANT BREEDING AND GENETICS IN THE FACULTY OF AGRICULTURE, UNIVERSITY OF NIGERIA, NSUKKA

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OCTOBER, 2016

CERTIFICATION

Enyi, Jacob Ikechukwu, a postgraduate student in the Department of Crop Science, with registration number, PG/M.SC/12/61810 has satisfactorily completed the requirements for research work for the award of the degree of Master of Science in the Department of Crop Science (Plant Breeding and Genetics). This work is original and has not been submitted in part or full for any other diploma or degree of this or any other University.

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DEDICATION

Dedicated to God Almighty and devoted geneticists and breeders all over the world

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I immensely appreciate God Almighty, the giver of wisdom and strength for making me have a successful research work and M.Sc program. I extol Him for His great deeds towards me. To Him be all the glory.

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ABSTRACT

Four field experiments were conducted at the Teaching and Research Farm of the Department of Crop Science, University of Nigeria, Nsukka to: (i) improve the photoperiodic response, especially in local (late) maturing varieties of Okra; (ii) estimate heterosis and heritability for improved yield and productivity; (iii) determine combining ability and gene effects of 13 genotypes of okra; (iv) estimate gene effects of quantitative traits; (v) determine inheritance pattern of qualitative traits for improved fruit production. The experimental materials used were three local varieties (Ele Ndu, Ele Ogwu, Ele Uhie) collected from local farmers in Nsukka LGA, Enugu State; and ten improved varieties (LUDU V., Esculentus V, Jokoso, Agwu Early, TAE 38-Dwarf, V-21 Ivra, Clemson spineless, LD88 V., V.35 and NHE 47-4 V) from the National Institute for Horticultural Research and Training (NIHORT), Okigwe, Imo State. General combining ability of the parents and specific combining ability of the hybrids were estimated using Griffingsô model 1 method 2 in a 5 x 5 diallel crosses. Chi square statistic was used to test for the inheritance pattern and degree of significance in traits of interest. õEle Uhieô parent showed significantly ($p < 0.05$) higher branch length, number of fruits/branch, number of fruits/plant, number of flowers/plant, plant height at maturity and total fruit yield/ hectare (123.7 cm, 8.31, 29.76, 9.03, 237.66 cm and 32.56 t/ha, respectively) than the other parents. óAgwu earlyô parent had lower days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting, days to fruit maturity and plant height at maturity (4.00, 22.21, 47.13, 48.31, 51.10, 52.28 and 57.8 cm). õEle Uhieô showed significantly ($p < 0.05$) higher 100 seed weight (5.19 g), dry fruit weight (11.46 g), fruit girth (11.10 cm), fruit weight (34.5 g), number of ridges/pod (11.33) and number of seeds/pod (120.57). The cross õUHIE x LD88ô had significantly ($p < 0.05$) higher number of branches/plant (7), number of fruits/branch (8.64), number of fruits/plant (35.63), number of flowers/plant (10.16) and total fruit yield/hectare (38.25 t/Ha). Higher negative better parent heterosis values were observed in the cross, õUHIE x CLMô in days to 50% germination (-46.32), days to flower bud initiation (-49.26), days to anthesis (-46.54), days to 50% flowering (-45.12), days to first fruiting (-45.12) and days to fruit maturity (-35.05). The cross óOGW x LD88ô had higher positive BPH value in total fruit yield/hectare (161.26). Narrow sense heritability in total fruit yield showed values above average in all the crosses except óAGW x CLMô, óAGW x LD88ô, óCLM x LD88ô, óOGW x CLMô and õUHIE x CLMô. õEle Uhieô was the best general combiner for number of branches/plant (0.65), number of fruits/branch (2.01), number of fruits/plant (2.37), number of fruits/stem (3.75) and total fruit yield (9.97). õEle Uhieô was the best general combiner in days to flower bud initiation (-7.18), days to anthesis (-7.46), days to 50% flowering (-8.11), days to first fruiting (-7.46) and days to fruit maturity (-8.43). The cross, õUHIE x LD88ô was the best specific combiner for number of fruits/branch (3.31), number of fruits/branch (0.7414), number of fruits/plant (9.34), number of flowers/plant (2.53) and total fruit yield (10.26). The gene effect for total fruit yield showed significant positive additive, dominance and additive x dominance gene effects occurred in all the crosses with the exception of õUHIE x AGWô, õUHIE x CLMô and õUHIE x LD88ô. The relative proportion of additive gene effect was important for high heritability estimates recorded. This suggests that its contribution to the inheritance of earliness is ideal for developing desired hybrids. The medium-long and green with pink patched fruits predominated in the F_2 populations and the observed ratio mostly fitted the expected ratio of 3:1. The hybrid õUHIE x LD88ô with significantly higher yield potential has the potential for commercial cultivation after further selection.

INTRODUCTION

Okra (*Abelmoschus* spp.*)* is one of the most significant vegetable crops in the Malvaceae family and is very popular in the Indo-Pak subcontinent (Kumar *et al*., 2010). It belongs to the genus *Abelmoschus* and the species *esculentus.* Okra is an upright annual, herbaceous plant with a hibiscus-like flower. It is a direct-sown vegetable with duration of 51-68 days for the early maturing varieties and 70-120 days for the late maturing varieties with partly deep taproot system. Its stem is semi-woody and sometimes pigmented with a green or reddish tinge of colour.

According to Martin (1982) and Siemonsma (1982), okra can be broadly classified into two main varieties, namely: Early Okra [*Abelmoschus esculentus* (L.) Moench] and Late or West African Okra [*Abelmoschus callei* (*A. Chev*.) Stevils]. Early Okra is similar to exotic Okra cultivars which are found in several okra growing regions of the world while Late Okra is restricted in distribution to the most humid parts of West Africa (Singh and Bhatnager, 1975; Martin, 1982; Siemonsma, 1982). Njoku (1958) coined the names early and late Okra when his studies on photoperiodism in Nigeria, showed that Early Okra has a Critical Day Length (CDL) of 12.50 h and so can flower at any time of the year while Late Okra with CDL of 12.25 h can only flower later in the year, around August-September, when natural day length shortens considerably.

Worldwide production of okra as fruit vegetable is estimated at six million tonnes/year. In West Africa, it is estimated at 500,000 to 600,000 tonnes/year (Burkil, 1997; Farinde *et al.,* 2007). It is one of the most important vegetable crops in Nigeria, accounting for 5.5% of the total vegetables cropped (Sorapong, 2012). Nigeria is the second largest producer of okra in the world with an estimated 0.72 million tonne produced annually, which represents 15% of total world annual production (Gulsen *et al*., 2007). It is a common household vegetable crop, cultivated primarily for its fresh pods and leaves. It is often called ña perfect villagerôs vegetableò because of its rich source of dietary fibre, minerals, and vitamins; often recommended by nutritionists in cholesterol controlling and weight reduction programmes (Holser and Bost, 2004; Sanjeet *et al.*, 2010). Its mucilage is suitable for medicinal and industrial applications (Adetuyi *et al*., 2012).

In crop improvement programme, the success rests upon isolation of valuable gene combinations as determined in the form of lines with high combining ability, lines which produce good progenies on crossing being of immense value to the plant breeder (Adiger *et al*., 2013). Diallel analysis provides good information on the genetic identity of genotypes as well as being one of the most powerful tools for characterizing the genetic architecture of plants (Obiadalla-Ali *et al*., 2013). Similarly, diallel crosses have been used in genetic research to determinate the inheritance of a trait among a set of genotypes and to measure combining ability and gene action for earliness, yield and yield components in Okra (Yan and Kang, 2003).

Okra research, especially in developed countries, has for long been concentrated on early or conventional okra, with little attention paid to late or West African varieties. Though, they are photoperiod sensitive with wide variations in days to flowering and fruiting, they also contain many desirable genes not found in early or conventional Okra (Singh and Bhatnager, 1975; Martin, 1982; Siemonsma, 1982; Udengwu, 2008). Sensitivity to photoperiodism is a very important expression of genetic diversity in Okra in West Africa (Udengwu, 2008). The photoperiodic nature apparently makes it difficult to cultivate the late maturing varieties twice during a growing season. Early cultivation in February/March often results in excessive vegetative growth as compared with planting in July/August (Adeniji, 2003).

There is every need to develop early flowering and consequently early maturing genotypes of okra with improved fruit yield so as to meet the ever increasing demands for the crop. Also, an understanding and subsequent improvement in the photoperiodic response of okra, especially the West African varieties is necessary in organizing a systematic breeding programme to improve yield and associated traits of the crop. Hence, the objectives of the study were:

- To improve the photoperiodic response, especially in local or late maturing varieties of Okra
- To estimate heterosis and heritability for improved yield and productivity
- To determine combining ability
- To estimate gene effects of quantitative traits
- To determine inheritance pattern of qualitative traits for improved fruit production

LITERATURE REVIEW

Okra (*Abelmoschus spp.*) also called lady's fingers (American), gumbo (West Indies), bhindi (India) or okra, is a traditional vegetable crop well known for its rounded and ridged nature of fruits (Kumar *et al.,* 2010). It is mainly an allopolyploid (hybrid polyploid) plant.

Origin and Distribution

The genus *Abelmoschus* originated in South-East Asia. Okra (*Abelmoschus* spp.) specifically originated somewhere around Ethiopia, and was cultivated by the ancient Egyptians by the 12th Century BC. Its cultivation spread throughout Middle East and North Africa (Tindall, 1983; Lamont, 1999 and Reddy, 2010). It is one of the most important vegetable crops, grown throughout the tropical and subtropical parts of the world. It is widespread in tropical, subtropical and warm temperate regions, but is particularly popular in West Africa, India, the Philippines, Thailand and Brazil. *Abelmoschus esculentus* has been reported from the whole of tropical Africa, whereas West African Okra [*Abelmoschus caillei* (A.Chev.) Stevels] is restricted to the humid and *per* humid climates of Africa (Siemonsma and Kouamé, 2004). It is one of the oldest cultivated crops and presently grown in many countries and is widely distributed from Africa to Asia, Southern Europe and America (Sorapong, 2012).

Growth and Development

Okra is erect, variable in branching, with many short branches that are connected to the thick semi-woody stem. The plant attains heights of 0.4 m - 0.80 m in early maturing varieties to 1.5 m-2 m in others (Udengwu, 2008). It is generally an upright annual plant. Its stem is rounded, erect, and variable in branching. The stems also bear leaves that are lobed and are generally hairy, some reaching up to 12cm in length. Leaves are cordate (heart-shaped), simple or palmately lobed and veined. The woody stem bear leaves that are generally hairy, some reaching up to 12 inches in length. Okra leaves are dark green in color and resemble a maple leaf (Kumar *et al*., 2010). Flower is axillary and solitary. Okra plants are characterized by indeterminate growth. Flowering is continuous but highly dependent upon biotic and abiotic stress. The plant bears its first flower one to two months after sowing *i.e.* improved varieties. The fruit is a capsule and grows quickly after flowering. The greatest increase in fruit length, height and diameter occurs during 4th to 6th day after pollination (Tripati *et al.,* 2011).

Floral and fruit biology

Okra flowers are 4-8 cm in diameter, with five white to yellow petals, often with a red or purple spot at the base of each petal and the flower withers within one day. The flower structure combines hermaphroditism and self compatibility. Flower bud appears in the axil of each leaf, above 6th to 8th leaf depending upon the cultivar. The crown of the stem at this time bears 3-4 underdeveloped flowers but later on during the period of profuse flowering of the plant there may be as many as 10 undeveloped flowers on a single crown. The flower buds, especially those of the conventional varieties take about 22-26 days from initiation to full bloom. The style is surrounded by a staminal column which may bear more than 100 anthers. The pollen may come in contact with the stigmas through a lengthening of the staminal column or through insect foraging (Thakur and Arora, 1986; Abdelmageed, 2010). Thus the flowers of okra are self fertile. The pollen grain is large with many pores, and every pore is a potential tube source; therefore, many tubes can develop from one pollen grain (Tripati *et al*., 2011).

The fruit is an elongated, conical or cylindrical capsule, comprising for the most part, five cavities containing ovules. The fruit is actually long pod and generally ribbed, developing in the leaf axil and spinelesss in cultivated kinds. The fruit is normally yellowish green to green, but is sometimes purple or whitish green. The pods are the edible portion, which are harvested while still tender and immature. They grow rapidly into long (10-30 cm) and narrow (5-10 cm) pod with a tip that is either pointed like a beak or blunt (Aladele *et al*., 2008).

Reproductive Pattern in Okra

Anthesis takes place at the end of the night. The flower is open at dawn, remains open all morning and closes in the middle of the afternoon (Al Ghzawi *et al*., 2003). Its pollen grains are very large and echinate, 156 ɛm in diameter with spines over 20 ɛm in length (Vaissière and Vinson, 1994) so that pollination with both self and cross pollen is possibly achieved by insects (Hamon and Koechlin, 1991b; Al Ghzawi *et al*., 2003). It is wilted in the evening and the petals usually fall off the next day along with the staminal column, consequently providing the insect with the possibility of efficiency in the process between 7:00 and 10: 00am (Azoô *et al*., 2011).

In okra, stigmas are exposed to allopollination at anthesis, and only anthers in the upper ring come into contact with stigmas. The moment of contact depends on the initial distance between these and the rate of elongation of the stamen sheath. All the wild *Abelmoschus* species bear fruits with five carpels (Reddy *et al.*, 2012). This character is still present in many cultivars. Mulcahy (1983) stressed that flowers of plants making preferential autogamy tend to self pollinate before or during opening. Exposure, of still receptive stigmas, to potential pollinators occurs only after self pollination. This makes easier to understand observed differences between cultivars. Because of the sticky pollens, allo-fertilization in okra is necessarily entomophilous *i.e*. pollinated by insects. The absence of systematic self-fertilization in Okra cultivars combined with a progressive self pollination mechanism can be used in plant breeding for at least two reasons - the emasculation operation is required for controlled hybrids. The removing of one hundred stamens from each flower is difficult and produces a stress and some varieties do not withstand this action very well. As a consequence, a high abscission level has been observed in numerous crosses (Hamon, 1988).

Climate and Soil Requirements

Okra requires a long, warm and humid growing period. It can be successfully grown in hot humid areas. It is sensitive to frost and extremely low temperatures. For normal growth and development a temperature between 24°C and 28°C is preferred. At 24°C the first flower bud may appear in the third leaf axil while at 28°C it may appear in sixth leaf axil. This higher position is not necessarily accompanied with a delay in time because at higher temperatures the plants grow faster and the higher position is reached earlier. For seed germination, optimum soil moisture and a temperature between 25°C and 35°C is needed with fastest germination observed at 35°C. Beyond this range the germination will be delayed and weak seeds may not even germinate (Tripati *et al.,* 2011). Loose, friable, well manured loam soils are desirable. A pH of 6.0ï 6.8 is ideally-suited. All soils need to be pulverized, moistened and enriched with organic matter before sowing.

Economic Importance of Okra

The economic importance of Okra cannot be overemphasized. It contains carbohydrate, proteins and vitamin C (Adebooye and Oputa, 1996). The essential and nonessential amino acids that

okra contains are comparable to that of soybean. Hence it plays a vital role in human diet. For consumption, young immature fruits are important fresh fruit ï vegetable that can be consumed in different forms. They could be boiled, fried or cooked. In Nigeria, Okra is usually boiled in water resulting in slimy soups and sauces, which are relished. The fruits also serve as soup thickeners (Schippers, 2000). The leaf buds and flowers are also edible. Okra seed could be dried. The dried seed is a nutritious material that can be used to prepare vegetable curds, or roasted and ground to be used as coffee additive or substitute. Okra leaves are considered good cattle feed, but this is seldom compatible with the primary use of the plant (Holser and Bost, 2004, Sanjeet *et al.*, 2010).

Okra mucilage is suitable for industrial and medicinal applications (Akinyele and Temikotan 2007). Industrially, okra mucilage is usually used for glace paper production and also has a confectionery use. Okra has found medical application as a plasma replacement or blood volume expander (Savello *et al.* 1980, Markose and Peter 1990, Lengsfeld *et al.* 2004, Adetuyi *et al.* 2008, Kumar *et al.* 2010).

Combining Ability and gene action in Okra

Griffing (1956) used diallel mating system to detect General Combining Ability (GCA) and Specific Combining Ability (SCA) in crop genotypes. General combining ability is due to genes, which are largely additive in their effects while specific combining ability is due to the genes with dominance or epistatic effect. The concept of general and specific combining ability (Sprague and Tatum, 1942) helps the breeder to assess the combining ability effects of the parents and thus select superior combiners for heterosis breeding (Adiger *et al*., 2013). Okra is a potentially self pollinated crop. The knowledge of gene action and combining ability helps in identifying the best combiners which may be hybridised either to exploit heterosis or to accumulate fixable genes through selection.

The importance of combining ability in selection of parents for hybridization has been emphasized by many workers in okra (Vijay and Manohar, 1986; Srivastava *et al.,* 2008; Sushmita and Das, 2003). The potentiality of any line to be used as a parent in hybridization depends on itôs *per se* performance and the performance of F_1 hybrid derived from it and its own

GCA effect. Parental per se performance is a good indicator of its *GCA* effects. Normally SCA effects do not contribute much to the improvement of self-pollinated crops. From the results of Adiger *et al*. (2013), it was evident that none of the male parents could act as good combiner for all the characters. The GCA effect varied in magnitude for different characters. In slight contrast, Akhtar *et al.* (2010) reported desirably high SCA along with desirably high GCA which could be utilized in recombination breeding programmes. According to Baker (1978), when crossing for quantitative traits, populations that reveal high GCA estimates for a character could serve as good parents for a diallel cross.

Borgaonkar *et al.* (2006) and Shukla *et al.* (1989) in their studies reported that for all the traits, except test weight, fruit weight, fruit yield/plant and fruit yield/hectare, the low x low combination of *GCA* status was present in heterosis cross combinations indicating predominance of non-additive gene action and very less of additive gene action in these crosses. It is possible that the cross showing high *SCA* effect also has parents showing high *GCA* effects, in which case both additive and non-additive gene actions can be utilized. Negative combiners (poor parents) could yield crosses with high *SCA* effects. This indicated that negative combining (poor parents) were capable of giving high *sca* effects. The high x low of low x high crosses, besides exhibiting the favourable additive *GCA* effects of the parent, complement the epistatic effects present in the cross, which would finally result in higher *SCA* effects. Also, in their studies, fruit yield was high in crosses involving lines exhibiting majority of hig x low and low x high *GCA* effects. The hybrid combination exhibiting highest per se performance also manifested high mid parent and *SCA* effects, justifying the existence of high degree of dominance and additive gene action

Heterosis in Okra

The expression of heterosis is the average superiority of an F_1 hybrid over its parents. According to Hallauer (1997), heterosis as one of the most widely used plant breeding terms has made dramatic impact on the development of breeding methods and high yields for many field crops, vegetables, ornamentals and tree species during the 20th Century. Heterosis plays a vital role in improving crop productivity and quality in order to feed ever-increasing human populations, especially in developing countries like Nigeria (Agbo and Teixeira da Silva*,* 2014). Heterosis occurs in the hybrids when the most appropriate and compatible combinations of parents are

involved. Hence, selection of suitable parents and assessment of degree of heterosis in the resulting crosses forms an important step. Knowledge of the magnitude of heterosis for various characters is essential in identifying better combinations to exploit them through heterosis breeding (Kumar *et al*., 2010).

According to Biswas *et al*. (2005), both positive and negative heterosis is useful in crop improvement, depending on the breeding objectives. In general, positive heterosis is desired for yield and negative heterosis for earliness in okra. High positive heterosis can be expected in crosses showing high levels of genetic variability (Chandra-Shekara *et al*., 2007).

Heterosis breeding has been recognized as one of the most suitable breeding methodology for enhancing fruit yield and quality in okra (Reddy *et al*., 2012). Heterosis has been the main driving force for acceptance of okra by the farmers for cultivation and consumers for consumption around the globe. Utilization of heterosis has allowed okra to become one of the major vegetable in many countries (Jagan *et al*., 2013)

Heritability and gene effect studies on okra

Heritability of metric characters has been identified as a genetic relationship between the parents and the offspring. These genetic components have been widely used to assess the degree to which a character is transmitted from parent to the offspring. Information on heritability could as well indicate the possibility and extent to which improvement in a character is possible. More often in biological research, broad and narrow sense heritabilities are used to evaluate the proportion of heredity and environment in the expression of a character (Adewusi *et al*., 2013). According to Adeniji (2003), in most okra species, especially the West African okra, high narrow sense heritability has been reported for pod length, pod width, plant height and number of seeds/pod. In the studies of Adeniji and Kehinde (2003), broad sense heritability estimates were never below 86% but the narrow sense heritability estimates ranged between 50 and 70%. A relatively high estimate of broad and narrow sense heritabilities for number of seeds/pod indicated that selection in the early generations for this character will be highly effective in developing a breeding strategy and a good genetic base for seed improvement in *Abelmoschus*

caillei. High estimates of narrow sense heritability shows that selection in the F_2 generation would lead to a substantial genetic improvement in seed yield.

Estimating the type of gene effects in plant population is essential to decide the type of breeding procedure to be followed (Arora, 1993). According to Adeniji and Kehinde (2003), the positive and high dominance effects observed for some of the characters implied that the inheritance of those characters tended towards better parents. The predominance of non-additive effects could reduce the progress of selection during early generations in okra (Gupta *et al.*, 1993). From the report of Sood and Sharma (2001), the magnitude of additive gene effects (*a*) was small relative to the corresponding dominance effects (*d*) in most cases. However, the negative value of (*d*) observed in most cases except in fruit length trait indicated that the alleles responsible for lower value of the trait were dominant over the alleles controlling high value.

Hybridization in Okra

At present, improving yield and ensuring its sustainability under adverse conditions through hybridization is the major objective of okra breeding programmes. In breeding for high yielding crop plants through hybridization, the breeders often face the problem of selecting parents and crosses. Hybridization enhances recombination among genes from different strains and selection of desirable types for different environments (Ezeaku and Awopetu, 1992). Hybridization has basiclly always been bi-parental, which is considered to be too restrictive to permit rapid improvement in selfing species (IITA, 2000). Besides failing to provide an effective system of enlarging the basic gene-pool, it also fails to open options of genetic recombination outside the narrow family lines of descent (Udengwu, 2008).

Inter-specific hybridization in okra

Inter specific hybridization has been mostly used for the transfer of specific characters such as disease and pest resistances, early maturity *etc* from related species to cultivated species. Prabu and Warade (2013), in their studies on crossability studies in genus *Abelmoschus* species, selected nine lines of *Abelmoschus* species (*viz*., *A. tuberculatus*ï 1, *A. tetraphyllus*ï 1 and 2, *A. ficulneus*-1, *A. moschatus*-1, *A. caillei*-1 and 2, *A. manihot* spp. *manihot*, *A. manihot* spp. *tetraphyllus*, *A. angulosus* and *A. manihot* (L.) Medikus) with eight cultivated *A. esculentus*

cultivars (*viz*., Pusa Sawani, Red Bhendi, Arka Abhay, Phule Utkarsha, Arka Anamika, Parbhani Kranti, Varsha Uphar and P-7). Overall, 100 crosses were attempted which includes both direct and reciprocal crosses. Crosses between *A. esculentus* and *A. tetraphyllus* were successfully made both directly and reciprocally by earlier workers (Jambhale, 1980; Sheela, 1986 and Sheela, 1994). However, Prakash (1986) reported success only when *A.esculentus* was used as female parent. The wild species *A. ficulneus* was found compatible but seed sterile with *A.esculentus* when used as female parent but incompatible with *A. esculentus* was used as the female parent. The major causes of hybrid inviability might be due to noncompatibility of the parental chromosomes, cytoplasmic genic interactions and non compatibility between embryo and the surrounding tissue called somaplastic sterility (Stebbins, 1958; Prabu and Warade, 2013).

Crosses with *A. moschatus* produced shrivelled and non-viable seeds indicating involvement of post-zygotic sterility during inter specific hybridization. In this incompatibility, zygote formation might be prevented by failure or ineffectiveness of pollen growth or failure of fertilization (Allard, 1990). However, Gadwal *et al.* (1968) obtained viable hybrids of this species with *A. esculentus* through embryo culture technique.

According to Hamon and Charrier (1983), the species which differed most from other *Abelmoschus* species was *A. moschatus*. The crosses between *A.esculentus* cultivars and *A.angulosus* were found successful only when *A.esculentus* cultivars were used as female parent. Samarajeewa *et al.* (1999) reported that when *A.angulosus* was used as the female parent incompatibility was observed resulting in failure of embryo formation. In such case, embryo rescue was successful to raise viable hybrids. When the cultivated type was used as female parent, progeny plants were produced without incompatibility difficulties.

The crosses between *A. caillei* and *A. esculentus* were found successful on both ways. Successful crossing between these two species was also reported by Hamon and Hamon (1991). According to Prabu and Warade (2013), maximum fruit set, average number of seeds per crossed fruits and highest crossability index were observed when *A. caillei* was mainly used as female parent. Sheela (1994) reported that the reciprocal differences in compatibility of the crosses involving *A. esculentus* and *A. caillei* can be attributed to the higher ploidy status of *A. caillei* as compared to

A. esculentus which provided better embryo endosperm balance. Chacko *et al.* (1996) also reported high degree of crossability in the cross *A. caillei* x *A. esculentus*. It is sometimes possible to obtain first-generation hybrids such as in crosses between *A. esculentus* and *A. tetraphyllus*, but the process is blocked at the second generation (Hamon, 1988). It is almost impossible to obtain crosses with *A. moschatus* (Hamon and Yapo, 1985).

Inheritance pattern of colour trait in okra

Though a good number of reports exist on the inheritance of fruit skin colour in okra, such reports come from studies done with exotic okra types in different parts of the world where the criteria for selection of ideal okra fruits, to meet consumers expectations, differ markedly from the ones in Nigeria and indeed West Africa (Udengwu, 2008). Work done on the inheritance pattern of this trait in other parts of the world, apart from being conflicting also somehow involved different fruit skin colours when compared with the local cultivars indigenous to West Africa. Kalia and Padda (1962) reported that in inter- varietal crosses between three varieties of okra having purple, green and creamy fruits, a multiple allelic series appeared to control fruit colour; green being dominant over cream while purple was dominant over both green and cream. Kolhe and DôCruz (1966) indicated that pigmentation on the fruit of Okra was monogenically controlled with reddish pigmentation being completely dominant over non pigmentation of fruits. They observed no new recombinants with respect to pigment in stem, fruit, leaf veins, petal veins and calyx and suggested that the genes causing colour in these plant parts of okra is most probably pleiotropic in action.

Inheritance pattern of spineness in Okra

The presence of spines in some local varieties, make picking an unpleasant job, although preferred by some consumers because they contain high percentage of mucilage and confer resistance against pests by reducing feeding capacity and oviposition of insects (Abdalla, 1969; Abdelmajeed, 2010). Few studies have been reported on the inheritance of spininess in okra. Kalia and Padda (1962), Nath and Dutta (1970) reported that fruit spineness was monogenically controlled with the absence of complete dominance of one allele over the other. Furthermore, Markose and Peter (1990) and Hamon and van Sloten (1995) reported monogenic and dominant inheritance for pod spininess. Similar results were obtained by Jambhale and Nerkar (1985) and

Jassim (1967) in the hybrids of *Hibiscus esculentus* and *Hibiscus manihot*. Abdelmajeed (2010) in his studies, mentioned that the strains producing fruits free of spines in the early part of the season have been found to produce spines on the pods late in the season; a factor that has prevented any conclusion on the mode of inheritance of this character.

Inheritance pattern of fruit shape in okra

Ariyo (1990a) indicated that the pattern of genetic variation observed in characters studied in West African okra suggests a lot of out crossing among the taxon. Wide morphological variation observed in okra characters studied could perhaps, be attributed to the preponderance of outcrossing among different accessions of the okra studied. Fruits displayed great diversity in size-shape and length. They ranged from short and triangular to long straight or long curved. Earliness, expressed by the lower leaf axil in which flower buds appear, is partly due to varietal characteristic. According to Sekyere-Oppong *et al*. (2011), fruit shape showed the greatest diversity among the okra accessions; from short and triangular to long straight or long curved. From their report, twenty percent accessions bore fruits with a shape score of 2 (long-straight), while 4% bore fruit with shape scores 6, 7, 13 and 14 (triangular-short, short-curved, cylindrical-short and triangular-curved, respectively). Fruit shape scores 5, 9, 10, 11 and 12 (long straight, short-triangular curved, short-curved, short-triangular curved and triangular-short, respectively), did not show any occurrence (zero percentages) while shape score of type 8 (short-curved) recorded the highest occurrence of 32% of the okra accessions.

MATERIALS AND METHOD

Experimental Site:

The experiment was conducted at the Teaching and Research Farm, Department of Crop Science, University of Nigeria, Nsukka located in the Derived Savanna Zone at Latitude $6^0$52ôN, and Longitude $07^0$24ôE, with an altitude of 447.26 m above sea level (Uguru *et al*., 2011).

Experimental Materials:

The experimental materials used for the study comprised of seeds of 13 varieties of Okra (*Abelmoschus* spp). The varieties were: 3 Local varieties (Ele Ndu, Ele Ogwu and Ele Uhie) as well as 10 improved varieties (Ludu V Dwarf, Esculentus V, Jokoso, Agwu Early, TAE 38 dwarf, Clemson spineless, V-21 Ivra, V.35, LD-88 and NHE 47.4 (Table 1).

Land Preparation and Sowing

The experimental field were ploughed and harrowed with tractor and marked out into blocks and plots. The okra seeds were soaked in water, the day before sowing. The seeds were sown at a depth of 1-2 cm at two seeds per hole with a spacing of 0.5 m within and 0.6 m between rows. The seedlings were thinned down to one at two weeks after sowing to give a population of 33 333 plants/hectare.

Sources of Planting Materials

The local varieties were sourced from local farmers in Nsukka and Obukpa communities both in Nsukka LGA of Enugu State; while the improved varieties were sourced from the National Horticultural Research Institute (NIHORT), Okigwe, Imo State (Table 1).

Table 1: Sources of planting materials and description

S/No.	Genotypes	Sources of collection	Description	Remarks	Code
1	LUDU V	NIHORT, Okigwe, Imo State	Dark green, slightly glabrous pods, early maturing and non-photoperiodically sensitive	Improved	LUDU
2	Esculentus V.	NIHORT, Okigwe, Imo State	Yellow green, glabrous pods, early maturing and non-photoperiodically sensitive	Improved	ESC
3	Jokoso	NIHORT, Okigwe, Imo State	Intermediate green, glabrous pods, early maturing and non-photoperiodically sensitive	Improved	JOK
4	Agwu early	NIHORT, Okigwe, Imo State	Intermediate green, glabrous pods, early maturing and non-photoperiodically sensitive	Improved	AGW
5	TAE 38	NIHORT, Okigwe, Imo State	Dark green, slightly glabrous pods, early maturing and non-photoperiodically sensitive	Improved	TAE
6	V-21 Ivra	NIHORT, Okigwe, Imo State	Green with pink patches, glabrous, early maturing and non-photoperiodically sensitive	Improved	V-21
7	Clemson spineless	NIHORT, Okigwe, Imo State	Yellow green, glabrous pods, early maturing and non-photoperiodically sensitive	Improved	CLM
8	LD 88	NIHORT, Okigwe, Imo State	Dark green, slightly glabrous pods, early maturing and non-photoperiodically sensitive	Improved	LD88
9	V.35	NIHORT, Okigwe, Imo State	Dark green, slightly glabrous pods, early maturing and non-photoperiodically sensitive	Improved	V.35
10	NHE 47-4 V	NIHORT, Okigwe, Imo State	Intermediate green, slightly spiny pods, early maturing and non-photoperiodically sensitive	Improved	NHE
11	Ele Ndu	Obukpa Community, Nsukka LGA, Enugu State	Dark green, glabrous pods, late maturing and non-photoperiodically sensitive	Local	NDU
12	Ele Ogwu	Obukpa Community, Nsukka LGA, Enugu State	Dark green, very spiny pods, late maturing and non-photoperiodically sensitive	Local	OGW
13	Ele Uhie	Obukpa Community Nsukka LGA, Enugu State	Green with pink patches, glabrous, late maturing and non-photoperiodically sensitive	Local	UHIE

NIHORT = National Horticultural Research Institute; LGA = Local Government Area

EXPERIMENT 1

Evaluation of Parent Varieties

The experiment required a land measurement of 50 m x 25 m, which was cleared, ploughed and harrowed. Seeds of the thirteen parent varieties were removed from their dried pods and soaked in water a day before planting. Poultry manure was incorporated into the soil at the rate of 8.33 tonnes/hectare so as to improve the fertility state of the land. The land was subsequently developed into beds. The experiment was laid out in a randomized complete block design and replicated three times. Each block with a measurement of 8.4 m x 7.5 m contained 13 plots, measuring 8.4m x 0.6m each. The seeds were sown at of 0.6 m between rows and 0.5 m within rows. Each block was separated by 1 m pathway. Weeding and other cultural practices were carried out at appropriate periods.

Data were collected from three sample plants/plot on the following parameters:

- Days to 50% germination
- Days to flower bud initiation
- Days to anthesis
- Days to 50% flowering
- Days to first fruit appearance
- Days to edible fruit maturity
- Branch length (cm)
- Plant height at maturity (cm)
- Stem girth (cm)
- Number of flowers/plant
- Number of branches/plant
- Number of fruits/branch
- Number of fruits/plant
- Number of fruits/stem
- Fruit length (cm)
- Fruit girth (cm)
- Fruit weight (g)
- Number of ridges/pod at maturity
- Number of seeds/pod at maturity
- 100-seed weight (g) at maturity
- Dry fruit weight (g) at maturity
- Total fruit yield (tonnes/hectare) at maturity

MODE OF DATA COLLECTION

- **Days to 50% germination:** this was done by counting the number of days from sowing to when half of the population have germinated.
- **Days to Flower Bud Initiation:** this was done by counting the number of days from seed sowing to development of flower buds that initiated flower production.

- **Days to anthesis (flower bud formation):** this was done by counting the number of days from seed sowing to period of first flower bud initiation. The buds are normally formed at tip of the plant..
- **Days to 50% flowering:** this was done by counting the number of days from seed sowing to when half of the population developed open flowers.
- **Days to First Fruiting:** this was done by counting number of days from seed sowing to first fruit appearance on the plant.
- **Days to Fruit Maturity:** this was done by counting the number of days from seed sowing to development of fruits of edible sizes for consumption. It was done 4-5 days after first fruit formation.
- **Branch Length:** this was done by measuring the average length of branches with a measuring tape from the point of attachment to the stem to the branch tip.
- **Fruit Girth (cm):** the circumference of the fruit was measured with a measuring tape.
- **Fruit Length (cm):** this was done by measuring the length of the fruit using a measuring tape.
- **Fruit Weight (g):** fresh fruit pod was harvested from the stalk and measured using a sensitive weighing balance (Sartorius, Goettingen, Germany, accuracy ± 0.001 g)
- **Number of Branches/Plant:** this was done by counting the number of productive branches on a given plant.
- **Number of Fruits/Branch:** the number of fruits formed on a productive branch were counted and recorded.
- **Number of Fruits/Plant:** the total number of fruits on a plant were counted and recorded. It was done repeatedly until the plant exhausts its fruiting capacity.
- **Number of fruits/stem:** this was done by counting the number of fruits formed exclusively on the stem of the plant.
- **Number of flowers/plant:** this was done by counting the number of developed flowers on a plant.
- **Number of Ridges/Pod:** this was done by counting the number of protruding edges on the fruit pod.

- **Plant Height at Maturity (cm):** the height of the plant was measured using a measuring tape. The measurement was taken from the base to the tip where the flower buds were formed.
- **Stem Girth (g):** with the aid of a vernier caliper and subsequent tracing with a ruler, the circumference of the stem was measured at the basal part (4-5 cm from the ground).
- **Dry Fruit Weight (g):** this was measured with a sensitive weighing balance (Sartorius, Goettingen, Germany, accuracy ± 0.001 g). First, the fruit is allowed to completely dry out on the plants, in the field and subsequently harvested and weighed.
- **100 Seed Weight (g):** this was done by counting 100 seeds from a dried pod and weighing with a sensitive weighing balance (Sartorius, Goettingen, Germany, accuracy ± 0.001 g).
- **Number of Seeds / Pod:** Seeds from a fully dried pod were extracted and counted.
- **Total Fruit Yield (tonnes/hectare):** this was estimated by weighing the fruits from three sampled plants and converting the fruit weights to tonnes/hectare. The formula is expressed thus;

$$\frac{\text{average fruit weight per plant (kg) x number of plants per plot x number of plots per hectare}}{1000}$$

EXPERIMENT 2

Generation of Hybrid Seeds (F_1)

Parents from Experiment 1 with desirable genetic traits were selected for improvement. Hand pollination was done by the removal of the androecium (stamens) of the flower before it opens. In the process, large portions of the epicalyx, calyx and the petals were removed. The emasculated flowers were covered with envelopes or white transparent materials and subsequently clipped with pins to prevent being blown off by wind. This was carried out a day before pollination. Crossing was done among parents in a diallel fashion in all possible combinations. The dusty pollens from freshly opened flowers were collected and dusted on stigmas of previously emasculated flowers and subsequently tagged for easy identification. Successful crosses were allowed to mature, dry and subsequently harvested which formed the F_1 seeds or hybrid seeds.

EXPERIMENT 3

Evaluation of F_1 Seeds and Production of F_2, BC_1 and BC_2 Generations (Seeds)

All the F_1 seeds generated were sown out and selfed to generate F_2 seeds, then hybrids exhibiting high heterosis were selected for backcrosses. The F_2 seeds selected were sown in a land area of 45 m x 20 m. The experiment was laid out in a randomized complete block design with three replications. Intra-row and inter-row spacing of planting was 0.6 m and 0.5 m, respectively with a 1 m path space separating each block. The backcrosses, i.e. BC_1 and BC_2 were obtained by crossing the F_1 hybrids back to either parent and subsequently tagged for easy identification. Data were collected on three sample plants on the following parameters.

- Days to 50% germination
- Days to flower bud initiation
- Days to anthesis
- Days to 50% flowering
- Days to first fruit appearance
- Days to edible fruit maturity
- Branch length (cm)
- Plant height at maturity (cm)
- Stem girth (cm)
- Number of flowers/plant
- Number of branches/plant
- Number of fruits/branch
- Number of fruits/plant
- Number of fruits/stem
- Fruit length (cm)
- Fruit girth (cm)
- Fruit weight (g)
- Number of ridges/pod at maturity
- Number of seeds/pod at maturity
- 100-seed weight (g) at maturity
- Dry fruit weight (g) at maturity
- Total fruit yield (tonnes/hectare) at maturity

EXPERIMENT 4

Evaluation of the Parents, F_2s, BC_1s and BC_2s

The seeds of the selected parents, F_2, BC_1 and BC_2 generations were sown as obtained from dried pods in experiment 3. Intra-row and inter-row spacing among stands measured 0.5 m and 0.6 m, respectively. The experiment was laid out in a randomized complete block design and replicated three times. Appropriate agronomic practices such as: weeding, organic manure application, fertilizer application, especially at the onset of bud initiation as well as irrigation activities were carried out timely and when necessary. Data were carried out on on 3 sample plants on the following parameters;

- Days to 50% germination
- Days to flower bud initiation
- Days to anthesis
- Days to 50% flowering
- Days to first fruit appearance
- Days to edible fruit maturity
- Branch length (cm)
- Plant height at maturity (cm)
- Stem girth (cm)
- Number of flowers/plant
- Number of branches/plant
- Number of fruits/branch
- Number of fruits/plant
- Number of fruits/stem
- Fruit length (cm)
- Fruit girth (cm)
- Fruit weight (g)
- Number of ridges/pod at maturity
- Number of seeds/pod at maturity
- 100-seed weight (g) at maturity
- Dry fruit weight (g) at maturity
- Total fruit yield (tonnes/hectare) at maturity

STATISTICAL ANALYSIS

Data obtained in Experiments 1, 2, 3 and 4 were subjected to analysis of variance and mean seperation for randomized complete block design using Genstat Release 10.3 Discovery Edition 3 (GENSTAT, 2011).

Estimation of Heterosis

In experiment 3, estimation of heterosis was carried out as Mid Parent Heterosis (MPH) and Better parent Heterosis (BPH) (Allard, 1960; Uguru and Umukoro, 2005).

Mid parent heterosis

This was estimated thus;

$$MPH = \frac{\overline{F1} - \overline{MP}}{\overline{MP}} \times 100$$

where: $\overline{MP} = \frac{\overline{P1} + \overline{P2}}{2}$

MP = Mid parent

Better parent Heterosis

This was estimated thus;

$$BPH = \frac{\overline{F1} - \overline{BP}}{\overline{BP}} \times 100$$

where:

BP= Better Parent

Test of Significance of Heterosis Value

This was estimated thus;

$$CD = \frac{\sqrt{2EMS}}{r} \times t$$

where:

t = t tabulated at 5% probability level;

EMS = Error mean square

r = Number of replications

CD = critical difference

(Source: Kumar *et al*., 2011)

Gene Effects on Characters under Study

Gene action on components of generation means was estimated using Haymanôs approach (Singh and Chaudbury, 1985).

Where;

F_2 mean, $m = \overline{F2}$

Additive mean, $a = \overline{B_1} - \overline{B_2}$

Dominance effect, $d = \overline{F_1} - 4\overline{F_2}$ ï $\left(\frac{1}{2}\right)\overline{P_1} - \left(\frac{1}{2}\right)\overline{P_2} + 2\overline{B_1} + 2\overline{B_2}$

Additive x additive, $aa = 2\overline{B_1} + 2\overline{B_2}$ ï $\overline{F_2}$

Additive x dominance, $ad = \overline{B_1} - \left(\frac{1}{2}\right)\overline{P_1} - \overline{B_2} + \left(\frac{1}{2}\right)\overline{P_2}$

Dominance x dominance, $dd = \overline{P_1} + \overline{P_2} + 2\overline{F_1} + 4\overline{F_2}$ ï $4\overline{B_1}$ ï $4\overline{B_2}$

t value of effect = $\frac{\text{effect}}{\text{standard error of effect}}$

Estimation of Variance Components of Characters

Estimation of genetic variances of quantitative characters was obtained using the variance estimate method. The variances of the parents, F_1s, F_2s, BC_1s and BC_2s were used in determining: additive variance, dominance variance, genotypic variance, phenotypic variance, environmental variance as well as heritability (narrow sense and broad sense heritabilities).

$\mathring{u}^2_e = \frac{P1 + P2 + F1}{3}$

$\mathring{u}^2_a = 2F_2 - (BC_1 + BC_2)$

$\mathring{u}^2_d = \frac{((BC_1 + BC_2 - F_2 - (P_1 + P_2 + F_1))}{3}$

$\mathring{u}^2_p = \mathring{u}^2_e + \mathring{u}^2_a + \mathring{u}^2_d$

$\mathring{u}^2_g = \mathring{u}^2_a + \mathring{u}^2_D$

Estimation of Heritability

Heritability was estimated thus;

$H_{bs} = \frac{\mathring{u}^2_g}{\mathring{u}^2_g} \times 100$

$H_{ns} = \frac{\mathring{u}^2_a}{\mathring{u}^2_p} \times 100$

where;

$\mathring{u}^2_e$= Enviromental variance

$\mathring{u}^2_a$= Additive variance

$\mathring{u}^2_d$= Dominance variance

$\mathring{u}^2_p$= Phenotypic variance

$\mathring{u}^2_g$= Genotypic variance

H_{bs}= Broad sense heritability

H_{ns}= Narrow sense heritability

BC_1= First backcross

BC_2= Second backcross

Combining Ability Analysis

Combining ability was estimated according to Griffings (1956) model 1 method 2, diallel analysis numerical approach, which involves parents and F_1 without the reciprocals. Variations among hybrids obtained were separated into two genetic components of General combining ability (GCA) and Specific combining ability (SCA) (Singh and Chaudhary, 1985). The analysis was done using the formula shown in Table 2.

Table 2: Analysis of Variance (ANOVA) for estimation of General Combining Ability (GCA) and Specific Combining Ability (SCA) effects

	Df	SS	EMS
GCA	n-1	$\frac{1}{n+2}\left[\sum\left(Y_{i.}+Y_{ii}\right)^2\right]-\frac{4}{n}Y^2..$	$\sigma^2 e+\frac{n+2}{n-1}\sum gi^2$
SCA	$\frac{n(n-1)}{2}$	$\sum\sum Y_{ij}{}^2-\frac{1}{n+2}\sum\left(Y_{i.}+Y_{ii}\right)^2-\frac{2}{(n+1)(n+2)}Y^2..$	$\sigma^2 e+\frac{2}{n(n-1)}\sum\sum_{i<j} sij^2$
Error	t-1(r-1)	$\frac{\text{(Total SS- Treatment SS- Rep SS)}}{\text{R}}$	$\sigma^2 e$

GCA effect (g_i) = $\frac{1}{n+2}\left[\left(\sum\left(Yi.+Yii\right)-\frac{2}{n}Y..\right)\right]$

SCA effect (Sij) = Yij- $Y_{ij}-\frac{1}{n+2}\left(Yi.+Yii+Y.j+Yjj\right)+\frac{2}{(n+1)(n+2)}Y..$

Where;

g_1 = general combining ability effect,

s_{IJ} = specific combination effect,

Yij = the mean of the i x j genotype,

Yi. = total array involving the i^{th} parent as female in a diallel cross

CD = critical difference

Yii = the value of the i^{th} parent in the array,
Yjj= the value of the jth parent in the array
Y^2 ...= grand total,
n = number of parents
df = degrees of freedom, r= number of replications

Estimation of Critical Values for GCA and SCA

CD value of GCA = $\sqrt{\frac{1}{n}\sigma^2 e \times t}$ (tabulated),

CD of SCA = $\sqrt{\frac{2(n-2)}{n}\sigma^2 e \times t}$ (tabulated).

Chi square (χ^2) test

Phenotypic ratio test was carried out on the F_2 generation using chi square (G^2) statistic and Yates correction for continuity of Chi square (G^2) when the degree of freedom was unitary, to test for inheritance pattern of qualitative traits in F_2 (Steel and Torrie, 1980; Udengwu, 2015).

It was estimated thus;

$$G^2 = \frac{\times (/O - E/)^2}{E}$$

When the degree of freedom was unitary, Yates correction of continuity was used, which was estimated thus;

$$G^2 = \frac{\times (/O - E/ - 0.5)^2}{E}$$

where;
O = Observed frequency
E = Expected frequency

RESULTS

Evaluation of the Parental Accessions

The parents evaluated varied considerably in performance and yield components (Table 3). ôEle Uhieô parent showed significantly ($p < 0.05$) higher branch length, number of fruits/branch, number of fruits/plant, number of flowers/plant, plant height at maturity and total fruit yield/ hectare (123.7 cm, 8.31, 29.76, 9.03, 237.66 cm and 32.56 t/ha, respectively); though, it was statistically similar to the parent, ôEle Nduô in number of fruits/branch, number of fruits/plant and total fruit yield (7.67, 26.67 and 30.59 t/ha). óJokosoô parent had significantly ($p < 0.05$) lower branch length, number of fruits/branch, number of fruits/plant, number of flowers/plant and total fruit yield (0.00, 0.00, 6.17, 2.15 and 4.02 t/ha, respectively). ôEle Ogwuô parent had significantly ($p < 0.05$) higher days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting and days to fruit maturity (8.33, 58.99, 91.25, 94.37, 92.25 and 100.63). On the other hand, óAgwu earlyô parent, had lower days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting, days to fruit maturity and plant height at maturity (4.00, 22.21, 47.13, 49.11, 48.13, 52.28 and 57.80 cm) respectively; though, it was statistically similar to the parent óClemson spinelessô in days to 50% flowering, days to first fruiting and days to fruit maturity (49.25, 48.31 and 54.83, respectively). ôEle Nduô had significantly ($p < 0.05$) higher stem girth (9.12 cm), while óV-21 Ivraô had lower stem girth (4.28 cm) than the other parental accessions evaluated.

The results of the fruit traits of the parental lines evaluated indicated that the accession, ôEle Uhieô showed significantly ($p < 0.05$) higher 100 seed weight, dry fruit weight, fruit girth, fruit weight, number of ridges/pod and number of seeds/pod (5.19 g, 11.46 g, 11.10 cm, 34.50 g, 11.33 and 120.57, respectively) compared to the other parental accessions, but statistically similar to ôEle Nduô in 100 seed weight and fruit weight (5.05 g and 33.39 g). óV-21 Ivraô parent had lower 100 seed weight, dry fruit weight, fruit girth, fruit weight, number of ridges/pod and number of seeds/pod (3.91 g, 5.90 g, 5.56 cm, 17.14 g, 6.00 and 56.25 respectively). óClemson spinelessô had higher fruit length (14.35 cm), though statistically similar to ôEle Uhieô (12.09 cm). The parent, ôEle Ogwuô, had significantly lower fruit length (4.08 cm) compared to all the parents (Table 4).

Table 3: Agronomic, yield and yield component traits of parental accessions of okra studied

ACCESSIONS	BL(cm)	D50%G	DBI	DA	D50%F	D1F	DFM	NoB/P	NoF/B	NoF/Pl	NoFl/Pl	NoF/St	PHM(cm)	StG(cm)	TFY(t/ha)
Agwu Early	16.50	4.00	22.21	47.13	49.11	48.13	52.28	1.67	1.67	7.80	3.83	4.47	37.80	5.92	5.52
Clemson	26.60	4.00	21.87	47.31	49.25	48.31	54.83	1.00	1.33	5.67	2.23	4.00	75.79	4.84	4.87
Ele Ndu	78.30	7.00	51.96	86.72	89.30	87.72	96.75	3.33	7.67	26.67	6.93	4.37	213.88	9.12	30.59
Ele Ogwu	74.80	8.33	58.99	91.25	94.37	92.25	100.63	1.33	3.33	15.85	4.33	9.48	189.40	8.73	11.51
Ele Uhie	123.70	6.67	55.27	83.04	86.14	84.04	92.03	2.33	8.31	29.56	9.03	8.95	237.66	7.27	32.56
Esculentus	26.60	4.67	23.95	48.98	51.18	49.98	54.50	1.33	1.67	8.22	2.00	4.97	54.89	5.00	7.98
Jokoso	0.00	6.00	25.05	50.09	53.40	51.08	55.32	0.00	0.00	6.17	2.15	6.17	64.65	4.71	4.02
LD88	28.40	4.00	23.00	48.17	50.90	49.17	52.70	2.00	2.67	8.28	3.90	2.82	64.16	6.27	7.97
LUDU V	20.70	4.33	22.54	47.54	50.87	48.54	52.47	1.00	1.67	9.03	2.67	4.43	65.07	6.22	7.57
NHE 47.4	12.90	5.00	26.09	51.24	54.90	52.24	55.89	0.67	1.00	7.56	2.42	5.85	63.97	6.03	6.07
TAE 38	33.10	5.00	24.19	49.20	52.40	50.20	53.95	2.33	2.67	9.07	3.67	4.70	48.92	6.61	9.50
V-21 Ivra	30.40	6.00	28.85	53.98	56.28	54.98	59.77	1.00	2.33	6.09	3.00	2.74	66.63	4.28	3.47
V.35	22.20	4.33	24.63	49.62	52.45	49.95	54.28	0.67	2.00	9.14	3.00	7.18	49.03	5.68	8.72
F-LSD (p<0.05)	37.27	0.56	1.39	1.82	1.91	1.80	2.04	1.54	2.33	2.79	1.06	4.68	7.96	0.39	2.53

Where BL= Branch length, , D50%G= Days to 50% germination, DBI= Days to flower bud initiation, DA= Days to anthesis, D50%F = Days to 50% flowering, DIF= Days to first fruiting, DFM= Days to fruit maturity, NoB/Pl= Number of branches/plant, NoF/B= Number of fruits/branch, NoF/Pl= Number of fruits/plant, NoFl/Pl= Number of flowers/plant, NoF/St= Number of fruits/stem, PHM= Plant height at maturity, StG= Stem girth, TFY(t/Ha)= Total fruit yield (tonnes/ Hectare)

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Table 4: Fruit characteristics of the parental accessions of okra studied

ACCESSIONS	100 SW(g)	DrFW(g)	FG(cm)	FL(cm)	FW(cm)	NoR/P	NoS/P
Agwu Early	4.37	6.11	6.59	4.74	21.34	8.00	62.68
Clemson	4.50	5.73	6.67	14.35	26.4	6.67	64.55
Ele Ndu	5.05	10.15	10.46	9.62	33.39	9.67	99.36
Ele Ogwu	4.23	5.72	7.66	4.08	21.88	8.00	51.64
Ele Uhie	5.193	11.46	11.10	12.09	34.50	11.33	120.57
Esculentus	4.66	6.82	9.13	8.59	29.40	7.00	70.96
Jokoso	3.43	6.38	8.00	6.52	19.65	6.00	50.32
LD88	4.58	7.47	7.93	8.70	29.00	10.00	72.84
LUDU V	4.56	7.29	9.08	8.03	25.42	9.00	73.14
NHE 47.4	3.50	7.69	8.83	7.68	24.28	10.00	52.18
TAE 38	4.60	6.84	8.57	8.93	30.89	10.00	71.85
V-21 Ivra	3.91	5.9	5.56	6.85	17.14	6.00	56.25
V.35	4.89	7.67	8.47	8.40	28.87	9.00	77.84
F-LSD (p<0.05)	0.36	1.37	2.18	1.22	3.77	0.48	5.65

Where 100 SW = 100 seed weight, DrFW= Dry fruit weight, FG= Fruit girth, FL= Fruit length, FW=Fruit weight, NoR/P= Number of ridges/pod, NoS/P= Number of seeds/pod, NoF/St= Number of fruits/stem.

Evaluation of F_1 Hybrids and their Parents

The agronomic, yield and yield component traits of the F_1 hybrids and selected parents revealed that the cross ôUHIE x LD88ô showed significantly ($p < 0.05$) higher number of branches/plant (7.00), number of fruits/branch (8.64), number of fruits/plant (35.63), number of flowers/plant (10.16) and total fruit yield/hectare (38.25 t/Ha) (Table 5). óClemson spinelessô parent had significantly ($p < 0.05$) lower number of branches/plant, number of fruits/branch, number of fruits/plant, number of flowers/plant and total fruit yield/hectare (0.33, 0.67, 4.40, 1.67 and 3.56 t/ha, respectively). óOGW x UHIEô had higher branch length (115.70 cm) compared to others. ôEle Ogwuô parent had higher days to 50% germination (7.17), days to flower bud initiation (64.85), days to anthesis (90.35), days to 50% flowering (93.45) and days to edible fruit maturity (99.27). óAgwu earlyô had lower days to 50% flowering (49.22), although it was statistically similar to óClemson spinelessô. On the other hand, óClemson spinelessô parent had significantly ($p < 0.05$) lower branch length (11.80 cm), days to 50% germination (4.00), days to flower bud initiation (22.41), days to anthesis (46.71), days to 50% flowering (49.28), days to first fruiting (47.71), days to edible fruit maturity (51.56) and stem girth (4.46cm). It was statistically similar to óAgwu earlyô and ôLD88ô parents in these traits. The cross, óOGW x LD88ô had higher stem girth (8.48 cm). It was statistically similar to ôEle Ogwuô (8.12 cm). With exception to ôEle Ogwuô and ôEle Uhieô parents, it was statistically similar to all the hybrids in days to 50% germination. On the other hand, ôEle Uhieô, showed significantly ($p < 0.05$) higher plant height at maturity (241.02 cm) and it was statistically similar to ôEle Ogwuô (208.29 cm). óAgwu earlyô had lower plant height at maturity compared to other accessions (61.50 cm).

The fruit traits of the F_1 hybrids and selected parents showed that the hybrid ôUHIE x LD88ô showed significantly ($p < 0.05$) higher 100 seed weight (4.66 g), dry fruit weight (11.51 g), fruit girth (8.50 cm), fruit weight (32.56 g) and number of ridges/pod (10.67). It was statistically similar to ôEle Uhieô in number of ridges/pod. ôEle Ogwuô on the other hand, had lower 100 seed weight (3.22 g). The cross, óOGW x LD88ô had lower dry fruit weight (7.22 g). It was statistically similar to óOGW x CLMô (7.23 g). óClemson spinelessô parent had lower fruit girth (5.65cm), number of ridges/pod (5.67), but showed higher fruit length (15.77cm). It was statistically similar to the cross ôUHIE x CLMô in fruit length (13.57cm). óAgwu earlyô had lower fruit weight (20.27 g), while ôEle Ogwuô had lower fruit length (4.73 cm). The parent, ôEle

Uhieọ had significantly ($p < 0.05$) higher number of seeds/pod (105.42) while ọEle Ogwuọ had lower number of seeds/pod (54.22) (Table 6).

Table 5: Agronomic, yield and yield component traits of the F_1 hybrids and selected parents of okra varieties used for the study

ACCESSIONS	BL(cm)	D50%G	DBI	DA	D50%F	D1F	DFM	NoB/P	NoF/B	NoF/Pl	NoFl/Pl	NoF/St	PHM(cm)	StG(cm)	TFY(t/ha)
AGW	24.90	4.00	22.47	46.71	49.22	47.71	51.67	1.00	2.00	7.95	3.33	4.71	61.50	5.43	5.32
CLM	11.80	4.33	22.49	46.70	49.28	47.70	51.56	0.33	0.67	4.40	1.67	3.58	66.88	4.46	3.56
LD-88	37.10	4.00	22.53	47.80	51.00	48.80	52.53	1.67	2.33	9.26	4.33	5.17	77.62	5.41	8.07
OGW	83.50	7.17	64.85	90.35	93.45	91.35	99.27	1.00	6.10	16.58	3.00	6.71	208.29	8.12	11.77
UHIE	81.20	6.82	55.96	82.38	84.90	83.38	96.91	1.67	8.35	31.41	8.70	17.85	241.02	7.10	31.50
AGW x CLM	29.30	4.17	22.05	48.21	50.50	49.20	53.28	1.43	2.33	9.73	4.33	4.44	67.62	6.24	7.03
AGW x LD88	42.60	4.00	25.27	52.23	54.80	53.23	57.56	1.67	4.07	10.55	5.67	6.72	56.88	7.18	10.58
CLM x LD88	62.10	4.33	22.55	49.14	51.60	50.13	54.51	1.33	3.00	7.19	5.00	3.93	72.32	5.49	8.24
OGW x AGW	83.50	4.17	36.22	62.22	65.80	63.22	68.43	3.33	6.37	24.76	6.85	8.45	128.49	8.08	20.83
OGW x CLM	59.20	4.00	38.81	63.88	67.10	64.87	70.04	2.00	5.58	11.18	5.33	3.21	146.65	5.88	13.20
OGW X LD88	102.80	4.67	35.95	61.33	64.71	62.40	67.59	5.47	7.43	29.38	9.25	3.67	138.53	8.48	30.75
OGW x UHIE	113.70	4.67	58.95	84.60	88.21	85.60	92.47	2.37	7.63	26.01	6.63	7.92	214.85	6.78	25.61
UHIE x AGW	67.60	4.17	33.50	59.96	62.12	60.96	66.11	3.90	8.00	31.66	7.24	11.98	147.29	6.15	30.77
UHIE x CLM	82.40	4.00	33.99	60.25	63.05	61.25	66.82	2.67	5.50	16.32	7.64	5.19	179.54	5.28	17.30
UHIE x LD88	80.50	4.00	36.07	61.92	64.81	62.92	68.15	7.00	8.64	35.63	10.16	4.74	161.47	6.68	38.25
F-LSD (p<0.05)	38.97	0.74	2.10	2.66	2.72	2.67	3.11	1.47	1.02	2.57	1.05	3.77	7.28	0.46	3.08

Where BL= Branch length, , D50%G= Days to 50% germination, DBI= Days to flower bud initiation, DA = Days to anthesis, D50%F = Days to 50% flowering, DIF= Days to first fruiting, DFM= Days to fruit maturity, NoB/Pl= Number of branches/plant, NoF/B= Number of fruits/branch, NoF/Pl= Number of fruits/plant, NoFl/Pl= Number of flowers/plant, NoF/St= Number of fruits/stem, PHM= Plant height at maturity, StG= Stem girth, TFY(t/Ha)= Total fruit yield (tonnes/ Hectare)

Table 6: Fruit Characteristics of the F_1 Hybrids and Selected Parents of Okra varieties studied

ACCESSIONS	100 SW(g)	DrFW(g)	FG(cm)	FL(cm)	FW(g)	NoR/P	NoS/P
AGW	3.73	7.52	6.87	5.67	20.27	6.00	68.74
CLM	3.55	7.71	5.65	15.77	24.36	5.67	69.67
LD-88	4.14	8.29	9.23	9.04	26.17	9.33	82.25
OGWU	3.22	7.59	6.14	4.73	21.20	6.00	54.22
UHIE	5.29	10.02	11.33	12.43	30.03	10.67	105.42
AGW x CLM	4.10	7.78	7.00	8.85	25.30	6.33	70.97
AGW x LD88	3.88	7.77	7.23	6.73	26.42	9.00	78.46
CLM x LD88	3.82	8.44	6.07	10.14	27.98	7.00	73.63
OGWU x AGW	3.41	7.99	6.56	5.40	24.73	7.00	54.92
OGWU x CLM	3.76	7.23	6.17	8.89	32.01	6.00	65.27
OGWU X LD88	3.69	7.22	6.91	6.41	31.31	8.33	71.32
OGWU x UHIE	4.17	8.95	7.15	7.80	29.31	8.00	88.37
UHIE x AGW	3.88	9.36	8.12	8.92	29.30	9.00	83.12
UHIE x CLM	4.27	10.39	7.25	13.57	29.88	7.00	83.69
UHIE x LD88	4.66	11.51	8.50	11.17	32.56	10.67	87.82
F-LSD ($p<0.05$)	0.21	1.33	0.79	0.75	2.10	0.77	4.50

Where 100-SW= 100 seed weight, DrFW= Dry fruit weight, FG= Fruit girth, FL= Fruit length, FW= Fruit weight, NoR/P= Number of ridges/fruit pod, NoS/P= Number of seeds/pod, NoF/St = Number of fruits/stem

Estimates of Mid Parent Heterosis (MPH) of agronomic, yield, yield component traits and fruit traits

Estimates of Mid Parent Heterosis (MPH) of the agronomic, yield and yield component traits of the F_1 hybrids (Table 7) showed that the cross óOGW x AGWô had significantly (CD < 0.05) higher negative MPH values for days to flower bud initiation (-40.04), days to anthesis (-27.96), days to 50% flowering (-26.21), days to first fruiting (-27.64) and days to edible fruit maturity (-30.24) while the cross óOGW x AGWô gave higher negative MPH value for days to 50% germination (-40.39). On the other hand, the cross óOGW x UHIEô had significantly (CD < 0.05) higher positive mid parent heterosis values for days to flower bud initiation (26.55), days to anthesis (26.91), days to 50% flowering (15.81), days to first fruiting (25.63) and days to edible fruit maturity (25.02) while óOGW x LD88 had higher positive value for days to 50% germination (14.32). The cross óCLM x LD88ô had higher negative MPH values for number of branches/plant (-0.37), number of fruits/branch (-28.83) and plant height at maturity (-21.27). The cross óOGW x LD88ô had higher positive heterosis value for branch length (185.95), while the cross óUHIE x AGWô had higher negative heterosis value for branch length (-7.14). óOGW x LD88ô had higher positive heterosis values for number of branches/plant (252.90) and total fruit yield (249.23) but had higher negative MPH value for number of fruits/stem (-34.23). The cross óOGW x CLMô had higher negative heterosis value for total fruit yield (-31.48). Similarly, the cross óOGW x CLMô had higher negative MPH values for number of flowers/plant (-18.19) and number of fruits/stem (-71.20). The cross óOGW x UHIEô had higher MPH values for number of fruits/plant (193.24) and plant height at maturity (232.59). For stem girth, higher positive MPH value was recorded for óAGW x LD88ô (45.49) while higher negative MPH value was recorded for óUHIE x CLMô (-24.36) for the trait. Similarly, the cross óAGW x LD88ô had higher positive MPH values for number of fruits/branch (171.35) and number of flowers/plant (89.00). The cross óUHIE x AGWô had higher positive MPH value for number of fruits/stem (93.54).

The estimates of Mid Parent Heterosis (MPH) of fruit traits of the F_1 hybrids, showed that the cross óUHIE x LD88ô had higher positive MPH values for 100 seed weight (25.10), dry fruit weight (59.31), fruit girth (29.97) and number of ridges/pod (48.92). The cross óUHIE x CLMô had higher positive MPH values for fruit length (89.92) and number of seeds/pod (39.26). The cross óOGW x LD88ô gave higher positive heterosis value for fruit weight (21.08). On the other

hand, the cross óOGW x CLMô had higher negative MPH values for 100 seed weight, dry fruit weight, fruit girth and number of ridges/pod (-19.91, -18.76, -32.68 and -29.41, respectively). Similarly, the cross óOGW x AGWô had higher negative MPH values for fruit length, fruit weight and number of seeds/pod (-37.06, -3.46 and -31.20, respectively) (Table 8).

Table 7: Mid parent heterosis of the agronomic, yield and yield component traits of F_1 hybrids of okra varieties studied

ACCESSIONS	BL(cm)	D50%G	DBI	DA	D50%F	D1F	DFM	NoB/P	NoF/B	NoF/Pl	NoFl/Pl	NoF/St	PHM(cm)	StG(cm)	TFY(t/ha)
AGW x CLM	59.67	0.12	1.91	3.22	2.54	3.13	3.23	115.04	74.53	57.57	73.20	7.12	5.34	26.19	58.33
AGW x LD88	74.23	-3.96	12.26	10.54	9.29	10.32	10.60	67.00	171.33	54.47	89.00	53.60	-21.27	45.49	81.94
CLM x LD88	2.99	-22.47	18.39	8.86	8.56	8.46	8.18	-0.37	-28.83	-44.35	36.43	-33.84	-49.41	-18.85	-16.94
OGW x AGW	1.40	-40.39	-40.04	-27.96	-26.21	-27.64	-30.24	149.44	-11.83	3.19	17.09	-31.19	-42.81	6.18	-3.72
OGW x CLM	7.15	-27.21	-0.50	-2.17	-0.89	-2.14	-6.73	29.03	4.49	-45.65	-18.19	-71.20	-4.97	-11.84	-31.48
OGW X LD88	185.95	14.32	-31.94	-22.12	-22.91	-21.84	-21.96	252.90	132.19	189.74	85.00	-34.23	122.54	26.38	249.23
OGW x UHIE	117.19	12.12	26.55	26.91	15.81	25.63	25.02	58.00	115.84	193.24	24.27	48.73	232.59	7.02	172.16
UHIE x AGW	-7.14	-1.88	-14.00	-7.69	-5.83	-7.56	-7.55	67.38	70.76	98.18	22.19	93.54	46.70	-9.36	111.70
UHIE x CLM	15.49	-2.08	-9.40	-4.44	-5.12	-4.36	-3.49	0.19	-7.95	-9.18	25.45	-10.98	30.51	-24.36	1.67
UHIE x LD88	-0.62	-7.73	-3.50	-1.09	-1.66	-1.12	-0.97	87.42	32.82	75.69	39.37	37.79	13.24	-6.96	74.06
CD5%	40.42	0.76	2.18	2.76	3.55	2.76	3.23	1.53	1.06	2.67	1.09	3.79	7.55	0.47	3.20

Where CD= Critical difference at 5% probability level, BL= Branch length, , D50%G= Days to 50% germination, DBI= Days to flower bud initiation, DA= Days to anthesis, D50%F = Days to 50% flowering, DIF= Days to first fruiting, DFM= Days to fruit maturity, NoB/Pl= Number of branches/plant, NoF/B= Number of fruits/branch, NoF/Pl= Number of fruits/ plant, NoFl/Pl= Number of flowers/plant, NoF/St= Number of fruits/stem, PHM= Plant height at maturity, StG= Stem girth, TFY(t/Ha)= Total fruit yield (tonnes/ Hectare)

Table 8: Mid parent heterosis of fruit traits of F_1 hybrids of okra varieties studied

ACCESSIONS	100 SW(g)	DrFW(g)	FG(cm)	FL(cm)	FW(g)	NoR/P	NoS/P
AGW x CLM	12.64	2.17	11.82	-17.44	13.38	8.48	2.55
AGW x LD88	0.91	-2.88	-2.82	-45.75	4.57	20.00	3.29
CLM x LD88	3.80	6.30	-21.01	47.28	18.13	-8.68	7.91
OGW x AGW	-19.86	-9.26	-24.90	-37.06	-3.46	-16.02	-31.20
OGW x CLM	-19.91	-18.76	-32.68	-16.45	15.71	-29.41	-25.99
OGW X LD88	-7.52	-7.14	-2.88	-17.72	21.08	8.68	-4.54
OGW x UHIE	8.31	10.43	7.52	-7.53	7.76	0.00	16.21
UHIE x AGW	7.33	13.94	28.58	14.80	11.17	28.57	29.32
UHIE x CLM	19.11	36.53	13.90	89.92	5.32	7.69	39.26
UHIE x LD88	25.10	59.31	29.97	46.01	2.84	48.92	28.59
CD5%	0.22	1.38	0.82	0.78	2.18	0.79	5.15

Where CD= Critical difference at 5% probability level, 100 SW= 100 seed weight, DrFW= Dry fruit weight, FG= Fruit girth, FL= Fruit length, FW= Fruit weight, NoR/P= Number of ridges/fruit pod, NoS/P= Number of seeds/fruit pod

Estimates of Better Parent Heterosis (BPH) of agronomic, yield, yield component traits and fruit traits

Estimates of Better Parent Heterosis (BPH) of the agronomic, yield and yield component traits of the F_1 hybrids (Table 9) showed that the cross óCLM x LD88ô had significantly (CD < 0.05) higher positive better parent heterosis value in branch length (67.39), while the cross, óOGW x CLMô, had higher negative heterosis value in branch length (-29.10). The cross óOGW x UHIEô had higher positive heterosis value for days to 50% flowering (35.81). It also had higher positive better parent heterosis values in days to flower bud initiation (49.10), days to anthesis (36.29), days to first fruiting (36.36) and days to fruit maturity (46.85). The cross óCLM x LD88ô had higher BPH positive values in number of fruits/branch (72.32), plant height at maturity (8.75) and stem girth (32.36). The cross, õUHIE x CLMô had higher negative better parent heterosis values in days to 50% germination (-46.32), days to flower bud initiation (-49.26), days to anthesis (-46.54), days to 50% flowering (-45.12), days to first fruiting (-46.86) and days to fruit maturity (-35.05). The cross óOGW x LD88ô had higher positive BPH value in total fruit yield/hectare (161.26). It was statistically similar to õUHIE x LD88ô. All the hybrids, excluding óAGW x CLMô, óAGW x LD88ô, óCLM x LD88ô and óOGW x UHIEô had negative BPH in days to bud initiation, days to anthesis, days to first fruiting and plant height at maturity. The hybrid, õUHIE x CLMô, had higher negative BPH in number of fruits/branch (-34.16) and stem girth (-25.59), while õUHIE x AGWô showed higher negative heterosis value in plant height at maturity (-38.89). In total fruit yield/hectare and number of flowers/plant, higher negative BPH values were recorded for õUHIE x CLMô (-45.08 and -35.18 respectively). The crosses, õUHIE x LD88ô, óOGW x LD88ô and óOGW x AGWô showed higher positive BPH in number of branches/plant, number of fruits/plant and number of flowers/plant (319.16, 113.55 and 128.33, respectively) while the hybrids, óCLM x LD88ô and óOGW x UHIEô had higher negative BPH in number of branches/plant (-20.36) and number of flowers/plant (-35.18). All the hybrids, excluding óOGW x UHIEô, õUHIE x AGWô and õUHIE x CLMô, had positive BPH in number of fruits/branch, number of fruits/plant, number of flowers/plant and total fruit yield,. Similarly, all the hybrids had negative BPH in days to 50% germination, with exception of óAGW x LD88ô and óCLM x LD88ô which had zero heterosis value in days to 50% germination.

The results of better parent heterosis for fruit traits of the F_1 hybrids revealed that with exception of the cross, óAGW x CLMô, all the hybrids had negative BPH in 100 seed weight. Similarly, all the crosses had negative BPH for number of ridges/pod with the exception of óOGW x AGWô, although in the case of number of seeds/pod, all the hybrids obtained had negative BPH. The cross, õUHIE x CLMô, had higher negative heterosis values in fruit girth (-36.01) and number of ridges/pod (-34.38). The cross, õUHIE x LD88ô showed higher positive heterosis values in fruit weight (25.07) and dry fruit weight (14.87). Similarly, the cross, óOGW x AGWô showed higher positive heterosis value in number of ridges/pod (16.67) Higher negative BPH occurred in óAGW x CLMô in fruit length (-43.85), õUHIE x CLMô in fruit girth (-36.01), õUHIE x AGWô in fruit weight (-2.43) and óOGW x UHIEô in dry fruit weight (-10.68) (Table 10).

Table 9: Better parent heterosis of the agronomic, yield and yield component traits of F_1 hybrids of okra varieties studied

ACCESSIONS	BL(cm)	D50%G	DBI	DA	D50%F	D1F	DFM	NoB/P	NoF/B	NoF/Pl	NoFl/Pl	NoF/St	PHM(cm)	StG(cm)	TFY (t/Ha)
AGW x CLM	17.67	-3.83	-1.96	3.12	2.54	3.21	3.12	43.00	16.65	30.00	30.00	5.73	2.10	15.04	32.14
AGW x LD88	14.82	0.00	12.16	9.08	9.29	9.27	9.58	0.00	74.32	30.79	30.79	29.98	8.75	32.36	31.10
CLM x LD88	67.39	0.00	0.90	2.73	28.56	2.80	3.77	-20.36	28.59	15.39	15.39	23.98	4.87	1.42	2.11
OGW x AGW	0.00	-41.86	-44.15	-30.79	-26.21	-31.02	-31.07	233.00	4.48	105.52	128.33	-25.95	-38.31	-0.42	76.98
OGW x CLM	-29.10	-44.19	-40.15	-29.00	-0.89	-29.30	-29.44	100.00	-8.57	77.77	11.10	-52.16	-29.59	-27.56	12.15
OGW X LD88	23.11	-4.88	-4.56	-3.69	-6.91	-3.12	-3.91	227.54	21.75	113.55	67.39	-45.31	-33.49	4.44	161.26
OGW x UHIE	36.17	34.88	49.10	36.29	35.81	36.36	46.85	41.92	-8.69	-23.80	-23.80	-5.63	-10.86	-16.43	-18.70
UHIE x AGW	-16.75	-38.87	-40.14	-26.89	-25.83	-27.22	-31.78	133.53	-4.23	-16.75	-16.75	-3.89	-38.89	-13.34	-2.32
UHIE x CLM	1.45	-46.32	-49.26	-46.54	-45.12	-46.86	-35.05	59.88	-34.16	-12.19	-35.18	-7.92	-25.51	-25.59	-45.08
UHIE x LD88	-0.86	-41.32	-35.54	-24.54	-1.66	-24.84	-29.68	319.16	3.40	16.82	16.82	-73.45	-33.01	36.34	21.43
CD5%	40.42	0.76	2.18	2.76	3.55	2.76	3.23	1.53	1.06	2.67	1.09	3.79	7.55	0.47	3.20

Where CD= Critical difference at 5% probability level, BL= Branch length, , D50%G= Days to 50% germination, DBI= Days to flower bud initiation, DA= Days to anthesis, D50%F = Days to 50% flowering, DIF= Days to first fruiting, DFM= Days to fruit maturity, NoB/Pl= Number of branches/plant, NoF/B= Number of fruits/branch, NoF/Pl= Number of fruits/ plant, NoFl/Pl= Number of flowers/plant, NoF/St= Number of fruits/stem, PHM= Plant height at maturity, StG= Stem girth, TFY(t/Ha)= Total fruit yield (tonnes/ Hectare)

Table 10: Better parent heterosis of fruit traits of F_1 hybrids of okra varieties studied

ACCESSIONS	100 SW(g)	DrFW(g)	FG(cm)	FL(cm)	FW(g)	NoR/P	NoS/P
AGW x CLM	-9.75	0.91	1.89	-43.85	3.86	-5.55	-1.87
AGW x LD88	-6.28	6.27	1.73	5.59	1.00	-3.57	-4.61
CLM x LD88	-7.72	1.81	4.29	12.17	6.92	-25.00	-10.48
OGW x AGW	-8.73	5.27	6.74	-4.76	16.65	16.67	-20.10
OGW x CLM	5.74	4.74	0.39	-43.64	19.09	-3.29	-6.32
OGW X LD88	-11.01	4.87	12.44	-29.06	8.18	-10.71	-13.29
OGW x UHIE	-21.12	-10.68	6.89	-37.29	-2.40	-25.00	-16.17
UHIE x AGW	-26.6	-6.59	-28.36	-28.28	-2.43	-15.63	-21.15
UHIE x CLM	-19.22	-3.69	-36.01	9.12	-0.50	-34.38	-20.61
UHIE x LD88	-11.91	14.87	-25.00	-10.16	25.07	-6.45	-16.7
CD5%	0.22	1.38	0.82	0.78	2.18	0.79	5.15

Where CD = Critical difference at 5% probability level, 100 SW= 100 seed weight, DrFW= Dry fruit weight, FG= Fruit girth, FL= Fruit length, FW= Fruit weight, NoR/P= Number of ridges/fruit pod, NoS/P= Number of seeds/pod

Evaluation of Selected Parents and F_2 Segregating Hybrids of Okra used for the study

The agronomic, yield and yield component traits of selected parents and the segregating F_2 crosses (Table 11) revealed that ðEle Ogwuô parent had significantly ($p < 0.05$) higher days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting and days to edible fruit maturity (7.33, 65.07, 91.28, 94.51, 92.28 and 100.56, respectively). The parent, óClemson spinelessô had significantly ($p < 0.05$) lower days to 50% germination(4.00), days to flower bud initiation (24.71), days to anthesis (43.70), days to 50% flowering (47.88), days to first fruiting (44.70) and days to edible fruit maturity (49.45). It was statistically similar to all the parents and hybrids in days to 50% germination with exception to ðEle Ogwuô, ðEle Uhieô, óOGW x UHIEô and óOGW x LD88ô (4.00). The cross ðUHIE x LD88ô had significantly ($p < 0.05$) higher number of branches/plant, number of fruits/branch, number of fruits/plant and total fruit yield/hectare (5.38, 8.13, 35.66 and 37.51 t/ha, respectively). ðEle Uhieô was statistically similar in total fruit yield/hectare (35.51 t/ha). It also had higher plant height at maturity (237.02 cm). It was statistically similar to óOGW x UHIEô (219.42 cm) and ðEle Ogwuô (203.61 cm). óClemson spinelessô had lower total fruit yield/hectare (4.06 t/ha). It also showed insignificant number of branches/plant as well as number of fruits/branch (0.00 and 0.00, respectively). Similarly, it had lower stem girth (4.54 cm) compared to others. óOGW x LD88ô had higher stem girth (9.18 cm). ðEle Ogwuô showed significantly ($p < 0.05$) higher branch length (87.30 cm). It was statistically similar to ðUHIE x LD88ô (83.70cm), while óAgwu earlyô showed lower branch length (18.10 cm).

The fruit traits of the selected parents and their F_2 progenies showed that ðEle Uhieô had significantly ($p < 0.05$) higher 100 seed weight (4.43 g). It was statistically similar to ðUHIE x LD88ô (4.28 g). It also showed significantly ($p < 0.05$) higher fruit girth, fruit weight and number of seeds/pod (11.92 cm, 33.57 g and 106.59 g, respectively). It was statistically similar to the cross, ðUHIE x LD88ô in fruit weight (30.77 g). The cross, óOGW x CLMô, showed lower 100 seed weight (3.91 g). It was statistically similar to the crosses óAGW x CLMô and óAGW x LD88ô. The cross óOGW x LD88ô had higher dry fruit weight (10.61 g). It was statistically similar to óOGW x AGWô (9.32 g). ðEle Ogwuô had significantly lower dry fruit weight (6.47 g). óClemson spinelessô had lower fruit girth (5.12 cm), while óAgwu earlyô had lower fruit weight (18.96 cm) and number of seeds/pod (50.97). It was statistically similar to the cross óOGW x

AGWô in number of seeds/pod (58.72). óUHIE x CLMô had significantly ($p < 0.05$) higher fruit length of 16.17 cm. It was statistically similar to óCLM x LD88ô (15.02 cm) and óClemson spinelessô (15.48 cm). óEle Ogwuô had significantly lower fruit length (4.70 cm) and lower number of ridges/pod (5.00). The hybrid, óUHIE x LD88ô had higher number of ridges/pod (9.67). It was statistically similar to óAGW x LD88ô in number of ridges/pod (Table 12).

Table 11: The agronomic, yield and yield component traits of F_2 segregating okra hybrids and their parents

ACCESSION	BL(cm)	D50%G	DBI	DA	D50%F	D1F	DFM	NoB/Pl	NoF/B	NoF/Pl	NoFl/Pl	NoF/St	PHM(cm)	StG(cm)	TFY (/t/Ha)
AGW	18.10	4.00	22.25	45.59	49.56	46.59	51.35	1.00	1.67	7.59	3.67	4.93	42.92	5.77	4.80
CLM	0.00	4.00	21.50	43.70	47.88	44.70	49.45	0.00	0.00	5.00	1.67	5.00	74.60	4.54	4.06
LD-88	33.40	4.33	24.71	46.36	49.21	47.36	51.67	1.67	2.33	9.17	3.67	5.47	59.30	5.55	8.47
OGW	87.30	7.33	65.07	91.28	94.51	92.28	100.56	1.33	2.90	18.08	2.00	12.25	203.61	7.92	13.54
UHIE	76.30	5.67	57.85	82.32	85.26	83.28	91.36	2.00	7.33	34.76	3.00	19.63	237.02	6.93	38.76
AGW x CLM	35.50	4.00	22.13	45.72	48.10	46.72	51.63	1.80	1.67	6.38	5.13	4.41	66.43	6.32	5.12
AGW x LD88	31.10	4.00	24.22	48.87	52.10	49.87	54.88	3.43	3.33	9.84	4.62	6.08	63.72	6.98	8.60
CLM x LD88	40.40	4.00	22.22	44.77	48.33	45.77	50.66	1.33	2.00	5.13	1.67	4.47	73.05	5.44	4.82
OGW x AGW	70.90	4.33	40.85	68.50	71.27	69.50	75.56	3.67	5.00	12.18	2.00	10.69	121.82	7.28	9.15
OGW x CLM	87.30	4.00	36.13	67.97	71.80	68.97	75.68	2.00	3.18	9.91	1.67	3.60	164.90	5.26	8.82
OGW x LD88	75.30	4.67	38.98	64.90	67.35	65.90	73.25	4.84	7.40	16.96	3.67	3.74	134.57	9.18	15.62
OGW x UHIE	69.00	6.43	61.52	85.03	88.27	86.03	87.80	2.00	4.00	27.69	3.67	12.18	219.42	7.10	25.77
UHIE x AGW	75.10	4.00	37.73	63.35	67.00	64.35	70.54	3.77	5.58	27.55	3.00	13.11	168.78	6.15	24.49
UHIE x CLM	55.60	4.00	36.15	62.57	65.95	63.57	70.00	1.67	3.41	19.61	6.85	6.73	188.02	5.04	19.02
UHIE x LD88	83.70	5.00	37.62	61.58	65.81	62.58	68.96	4.38	8.13	35.66	3.33	8.97	175.75	6.91	36.51
F-LSD 0.05	47.39	0.61	2.36	1.32	2.41	1.31	2.81	1.54	2.70	2.91	1.98	7.37	7.93	0.40	2.43

Where BL= Branch length, , D50%G= Days to 50% germination, DBI= Days to flower bud initiation, DA= Days to anthesis, D50%F = Days to 50% flowering, DIF= Days to first fruiting, DFM= Days to fruit maturity, NoB/Pl= Number of branches/plant, NoF/B= Number of fruits/branch, NoF/Pl= Number of fruits/plant, NoFl/Pl= Number of flowers/plant, NoF/St= Number of fruits/stem, PHM= Plant height at maturity, StG= Stem girth, TFY(t/Ha)= Total fruit yield (tonnes/ Hectare) AGW = Agwu early, CLM = Clemson spineless, OGW = Ele Ogwu, AGW x CLM = Agwu x Clemson, AGW x LD88 = Agwu x LD88, CLM x LD88 = Clemson x LD88, OGW x AGW = Ele Ogwu x Agwu early, OGW x CLM = Ogwu x Clemson spineless, OGW x LD88 = Ogwu x LD88, OGW x UHIE = Ogwu x Uhie, UHIE x AGW = Uhie x Agwu, UHIE x CLM = Uhie x Clemson spineless, UHIE x LD88 = UHIE x LD88

Table 12: Fruit characteristics of F_2 segregating okra hybrids and their parents

ACCESSION	100 SW(g)	DrFW(g)	FG(cm)	FL(cm)	FW(g)	NoR/P	NoS/P
AGW	3.99	8.56	6.68	6.27	18.96	6.67	50.97
CLM	3.93	8.72	5.18	15.48	24.37	6.33	68.09
LD-88	4.09	7.46	8.95	8.10	28.14	7.33	76.66
OGW	4.25	6.47	6.94	4.70	22.52	5.00	58.85
UHIE	4.43	8.73	11.92	11.39	33.57	9.00	106.59
AGW x CLM	3.93	8.05	6.83	9.73	23.63	6.00	58.61
AGW x LD88	3.93	8.55	8.50	6.86	26.04	9.67	66.75
CLM x LD88	4.03	8.72	6.18	15.02	28.06	6.00	70.95
OGW x AGW	3.83	9.32	6.43	4.98	22.8	6.33	58.72
OGW x CLM	3.91	8.70	6.45	7.87	26.7	7/00	66.61
OGW x LD88	3.96	10.61	7.27	6.42	27.67	8.00	68.85
OGW x UHIE	4.22	9.16	7.51	8.92	27.99	9.67	81.9
UHIE x AGW	4.08	8.72	8.15	8.48	26.76	6.00	71.94
UHIE x CLM	4.21	8.98	7.28	16.17	29.33	5.33	78.36
UHIE x LD88	4.28	7.24	8.55	12.20	30.77	9.67	79.46
F-LSD 0.05	**0.11**	**1.16**	**0.57**	**0.78**	**2.11**	**0.74**	**5.90**

Where 100 SW = 100 Seed weight, DrFW = Dry fruit weight, FG = Fruit girth, FL = Fruit length, FW = Fruit weight, NoR/P = Number of ridges/fruit pod, NoS/P = Number of seeds/pod, AGW = Agwu early, CLM = Clemson spineless, OGW = Ele Ogwu, AGW x CLM = Agwu x Clemson, AGW x LD88 = Agwu x LD88, CLM x LD88 = Clemson x LD88, OGW x AGW = Ogwu x Agwu, OGW x CLM= Ogwu x Clemson spineless, OGW x LD88 = Ogwu x LD88, OGW x UHIE = Ogwu x Uhie, UHIE x AGW = Uhie x Agwu, UHIE x CLM = Uhie x Clemson spineless, UHIE x LD88 = Uhie x LD88

Generational means of the agronomic, yield and yield component traits of selected parents and crosses used for the study.

The generational means of the agronomic, yield and yield component traits of selected parents and crosses (Table 13) showed that the cross, óUHIE x AGWô of BC_1 generation had significantly ($p < 0.05$) higher branch length (122.40 cm). It was statistically similar to óOGW x LD88ô (120.90 cm) and óOGW x UHIEô (113.70 cm) of BC_1 generation. It also showed higher number of branches/plant (5.67). óClemson spinelessô showed no number of branches/plant and branch length. óAGW x CLMô of the BC_2 generation had lower days to 50% flowering (47.15) and days to edible fruit maturity (48.94), although was statistically similar to óClemsonô in these traits. Similarly, the parent óClemsonô showed significantly ($p < 0.05$) lower days to flower bud initiation (21.60), days to first fruiting (44.70), number of fruits/plant (5.00), number of flowers/plant (1.67), stem girth (4.54) and total fruit yield/hectare (4.06 t/ha). It also showed no number of fruits/branch. On the other hand, ôEle Ogwuô parent showed significantly ($p < 0.05$) higher days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting and days to edible fruit maturity (7.33, 55.07, 91.28, 95.11, 92.28 and 100.56, respectively). óOGW x LD88ô of BC_1 generation had higher stem girth compared to others (7.99 cm). With exception of ôEle Ogwuô and óOGW x UHIEô of F_2 generation, days to 50% germination was similar in all the parents and generational crosses. The cross óUHIE x LD88ô of BC_1 had significantly ($p < 0.05$) higher number of branches/plant (7.67), number of fruits/branch (10.82), number of fruits/plant (42.97) and number of flowers/plant (8.69) and Total fruit yield/hectare (49.88 t/ha). The hybrid, óAGW x LD88ô of BC_1 showed significantly lower plant height at maturity (42.29 cm). It was statistically similar to óAgwu earlyô (42.92 cm). On the other hand, ôEle Uhieô showed significantly ($p < 0.05$) higher plant height at maturity (237.02 cm). It was statistically similar to the BC_1 generation of óUHIE x CLMô (222.40 cm) and BC_2 generation of óOGW x UHIEô (224.38 cm).

The generational means of fruit traits of crosses revealed that the cross, óUHIE x LD88ô of F_1 had significantly ($p < 0.05$) higher 100 seed weight (4.66 g). It was statistically similar to the cross óOGW x UHIEô of F_2 (4.41 g). It also had higher dry fruit weight (11.51 g) and number of ridges/pod (10.67). óOGW x AGWô of F_1 generation and the parents, óAgwu earlyô and ôEle Ogwuô had lower 100 seed weight, dry fruit weight and number of ridges/pod (3.41 g, 7.56 g and

5.00) respectively compared to others. óOGW x AGWô of F_1 also had lower number of seeds/pod (50.97). ðEle Uhieô parent had higher number of seeds/pod (106.59). The cross, óUHIE x CLMô of BC_2 had higher fruit length (15.92 cm). It was statistically similar to óUHIE x CLMô of BC_1 (13.81 cm), óCLM x LD88ô of BC_1 (12.73 cm) and óClemsonô parent (15.48 cm). ðEle Ogwuô had significantly ($p < 0.05$) lower value of 4.70 cm in fruit length. ðEle Uhieô showed higher fruit girth (11.92 cm). It was statistically similar to óOGW x UHIEô of BC_2 (10.23 cm). The cross, óUHIE x LD88ô had higher fruit weight (34.71 g). It was statistically similar to ðEle Uhieô (33.57 g), óUHIE x LD88ô of F_1 (32.56 cm), óUHIE x LD88ô of F_2 (30.77 g), óUHIE x LD88ô of BC_2 (30.23 g) and óUHIE x CLMô of BC_1 (30.07 g). The cross, óOGW x AGWô showed lower fruit weight (17.58 g) (Table 14).

Table 13: Means of agronomic, yield and yield component traits of parents, F_1, F_2, BC_1 and BC_2 of okra varieties studied.

Parents/Crosses	BL(cm)	D50%G	DBI	DA	D50%F	D1F	DFM	NoB/Pl
Parents								
AGW	18.10	4.00	22.25	45.59	48.33	46.59	51.35	1.00
CLM	0.00	4.00	21.50	43.70	47.35	44.70	49.45	0.00
LD-88	33.40	4.33	24.71	46.36	49.60	47.36	51.67	1.67
OGW	87.30	7.33	65.07	91.28	95.11	92.28	100.56	1.33
UHIE	76.30	5.67	57.85	82.32	84.05	83.28	91.36	2.00
F1								
AGW x CLM	29.30	4.17	22.05	48.21	51.11	49.20	53.28	1.43
AGW x LD88	42.60	4.00	25.27	52.23	55.10	53.23	57.56	1.67
CLM x LD88	62.10	4.33	22.55	49.14	51.52	50.13	54.51	1.33
OGW x AGW	83.50	4.17	36.22	62.22	65.20	63.22	68.43	3.33
OGW x CLM	59.20	4.00	38.81	63.88	67.85	64.87	70.04	2.00
OGW X LD88	102.80	4.67	35.95	61.33	65.10	62.40	67.59	5.47
OGW x UHIE	113.70	4.67	58.95	84.60	88.10	85.60	92.47	2.37
UHIE x AGW	67.60	4.17	33.50	59.96	63.85	60.96	66.11	3.90
UHIE x CLM	82.40	4.00	33.99	60.25	63.10	61.25	66.82	2.67
UHIE x LD88	80.50	4.00	36.07	61.92	64.25	62.92	68.15	7.00
F2								
AGW x CLM	35.50	4.00	22.13	45.72	48.90	46.72	51.63	1.80
AGW x LD88	31.10	4.00	24.22	48.87	52.22	49.87	54.88	3.43
CLM x LD88	40.40	4.00	22.22	44.77	48.10	45.77	50.66	1.33
OGW x AGW	70.90	4.33	40.85	68.50	71.31	69.50	75.56	3.67
OGW x CLM	87.30	4.00	36.13	67.97	71.10	68.97	75.68	2.00
OGW X LD88	75.30	4.67	38.98	64.90	67.35	65.90	73.25	4.84
OGW x UHIE	69.00	6.43	61.52	85.03	88.10	86.03	87.80	2.00
UHIE x AGW	75.10	4.00	37.73	63.35	67.10	64.35	70.54	3.77
UHIE x CLM	55.60	4.00	36.15	62.57	65.25	63.57	70.00	1.67
UHIE x LD88	83.70	5.00	37.62	61.58	63.90	62.58	68.96	4.38

Table 13 cont'd: Means of agronomic, yield and yield component traits of parents, F_1, F_2, BC_1 and BC_2 of okra varieties studied

Parents/crosses	BL(cm)	D50%G	DBI	DA	D50%F	D1F	DFM	NoB/Pl
BC1								
AGW x CLM	28.10	4.00	23.52	46.76	49.25	47.76	53.14	1.67
AGW x LD88	21.40	4.03	23.45	47.65	51.31	48.65	53.09	2.67
CLM x LD88	24.70	4.00	21.90	44.02	48.11	45.02	49.72	1.00
OGW x AGW	85.60	5.00	54.97	72.78	75.10	73.78	80.09	3.00
OGW x CLM	67.10	5.33	54.81	72.22	74.27	73.22	79.52	2.33
OGW X LD88	120.90	5.00	54.13	72.65	74.91	73.65	80.22	3.00
OGW x UHIE	103.70	5.33	62.08	84.12	87.30	85.12	93.42	2.67
UHIE x AGW	122.40	4.33	51.14	74.33	78.25	75.33	81.45	5.67
UHIE x CLM	93.00	5.00	50.78	74.63	78.44	75.63	82.35	1.67
UHIE x LD88	98.60	4.67	55.15	78.25	81.30	79.25	87.64	7.67
BC2								
AGW x CLM	23.60	4.00	21.76	43.77	47.15	44.44	48.94	0.67
AGW x LD88	27.30	4.00	22.12	46.78	49.20	47.78	52.29	3.57
CLM x LD88	31.10	4.00	24.22	45.64	48.30	46.64	50.80	2.33
OGW x AGW	55.70	4.33	32.62	58.20	61.11	59.20	64.67	3.00
OGW x CLM	60.10	4.67	30.27	53.76	57.15	54.76	59.65	1.00
OGW X LD88	70.10	4.00	30.03	55.38	58.40	56.38	61.46	4.67
OGW x UHIE	76.50	5.00	59.08	79.25	81.30	80.25	89.00	3.00
UHIE x AGW	67.80	4.00	28.14	55.28	58.44	55.28	60.56	3.00
UHIE x CLM	27.80	4.00	29.20	60.43	63.15	61.43	66.92	0.33
UHIE x LD88	84.10	4.00	29.93	55.86	58.47	56.86	62.01	3.33
F-LSD($p< 0.05$)	45.36	0.57	2.03	2.24	2.70	2.28	2.78	1.63

Where BL= Branch length, D50%G = Days to 50% germination, DBI = Days to flower bud initiation, DA = Days to anthesis, DIF = Days to first fruiting, DFM = Days to fruit maturity, NoB/Pl = Number of branches/plant, AGW = Agwu early, CLM = Clemson spineless, OGW = Ele Ogwu, AGW x CLM = Agwu x Clemson, AGW x LD88 = Agwu x LD88, CLM x LD88 = Clemson x LD88, OGW x AGW = Ele Ogwu x Agwu early, OGW x CLM = Ogwu x Clemson spineless, OGW x LD88 = Ogwu x LD88, OGW x UHIE = Ogwu x Uhie, UHIE x AGW = Uhie x Agwu, UHIE x CLM = Uhie x Clemson spineless, UHIE x LD88 = Uhie x LD88, F_1 = First filial generation, F_2 = Second filial generation, BC_1 = First backcross, BC_2 = Second Backcross, F-LSD = Fishersô Least square difference.

Table 13 cont'd: Means of agronomic, yield and yield component traits of parents, F_1, F_2, BC_1 and BC_2 of okra varieties studied

Parents/Crosses	NoF/B	NoF/Pl	NoFl/Pl	NoF/St	PHM(cm)	StG(cm)	TFY(t/ha)
Parents							
AGW	1.67	7.59	3.67	4.93	42.92	5.77	4.80
CLM	0.00	5.00	1.67	5.00	74.60	4.54	4.06
LD-88	2.33	9.17	3.67	5.47	59.30	5.55	8.47
OGW	2.90	18.08	2.00	12.25	203.61	7.92	13.54
UHIE	7.33	34.76	3.00	19.63	237.02	6.93	38.76
F1							
AGW x CLM	2.33	9.73	4.33	2.95	67.62	6.24	7.03
AGW x LD88	4.07	10.55	5.67	2.45	56.88	7.18	10.58
CLM x LD88	3.00	7.19	5.00	2.37	72.32	5.49	8.24
OGW x AGW	6.37	24.76	6.85	3.00	128.49	8.08	20.83
OGW x CLM	5.58	11.18	5.33	3.92	146.65	5.88	13.20
OGW X LD88	7.43	29.38	7.25	2.53	138.53	8.48	30.75
OGW x UHIE	7.63	26.01	6.63	13.81	214.85	6.78	25.61
UHIE x AGW	8.00	31.66	7.24	7.93	147.29	6.15	30.77
UHIE x CLM	5.50	16.32	7.64	11.72	179.54	5.28	17.30
UHIE x LD88	8.64	35.63	10.16	6.82	161.47	6.68	38.25
F2							
AGW x CLM	1.67	6.38	5.13	4.41	66.43	6.32	5.12
AGW x LD88	3.33	9.84	4.62	6.08	63.72	6.98	8.60
CLM x LD88	2.00	5.13	1.67	4.47	73.05	5.44	4.82
OGW x AGW	5.00	12.18	2.00	10.69	121.82	7.28	9.15
OGW x CLM	3.18	9.91	1.67	4.60	164.90	5.26	8.82
OGW X LD88	7.40	16.96	3.67	3.74	134.57	9.18	15.62
OGW x UHIE	4.00	27.69	3.67	15.18	219.42	7.10	25.77
UHIE x AGW	5.58	27.55	3.00	13.11	168.78	6.15	24.49
UHIE x CLM	3.41	19.61	6.85	6.73	188.02	5.04	19.02
UHIE x LD88	8.13	35.66	3.333	8.97	175.75	6.91	36.51

Table 13 cont'd: Means of agronomic, yield and yield component traits of parents, F_1, F_2, BC_1 and BC_2 of okra varieties studied

Parents/Crosses	NoF/B	NoF/Pl	NoFl/Pl	NoF/St	PHM(cm)	StG(cm)	TFY(t/ha)
BC1							
AGW x CLM	2.33	9.05	3.20	5.40	54.76	6.59	7.76
AGW x LD88	3.33	7.43	2.67	3.04	42.29	6.41	4.68
CLM x LD88	1.33	4.64	7.25	3.17	75.16	4.83	3.86
OGW x AGW	5.81	21.91	4.98	7.82	165.99	6.98	19.28
OGW x CLM	3.33	17.20	3.33	7.25	185.19	5.28	14.58
OGW X LD88	8.73	24.49	5.09	5.76	175.55	9.99	19.36
OGW x UHIE	5.77	32.38	5.33	17.09	210.32	6.36	28.33
UHIE x AGW	8.35	38.65	2.55	7.33	213.74	5.51	37.70
UHIE x CLM	4.37	27.32	8.63	4.24	222.40	5.03	27.70
UHIE x LD88	10.82	42.97	8.69	21.57	188.53	6.24	49.88
BC2							
AGW x CLM	1.33	4.58	3.33	3.19	72.19	5.23	3.57
AGW x LD88	4.90	8.56	4.00	0.83	63.55	7.25	7.86
CLM x LD88	3.43	8.23	4.33	2.90	65.28	5.46	6.77
OGW x AGW	3.97	17.99	4.67	8.47	102.55	5.06	10.51
OGW x CLM	2.00	10.40	5.18	8.07	127.52	4.82	9.12
OGW X LD88	6.85	18.83	7.77	2.30	114.23	7.80	17.43
OGW x UHIE	6.12	37.48	6.27	16.74	224.58	6.18	35.85
UHIE x AGW	5.79	18.48	4.97	3.84	120.91	4.72	14.56
UHIE x CLM	1.33	13.65	3.67	4.63	188.16	5.21	14.56
UHIE x LD88	7.89	27.41	5.33	12.49	142.05	7.34	27.65
F-LSD (p<0.05)	2.59	2.68	1.46	7.46	7.04	0.44	2.81

Where NoF/B = Number of fruits/branch, NoF/Pl = Number of fruits/plant, NoFl/Pl = Number of flowers/plant, NoF/St= Number of fruits/stem, PHM = Plant height at edible maturity, StG = Stem girth, TFY(t/Ha) = Total fruit yield (tonnes/ Hectare) AGW = Agwu early, CLM = Clemson spineless, OGW = Ele Ogwu, AGW x CLM = Agwu x Clemson, AGW x LD88 = Agwu x LD88, CLM x LD88 = Clemson x LD88, OGW x AGW = Ogwu x Agwu, OGW x CLM = Ogwu x Clemson spineless, OGW x LD88 = Ogwu x LD88, OGW x UHIE = Ogwu x Uhie, UHIE x AGW= Uhie x Agwu, UHIE x CLM = Uhie x Clemson spineless, UHIE x LD88 = Uhie x LD88, F_1 = First filial generation, F_2 = Second filial generation, BC_1 = First backcross, BC_2 = Second Backcross, F-LSD = Fishersô Least square difference at 5% probability level..

Table 14: Means of fruit traits of parents, F_1, F_2, BC_1 and BC_2 of okra varieties studied

Parents/Crosses	100 SW(g)	DrFW(g)	FG(cm)	FL(cm)	FW(g)	NoR/P	NoS/P
Parents							
AGW	3.99	7.56	6.68	6.27	18.96	6.67	50.97
CLM	3.93	8.72	5.18	15.48	24.37	6.33	68.09
LD-88	4.09	7.46	8.95	8.10	28.14	7.33	76.66
OGW	4.25	8.47	6.94	4.70	22.52	5.00	58.85
UHIE	4.43	8.73	11.92	11.39	33.57	9.00	106.59
F1							
AGW x CLM	4.10	7.78	7.00	8.85	25.30	6.33	70.97
AGW x LD88	3.88	7.77	7.23	6.73	26.42	9.00	78.46
CLM x LD88	3.82	8.44	6.07	10.14	27.98	7.00	73.63
OGW x AGW	3.41	7.99	6.56	5.40	24.73	7.00	54.92
OGW x CLM	3.76	7.23	6.17	8.89	32.01	6.00	65.27
OGW X LD88	3.69	7.22	6.91	6.41	31.31	8.33	71.32
OGW x UHIE	4.17	8.95	7.15	7.80	29.31	8.00	88.37
UHIE x AGW	3.88	9.36	8.12	8.92	29.30	9.00	83.12
UHIE x CLM	4.27	10.39	7.25	13.57	29.88	7.00	83.69
UHIE x LD88	4.66	11.51	8.50	11.17	32.56	10.67	87.82
F2							
AGW x CLM	3.93	8.05	6.83	9.73	23.63	6.00	58.61
AGW x LD88	3.93	8.55	8.50	6.86	26.04	9.67	66.75
CLM x LD88	4.03	8.72	6.18	15.02	28.06	6.00	70.95
OGW x AGW	3.83	9.32	6.43	4.98	22.80	6.33	58.72
OGW x CLM	3.91	8.70	6.45	7.87	26.70	7.00	66.61
OGW X LD88	3.96	10.61	7.27	6.42	27.67	9.00	68.85
OGW x UHIE	4.22	9.16	7.51	8.92	27.99	9.67	81.90
UHIE x AGW	4.08	8.72	8.15	8.48	26.76	6.00	71.94
UHIE x CLM	4.21	8.98	7.28	16.17	29.33	5.33	78.36
UHIE x LD88	4.28	7.24	8.55	12.20	30.77	6.17	79.46

Table 14 cont'd: Means of fruit traits of parents, F_1, F_2, BC_1 and BC_2 of okra varieties studied

Parents/Crosses	100SW(g)	DrFW(g)	FG(cm)	FL(cm)	FW(g)	NoR/P	NoS/P
BC1							
AGW x CLM	3.95	7.65	6.34	8.03	25.34	6.17	63.78
AGW x LD88	3.92	9.35	7.41	6.48	18.77	6.80	64.95
CLM x LD88	4.06	9.00	5.12	12.73	25.17	8.33	77.27
OGW x AGW	3.95	10.08	7.13	5.78	26.52	9.67	65.21
OGW x CLM	4.07	11.32	7.07	7.31	25.46	9.67	65.75
OGW X LD88	3.95	10.76	8.64	6.67	23.75	8.00	65.97
OGW x UHIE	4.18	9.59	7.29	6.28	26.10	8.67	83.11
UHIE x AGW	4.10	8.97	7.40	9.04	29.29	7.33	71.52
UHIE x CLM	4.13	12.86	7.05	13.81	30.07	10.67	79.39
UHIE x LD88	4.33	14.97	8.83	11.21	34.71	8.56	90.98
BC2							
AGW x CLM	4.12	8.42	6.16	10.59	23.23	7.00	70.20
AGW x LD88	3.94	8.50	7.06	8.12	27.62	6.00	74.96
CLM x LD88	4.16	9.45	6.42	9.90	24.52	9.33	79.85
OGW x AGW	3.92	9.07	7.80	6.45	17.58	7.67	58.50
OGW x CLM	4.12	9.91	6.12	10.65	26.44	8.00	71.53
OGW X LD88	4.03	12.07	8.68	9.23	27.77	11.33	75.76
OGW x UHIE	4.41	11.72	10.23	8.55	28.74	9.67	89.05
UHIE x AGW	3.91	11.25	6.84	7.26	23.67	8.00	67.22
UHIE x CLM	3.91	12.30	6.09	15.92	27.18	8.33	74.01
UHIE x LD88	4.15	12.36	8.96	9.34	30.23	10.00	83.15
F-LSD (p<0.05)	0.13	1.01	0.58	0.88	1.98	0.78	5.04

Where 100 SW = 100 Seed weight, DrFW = Dry fruit weight, FG = Fruit girth, FL = Fruit length, FW = Fruit weight, NoR/P = Number of ridges/fruit pod, NoS/P = Number of seeds/pod, AGW = Agwu early, CLM = Clemson spineless, OGW = Ele Ogwu, AGW x CLM = Agwu x Clemson, AGW x LD88 = Agwu x LD88, CLM x LD88 = Clemson x LD88, OGW x AGW = Ogwu x Agwu, OGW x CLM= Ogwu x Clemson spineless, OGW x LD88 = Ogwu x LD88, OGW x UHIE = Ogwu x Uhie, UHIE x AGW = Uhie x Agwu, UHIE x CLM = Uhie x Clemson spineless, UHIE x LD88 = Uhie x LD88, F_1 = First filial generation, F_2 = Second filial generation, BC_1 = First backcross, BC_2 = Second Backcross, F-LSD = FishersôLeast square difference at 5% probability level..

Estimates of the variance components, broad and narrow sense heritabilities in the crosses

The estimates of variance components, narrow sense and broad sense heritability in the segregating population for agronomic, yield and fruit characters (Tables 15-24) are expressed according to the crosses.

AGW x CLM

Days to 50% germination had higher Ve, Va, Vd, Vg and Vp (49.25, 88.57, 57.31, 195.13 and 145.88, respectively) than all the other traits. Number of fruits/branch had higher broad sense heritability (98.04%) and 100 seed weight had higher narrow sense heritability (67.11%). On the other hand, 100 seed weight had lower Ve, Va, Vd and Vp and Vg (0.02, 0.35, 1.07 and 1.44). It also had lower Vg (1.60). Days to first fruiting had lower broad sense heritability (55.01%) and narrow sense heritability (25.60%).

AGW x LD88

Days to edible fruit maturity had higher values in all the genetic components of interest studied except for Ve which had higher stem girth. 100 seed weight showed lower values in Ve (0.20), Va (0.004), Vd (0.85), Vp (1.05) and Vg (1.31). It also had lower broad sense heritability (37.22%). Days to 50% flowering had lower narrow sense heritability (32.15%). Number of fruits/stem had lower Ve (0.13). Number of branches/plant showed higher broad sense heritability (96.48%) while fruit girth had higher in narrow sense heritability (77.31%).

CLM x LD88

Fruit length had higher Ve (7.18), Va (15.97), Vd (28.12), Vp (51.27) and Vg (44.09). 100 seed weight had lower Ve, Va, Vd and Vp (0.002, 0.97, 0.006 and 0.98, respectively). Number of fruits/branch also had lower Vg (1.64). Broad sense heritability was higher in dry fruit weight (99.01%) and lower in 100 seed weight (34.87%). Higher narrow sense heritability was observed in branch length (62.49%) but lower in stem girth (21.01%).

OGW x AGW

Days to fruit maturity showed higher Ve (3.74), Va (20.35), Vd (21.24), Vp (45.32) and Vg (41.58). 100 seed weight had lower Ve, Va, Vd, Vp and Vg (0.13, 1.54, 2.43, 4.10 and 3.05,

respectively). It was statistically similar to plant height at maturity and dry fruit weight. Number of seeds/pod had lower broad sense heritability (57.12%). 100 seed weight had higher broad sense heritability (98.16%). Higher narrow sense heritability was observed in number of branches/plant (58.98%) while lower narrow sense heritability was observed in plant height at maturity (32.17%).

OGW x CLM

Higher values for all the genetic components studied was shown in days to anthesis except for environmental variance which had total higher fruit yield/ hectare (5.37). 100 seed weight showed lower Ve (0.26), Va (0.78), Vd (0.53), Vp (2.57) and Vg (2.31). Fruit weight had higher broad sense heritability (98.22%) while plant height at maturity had higher narrow sense heritability (68.33%). Broad sense heritability was lower for branch length (53.69%) while days to 50% germination had lower narrow sense heritability (23.45%).

OGW x LD88

Number of branches/plant showed higher values in all the genetic components studied except in environmental variance, which was higher in days to flower bud initiation. 100 seed weight had lower Ve (0.55), Va (1.05), Vd (1.42) and Vp (3.02). It was statistically similar to number of flowers/plant. Similarly, number of flowers/plant had lower Vg (0.60). Number of branches/plant also had higher broad sense heritability (99.72%), while branch length had lower broad sense heritability (34.80). Narrow sense heritability was higher in number of flowers/plant (77.19%) and lower in days to 50% germination (28.81%).

OGW x UHIE

Total fruit yield showed higher Ve (4.96), Va (38.57), Vd (36.55), Vp (86.07) and Vg (85.12). Lower values for all the genetic components was observed in 100 seed weight. Number of branches/plant had higher broad sense heritability (99.26%) while number of seeds/pod had higher narrow sense heritability (79.43%). Days to 50% germination had both lower broad and narrow sense heritabilities (51.86% and 27.06%).

UHIE x AGW

Days to edible fruit maturity had higher values in all the genetic components studied with exception to environmental variance which showed higher value in number of ridges/pod (4.10). 100 seed weight had lower values in all the genetic components studied. It was statistically similar to total fruit yield/hectare for Ve. On the other hand, total fruit yield had higher broad sense heritability (99.41%) while branch length had lower (47.21%). Higher narrow sense heritability was shown in number of fruits/stem (69.99%) while days to 50% germination gave lower narrow sense heritability (21.92%).

UHIE x CLM

With the exception of stem girth with higher Ve (6.32), fruit length had higher values in Va, Vd, Vp and Vg (5.21, 78.39, 80.31, 163.90 and 158.69, respectively). 100 seed weight had lower lower values in all the variance components studied. Broad sense heritability was higher in days to edible fruit maturity (97.96%) and lower in days to 50% germination (49.24%). Higher narrow sense heritability was shown in days to edible fruit maturity (68.19%) and lower in branch length (24.65%).

UHIE x LD88

Higher values in all the genetic components studied was observed in total fruit yield. 100 seed weight was observed to have lower values in Ve (0.19), Va (1.35), Vd (0.21), Vp (1.75) and Vg (2.57). It was statistically similar to days to edible fruit maturity in Ve. Higher broad sense heritability was shown in fruit weight (99.60%) but lower in days to 50% germination (39.23%). Higher narrow sense heritability was observed in branch length (63.04%) and lower in number of branches/plant (20.85%).

Table 15: Estimates of Variance Components, Broad and Narrow Sense Heritability of the cross AGW x CLM

TRAITS	Ve	Va	Vd	Vp	Vg	Hbs	Hns
BL	0.59	1.26	0.34	2.19	1.60	73.11	57.53
D50%G	49.25	88.57	57.31	195.13	145.88	74.76	45.39
DBI	2.64	1.59	1.84	6.07	3.43	76.56	26.27
DA	1.04	1.40	1.22	2.66	1.62	70.93	28.98
D50%F	1.25	1.75	2.55	3.55	2.10	71.80	29.55
D1F	3.81	1.82	2.84	8.46	4.66	75.01	25.60
DFM	2.20	1.69	2.83	6.71	4.52	77.29	33.45
FG	2.06	1.57	3.55	7.18	5.11	71.25	51.82
FL	1.17	3.58	2.51	6.26	6.10	97.31	57.17
FW	1.97	1.13	1.98	4.08	3.11	76.25	53.11
NoB/Pl	0.29	1.90	2.32	4.52	4.22	93.50	32.10
NoF/B	1.08	1.46	2.68	4.22	4.14	98.04	34.49
NoF/Pl	1.08	1.55	2.28	4.91	3.83	77.98	31.57
NoFl/Pl	1.48	4.85	6.56	11.89	11.41	96.00	40.81
NoF/St	1.59	3.21	7.54	12.40	10.55	82.26	47.31
NoR/P	2.30	3.99	5.39	11.68	9.38	80.32	54.14
PHM	2.85	3.84	4.03	10.72	7.87	73.43	35.84
StG	4.92	2.15	1.37	8.43	3.51	41.66	25.44
DrFW	2.26	5.05	6.01	13.31	11.06	83.05	67.93
NoS/P	1.39	0.97	1.35	3.71	2.32	62.51	56.17
100 SW	0.02	0.35	1.07	1.44	3.12	85.76	67.11
TFY(t/ha)	5.30	3.36	4.10	12.76	7.46	58.45	26.30

Where BL =Branch length, D50%G = Days to 50% germination, DBI = Days to bud initiation, DA = Days to anthesis, D50%F = Days to 50% flowering, D1F =Days to first flowering, DFM= Days to fruit maturity, FG = Fruit girth, FL = Fruit length, FW = Fruit weight, NoB/Pl = Number of branches/plant, NoF/B = Number of fruits/branch, NoF/Pl = Number of fruits/plant, NoFl/Pl = Number of flowers/plant, NoF/St=Number of fruits/stem, PHM = Plant height at maturity, StG = Stem girth, NoR/P = Number of ridges/pod, DrFW = Dry fruit weight, NoS/P = Number of seeds/pod, 100 SW = 100 Seed weight, TFY(t/ha) = Total fruit yield in tonnes/hectare,

Table 16: Estimates of variance components, broad and narrow sense heritability of the cross AGW x LD88

TRAITS	Ve	Va	Vd	Vp	Vg	Hbs	Hns
BL	1.19	2.18	0.26	3.63	2.44	67.16	60.12
D50%G	2.48	4.00	5.61	12.08	9.61	95.27	39.62
DBI	2.55	1.66	0.95	5.16	2.61	50.50	32.17
DA	5.00	0.78	2.71	8.48	3.49	41.10	39.15
D50%F	3.50	4.11	2.05	9.66	6.89	45.33	32.15
D1F	2.12	1.98	5.73	9.83	7.71	78.43	40.11
DFM	2.31	13.19	15.65	31.16	28.85	92.58	32.34
FG	2.07	1.78	2.67	6.51	4.45	68.26	77.31
FL	2.14	2.59	3.75	8.48	6.34	74.75	60.50
FW	0.83	8.70	6.25	15.77	14.95	94.75	55.12
NoB/Pl	0.40	4.18	6.83	11.41	11.01	96.48	46.65
NoF/B	2.35	3.84	4.19	10.38	8.03	77.35	46.98
NoF/Pl	0.65	1.43	2.43	4.51	3.86	85.59	31.69
NoFl/Pl	0.36	2.57	3.87	6.79	6.44	94.73	37.84
NoF/St	2.13	1.23	3.51	5.87	5.69	90.35	60.12
PHM	3.11	2.29	4.37	9.76	6.65	68.16	33.42
StG	5.89	2.66	1.79	10.35	4.46	83.05	65.71
NoR/P	4.29	2.46	3.84	10.59	6.30	89.47	73.21
DrFW	1.24	12.31	14.06	27.61	26.37	95.51	44.58
NoS/P	2.51	1.65	2.25	6.42	3.91	70.87	45.76
100 SW	0.20	0.004	0.85	1.05	1.31	37.22	32.98
TFY(t/Ha)	5.24	5.16	4.46	14.86	9.62	64.75	44.75

Where BL =Branch length, D50%G = Days to 50% germination, DBI = Days to bud initiation, DA = Days to anthesis, D50%F = Days to 50% flowering, D1F =Days to first flowering, DFM= Days to fruit maturity, FG = Fruit girth, FL = Fruit length, FW = Fruit weight, NoB/Pl = Number of branches/plant, NoF/B = Number of fruits/branch, NoF/Pl = Number of fruits/plant, NoFl/Pl = Number of flowers/plant, NoF/St=Number of fruits/stem, PHM = Plant height at maturity, StG = Stem girth, NoR/P = Number of ridges/pod, DrFW = Dry fruit weight, NoS/P = Number of seeds/pod, 100 SW = 100 Seed weight, TFY(t/ha) = Total fruit yield in tonnes/hectare

Table 17: Estimates of variance components, broad and narrow sense heritability of the cross CLM x LD88

TRAITS	Ve	Va	Vd	Vp	Vg	Hbs	Hns
BL	1.26	2.95	0.51	4.72	3.46	73.39	62.49
D50%G	0.65	5.94	9.30	15.9	15.25	95.90	37.39
DBI	1.65	1.14	2.23	5.02	3.37	67.16	22.71
DA	3.06	1.94	2.85	7.85	4.79	60.97	24.67
D50%F	3.11	2.05	2.85	8.01	7.45	55.66	36.14
D1F	1.26	2.29	1.65	5.20	3.94	75.76	44.06
DFM	5.48	6.29	6.47	18.23	12.76	69.96	34.47
FG	2.03	1.94	2.44	6.42	4.38	68.33	30.26
FL	7.18	15.97	28.12	51.27	44.09	86.00	61.15
FW	0.58	2.47	3.22	6.28	5.69	90.69	59.34
NoB/Pl	0.57	3.84	4.59	9.00	8.43	93.70	42.72
NoF/B	0.60	1.57	1.06	2.23	1.64	73.26	25.63
NoF/Pl	1.15	0.80	2.20	4.16	3.01	72.28	19.33
NoFl/Pl	0.50	3.02	4.39	7.91	7.41	93.71	38.21
NoF/St	1.12	1.71	1.96	4.78	4.02	88.57	41.45
PHM	0.76	1.77	3.46	5.99	5.23	87.29	41.52
StG	2.52	1.43	2.87	6.82	4.30	63.11	21.01
NoR/P	2.06	4.92	5.22	12.2	10.14	83.10	50.34
DrFW	0.12	6.63	5.13	11.88	11.77	99.01	55.81
NoS/P	2.60	1.47	2.68	6.76	4.16	61.52	44.75
100 SW	0.002	0.97	0.006	0.98	3.22	34.87	48.91
TFY(t/Ha)	7.16	2.93	2.97	13.06	5.9	45.18	47.52

Where BL =Branch length, D50%G = Days to 50% germination, DBI = Days to bud initiation, DA = Days to anthesis, D50%F = Days to 50% flowering, D1F =Days to first flowering, DFM= Days to fruit maturity, FG = Fruit girth, FL = Fruit length, FW = Fruit weight, NoB/Pl = Number of branches/plant, NoF/B = Number of fruits/branch, NoF/Pl = Number of fruits/plant, NoFl/Pl = Number of flowers/plant, NoF/St=Number of fruits/stem, PHM = Plant height at maturity, StG = Stem girth, NoR/P = Number of ridges/pod, DrFW = Dry fruit weight, NoS/P = Number of seeds/pod, 100 SW = 100 Seed weight, TFY(t/ha) = Total fruit yield in tonnes/hectare

Table 18: Estimates of variance components, broad and narrow sense heritability of the cross OGW x AGW

TRAITS	Ve	Va	Vd	Vp	Vg	Hbs	Hns
BL	2.84	12.07	23.39	38.30	35.46	92.58	35.52
D50%G	1.73	1.37	1.99	5.09	3.36	65.97	46.87
DBI	0.56	8.31	9.49	18.35	17.79	96.95	45.25
DA	0.78	7.49	6.15	14.41	13.63	94.58	51.93
D50%F	0.90	1.55	3.25	5.10	3.45	88.10	40.11
D1F	0.32	7.87	8.22	16.41	16.09	98.04	47.95
DFM	3.74	20.35	21.24	45.32	41.58	91.75	44.89
FG	0.42	3.25	2.20	5.87	5.45	92.83	45.29
FL	3.19	7.53	8.54	20.26	16.07	79.33	37.17
FW	0.97	2.52	3.86	7.36	6.38	86.78	34.25
NoB/Pl	0.62	3.62	5.05	9.30	8.67	93.30	58.98
NoF/B	1.29	2.07	3.87	7.22	5.93	82.18	58.65
NoF/Pl	2.61	3.79	2.73	9.12	6.52	71.42	51.52
NoFl/Pl	0.71	5.17	7.69	13.56	12.86	94.79	58.12
NoF/St	5.54	2.33	2.79	8.66	25.78	78.49	46.26
PHM	0.17	1.88	2.90	4.95	3.78	95.63	32.17
StG	2.98	5.66	7.21	15.84	12.86	81.20	55.72
NoR/P	1.16	1.29	1.50	3.94	2.79	70.69	32.72
DrFW	1.11	1.13	1.91	4.15	3.05	73.35	47.30
NoS/P	1.57	0.92	1.17	3.66	2.09	57.12	35.22
100 SW	0.13	1.54	2.43	4.10	6.96	68.16	55.76
TFY(t/ha)	1.51	8.21	9.46	19.18	17.67	92.12	52.81

Where BL =Branch length, D50%G = Days to 50% germination, DBI = Days to bud initiation, DA = Days to anthesis, D50%F = Days to 50% flowering, D1F =Days to first flowering, DFM= Days to fruit maturity, FG = Fruit girth, FL = Fruit length, FW = Fruit weight, NoB/Pl = Number of branches/plant, NoF/B = Number of fruits/branch, NoF/Pl = Number of fruits/plant, NoFl/Pl = Number of flowers/plant, NoF/St=Number of fruits/stem, PHM = Plant height at maturity, StG = Stem girth, NoR/P = Number of ridges / pod, DrFW = Dry fruit weight, NoS/P = Number of seeds/pod, 100 SW = 100 Seed weight, TFY(t/ha) = Total fruit yield in tonnes/hectare,

Table 19: Estimates of variance components, broad and narrow sense heritability of the cross OGW x CLM

TRAITS	Ve	Va	Vd	Vp	Vg	Hbs	Hns
BL	2.38	1.82	1.94	5.14	2.76	53.69	35.36
D50%G	3.41	1.75	2.30	7.45	4.04	54.28	23.45
DBI	0.97	6.61	8.86	16.44	15.47	94.13	50.21
DA	0.70	17.62	19.28	37.61	36.90	98.13	56.86
D50%F	0.85	14.33	15.71	33.45	30.15	86.35	53.15
D1F	1.61	1.31	2.41	5.32	3.71	69.76	54.53
DFM	2.46	1.98	2.85	7.29	4.83	66.23	57.31
FG	1.16	1.57	2.96	5.68	4.53	79.61	27.56
FL	0.33	0.80	1.30	3.03	1.80	88.60	64.69
FW	0.29	7.74	8.46	16.50	16.20	98.22	56.92
NoB/Pl	0.41	4.70	2.80	7.91	7.50	94.84	49.43
NoF/B	1.01	1.97	2.27	5.25	4.24	80.84	37.50
NoF/Pl	1.96	6.33	8.35	16.64	14.68	88.23	48.03
NoFl/Pl	0.42	2.65	2.99	6.07	5.65	93.06	43.73
NoF/St	0.26	3.77	11.34	15.77	20.56	91.22	52.56
PHM	1.00	1.49	2.76	5.25	4.24	80.91	68.33
StG	1.51	4.96	8.14	14.61	13.10	89.66	33.97
NoR/P	1.06	2.02	3.53	6.61	5.55	83.93	50.57
DrFW	1.05	1.15	1.85	4.05	2.99	74.00	58.37
NoS/P	2.52	2.18	2.34	7.04	4.52	64.25	41.01
100 SW	0.26	0.78	0.53	2.57	2.31	69.80	30.47
TFY(t/ha)	5.37	11.19	11.34	27.90	22.53	80.77	40.11

Where BL =Branch length, D50%G = Days to 50% germination, DBI = Days to bud initiation, DA = Days to anthesis, D50%F = Days to 50% flowering, D1F =Days to first flowering, DFM= Days to fruit maturity, FG = Fruit girth, FL = Fruit length, FW = Fruit weight, NoB/Pl = Number of branches/plant, NoF/B = Number of fruits/branch, NoF/Pl = Number of fruits/plant, NoFl/Pl = Number of flowers/plant, NoF/St=Number of fruits/stem, PHM = Plant height at maturity, StG = Stem girth, NoR/P = Number of ridges/pod, DrFW = Dry fruit weight, NoS/P = Number of seeds/pod, 100 SW = 100 Seed weight, TFY(t/ha) = Total fruit yield in tonnes/hectare

Table 20: Estimates of variance components, broad and narrow sense heritability of the cross OGW x LD88

TRAITS	Ve	Va	Vd	Vp	Vg	Hbs	Hns
BL	3.79	1.85	0.67	5.82	2.02	34.80	31.84
D50%G	2.29	1.19	2.84	6.32	4.03	63.72	28.81
DBI	5.33	46.79	47.32	99.44	94.11	94.64	47.05
DA	1.21	4.63	4.23	9.07	8.86	97.64	50.97
D50%F	1.05	2.35	2.11	6.05	5.33	90.77	52.35
D1F	1.30	7.92	9.65	18.87	17.57	93.10	51.96
DFM	0.63	3.89	4.13	8.64	8.01	92.73	55.00
FG	1.29	1.10	3.51	4.90	4.62	94.11	62.48
FL	3.01	2.88	3.29	9.18	6.17	67.22	31.34
FW	1.50	25.33	21.74	48.58	47.08	96.91	72.15
NoB/Pl	0.82	55.44	58.08	113.84	113.52	99.72	68.70
NoF/B	0.65	1.53	2.67	4.41	4.19	95.14	74.63
NoF/Pl	1.39	6.73	9.70	16.82	16.43	97.68	69.99
NoFl/Pl	0.65	1.23	2.37	4.84	0.60	70.91	77.19
NoF/St	0.93	1.49	2.77	3.39	4.26	91.57	71.66
PHM	3.95	2.26	3.84	10.05	6.10	60.66	42.48
StG	5.33	7.48	8.33	21.14	15.82	84.80	75.40
NoR/P	1.15	1.28	2.16	5.59	2.44	88.03	55.81
DrFW	2.02	2.09	2.56	6.67	4.65	79.67	51.36
NoS/P	1.37	1.72	1.77	4.86	3.49	71.80	55.38
100 SW	0.55	1.05	1.42	3.02	2.66	62.89	68.80
TFY(t/Ha)	2.15	54.41	50.45	107.01	104.86	97.99	70.85

Where BL =Branch length, D50%G = Days to 50% germination, DBI = Days to bud initiation, DA = Days to anthesis, D50%F = Days to 50% flowering, D1F =Days to first flowering, DFM= Days to fruit maturity, FG = Fruit girth, FL = Fruit length, FW = Fruit weight, NoB/Pl = Number of branches/plant, NoF/B = Number of fruits/branch, NoF/Pl = Number of fruits/plant, NoFl/Pl = Number of flowers/plant, NoF/St=Number of fruits/stem, PHM = Plant height at maturity, StG = Stem girth, NoR/P = Number of ridges/pod, DrFW = Dry fruit weight, NoS/P = Number of seeds/pod, 100 SW = 100 Seed weight, TFY(t/ha) = Total fruit yield in tonnes/hectare

Table 21: Estimates of variance components, broad and narrow sense heritability of the cross OGW x UHIE

TRAITS	Ve	Va	Vd	Vp	Vg	Hbs	Hns
BL	2.60	11.80	11.29	25.69	23.09	89.89	45.94
D50%G	1.16	0.65	0.60	2.40	1.25	51.86	27.06
DBI	2.56	12.54	10.66	25.76	23.20	90.07	48.68
DA	0.25	3.97	4.51	8.73	8.48	97.13	45.46
D50%F	1.15	3.25	3.98	8.38	6.83	93.48	42.18
D1F	1.29	8.74	6.52	16.55	15.26	92.21	32.80
DFM	1.17	4.98	5.37	11.52	10.35	98.96	49.31
FG	0.55	0.78	1.23	3.16	1.61	84.69	67.66
FL	4.25	26.97	29.93	61.16	56.90	93.05	74.10
FW	0.57	3.56	3.81	7.94	7.37	92.87	74.87
NoB/Pl	0.20	15.11	11.62	26.93	26.73	99.26	66.11
NoF/B	0.31	12.83	15.36	28.50	28.19	98.90	55.01
NoF/Pl	0.58	1.52	1.23	3.33	2.75	82.49	65.51
NoFl/Pl	1.26	5.43	5.88	12.57	11.31	90.01	63.22
NoF/St	4.21	13.27	15.00	32.49	30.34	88.47	50.37
PHM	2.78	2.41	3.28	8.46	5.69	67.19	68.44
StG	8.33	6.21	7.12	21.66	13.33	61.55	68.68
NoR/P	3.08	2.70	2.81	8.59	5.50	64.09	61.41
DrFW	1.04	1.11	1.30	3.45	2.41	69.95	62.16
NoS/P	1.85	3.88	4.11	9.84	7.99	91.22	79.43
100 SW	0.16	0.23	0.65	1.05	0.89	64.95	62.30
TFY(t/Ha)	4.96	38.57	36.55	86.07	85.12	94.06	53.33

Where BL =Branch length, D50%G = Days to 50% germination, DBI = Days to bud initiation, DA = Days to anthesis, D50%F = Days to 50% flowering, D1F =Days to first flowering, DFM= Days to fruit maturity, FG = Fruit girth, FL = Fruit length, FW = Fruit weight, NoB/Pl = Number of branches/plant, NoF/B = Number of fruits/branch, NoF/Pl = Number of fruits/plant, NoFl/Pl = Number of flowers/plant, NoF/St=Number of fruits/stem, PHM = Plant height at maturity, StG = Stem girth, NoR/P = Number of ridges/pod, DrFW = Dry fruit weight, NoS/P = Number of seeds/pod, 100 SW = 100 Seed weight, TFY(t/ha) = Total fruit yield in tonnes/hectare

Table 22: Estimates of variance components, broad and narrow sense heritability of the cross UHIE x AGW

TRAITS	Ve	Va	Vd	Vp	Vg	Hbs	Hns
BL	3.81	2.74	1.67	7.21	3.41	47.21	37.94
D50%G	3.18	1.64	2.72	7.53	4.36	57.84	21.72
DBI	1.63	26.32	26.76	54.71	53.08	97.02	48.10
DA	0.54	4.36	5.34	10.24	9.70	94.75	42.59
D50%F	0.95	3.88	6.10	10.93	8.45	91.35	52.42
D1F	0.78	4.83	5.23	10.84	10.06	92.83	54.60
DFM	3.33	67.03	67.29	137.65	134.32	97.58	68.70
FG	1.52	5.20	6.67	13.39	11.87	88.68	38.87
FL	4.08	3.79	3.48	11.35	7.27	64.09	33.43
FW	0.39	8.52	9.95	18.85	18.46	97.94	55.18
NoB/Pl	0.33	3.26	5.93	9.52	9.19	96.55	54.26
NoF/B	0.25	2.86	2.98	6.09	5.84	95.89	56.94
NoF/Pl	0.58	2.62	3.83	7.03	6.45	91.69	57.26
NoFl/Pl	2.15	6.41	8.40	16.95	14.81	87.34	57.80
NoF/St	0.67	64.88	48.49	12.25	88.58	77.86	69.99
PHM	2.29	1.32	1.24	4.85	2.56	52.84	27.29
StG	3.08	6.77	9.47	19.32	16.24	84.05	45.05
NoR/P	4.10	2.06	3.36	9.52	5.42	56.94	41.62
DrFW	2.02	1.44	1.63	5.08	3.07	60.32	48.24
NoS/P	1.64	3.37	1.64	6.64	5.00	75.30	50.67
100 SW	0.40	1.22	0.79	2.40	2.00	63.29	50.60
TFY(t/ha)	0.10	8.18	9.07	17.35	17.25	99.41	57.16

Where BL =Branch length, D50%G = Days to 50% germination, DBI = Days to bud initiation, DA = Days to anthesis, D50%F = Days to 50% flowering, D1F =Days to first flowering, DFM= Days to fruit maturity, FG = Fruit girth, FL = Fruit length, FW = Fruit weight, NoB/Pl = Number of branches/plant, NoF/B = Number of fruits/branch, NoF/Pl = Number of fruits/plant, NoFl/Pl = Number of flowers/plant, NoF/St=Number of fruits/stem, PHM = Plant height at maturity, StG = Stem girth, NoR/P = Number of ridges/pod, DrFW = Dry fruit weight, NoS/P = Number of seeds/pod, 100 SW = 100 Seed weight, TFY(t/ha) = Total fruit yield in tonnes/hectare

Table 23: Estimates of Variance Components, Broad and Narrow Sense Heritability of the cross UHIE x CLM

TRAITS	Ve	Va	Vd	Vp	Vg	Hbs	Hns
BL	1.69	5.30	14.50	21.49	19.80	92.14	24.65
D50%G	2.17	0.64	1.46	2.27	2.10	49.24	54.97
DBI	1.07	11.21	13.81	26.09	25.02	95.89	62.96
DA	0.88	13.81	15.02	29.70	28.83	97.05	66.50
D50%F	1.12	10.37	13.42	24.91	23.68	95.62	61.51
D1F	0.68	4.32	4.75	9.75	9.07	93.06	54.36
DFM	2.50	58.88	60.82	122.20	119.70	97.96	68.19
FG	0.23	1.17	2.83	4.22	4.00	94.59	57.64
FL	5.21	78.39	80.31	163.90	158.69	96.82	47.83
FW	0.51	1.06	1.80	3.37	2.86	84.80	51.42
NoB/Pl	1.21	6.97	7.26	15.43	14.23	92.20	55.15
NoF/B	1.23	1.32	3.37	5.92	4.69	79.21	52.30
NoF/Pl	0.66	7.25	9.86	17.77	17.11	96.28	60.80
NoFl/Pl	3.16	28.67	29.70	61.53	58.37	94.86	46.59
NoF/St	3.28	5.12	8.20	22.89	5.39	85.70	37.37
PHM	2.28	2.37	2.54	7.19	4.91	68.27	32.95
StG	6.32	3.34	7.35	17.01	10.69	62.85	39.65
NoR/P	2.89	1.61	2.85	7.36	4.47	60.72	51.95
DrFW	1.04	1.78	2.48	5.31	4.27	80.38	43.60
NoS/P	1.65	3.83	2.27	7.74	6.10	78.74	49.45
100 SW	0.34	0.84	0.08	1.26	5.67	64.31	47.27
TFY(t/ha)	1.28	4.26	4.76	10.29	9.02	87.60	41.38

Where BL =Branch length, D50%G = Days to 50% germination, DBI = Days to bud initiation, DA = Days to anthesis, D50%F = Days to 50% flowering, D1F =Days to first flowering, DFM= Days to fruit maturity, FG = Fruit girth, FL = Fruit length, FW = Fruit weight, NoB/Pl = Number of branches/plant, NoF/B = Number of fruits/branch, NoF/Pl = Number of fruits/plant, NoFl/Pl = Number of flowers/plant, NoF/St=Number of fruits/stem, PHM = Plant height at maturity, StG = Stem girth, NoR/P = Number of ridges/pod, DrFW = Dry fruit weight, NoS/P = Number of seeds/pod, 100 SW = 100 Seed weight, TFY(t/ha) = Total fruit yield in tonnes/hectare

Table 24: Estimates of variance components, broad and narrow sense heritability of the cross UHIE x LD88

TRAITS	Ve	Va	Vd	Vp	Vg	Hbs	Hns
BL	3.91	13.04	3.73	20.69	16.77	81.08	63.04
D50%G	5.17	2.12	1.22	8.50	3.34	39.23	24.90
DBI	0.99	8.62	10.83	20.43	19.45	95.18	42.19
DA	0.51	5.59	8.03	14.13	13.62	96.41	39.59
D50%F	0.62	6.11	7.58	14.31	12.68	88.45	58.71
D1F	0.58	51.93	53.25	105.76	105.18	99.45	49.10
DFM	1.02	5.45	3.60	9.18	9.05	98.66	59.41
FG	1.76	9.13	7.48	18.37	16.61	90.44	49.70
FL	4.52	23.30	17.30	41.12	40.59	98.73	56.66
FW	0.66	83.73	80.31	164.70	164.04	99.60	50.84
NoB/Pl	1.15	0.60	1.12	2.87	1.72	60.01	20.85
NoF/B	1.29	6.35	6.61	13.25	12.96	97.82	47.91
NoF/Pl	3.29	1.40	2.01	3.70	3.41	92.19	37.86
NoFl/Pl	5.33	35.19	36.63	77.16	71.82	93.09	45.61
NoF/St	2.33	5.73	18.46	26.52	48.27	85.71	52.34
PHM	5.45	2.18	2.22	9.85	4.40	44.64	22.16
StG	7.31	4.87	9.86	22.04	14.73	66.84	52.11
NoR/P	2.21	1.62	1.54	5.36	3.15	58.86	60.13
DrFW	2.03	1.71	1.29	5.03	3.00	59.69	43.96
NoS/P	3.00	4.58	3.04	10.62	7.62	71.74	43.15
100 SW	0.19	1.35	0.21	1.75	2.57	68.35	36.07
TFY(t/Ha)	10.52	108.13	110.03	228.68	218.16	95.40	57.28

Where BL =Branch length, D50%G = Days to 50% germination, DBI = Days to bud initiation, DA = Days to anthesis, D50%F = Days to 50% flowering, D1F =Days to first flowering, DFM= Days to fruit maturity, FG = Fruit girth, FL = Fruit length, FW = Fruit weight, NoB/Pl = Number of branches/plant, NoF/B = Number of fruits/branch, NoF/Pl = Number of fruits/plant, NoFl/Pl = Number of flowers/ plant, NoF/St=Number of fruits/stem, PHM = Plant height at maturity, StG = Stem girth, NoR/P = Number of ridges/pod, DrFW = Dry fruit weight, NoS/P = Number of seeds/pod, 100 SW = 100 Seed weight, TFY(t/ha) = Total fruit yield in tonnes/hectare

Variance Components of General Combining Ability (GCA) And Specific Combining Ability (SCA) of the Okra Traits studied

The result in Table 25 shows the mean square performance of parental accessions and their hybrids. Mean squares of the genotypes were partitioned into GCA and SCA. Analysis of variance for combining ability of the agronomic, yield and yield component traits the okra genotypes showed a significant ($p < 0.05$) GCA variance in all the traits studied. Significant SCA variance was observed in all the traits with the exception of days to 50% germination (0.59), number of flowers/plant (0.19) and stem girth (0.18). For GCA/SCA ratio greater than one, additive gene effect was dominant in magnitude in all the traits studied except in days to flower bud initiation (0.84), days to anthesis (0.21), days to 50% flowering (58.34), days to first fruiting (0.03), days to fruit maturity (0.69) and plant height at maturity (0.99) which exhibited predominance of non-additive gene effect.

The analysis of variance for combining ability for fruit traits of okra studied showed non-significant ($p < 0.05$) GCA and SCA effect in 100 seed weight and number of ridges / pod (Table 26). Fruit girth had non-significant SCA variance. The GCA/SCA ratio showed that additive gene effect was predominant in all the fruit traits studied with the exception of 100 seed weight and number of seeds / pod.

Table 25: Analysis of variance for combining ability of agronomic, yield and yield component traits of F_1 Okra hybrids used for the study

		Mean squares														
SoV	**df**	**BL**	**D50%G**	**DBI**	**DA**	**D50%F**	**D1F**	**DFM**	**NoB/P**	**NoF/B**	**NoF/Pl**	**NoFl/Pl**	**NoF/St**	**PHM**	**StG**	**TFY(t/Ha)**
GCA	**4**	691.27*	9.13*	33.84*	54.83*	58.34*	74.12*	62.06*	29.66*	44.17*	188.44*	51.80*	55.06*	1257.66*	1.41	173.95*
SCA	**10**	223.96*	0.59	11.17*	11.86*	14.37*	11.92*	15.88*	9.61*	13.05*	35.81*	0.19	3.60*	585.12*	0.18	50.32*
ERROR	**40**	66.97	1.81	1.68	3.65	3.89	3.7	3.32	7.22	3.48	22.06	3.71	61.58	176.93	0.69	31.72
GCA/SCA RATIO		2.75	0.68	0.84	0.21	0.27	0.03	0.69	7.90	6.58	2.99	4.37	3.42	0.99	5.97	4.53

Where SoV= sources of variation, df = degree of freedom, BL= Branch length, D50%G= Days to 50% germination, DBI= Days to flower bud initiation,DA= Days to anthesis, D50%F = Days to 50% flowering, DIF= Days to first fruiting, DFM= Days to fruit maturity, , NoB/Pl= Number of branches/plant, NoF/B= Number of fruits/branch, NoF/Pl= Number of fruits/plant, NoFl/Pl= Number of flowers/plant, NoF/St= Number of fruits/stem, PHM= Plant height at edible maturity, StG= Stem girth, TFY(t/Ha)= Total fruit yield (tones/ Hectare)

Table 26: Analysis of variance for combining ability of fruit traits of F_1 Okra hybrids used for the study

		Mean squares						
SoV	**Df**	**100 SW**	**DrFW**	**FG**	**FL**	**FW**	**NoR/P**	**NoS/P**
GCA	**4**	0.80	8.66*	65.60*	82.91*	250.84*	2.93	704.60*
SCA	**10**	0.10	6.14*	2.65	25.73*	37.08*	1.93	60.20*
ERROR	**40**	0.15	5.88	2.07	1.86	14.69	0.96	8.25
GCA/SCA RATIO		0.86	1.64	4.23	0.11	7.37	3.28	0.74

Where SoV= sources of variation, df= degree of freedom, 100 SW= 100 seed weight, DrFW= Dry fruit weight, FG= Fruit girth, FL= Fruit length, FW= Fruit weight, NoR/P= Number of ridges / fruit pod, NoS/P= Number of seeds / fruit pod

Estimates of General combining ability of the parental accessions of okra

The general combining ability (GCA) of the agronomic, yield and yield component traits of the parental accessions of okra studied (Table 27) showed that óClemson spinelessô parent (g_2) had lower GCA effect in branch length (-18.33), days to anthesis (-7.46), days to fruit maturity (-8.43), number of branches/plant (-0.95), number of fruits/branch (-1.81), number of fruits/plant (-8.20), number of flowers/plant (-1.97), stem girth (-0.98), number of fruits/stem (-2.20) and total fruit yield (-7.46). óAgwu earlyô (g_1) had lower GCA effect in days to 50% flowering (-7.84). õEle Ogwuô parent (g_4) had higher GCA effect in branch length (20.19), days to 50% germination (0.63), days to flower bud initiation (12.42), days to anthesis (12.24), days to 50% flowering (13.05), days to first fruiting (12.24), days to fruit maturity (12.90) and stem girth (0.96). It was observed that the GCA effect of õEle Uhieô (g_5) parent was higher in number of branches/plant (0.65), number of fruits/branch (2.01), number of fruits/plant (9.26), number of flowers/plant (2.37), number of fruits/stem (3.75), plant height at maturity (58.31) and total fruit yield (9.97) than all the parents. õLD88ô (g_3) had lower days to first fruiting (-6.67). Significantly lower GCA value was observed in óAgwuô (g_1) parent in days to 50% germination (-0.41) and days to flower bud initiation (-7.24).

GCA estimates of the fruit traits of the Okra genotypes studied (Table 28) showed a higher GCA effect for õEle Uhieô (g_5) parent in 100 seed weight (0.53), dry fruit weight (1.31), fruit girth (1.37), fruit weight (2.45), number of ridges/pod (1.37) and number of seeds/pod (14.10). õEle Ogwuô (g_4) gave lower GCA effect in 100 seed weight, dry fruit weight, fruit girth, fruit length and number of seeds/pod. Higher GCA effect was observed in óClemsonô (g_2) for fruit length (2.68). óAgwuô (g_1) and óClemson spinelessô (g_2) parents had lower GCA effects in fruit weight and number of ridges/pod (-2.66 and -1.25) respectively.

Table 27: General combining ability estimates of agronomic, yield and yield component traits of F_1 okra hybrids used for the study

GCA	BL	D50%G	DBI	DA	D50%F	D1F	DFM	NoB/P	NoF/B	NoF/Pl	NoFl/Pl	NoF/St	PHM	StG	TFY(t/Ha)
g_1	-16.01	-0.41	-7.24	-7.29	-7.84	-7.29	-8.29	-0.34	-0.95	-2.57	-0.53	0.24	-41.81	-0.03	-3.61
g_2	-18.33	-0.32	-7.18	-7.46	-7.56	-7.46	-8.43	-0.95	-1.81	-8.2	-1.97	-2.2	-22.69	-0.98	-7.46
g_3	-3.24	-0.34	-6.82	-6.69	-6.85	-6.69	-7.7	0.58	0.51	0.91	0.18	-1.42	-32.11	-0.01	0.16
g_4	20.19	0.63	12.42	12.24	13.05	12.24	12.9	0.06	1.26	2.41	-0.06	-0.38	38.3	0.96	1.26
g_5	17.39	0.44	8.82	9.2	9.35	9.2	11.52	0.65	2.01	9.26	2.37	3.75	58.31	0.06	9.97
SE	18.06	0.27	0.67	0.88	0.91	0.87	0.99	0.75	1.13	1.35	0.51	2.27	3.86	0.19	1.23
CD (5%)	117.15	2.22	6.30	8.00	8.11	8.01	9.36	4.42	3.07	7.73	3.17	12.91	21.89	1.37	9.27

Where; BL= Branch length, D50%G= Days to 50% germination, DBI= Days to flower bud initiation,DA= Days to anthesis, D50%F = Days to 50% flowering, DIF= Days to first fruiting, DFM= Days to fruit maturity, NoB/Pl= Number of branches/plant, NoF/B= Number of fruits/branch, NoF/Pl= Number of fruits/plant, NoFl/Pl= Number of flowers/plant, NoF/St= Number of fruits/stem, PHM= Plant height at edible maturity, StG= Stem girth, TFY(t/Ha)= Total fruit yield (tonnes/ Hectare) GCA= general combining ability, SE= standard error, CD= critical difference at 5%, g1=Agwu, g2= Clemson spineless, g3= LD88, g4= Ele Ogwu, g5= Ele Uhie.

Table 28: General combining ability estimates of fruit traits of F_1 Okra hybrids used for the study

GCA	100 SW	DrFW	FG	FL	FW	NoR/P	NoS/P
g_1	-0.16	-0.45	-0.20	-1.85	-2.66	-0.44	-4.31
g_2	-0.11	-0.26	-0.90	2.68	-0.15	-1.25	-3.18
g_3	0.07	0.06	0.44	-0.24	0.95	1.04	2.94
g_4	-0.34	0.65	0.71	-2.32	0.60	-0.72	-9.55
g_5	0.53	1.31	1.37	1.73	2.45	1.37	14.10
SE	0.18	0.67	1.06	0.59	1.83	0.23	2.74
CD(5%)	0.64	3.99	2.37	2.26	6.31	2.30	14.93

Where; 100 SW= 100 seed weight, DrFW= Dry fruit weight, FG= Fruit girth, FL= Fruit length, FW= Fruit weight, NoR/P= Number of ridges/fruit pod, NoS/P= Number of seeds/fruit pod, GCA= general combining ability, SE= standard error, CD = critical difference at 5%, g1 = Agwu, g2 = Clemson spineless, g3 = LD88, g4 = Ele Ogwu, g5 = Ele Uhie

Estimates of specific combining ability of the okra hybrids used for the study

The specific combining ability (SCA) effects of the agronomic, yield and yield component traits of the okra hybrids showed that the cross óAGW x CLMô (s_{12}) had significantly ($p < 0.05$) higher SCA effect in days to 50% germination (0.88), days to flower bud initiation (4.30), days to anthesis (8.24), days to 50% flowering (8.35), days to first fruiting (8.38), days to fruit maturity (9.36) and stem girth (2.03) (Table 29). The cross óAGW x LD88ô (s_{13}) had negative SCA effect in all the attributes studied. The hybrid õUHIE x LD88ô (s_{45}) had higher SCA in number of branches/plant (3.31), number of fruits/branch (0.74), number of fruits/plant (9.34), number of flowers/plant (2.53) and total fruit yield/hectare (10.26). Higher SCA effect was observed in the cross õUHIE x CLMô (s_{35}) for branch length and plant height at maturity (19.19 and 14.42, respectively). The hybrid, óOGW x AGWô (s_{15}) had positive SCA effect in number of fruits/stem (2.03).

The specific combining ability effect for fruit traits of okra studied (Table 30) showed that the cross óAGW x LD88ô (s_{13}) had lower SCA effect in 100 seed weight, dry fruit weight, fruit girth, fruit length, fruit weight, number of ridges/pod and number of seeds/pod (-5.68, -12.52, -10.85, -13.12, -36.99, -10.38 and -104.39, respectively). The hybrid, õUHIE x LD88ô (s_{45}) had significantly ($p < 0.05$) higher SCA in dry fruit weight (1.63), fruit length (0.64) and number of ridges/pod (0.52). Higher SCA was observed in the hybrid óAGW x CLMô (s_{12}) in 100 seed weight and fruit girth. The hybrids, óOGW x CLMô (s_{23}) and óOGW x UHIEô (s_{25}) had higher SCA effect in fruit weight and number of seeds/pod (4.77 and 7.96, respectively)

Table 29: Specific combining ability effects of the agronomic, yield and yield component traits of the okra hybrids used for the study

SCA	BL	D50%G	DBI	DA	D50%F	D1F	DFM	NoB/P	NoF/B	NoF/Pl	NoFl/Pl	NoF/St	PHM	StG	TFY(t/Ha)
S_{12}	2.42	0.88	4.30	8.24	8.35	8.38	9.36	0.35	0.07	0.88	0.38	0.55	4.97	1.46	0.72
S_{13}	-93.93	-6.33	-46.74	-82.36	-83.44	-83.80	-91.09	-4.53	-6.16	-29.53	-8.32	-8.02	-183.7	-8.45	-26.95
S_{14}	19.52	0.43	1.11	2.11	2.56	2.10	2.84	-0.76	-0.08	-1.64	-1.29	0.99	-2.38	0.03	-2.32
S_{15}	15.18	-0.62	-4.41	-3.91	-4.05	-3.91	-3.97	1.16	0.66	6.99	2.36	2.03	2.50	0.69	4.99
S_{23}	-6.81	-0.88	-1.87	-2.08	-2.15	-2.09	-2.23	0.43	0.73	-0.97	0.29	-0.77	1.54	-0.55	1.22
S_{24}	21.7	-0.19	-5.09	-5.39	-5.45	-5.34	-5.41	2.37	1.28	9.94	2.05	-1.09	2.84	1.07	9.47
S_{25}	11.98	-0.97	2.26	1.98	2.10	1.98	0.26	-0.8	-1.04	-3.60	-0.77	-2.00	-11.26	-0.69	-3.81
S_{34}	2.08	-0.42	-3.53	-3.13	-3.20	-3.13	-4.91	1.14	0.54	7.04	0.32	1.44	1.29	-0.33	6.22
S_{35}	19.19	-0.69	-3.09	-2.68	-2.85	-2.67	-4.06	0.51	-0.1	-2.68	0.16	-2.91	14.42	-0.24	-3.40
S_{45}	2.20	-0.66	-1.37	-1.77	-1.91	-1.77	-3.46	3.31	0.74	9.34	2.53	-4.14	5.77	0.18	10.26
SE	19.02	0.36	1.02	1.30	1.35	1.30	1.52	0.72	0.50	1.26	0.52	2.26	3.56	0.22	1.51
CD (5%)	286.95	5.43	15.44	19.6	20.05	19.63	22.92	10.83	7.52	18.93	7.77	31.63	53.62	3.36	22.70

Where; BL= Branch length, D50%G= Days to 50% germination, DBI= Days to flower bud initiation,DA= Days to anthesis, D50%F = Days to 50% flowering, DIF= Days to first fruiting, DFM= Days to fruit maturity, NoB/Pl= Number of branches/plant, NoF/B= Number of fruits/branch, NoF/Pl= Number of fruits/plant, NoFl/Pl= Number of flowers/plant, NoF/St= Number of fruits/stem, PHM= Plant height at edible maturity, StG= Stem girth, TFY(t/Ha)= Total fruit yield (tones/ Hectare), SCA= specific combining ability, SE= standard error, CD= critical difference at 5%, S_{12}=Agwu x Clemson, S_{13}= Agwu x LD88, S_{14}= Clemson x LD88, S_{15}= Ogwu x Agwu, S_{23}= Ogwu x Clemson, S_{24}= Ogwu x LD88, S_{25}= Ogwu x Uhie, S_{34}= Uhie x agwu, S_{35} = Uhie x Clemson, S_{45}= Uhie x LD88

Table 30: Specific combining ability effects of fruit traits of the okra hybrids used for the study

SCA	100 SW	DrFW	FG	FL	FW	NoR/P	NoS/P
S_{12}	0.87	1.02	1.72	-0.66	1.73	1.10	12.11
S_{13}	-5.68	-12.52	-10.85	-13.12	-36.99	-10.38	-104.39
S_{14}	-0.11	0.13	-0.82	-1.34	-0.81	-0.52	-1.99
S_{15}	-0.07	0.57	0.13	0.54	0.00	0.43	-7.07
S_{23}	0.23	-0.38	0.44	-0.51	4.77	0.24	2.14
S_{24}	-0.02	-0.71	-0.17	-0.06	2.96	0.29	2.07
S_{25}	0.01	-0.23	-0.85	-0.65	-0.54	-0.38	7.96
S_{34}	-0.47	-0.01	-0.40	0.01	1.52	0.33	-2.52
S_{35}	-0.12	0.83	-0.57	0.12	-0.41	-0.86	-3.09
S_{45}	0.08	1.63	-0.66	0.65	1.16	0.52	-5.08
SE	0.10	0.65	0.39	0.37	1.02	0.37	2.42
CD (5%)	1.56	9.78	5.80	5.54	15.45	5.64	36.56

Where; 100 SW= 100 seed weight, DrFW= Dry fruit weight, FG= Fruit girth, FL= Fruit length, FW= Fruit weight, NoR/P= Number of ridges/fruit pod, NoS/P= Number of seeds/fruit pod, SCA= specific combining ability, SE= standard error, CD= critical difference at 5%, S_{12}=Agwu x Clemson, S_{13}= Agwu x LD88, S_{14}= Clemson x LD88, S_{15}= Ogwu x Agwu, S_{23}= Ogwu x Clemson, S_{24}= Ogwu x LD88, S_{25}= Ogwu x Uhie, S_{34}= Uhie x agwu, S_{35}= Uhie x Clemson, S_{45}= Uhie x LD88

Estimates of Gene Effect for Agronomic, Yield and Yield Component Traits of Okra used in the study

The gene effects for agronomic, yield and yield component traits were studied using means of several generations. Variable gene effects were observed among cross combinations. The results were shown in Table 31.

Branch Length

All the crosses with the exception of óAGW x CLMô, óAGW x LD88ô and óCLM x LD88ô, exhibited significant *a*. Only óOGW x UHIEô showed significant *d*. With the exception of óAGW x CLMô and óAGW x LD88ô, all the crosses exhibited significant *ad.* Significant *dd* was observed in all the crosses. Also, significant *m* was observed in all the crosses.

Days to 50% Germination

The crosses, óAGW x CLMô, óAGW x LD88ô and óCLM x LD88ô exhibited significant *a* and *aa*. All the crosses showed significant *d.* With the exception of óOGW x AGWô and óUHIE x LD88ô, all the crosses showed significant *ad*. All the crosses showed significant *m* and *dd.*

Days to Flower Bud Initiation

In days to flower bud initiation, the crosses, óAGW x CLMô, óAGW x LD88ô and óCLM x LD88ô exhibited significant *a, aa* and *ad.* With the exception of óOGW x UHIEô all the crosses exhibited significant *d*. All the crosses exhibited significant *m* and *dd*.

Days to Anthesis

In days to anthesis, the crosses, óAGW x CLMô, óAGW x LD88ô and óCLM x LD88ô exhibited significant *a, aa* and *ad.* All the crosses exhibited significant *m* and *dd*. With the exception of óOGW x UHIEô all the crosses exhibited significant *d*.

Days to 50% Flowering

In days to 50% flowering, the crosses, óAGW x CLMô, óAGW x LD88ô and óCLM x LD88ô exhibited significant additive, additive x additive and additive x dominance gene effects. With

the exception of óOGW x UHIEô all the crosses exhibited significant dominance gene effect. All the crosses exhibited significant mean and dominance x dominance gene effects.

Days to First Fruiting

All the crosses showed significant *m.* The crosses, óAGW x CLMô, óAGW x LD88ô and óCLM x LD88ô exhibited significant *a, aa* and *ad.* With the exception of óOGW x UHIEô all the crosses exhibited significant *d*. Also, all the crosses exhibited significant *dd*.

Days to Edible Fruit Maturity

In days to edible fruit maturity, all the crosses exhibited significant *m.* The crosses, óAGW x CLMô, óAGW x LD88ô and óCLM x LD88ô exhibited significant *a, aa* and *ad.* With the exception of óOGW x UHIEô all the crosses exhibited significant *d*. All the crosses exhibited significant *dd*.

Number of Branches/Plant

All the crosses exhibited significant *m, a* and *dd*. Only the cross óCLM x LD88ô showed significant *d.* With the exception of óAGW x CLMô and óCLM x LD88ô, all the crosses exhibited significant *aa*. All the crosses with exception of óAGW x CLMô and óAGW x LD88ô, exhibited significant *ad*.

Number of Fruits/Branch

All the crosses exhibited *m, a, ad* and *dd*. Only the cross CLM x LD88 showed significant *d.* With the exception of óAGW x CLMô, óAGW x LD88ô and óCLM x LD88ô, all the crosses exhibited significant *ad*.

Number of fruits/plant

With the exception of óAGW x CLMô and óAGW x LD88ô all the crosses exhibited *a*. óAGW x CLMô, óAGW x LD88ô and óCLM x LD88ô showed significant *d*. All the crosses with the exception of óAGW x CLMô, óAGW x LD88ô and óCLM x LD88ô showed significant *aa* and *ad*. All the crosses showed significant *m* and *dd*.

Number of Flowers/Plant

For number of flowers/plant, all the crosses showed significant *m.* All the crosses showed significant *aa* with the exception of óAGW x CLMôand óAGW x LD88ô. óAGW x CLMô, óAGW x LD88ôand óCLM x LD88ôshowed significant *d*. All the crosses showed significant *aa* and *ad* with the exception of óAGW x CLMô, óAGW x LD88ôand óCLM x LD88ô.

Number of fruits/stem

In number of fruits/stem, all the crosses showed significant *m, a, aa* and *dd*. óAGW x CLMô, óAGW x LD88ôand óCLM x LD88ôshowed significant *d*. All the crosses exhibited significant *ad* with the exception of óAGW x CLMô.

Plant height at edible maturity

In plant height at maturity, only óCLM x LD88ôand óOGW x LD88ôhad significant *a.* Only the cross óOGW x UHIEôexhibited significant *d*. The crosses, óAGW x LD88ô, óCLM x LD88ô, óOGW x UHIEôand óUHIE x AGWôexhibited significant *aa*. óCLM x LD88ôand óUHIE x LD88ôexhibited significant *ad*. All the crosses showed significant *m* and *dd*.

Stem Girth

The crosses, óAGW x CLMô, óAGW x LD88ô, óCLM x LD88ô, óOGW x AGWôand óUHIE x LD88ô had significant *a. aa* and *ad*. Significant *m* and *d* were observed in all the crosses. Similarly, all the crosses had significant *dd*.

Total Fruit Yield

All the crosses exhibited significant *m*, *a, aa* and *dd*. With the exception of óAGW x CLMôand óCLM x LD88ôall the crosses exhibited significant *ad*.

Table 31: Gene effects of agronomic, yield and yield component traits of okra crosses used for the study

TRAITS	Crosses	*m*	*a*	*d*	*aa*	*Ad*	*dd*
BL	**AGW x CLM**	0.07*	0.21	-2.26	0.87	0.24	1.69*
	AGW x LD88	0.06*	0.10	-1.06	1.37	0.25	2.06*
	CLM x LD88	0.14*	2.43	2.20	7.68	2.32	14.38*
	OGW x AGW	0.96*	7.35*	-25.81	3.00	8.13*	-30.84*
	OGW x CLM	0.16*	7.92*	-38.12	4.05	7.06*	-55.52*
	OGW x LD88	0.41*	3.37*	-27.23	7.07	3.37*	-11.39*
	OGW x UHIE	6.59*	10.87*	11.84*	23.81*	10.87*	-32.05*
	UHIE x AGW	3.34*	5.43*	-5.95	4.54	-0.43*	-13.76*
	UHIE x CLM	5.71*	3.32*	-3.46	8.60	3.32*	-7.07*
	UHIE x LD88	9.96*	3.65*	-14.34	3.79	3.65*	-15.91*
D50%G	**AGW x CLM**	0.00*	9.50*	1.09*	12.00*	0.59*	-1.44*
	AGW x LD88	0.11*	7.83*	1.63*	8.32*	1.00*	-3.93*
	CLM x LD88	0.00*	5.94*	-5.68*	5.89*	2.81*	-10.61*
	OGW x AGW	0.25*	2.02	-4.90*	2.49	2.06	-9.42*
	OGW x CLM	0.19*	4.65	-11.12*	1.63	4.47*	-22.41*
	OGW x LD88	0.44*	2.25	-9.19*	1.06	2.25*	-19.25*
	OGW x UHIE	0.24*	2.61	9.28*	2.75	2.61*	-19.04*
	UHIE x AGW	0.50*	3.24	-12.20*	3.43	3.24*	-26.34*
	UHIE x CLM	0.11*	1.03	8.86*	4.94	1.03*	-17.39*
	UHIE x LD88	0.50*	-1.62	2.02*	3.27	-1.62	-6.03*
DBI	**AGW x CLM**	0.26*	1.55*	2.32*	4.31*	1.51*	-5.94*
	AGW x LD88	0.94*	0.36*	-2.74*	11.25*	0.20*	1.09*
	CLM x LD88	3.45*	2.02*	-10.64*	10.80*	2.27*	-18.60*
	OGW x AGW	5.61*	-1.28	-9.24*	1.43	-1.41	-19.31*
	OGW x CLM	1.78*	-9.57	-15.50*	3.58	-9.79	-41.71*
	OGW x LD88	3.32*	-5.25	-1.63*	4.96	-5.25	-22.92*
	OGW x UHIE	1.82*	-1.68	-28.37	8.66*	-1.68	7.25*
	UHIE x AGW	5.34*	-4.82	2.87*	10.37	-4.82	-15.85*
	UHIE x CLM	0.00*	-2.40	2.35*	12.20	2.40*	-21.19*
	UHIE x LD88	0.00*	-1.26	-2.89*	4.15	-1.26	9.66*

Where BL= Branch length, D50%G = Days to 50% germination, DBI= Days to flower bud initiation, AGW = Agwu early, CLM = Clemson spineless, OGW = Ele Ogwu, AGW x CLM = Agwu x Clemson, AGW x LD88 = Agwu x LD88, CLM x LD88 = Clemson x LD88, OGW x AGW = Ele Ogwu x Agwu early, OGW x CLM = Ogwu x Clemson spineless, OGW x LD88 = Ogwu x LD88, OGW x UHIE = Ogwu x Uhie, UHIE x AGW = Uhie x Agwu, UHIE x CLM = Uhie x Clemson spineless, UHIE x LD88 = Uhie x LD88, *m* = mean effect of F_2, *a* =additive effect, *d* = dominance effect, *aa* = additive x additive effect, *ad* = additive x dominance effect, *dd* = dominance effect.

Table 31 cont'd

TRAITS	Crosses	*m*	*a*	*d*	*aa*	*ad*	*dd*
DA	**AGW x CLM**	1.03*	1.70*	2.05*	4.81*	1.48*	-5.05*
	AGW x LD88	0.87*	5.02*	0.94*	12.91*	5.44*	-21.93*
	CLM x LD88	2.31*	2.89*	7.19*	14.00*	2.50*	-23.80*
	OGW x AGW	8.88*	-0.64	-23.24*	1.66	-0.68	-19.96*
	OGW x CLM	2.11*	-1.12	-5.90*	4.89	-1.44	-6.19*
	OGW x LD88	8.98*	-1.91	-28.72*	-0.70	-1.91	2.69*
	OGW x UHIE	1.36*	-4.05	-42.91	7.80	-4.05	-14.10*
	UHIE x AGW	1.46*	-3.89	15.44*	-18.93	-3.89	-34.64*
	UHIE x CLM	0.31*	-9.82	15.05*	-33.45	9.82*	-61.65*
	UHIE x LD88	7.38*	-3.02	-20.84*	-12.93	-3.02	-22.83*
D50%F	**AGW x CLM**	1.10*	1.86*	-1.95*	4.95*	1.55*	-5.08*
	AGW x LD88	0.93*	5.1*	0.86*	12.98*	5.61*	-21.45*
	CLM x LD88	2.38*	2.92*	-5.33*	14.63*	2.41*	-24.67*
	OGW x AGW	8.95*	-0.71	-21.45*	1.71	-0.63	-19.77*
	OGW x CLM	2.15*	-1.15	-5.75*	4.90*	-1.45	-7.25*
	OGW x LD88	9.05*	-1.98	-29.35*	-0.77	-1.98	-1.42*
	OGW x UHIE	1.41*	-4.25	-41.45	-5.35	-4.20	-15.28*
	UHIE x AGW	1.50*	-3.92	-12.48*	-18.90	-2.95	-34.68*
	UHIE x CLM	0.38*	-10.21	-15.20*	-35.42	8.66*	-62.15*
	UHIE x LD88	7.50*	-3.22	-20.95*	-12.99	-3.10	-23.07*
D1F	**AGW x CLM**	0.01*	6.14*	-17.21*	17.81*	6.24*	-32.76*
	AGW x LD88	4.95*	0.56*	-15.03*	1.09*	1.29*	-7.31*
	CLM x LD88	1.01*	1.11*	-6.72*	7.54*	1.09*	-8.55*
	OGW x AGW	1.90*	-4.2	-4.41*	-9.45	-3.61	-13.16*
	OGW x CLM	3.19*	-1.06	-0.09*	-10.19	-1.9	-18.41*
	OGW x LD88	3.04*	-1.09	-4.90*	-3.32	-1.09	-4.82*
	OGW x UHIE	3.77*	-1.92	-25.56	-4.89	-1.92	-8.09*
	UHIE x AGW	0.49*	-2.57	-9.95*	-9.11	-2.57	-13.57*
	UHIE x CLM	6.6*	-0.9	-14.81*	-0.05	0.90*	-10.16*
	UHIE x LD88	4.47*	-0.39	-6.13*	-5.56	-0.39	-7.65*

Where DA = Days to anthesis, D50%F = Days to 50% flowering, D1F= Days to first fruiting, AGW = Agwu early, CLM = Clemson spineless, OGW = Ele Ogwu, AGW x CLM = Agwu x Clemson, AGW x LD88 = Agwu x LD88, CLM x LD88 = Clemson x LD88, OGW x AGW = Ele Ogwu x Agwu early, OGW x CLM = Ogwu x Clemson spineless, OGW x LD88 = Ogwu x LD88, OGW x UHIE = Ogwu x Uhie, UHIE x AGW = Uhie x Agwu, UHIE x CLM = Uhie x Clemson spineless, UHIE x LD88 = Uhie x LD88, *m* = mean effect of F_2, *a* =additive effect, *d* = dominance effect, *aa* = additive x additive effect, *ad* = additive x dominance effect, *dd* = dominance effect.

Table 31 cont'd

TRAITS	Crosses	*m*	*a*	*d*	*aa*	*ad*	*dd*
DFM	**AGW x CLM**	0.52*	0.97*	-2.79*	8.35*	0.08*	-5.44*
	AGW x LD88	1.51*	0.55*	-4.19*	3.43*	1.52*	3.25*
	CLM x LD88	0.75*	0.27*	-3.30*	2.27*	0.27*	4.59*
	OGW x AGW	2.49*	-3.52	-2.34*	-0.42	-3.15	-3.30*
	OGW x CLM	2.33*	-1.22	-5.79*	-0.22	-3.02	0.73*
	OGW x LD88	0.52*	-1.56	23.77*	0.3	-1.56	-43.05*
	OGW x UHIE	5.75*	-0.16	-14.40	-0.96	-0.16	-8.26*
	UHIE x AGW	6.85*	-0.73	-23.44*	-5.34	-0.73	-9.73*
	UHIE x CLM	6.11*	-0.77	-18.50*	-3.2	0.77*	-6.29*
	UHIE x LD88	10.78*	-4.11	-18.00*	-5.76	-4.11	-27.23*
NoB/Pl	**AGW x CLM**	0.44*	0.03*	-0.67	0.52	0.03	0.22*
	AGW x LD88	0.24*	0.15*	-2.28	8.82*	0.24	-15.93*
	CLM x LD88	3.78*	1.59*	11.89*	2.15	1.62*	-1.80*
	OGW x AGW	2.29*	2.25*	-6.54	3.21*	2.31*	-23.80*
	OGW x CLM	3.00*	1.57*	-6.88	5.58*	1.26*	-29.32*
	OGW x LD88	2.45*	0.27*	-16.03	2.46*	0.27*	-43.02*
	OGW x UHIE	5.86*	1.54*	-6.77	10.22*	1.54*	-19.25*
	UHIE x AGW	0.62*	0.79*	-4.07	4.90*	0.79*	-7.94*
	UHIE x CLM	0.44*	3.78*	-16.61	1.32*	3.78*	2.19*
	UHIE x LD88	4.02*	2.19*	-13.48	5.13*	3.40*	-3.36*
NoF/B	**AGW x CLM**	0.38*	1.99*	-2.38	1.35	-4.97	-5.46*
	AGW x LD88	0.25*	1.84*	-2.75	1.49	-1.01	-5.56*
	CLM x LD88	0.00*	1.79*	16.54*	2.15	-2.09	-32.30*
	OGW x AGW	0.50*	2.68*	-6.92	9.63*	3.26*	-14.91*
	OGW x CLM	0.26*	3.75*	-18.19	9.36*	2.62*	-34.97*
	OGW x LD88	6.59*	0.10*	-22.47	3.35*	0.10*	7.98*
	OGW x UHIE	6.69*	2.05*	-20.77	11.62*	2.05*	5.12*
	UHIE x AGW	0.69*	1.42*	-7.26	8.59*	1.43*	-15.67*
	UHIE x CLM	0.50*	7.92*	-23.46	4.27*	7.92*	-47.14*
	UHIE x LD88	4.73*	3.63*	-8.37	4.96*	13.63*	-8.20*

Where DFM = Days to edible fruit maturity, NoB/P = Number of branches/plant, NoF/B = Number of fruits/branch, AGW = Agwu early, CLM = Clemson spineless, OGW = Ele Ogwu, AGW x CLM = Agwu x Clemson, AGW x LD88 = Agwu x LD88, CLM x LD88 = Clemson x LD88, OGW x AGW = Ele Ogwu x Agwu early, OGW x CLM = Ogwu x Clemson spineless, OGW x LD88 = Ogwu x LD88, OGW x UHIE = Ogwu x Uhie, UHIE x AGW = Uhie x Agwu, UHIE x CLM = Uhie x Clemson spineless, UHIE x LD88 = Uhie x LD88, *m* = mean effect of F_2, *a* =additive effect, *d* = dominance effect, *aa* = additive x additive effect, *ad* = additive x dominance effect, *dd* = dominance effect.

Table 31 cont'd

TRAITS	Crosses	*m*	*a*	*d*	*aa*	*ad*	*dd*
NoF/Pl	**AGW x CLM**	0.64*	0.50	-0.63*	1.36	0.08	1.56*
	AGW x LD88	0.71*	0.50	-0.04*	2.09	0.46	-1.58*
	CLM x LD88	0.72*	1.19*	0.30*	3.43	2.06	-2.88*
	OGW x AGW	1.32*	3.66*	-4.31	2.44*	4.32*	-9.24*
	OGW x CLM	2.26*	4.70*	-8.69	2.09*	2.87*	-22.09*
	OGW x LD88	4.45*	3.00*	-9.78	1.97*	0.30*	-41.60*
	OGW x UHIE	0.88*	2.50*	-9.85	0.74*	3.50*	-18.00*
	UHIE x AGW	1.06*	3.07*	-9.28	0.71*	3.07*	-17.91*
	UHIE x CLM	0.62*	1.91*	-5.67	5.54*	1.91*	-7.11*
	UHIE x LD88	6.10*	3.11*	-14.63	2.80*	3.11*	-3.87*
NoFl/Pl	**AGW x CLM**	1.49*	0.33	-1.71*	0.74	0.30	1.10*
	AGW x LD88	0.83*	0.75	-2.15*	0.67	0.78	-0.07*
	CLM x LD88	0.44*	1.24*	-1.34*	3.02	1.37	-4.54*
	OGW x AGW	0.50*	3.47*	-9.70	11.35*	3.48*	-19.04*
	OGW x CLM	1.79*	5.85*	-8.68	13.93*	5.47*	-26.09*
	OGW x LD88	1.48*	2.68*	-4.82	8.51*	2.68*	-15.55*
	OGW x UHIE	2.83*	1.48*	-7.10	14.82*	0.48*	28.10*
	UHIE x AGW	3.75*	2.14*	-14.85	25.66*	2.14*	-50.44*
	UHIE x CLM	8.30*	1.38*	-28.05	3.63*	1.38	8.23*
	UHIE x LD88	5.11*	4.73*	-5.62	8.69*	4.73*	-15.38*
NoF/St	**AGW x CLM**	8.54*	3.87*	9.36*	7.06*	0.25	-7.89*
	AGW x LD88	10.02*	5.12*	8.93*	10.40*	2.31*	-9.13*
	CLM x LD88	8.42*	5.66*	22.54*	16.67*	2.86*	-7.21*
	OGW x AGW	12.41*	6.16*	-8.55	3.92*	4.03*	-5.59*
	OGW x CLM	13.53*	3.79*	-17.66	8.06*	0.42*	-5.52*
	OGW x LD88	9.58*	1.11*	-6.37	11.40*	4.37*	-13.89*
	OGW x UHIE	3.62*	3.68*	-13.09	2.82*	5.67*	-28.22*
	UHIE x AGW	4.34*	3.26*	-9.44	5.40*	1.27*	-21.72*
	UHIE x CLM	4.02*	5.31*	-15.43	6.36*	1.56*	-34.27*
	UHIE x LD88	5.62*	4.61*	-12.78	9.66*	8.61*	-34.12*

Where NoF/Pl = Number of fruits/plant, NoFl/Pl = Number of flowers/plant, NoF/St= Number of fruits/stem, AGW = Agwu early, CLM = Clemson spineless, OGW = Ele Ogwu, AGW x CLM = Agwu x Clemson, AGW x LD88 = Agwu x LD88, CLM x LD88 = Clemson x LD88, OGW x AGW = Ele Ogwu x Agwu early, OGW x CLM = Ogwu x Clemson spineless, OGW x LD88 = Ogwu x LD88, OGW x UHIE = Ogwu x Uhie, UHIE x AGW = Uhie x Agwu, UHIE x CLM = Uhie x Clemson spineless, UHIE x LD88 = Uhie x LD88, *m* = mean effect of F_2, *a* =additive effect, *d* = dominance effect, *aa* = additive x additive effect, *ad* = additive x dominance effect, *dd* = dominance effect.

Table 31 cont'd

TRAITS	Crosses	*m*	*a*	*d*	*aa*	*ad*	*dd*
PHM	**AGW x CLM**	0.49*	0.76	-2.69	1.60	2.49	-10.32*
	AGW x LD88	0.17*	0.79	-2.38	2.70*	-1.11	3.98*
	CLM x LD88	0.08*	10.55*	-24.56	2.86*	13.26*	-48.04*
	OGW x AGW	6.71*	-0.44	-24.69	1.70	-1.33	13.12*
	OGW x CLM	2.62*	-0.38	-7.68	0.73	-3.57	10.18*
	OGW x LD88	11.67*	5.75*	-20.93	1.23	-0.75	-16.73*
	OGW x UHIE	1.37*	-2.69	5.43*	7.21*	-2.69	-9.76*
	UHIE x AGW	3.69*	-3.47	-3.62	6.57*	-3.47	-11.41*
	UHIE x CLM	1.81*	0.27	2.08	3.67	0.27	-10.36*
	UHIE x LD88	5.81*	-8.67	-21.00	3.08	8.67*	-71.44*
StG	**AGW x CLM**	1.45*	1.75*	-3.23*	7.57*	1.76*	-14.96*
	AGW x LD88	1.81*	1.93*	-2.44*	7.83*	1.91*	-15.47*
	CLM x LD88	1.27*	4.90*	-0.36*	4.14*	3.90*	-8.15*
	OGW x AGW	8.21*	3.37*	-19.17*	5.37*	3.35*	-10.49*
	OGW x CLM	9.96*	-2.68	-14.68*	1.15	-2.69	-30.18*
	OGW x LD88	2.38*	-5.20	-9.34*	1.43	5.20*	32.77*
	OGW x UHIE	5.29*	-4.78	-1.90*	1.71	-4.80	-35.33*
	UHIE x AGW	3.53*	-1.49	-8.17*	2.40	-1.49	-4.78*
	UHIE x CLM	3.66*	1.84*	-6.60*	4.35*	1.84*	-8.60*
	UHIE x LD88	9.59*	5.98*	-24.76*	3.96*	5.98*	7.82*
TFY(t/ha)	**AGW x CLM**	0.11*	1.26*	-4.11	4.85*	1.25	-8.76*
	AGW x LD88	0.04*	6.09*	-1.57	1.90*	5.98*	-24.99*
	CLM x LD88	0.08*	0.64*	-3.06	3.41*	0.64	-6.26*
	OGW x AGW	3.37*	5.16*	-12.52	2.39*	7.06*	-43.92*
	OGW x CLM	5.98*	5.77*	0.30	2.15*	3.77*	-36.11*
	OGW x LD88	2.00*	2.90*	-21.49	2.04*	2.90*	-53.17*
	OGW x UHIE	1.34*	0.72*	-2.46	3.60*	0.72*	-1.48*
	UHIE x AGW	4.07*	0.43*	-10.06	1.84*	0.43*	-3.06*
	UHIE x CLM	8.54*	0.54*	-30.25	5.47*	0.54*	1.63*
	UHIE x LD88	5.78*	6.63*	-3.34	1.44*	12.61*	-21.78*

Where StG = Stem girth, TFY= Total fruit yield (tonnes/hectare), AGW = Agwu early, CLM = Clemson spineless, OGW = Ele Ogwu, AGW x CLM = Agwu x Clemson, AGW x LD88 = Agwu x LD88, CLM x LD88 = Clemson x LD88, OGW x AGW = Ele Ogwu x Agwu early, OGW x CLM = Ogwu x Clemson spineless, OGW x LD88 = Ogwu x LD88, OGW x UHIE = Ogwu x Uhie, UHIE x AGW = Uhie x Agwu, UHIE x CLM = Uhie x Clemson spineless, UHIE x LD88 = Uhie x LD88, *m* = mean effect of F_2, *a* =additive effect, *d* = dominance effect, *aa* = additive x additive effect, *ad* = additive x dominance effect, *dd* = dominance effect.

Estimates of Gene Effects for Fruit Traits of Okra used for the study

The gene effects for fruit traits were studied using means of several generations. Variable gene effects were observed among cross combinations. The results were shown in Table 32.

100 seed weight

All the crosses with the exception of óAGW x CLMô, óAGW x LD88ô and óCLM x LD88ô, exhibited significant *a, aa* and *ad*. All the crosses showed significant *d*. Significant *m* and *dd* were observed in all the crosses.

Dry fruit weight

Significant *m* was observed in all the crosses. Similarly, all the crosses with the exception of óAGW x CLMô, óAGW x LD88ô and óCLM x LD88ô, exhibited significant *a* and *ad*. None of the crosses showed significant *aa*. The crosses, óAGW x LD88ô, óCLM x LD88ô, óOGW x LD88ô, ôUHIE x AGWô and ôUHIE x LD88ô showed significant *d.* Significant *dd* was observed in all the crosses.

Fruit girth

Significant *m* was observed in all the crosses. Also, all the crosses with the exception of óAGW x CLMô, óOGW x CLMô and ôUHIE x AGWô, exhibited significant *a* and *ad*. The crosses, óAGW x LD88ô, óCLM x LD88ô, óOGW x LD88ô, óOGW x UHIEô and ôUHIE x LD88ô showed significant *d*. Only the cross, óCLM x LD88ô exhibited significant *ad*. Significant *dd* was observed in all the crosses.

Fruit length

All the crosses with the exception of óAGW x CLMô, óAGW x LD88ô and óOGW x LD88ô, exhibited significant *a* and *ad*. None of the crosses showed significant *aa*. Significant *m* and *dd* were observed in all the crosses. óAGW x CLMô, óAGW x LD88ô, óOGW x CLMô, óOGW x LD88ô, ôUHIE x CLMô and ôUHIE x LD88ô showed significant *d*.

Fruit weight

All the crosses exhibited significant *a*. Significant *d* was observed in óAGW x CLMô, óAGW x LD88ô,ô CLM x LD88ô, õUHIE x AGWô and õUHIE x LD88ô. Significant *aa* and *ad* were observed in óAGW x CLMô, óAGW x LD88ô, óCLM x LD88ô and óOGW x LD88ô. Significant *dd* was observed in all the crosses.

Number of ridges/pod

All the crosses exhibited significant *a* and *aa*. Significant *d* was observed in óAGW x CLMô, óAGW x LD88ô, óOGW x AGWô, óOGW x LD88ô, õUHIE x AGWô and õUHIE x LD88ô. Significant *ad* was observed in óCLM x LD88ô, óOGW x UHIEô and õUHIE x LD88ô. *dd* was significant in all the crosses.

Number of seeds/pod

Only the crosses, óAGW x CLMô, óAGW x LD88ô and óCLM x LD88ô, exhibited significant *a, aa* and *ad*. All the crosses showed significant *d*. Similarly, significant *dd* was observed in all the crosses.

Table 32: Gene effects of the fruit characteristics of crosses of okra varieties used for the study

TRAITS	Crosses	*m*	*a*	*d*	*aa*	*ad*	*dd*
100 SW	**AGW x CLM**	0.74*	0.56	2.18*	3.99*	0.49	-5.64*
	AGW x LD88	1.09*	1.45	-5.79*	8.97*	1.30	-17.08*
	CLM x LD88	2.60*	2.16	-4.28*	3.52	1.15	-6.94*
	OGW x AGW	3.48*	-2.87	-7.09*	1.61	2.72*	-34.75*
	OGW x CLM	3.22*	0.78	-0.65*	2.98	2.64*	-18.68*
	OGW x LD88	3.82*	2.65	-13.65*	2.45	2.65*	-43.61*
	OGW x UHIE	2.39*	4.60*	-14.35*	2.03	4.60*	-41.12*
	UHIE x AGW	1.90*	3.73*	-31.10*	3.58*	3.73*	-68.76*
	UHIE x CLM	1.58*	2.87*	-19.07*	2.77	2.87*	-43.49*
	UHIE x LD88	7.41*	5.07*	-1.60*	2.07	2.07*	-39.02*
DrFW	**AGW x CLM**	0.03*	0.11	-0.32	0.50	0.33	-0.02*
	AGW x LD88	0.05*	0.18	1.33*	1.53	-0.06	-2.14*
	CLM x LD88	0.12*	0.46	1.74*	0.94	0.50	-1.31*
	OGW x AGW	0.04*	1.37*	-0.89	1.03	2.37*	-1.63*
	OGW x CLM	0.02*	1.77*	-3.42	3.49	1.32*	-6.78*
	OGW x LD88	0.16*	1.47*	4.19*	-4.60	1.47*	-9.07*
	OGW x UHIE	0.34*	2.96*	-5.61	-6.52	2.96*	-12.82*
	UHIE x AGW	0.06*	4.07*	8.33*	-8.47	4.07*	-16.84*
	UHIE x CLM	0.12*	2.54*	-5.96	-6.18	2.54*	-12.11*
	UHIE x LD88	0.07*	1.67*	8.11*	-8.23	1.67*	-16.29*
FG	**AGW x CLM**	0.10*	1.95	-4.73	-5.05	0.96	-9.86*
	AGW x LD88	0.10*	1.78*	5.14*	-5.46	2.78*	10.66*
	CLM x LD88	0.06*	4.17*	10.87*	11.10*	4.15*	22.09*
	OGW x AGW	0.06*	1.35*	-3.49	-3.62	1.36*	-7.04*
	OGW x CLM	0.04*	0.76	-4.34	-4.47	0.74	-8.89*
	OGW x LD88	0.07*	1.39*	5.24*	-5.35	1.39*	-10.52*
	OGW x UHIE	0.08*	1.12*	3.46*	-3.53	1.12*	-6.74*
	UHIE x AGW	0.09*	0.31	-4.37	-4.64	0.61	-9.25*
	UHIE x CLM	0.05*	1.37*	-4.23	-4.36	1.37*	-8.71*
	UHIE x LD88	0.03*	2.37*	7.68*	-1.71	3.37*	-3.33*

Where 100 SW = 100 seed weight, DrFW = dry fruit weight, FG = Fruit girth, AGW = Agwu early, CLM = Clemson spineless, OGW = Ele Ogwu, AGW x CLM = Agwu x Clemson, AGW x LD88 = Agwu x LD88, CLM x LD88 = Clemson x LD88, OGW x AGW = Ele Ogwu x Agwu early, OGW x CLM = Ogwu x Clemson spineless, OGW x LD88 = Ogwu x LD88, OGW x UHIE = Ogwu x Uhie, UHIE x AGW = Uhie x Agwu, UHIE x CLM = Uhie x Clemson spineless, UHIE x LD88 = Uhie x LD88, *m* = mean effect of F_2, *a* =additive effect, *d* = dominance effect, *aa* = additive x additive effect, *ad* = additive x dominance effect, *dd* = dominance effect.

Table 32 cont'd: Gene effects of fruit characteristics of crosses of okra varieties used for the study

TRAITS	Crosses	*m*	*a*	*d*	*aa*	*ad*	*dd*
FL	**AGW x CLM**	0.03*	0.07	3.43*	3.67	0.18	-6.77*
	AGW x LD88	0.04*	0.76	5.68*	5.87	0.60	-11.22*
	CLM x LD88	0.38*	3.46*	-0.67	1.32	2.47*	-1.58*
	OGW x AGW	4.21*	0.62	-5.77	-7.07	0.85	-13.52*
	OGW x CLM	1.07*	2.51*	4.05*	-7.31	1.26*	-13.72*
	OGW x LD88	2.16*	3.81*	17.95*	-24.42	3.81*	-48.79*
	OGW x UHIE	4.15*	4.19*	-8.33	-20.72	4.19*	-41.28*
	UHIE x AGW	4.66*	0.80*	-10.93	-24.68	1.80*	-48.92*
	UHIE x CLM	1.51*	3.15*	16.39*	-20.85	3.15*	-41.56*
	UHIE x LD88	7.03*	7.11*	8.29*	-12.65	7.11*	-24.98*
FW	**AGW x CLM**	0.17*	3.50*	6.24*	2.61*	3.76	-11.91*
	AGW x LD88	0.20*	16.45*	4.66*	1.71*	15.92*	-80.41*
	CLM x LD88	0.52*	6.10*	24.93*	2.71*	6.32*	-51.25*
	OGW x AGW	3.18*	3.33*	-0.14	1.75	3.11	-13.00*
	OGW x CLM	4.08*	3.44*	-1.62	1.62	3.22	-25.93*
	OGW x LD88	0.44*	5.09*	-35.81	3.63*	5.09*	-56.25*
	OGW x UHIE	2.77*	4.11*	-3.69	1.28	4.11	-17.17*
	UHIE x AGW	8.33*	1.01*	28.34*	-4.52	1.07	11.37*
	UHIE x CLM	3.74*	1.44*	-9.60	0.09	1.44	2.90*
	UHIE x LD88	12.48*	1.15*	42.48*	-7.02	1.15	17.98*
NoR/P	**AGW x CLM**	0.25*	0.51*	0.26*	2.78*	0.73	-0.20*
	AGW x LD88	0.24*	0.33*	0.77*	1.54*	0.21	-1.96*
	CLM x LD88	0.11*	4.12*	-9.53	9.96*	4.03*	19.73*
	OGW x AGW	0.24*	0.13*	4.52*	5.04*	-0.04	-9.33*
	OGW x CLM	0.00*	0.53*	-5.95	6.04*	-0.63	-11.90*
	OGW x LD88	0.28*	1.49*	4.32*	4.71*	-1.49	-8.54*
	OGW x UHIE	0.24*	3.13*	-7.55	8.03*	3.13*	-15.56*
	UHIE x AGW	0.19*	1.50*	3.23*	3.81*	-1.50	-7.62*
	UHIE x CLM	0.25*	4.64*	-13.28	14.04*	-4.64	-28.07*
	UHIE x LD88	0.26*	5.76*	14.04*	14.21*	5.76*	-27.20*

Where FL = Fruit length, FW = Fruit weight, NoR/P = Number of ridges/pod, AGW = Agwu early, CLM = Clemson spineless, OGW = Ele Ogwu, AGW x CLM = Agwu x Clemson, AGW x LD88 = Agwu x LD88, CLM x LD88 = Clemson x LD88, OGW x AGW = Ele Ogwu x Agwu early, OGW x CLM = Ogwu x Clemson spineless, OGW x LD88 = Ogwu x LD88, OGW x UHIE = Ogwu x Uhie, UHIE x AGW = Uhie x Agwu, UHIE x CLM = Uhie x Clemson spineless, UHIE x LD88 = Uhie x LD88, *m* = mean effect of F_2, *a* =additive effect, *d* = dominance effect, *aa* = additive x additive effect, *ad* = additive x dominance effect, *dd* = dominance effect.

Table 32 cont'd: Gene effects of the Fruit Characteristics of crosses of Okra varieties used for the study

TRAITS	Crosses	*m*	*a*	*d*	*aa*	*ad*	*dd*
NoS/P	**AGW x CLM**	1.14*	6.00*	-11.66*	14.87*	5.67*	-16.03*
	AGW x LD88	4.47*	3.50*	-5.14*	3.54*	2.78*	-4.55*
	CLM x LD88	1.25*	6.05*	-14.53*	16.89*	6.63*	-22.45*
	OGW x AGW	1.22*	-5.91	-11.78*	3.47	-4.71	-7.36*
	OGW x CLM	0.87*	-2.06	-5.40*	8.11*	-4.61	-6.24*
	OGW x LD88	0.57*	-1.48	-10.86*	5.48	-1.48	3.27*
	OGW x UHIE	2.79*	-3.01	-10.45*	3.28	-3.01	15.47*
	UHIE x AGW	3.29*	-2.03	-1.23*	3.71	-2.03	2.43*
	UHIE x CLM	1.14*	-2.16	-7.50*	5.98	-2.16	-2.09*
	UHIE x LD88	6.94*	-2.46	-17.08*	0.74	-2.46	4.53*

Where NoS/P = Number of seeds/pod, AGW = Agwu early, CLM = Clemson spineless, OGW = Ele Ogwu, AGW x CLM = Agwu x Clemson, AGW x LD88 = Agwu x LD88, CLM x LD88 = Clemson x LD88, OGW x AGW = Ele Ogwu x Agwu early, OGW x CLM = Ogwu x Clemson spineless, OGW x LD88 = Ogwu x LD88, OGW x UHIE = Ogwu x Uhie, UHIE x AGW = Uhie x Agwu, UHIE x CLM = Uhie x Clemson spineless, UHIE x LD88 = Uhie x LD88, *m* = mean effect of F_2, *a* =additive effect, *d* = dominance effect, *aa* = additive x additive effect, *ad* = additive x dominance effect, *dd* = dominance effect.

Inheritance pattern of Qualitative Traits of Okra studied

Inheritance Pattern of Fruit Shape in Okra

The result in Table 33 showed that the cross between Agwu (conical short) and Clemson (cylindrical long) produced all cylindrical long F_1s. The F_2s segregated into 28 conical short and 52 cylindrical long fruits. The corrected chi square estimate value of 4.01 at probability value of 0.05-0.01 at expected ratio of 3:1 was obtained. The observed ratio did not fall into the expected ratio, thus indicating there was significant difference (Table 34).

The result in Table 35 showed that Agwu (conical short) x LD88 (lanceolate) produced 78 lanceolate F_1 fruits. The F_2s segregated into 27 conical short and 41 lanceolate fruits. At expected ratio of 3:1, the corrected chi square value was 7.47 at probability value of 0.05-0.01. There was significant difference because the observed ratio did not fit into the expected ratio (Table 36).

The results in Tables 37 and 38 showed that the cross between Clemson (cylindrical long) and LD88 (lanceolate) produced all F_1s as lanceolate long. The F_2s segregated into 13 lanceolate and 43 lanceolate long fruits. At expected ratio of 3:1, the corrected chi square value at probability value of 0.50-0.25 was 0.30. The observed ratio fit into the expected ratio, thus indicating no significant difference.

The cross Ogwu (spherical short) x Agwu (conical short) resulted in spherical short F_1 fruits. The F_2s segregated into 45 spherical short and 25 conical short fruits (Table 39). 4.02 was obtained as the value of the corrected chi square at expected ratio of 3:1 at probability level of 0.50-0.25. The observed ratio did not fit into the expected ratio, thus indicating there was significant difference (Table 40).

The result in Table 41 showed that the cross between Ogwu (spherical short) and Clemson (cylindrical long) produced all cylindrical long F_1s. the F_2s segregated into 19 spherical short and 37 cylindrical long fruits. Corrected chi square value of 2.17 was obtained at probability value of 0.10-0.05. At expected ratio of 3:1, the observed ratio did not fit into the expected ratio, thus indicating there was significant difference (Table 42).

The result of the cross between Ogwu (spherical short) and LD88 (lanceolate) resulted in all spherical short F_1 fruits. The F_2 segregated into 51 spherical short and 20 lanceolate fruits (Table 43). Corrected chi square estimate value of 0.31 at probability value of 0.50-0.25 was obtained. At expected ratio of 3:1, the observed ratio fit into the expected ratio, thus indicating there was no significant difference (Table 44).

The result in Table 45 showed that the cross between Ogwu (spherical short) and Uhie (triangular long) resulted in all spherical long F_1 fruits. The F_2 segregated into 14 spherical short, 18 triangular long and 33 spherical long fruits. Table 46 showed that the chi square value of 0.51 was obtained at probability value of 0.75-0.50. At expected ratio of 1:2:1, the observed ratio did not fit into the expected ratio, thus indicating there was significant difference.

The cross between Uhie (triangular long) and Agwu (conical short) resulted in all conical long F_1 fruits, with the F_2 segregating into 18 triangular long, 7 conical short and 59 conical long fruits (Table 47). At expected ratio of 1:2:1, chi square value of 16.64 at probability level of 0.05-0.01 was obtained. The observed ratio did not fit into the expected ratio, thus indicating there was significant difference (Table 48).

In Table 49, the result of the cross between Uhie (triangular long) and Clemson (cylindrical long) resulted in all cylindrical long F_1s. The F_2s segregated into 27 triangular long and 57 cylindrical long. Corrected chi square value of 2.11 at probability level of 0.10-0.05 was obtained. The observed ratio fit into the expected ratio, thus indicating there was no significant difference at expected ratio of 3:1 (Table 50).

The cross between Uhie (triangular long) and LD88 (lanceolate) gave 58 lanceolate long F_1 fruits, with F_2 fruits segregating into 16 triangular long, 28 lanceolate and 39 lanceolate long (Table 51). Chi square value of 3.77 was obtained at probability level of 0.25-0.10. The observed ratio did not fit into expected ratio of 1:2:1, thus indicating there was significant difference (Table 52).

Table 33: Phenotypic Expression of Fruit shape in cross Agwu (Conical-short) x Clemson (Cylindrical-long) Okra genotypes

	PHENOTYPES						
Fruit Shape	**P_1(AGWU)**	**P_2(CLEMSON)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Conical-short	69	0	0	28	36	12	**145**
Cylindrical-long	0	71	48	52	20	55	**256**
TOTAL	**69**	**71**	**48**	**80**	**56**	**67**	**391**

Table 34: Chi-Square Estimate of Fruit shape in F_2 progenies progenies in cross Agwu (Conical-short) x Clemson (Cylindrical-long) Okra Genotypes

	Observed	**Expected**				
Fruit shape	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Conical-short	28	20	8	64	3.20	2.81
Cylindrical-long	52	60	-8	64	1.07	1.20
TOTAL	**80**	**80**	**0**	**128**	**4.27**	**4.01**

Expected ratio = 3:1
χ^2 = 4.27
Corrected χ^2 = 4.01
Probability value for χ^2 = 0.05-0.01
Probability value for corrected χ^2 = 0.05

Table 35: Phenotypic Expression of Fruit shape in cross Agwu (Conical-short) x LD88 (Lanceolate) Okra genotypes

	PHENOTYPES						
Fruit Shape	**P_1(AGWU)**	**P_2 (LD88)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Conical-short	69	0	0	27	39	15	**150**
Lanceolate	0	85	78	41	27	53	**284**
TOTAL	**69**	**85**	**78**	**68**	**66**	**68**	**434**

Table 36: Chi-Square Estimate of Fruit shape in F_2 progenies progenies in cross Agwu (Conical-short) x LD88 (Lanceolate) Okra Genotypes

	Observed	**Expected**				
Fruit shape	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Conical-short	27	17	10	100	5.88	5.31
Lanceolate	41	51	-10	100	1.96	2.16
TOTAL	**68**	**68**	**0**	**200**	**7.84**	**7.47**

Expected ratio = 3:1
χ^2 = 7.84
Corrected χ^2 = 7.47
Probability value for χ^2 = 0.05-0.01
Probability value for corrected χ^2 = 0.05-0.01

Table 37: Phenotypic Expression of Fruit shape in cross Clemson (Cylindrical-long) x LD88 (Lanceolate) Okra genotypes

	PHENOTYPES						
Fruit Shape	**P_1(CLEMSON)**	**P_2 (LD88)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Cylindrical-long	71	0	0	0	21	11	**103**
Lanceolate	0	85	0	13	10	32	**140**
Lanceolate-long	0	0	62	45	33	20	**160**
TOTAL	**71**	**85**	**62**	**58**	**64**	**63**	**403**

Table 38: Chi-Square Estimate of Fruit shape in F_2 progenies progenies in cross Clemson (Cylindrical-long) x LD88 (Lanceolate) Okra Genotypes

	Observed	**Expected**				
Fruit shape	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Lanceolate	13	14.50	-1.50	2.25	0.16	0.28
Lanceolate-long	45	43.50	1.50	2.25	0.05	0.02
TOTAL	**58**	**58**	**0**	**4.50**	**0.21**	**0.30**

Expected ratio = 3:1 $\chi^2 = 0.21$ Corrected $\chi^2 = 0.30$

Probability value for $\chi^2 = 0.50\text{-}0.25$

Probability value for corrected $\chi^2 = 0.50\text{-}0.25$

Table 39: Phenotypic Expression of Fruit shape in cross Ogwu (Spherical-short) x Agwu (Conical short) Okra genotypes

	PHENOTYPES						
Fruit Shape	**P_1(OGWU)**	**P_2(AGWU)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Spherical-short	78	0	61	45	55	28	**267**
Conical short	0	68	0	25	8	47	**148**
TOTAL	**78**	**68**	**61**	**70**	**63**	**75**	**415**

Table 40: Chi-Square Estimate of Fruit shape in F_2 progenies progenies in cross Ogwu (Spherical-short) x Agwu (Conical short) Okra Genotypes

	Observed	**Expected**				
Fruit shape	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Spherical-short	45	52.50	-7.50	56.25	1.07	1.22
Conical short	25	17.50	7.50	56.25	3.21	2.80
TOTAL	**70**	**70**	**0**	**112.50**	**4.28**	**4.02**

Expected ratio = 3:1 $\chi^2 = 4.28$

Corrected $\chi^2 = 4.02$ Probability value for $\chi^2 = 0.50\text{-}0.25$

Probability value for corrected $\chi^2 = 0.50\text{-}0.25$

Table 41: Phenotypic Expression of Fruit shape in cross Ogwu (Spherical-short) x Clemson (Cylindrical-long) Okra genotypes

	PHENOTYPES						
Fruit Shape	**P_1(OGWU)**	**P_2(CLEMSON)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Spherical-short	78	0	0	19	40	22	**182**
Cylindrical-long	0	71	69	37	21	63	**238**
TOTAL	**78**	**71**	**69**	**56**	**61**	**85**	**420**

Table 42: Chi-Square Estimate of Fruit shape in F_2 progenies progenies in cross Ogwu (Spherical-short) x Clemson (Cylindrical-long) Okra Genotypes

	Observed	**Expected**				
Fruit shape	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Spherical-short	37	42	-5	25	0.60	0.72
Cylindrical-long	19	14	5	25	1.79	1.45
TOTAL	**56**	**56**	**0**	**50**	**2.39**	**2.17**

Expected ratio = 3:1 $\chi^2 = 2.39$ Corrected $\chi^2 = 2.17$

Probability value for corrected $\chi^2 = 0.10\text{-}0.05$ Probability value for $\chi^2 = 0.10\text{-}0.05$

Table 43: Phenotypic Expression of Fruit shape in cross Ogwu (Spherical-short) x LD88 (Lanceolate) Okra genotypes

	PHENOTYPES						
Fruit Shape	**P_1(OGWU)**	**P_2(LD88)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Spherical-short	78	0	57	51	53	21	**260**
Lanceolate	0	85	0	20	8	61	**174**
TOTAL	**78**	**85**	**57**	**71**	**61**	**82**	**434**

Table 44: Chi-Square Estimate of Fruit shape in F_2 progenies progenies in cross Ogwu (Spherical-short) x LD88 (Lanceolate) Okra Genotypes

	Observed	**Expected**				
Fruit shape	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Spherical-short	51	53.25	-2.25	5.06	0.10	0.14
Lanceolate	20	17.75	2.25	5.06	0.29	0.17
TOTAL	**71**	**71**	**0**	**10.12**	**0.39**	**0.31**

Expected ratio = 3:1 $\chi^2 = 0.39$ Corrected $\chi^2 = 0.31$

Probability value for $\chi^2 = 0.50\text{-}0.25$

Probability value for corrected $\chi^2 = 0.50\text{-}0.25$

Table 45: Phenotypic Expression of Fruit shape in cross Ogwu (Spherical-short) x Uhie (Triangular-long) Okra genotypes

	PHENOTYPES						
Fruit Shape	**P_1(OGWU)**	**P_2(UHIE)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Spherical-short	78	0	0	14	25	17	**134**
Triangular-long	0	81	0	18	16	25	**140**
Spherical-long	0	0	61	33	23	14	**131**
TOTAL	**78**	**81**	**61**	**65**	**64**	**56**	**405**

Table 46: Chi-Square Estimate of Fruit shape in F_2 progenies progenies in cross Ogwu (Spherical-short) x Uhie (Triangular-long) Okra Genotypes

	Observed	**Expected**			
Fruit shape	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**
Spherical-short	14	16.25	-2.25	5.06	0.31
Triangular-long	18	16.25	1.75	3.06	0.19
Spherical-long	33	32.50	0.50	0.25	0.0077
TOTAL	**65**	**65**	**0**	**8.37**	**0.51**

Expected ratio = 1:2:1
$g^2 = 0.51$
Probability value for g^2 = 0.75-0.50

Table 47: Phenotypic Expression of Fruit shape in cross Uhie (Triangular-long) x Agwu (Conical-short) Okra genotypes

	PHENOTYPES						
Fruit shape	**P_1 (UHIE)**	**P_2(AGWU)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Triangular-long	81	0	0	18	31	17	**147**
Conical-short	0	69	0	7	15	25	**116**
Conical-long	0	0	73	59	20	32	**184**
TOTAL	**81**	**69**	**73**	**84**	**66**	**74**	**447**

Table 48: Chi-Square Estimate of Fruit shape in F_2 progenies progenies in cross Uhie (Triangular-long) x Agwu (Conical-short) Okra Genotypes

	Observed	**Expected**			
Fruit shape	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**
Triangular-long	18	21	-3	9	0.43
Conical-short	7	21	-14	196	9.33
Conical-long	59	42	17	289	6.88
TOTAL	**84**	**84**	**0**	**494**	**16.64**

Expected ratio = 1:2:1
$g^2 = 16.64$
Probability value for g^2 = 0.05-0.01

Table 49: Phenotypic Expression of Fruit shape in cross Uhie (Triangular-long) x Clemson (Cylindrical-long) Okra genotypes

	PHENOTYPES						
Fruit shape	**P_1 (UHIE)**	**P_2(CLEMSON)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Triangular-long	81	0	0	27	59	14	**181**
Cylindrical-long	0	71	49	57	30	49	**256**
TOTAL	**81**	**71**	**49**	**84**	**89**	**63**	**437**

Table 50: Chi-Square Estimate of Fruit shape in F_2 progenies progenies in cross Uhie (Triangular-long) x Clemson (Cylindrical-long) Okra Genotypes

	Observed	**Expected**				
Fruit shape	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Triangular-long	27	21	6	36	1.71	1.44
Cylindrical-long	57	63	-6	36	0.57	0.67
TOTAL	**84**	**84**	**0**	**72**	**2.28**	**2.11**

Expected ratio = 3:1 $\chi^2 = 2.28$ Corrected $\chi^2 = 2.11$

Probability value for $\chi^2 = 0.10\text{-}0.05$

Probability value for corrected $\chi^2 = 0.10\text{-}0.05$

Table 51: Phenotypic Expression of Fruit shape in cross Uhie (Triangular-long) x LD88 (Lanceolate) Okra genotypes

	PHENOTYPES						
Fruit shape	**P_1 (UHIE)**	**P_2 (LD88)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Triangular-long	81	0	0	16	38	14	**149**
Lanceolate	0	85	0	28	17	41	**171**
Lanceolate-long	0	0	58	39	23	31	**151**
TOTAL	**81**	**85**	**58**	**83**	**78**	**86**	**471**

Table 52: Chi-Square Estimate of Fruit shape in F_2 progenies progenies in cross Uhie (Triangular-long) x LD88 (Lanceolate) Okra Genotypes

	Observed	**Expected**			
Fruit shape	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**
Triangular-long	16	20.75	-4.75	22.56	1.09
Lanceolate	28	20.75	7.25	52.56	2.53
Lanceolate-long	39	41.50	-2.50	6.25	0.15
TOTAL	**83**	**83**	**0**	**81.37**	**3.77**

Expected ratio = 1:2:1

$\chi^2 = 3.77$

Probability value for $\chi^2 = 0.25\text{-}0.10$

Inheritance Pattern of Fruit Pubescence

In Table 53, the cross between Agwu (intermediate smooth) and Clemson (very smooth) resulted in all intermediate smooth F_1s. The F_2s segregated into 53 intermediate smooth and 27 very smooth fruits. The corrected chi square value of 3.05 at probability level of 0.05-0.01 was obtained. The observed ratio fit into the expected ratio of 3:1, thus indicating there was no significant difference (Table 54).

Agwu (intermediate smooth) x LD88 (intermediate smooth) resulted in F_1s with intermediate smooth fruits. The F_2s segregated into 49 intermediate smooth and 19 very smooth fruits (Table 55). Corrected chi square value of 0.25-0.10 at probability level of 0.50 was obtained. The observed ratio fit into the expected ratio of 3:1, thus indicating there was significant difference (Table 56).

In Table 57, the cross between Clemson (very smooth) and LD88 (intermediate smooth) gave F_1s of 62 intermediate smooth fruits. The F_2s segregated into 22 very smooth and 36 intermediate smooth fruits. Corrected chi square value of 4.85 at probability level of 0.05-0.01 was obtained. The observed ratio did not fit into the expected ratio of 3:1, thus indicating there was significant difference (Table 58).

In Table 59, the cross Ogwu (very prickly) x Agwu (intermediate smooth) produced all slightly prickly F_1 fruits. The F_2 fruits segregated into 25 very prickly, 12 intermediate smooth and 33 slightly prickly. Chi square value of 32.05 at probability level of 0.25-0.10 was obtained. Observed ratio fit into the expected ratio of 3:1, thus indicating there was no significant difference (Table 60).

In Table 61, the cross between Ogwu (very prickly) and Clemson (very smooth) produced all intermediate prickly F_1s. The F_2 fruits segregated into 9 very prickly, 14 very smooth and 33 intermediate prickly. At probability level of 0.25-0.10, the chi square value of 2.68 was obtained. Observed ratio fit into the expected ratio of 1:1:2, thus indicating no significant difference (Table 62).

In Table 63, the cross between Ogwu (very prickly) and LD88 (intermediate smooth) produced all F_1s as intermediate prickly. The F_2s segregated into 23 very prickly, 17 slightly smooth and 31 intermediate prickly. Table 64 showed that at probability level of 0.25-0.10, chi square value of 2.15 was obtained. The observed ratio fit into the expected ratio of 1:2:1, thus indicating no significant difference.

Table 65 showed the cross between Ogwu (very prickly) and Uhie (very smooth) produced all intermediate prickly F_1 fruits. The F_2 fruits segregated into 25 very prickly, 8 very smooth and 32 intermediate prickly. At probability level of 0.05-0.01, chi square value of 8.91 was obtained. The observed ratio did not fit into the expected ratio of 1:2:1, thus indicating there was significant difference (Table 66).

Table 67 showed that the cross between Uhie (very smooth) and Agwu (intermediate smooth) produced all intermediate smooth F_1s. The F_2s segregated into 69 very smooth and 15 intermediate smooth fruits. Table 64 showed that at probability level of 0.05-0.01, corrected chi square value of 2.49 was obtained. The observed ratio did not fit into the expected ratio of 3:1, thus indicating significant difference (Table 68).

In Table 69, the cross between Uhie (very smooth) and Clemson (very smooth) produced all very smooth F_1 fruits. The F_2 segregated into 81 very smooth and 3 intermediate smooth fruits. Corrected chi square value of 21.16 was obtained at probability level of 0.05-0.01. The observed ratio did not fit into the expected ratio of 3:1, thus indicating that there was significant difference (Table 70).

In Table 71, the cross between Uhie (very smooth) and LD88 (intermediate smooth), produced all intermediate smooth F_1 fruits. The F_2 fruits segregated into 38 very smooth and 45 intermediate smooth. Corrected chi square value of 18.58 was obtained at probability level of 0.05-0.01. The observed ratio did not fit into the expected ratio of 3:1, thus indicating there was significant difference (Table 72).

Table 53: Phenotypic Expression of Fruit pubescence in crosses Agwu (Intermediate smooth) x Clemson (Very smooth) Okra genotypes

	PHENOTYPES						
Fruit Pubescence	**P_1(AGWU)**	**P_2(CLEMSON)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Intermediate smooth	69	0	48	53	45	39	**254**
Very smooth	0	71	0	27	11	28	**137**
TOTAL	**69**	**71**	**48**	**80**	**56**	**67**	**391**

Table 54: Chi-Square Estimate of Fruit pubescence in F_2 progenies progenies in cross Agwu (Intermediate smooth) x Clemson (Very smooth) Okra Genotypes

	Observed	Expected				
Fruit pubescence	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Intermediate smooth	53	60	-7	49	0.82	0.94
Very smooth	27	20	7	49	2.45	2.11
TOTAL	**80**	**80**	**0**	**98**	**3.27**	**3.05**

Expected ratio = 3:1
χ^2 = 3.27
Corrected χ^2 = 3.05
Probability value for χ^2 = 0.05-0.01
Probability value for corrected χ^2 = 0.05-0.01

Table 55: Phenotypic Expression of Fruit pubescence in crosses Agwu (Intermediate smooth) x LD88 (Intermediate smooth) Okra genotypes

	PHENOTYPES						
Fruit Pubescence	**P_1(AGWU)**	**P_2(LD88)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Intermediate smooth	69	85	78	49	37	51	**369**
Very smooth	0	0	0	19	29	17	**65**
TOTAL	**69**	**85**	**78**	**68**	**66**	**68**	**434**

Table 56: Chi-Square Estimate of Fruit pubescence in F_2 progenies progenies in cross Agwu (Intermediate smooth) x LD88 (Intermediate smooth) Okra Genotypes

	Observed	Expected				
Fruit pubescence	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Intermediate smooth	49	51	-2	4	0.08	0.12
Very smooth	19	17	2	4	0.24	0.13
TOTAL	**68**	**68**	**0**	**8**	**0.32**	**0.25**

Expected ratio = 3:1
χ^2 = 0.32
Corrected χ^2 = 0.25
Probability value for χ^2 = 0.50-0.25
Probability value for corrected χ^2 = 0.50-0.25

Table 57: Phenotypic Expression of Fruit pubescence in crosses Clemson (Very smooth) x LD88 (Intermediate smooth) Okra genotypes

	PHENOTYPES						
Fruit Pubescence	**P_1(CLEMSON)**	**P_2(LD88)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Very smooth	71	0	0	22	36	18	**147**
Intermediate smooth	0	85	62	36	28	45	**256**
TOTAL	**71**	**85**	**62**	**58**	**64**	**63**	**403**

Table 58: Chi-Square Estimate of Fruit pubescence in F_2 progenies progenies in cross Clemson (Very smooth) x LD88 (Intermediate smooth) Okra Genotypes

	Observed	**Expected**				
Fruit pubescence	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Very smooth	22	14.50	7.50	56.25	3.88	3.38
Intermediate smooth	36	43.50	-7.50	56.25	1.29	1.47
TOTAL	**58**	**58**	**0**	**112.50**	**5.17**	**4.85**

Expected ratio = 3:1 $\chi^2 = 5.17$ Corrected $\chi^2 = 4.85$
Probability value for $\chi^2 = 0.05$-0.01
Probability value for corrected $\chi^2 = 0.05$-0.01

Table 59: Phenotypic Expression of Fruit pubescence in cross Ogwu (very prickly) x Agwu (intermediate smooth) Okra genotypes

	PHENOTYPES						
Fruit pubescence	**P_1(OGWU)**	**P_2(AGWU)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Very prickly	78	0	0	25	45	27	**175**
Intermediate smooth	0	68	0	12	0	19	**99**
Slightly prickly	0	0	61	33	18	29	**141**
TOTAL	**78**	**68**	**61**	**70**	**63**	**75**	**415**

Table 60: Chi-Square Estimate of Fruit pubescence in F_2 progenies progenies in cross Ogwu (very prickly) x Agwu (intermediate smooth) Okra Genotypes

	Observed	**Expected**			
Fruit pubescence	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**
Very prickly	25	17.5	7.5	56.25	3.21
Intermediate smooth	12	35	-23	529	15.11
Slightly prickly	33	17.5	15.5	240.25	13.73
TOTAL	**70**	**70**	**0**	**825.5**	**32.05**

Expected ratio = 1:2:1 $\chi^2 = 32.05$
Probability value for $\chi^2 = 0.25$-0.10

Table 61: Phenotypic Expression of Fruit Pubescence in cross Ogwu (Very prickly) x Clemson (Very Smooth) Okra genotypes

	PHENOTYPES						
Fruit Pubescence	**P_1(OGWU)**	**P_2(CLEMSON)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Very prickly	78	0	0	9	19	5	**111**
Very smooth	0	71	0	14	0	23	**108**
Intermediate prickly	0	0	69	33	42	57	**201**
TOTAL	**78**	**71**	**69**	**56**	**61**	**85**	**420**

Table 62: Chi-Square Estimate of Fruit Pubescence in F_2 progenies progenies in cross Ogwu (Very prickly) x Clemson (Very smooth) Okra Genotypes

	Observed	**Expected**			
Fruit pubescence	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**
Very prickly	9	14	-5	25	1.79
Very smooth	14	14	0	0	0
Intermediate prickly	33	28	5	25	0.89
TOTAL	**56**	**56**	**0**	**50**	**2.68**

Expected ratio = 1:1:2 $\chi^2 = 2.68$

Probability value for $\chi^2 = 0.25\text{-}0.10$

Table 63: Phenotypic Expression of Fruit pubescence in crosses Ogwu (Very prickly) x LD88 (intermediate Smooth) Okra genotypes

	PHENOTYPES						
Fruit Pubescence	**P_1(OGWU)**	**P_2(LD88)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Very prickly	78	0	0	23	21	11	**133**
Intermediate smooth	0	85	0	17	4	24	**130**
Intermediate prickly	0	0	57	31	36	47	**171**
TOTAL	**78**	**85**	**57**	**71**	**61**	**82**	**434**

Table 64: Chi-Square Estimate of Fruit pubescence in F_2 progenies progenies in cross Ogwu (Very prickly) x LD88 (Slightly smooth) Okra Genotypes

	Observed	**Expected**			
Fruit pubescence	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**
Very prickly	23	17.75	5.25	27.56	1.55
Slightly smooth	17	17.75	-0.75	0.56	0.03
Intermediate prickly	31	35.50	-4.50	20.25	0.57
TOTAL	**71**	**71**	**0**	**48.37**	**2.15**

Expected ratio = 1:2:1

$\chi^2 = 2.15$

Probability value for $\chi^2 = 0.25\text{-}0.10$

Table 65: Phenotypic Expression of Fruit pubescence in crosses Ogwu (Very prickly) x Uhie (Very smooth) Okra genotypes

	PHENOTYPES						
Fruit Pubescence	**P_1(OGWU)**	**P_2(UHIE)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Very prickly	78	0	0	25	48	11	**162**
Very smooth	0	81	0	8	0	14	**103**
Intermediate prickly	0	0	61	32	16	31	**140**
TOTAL	**78**	**81**	**61**	**65**	**64**	**56**	**405**

Table 66: Chi-Square Estimate of Fruit pubescence in F_2 progenies progenies in cross Ogwu (Very prickly) x Uhie (Very smooth) Okra Genotypes

	Observed	**Expected**			
Fruit pubescence	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**
Very prickly	25	16.25	8.75	76.56	4.71
Smooth	8	16.25	-8.25	68.06	4.19
Intermediate prickly	32	32.50	-0.50	0.25	0.008
TOTAL	**65**	**65**	**0**	**144.87**	**8.91**

Expected ratio = 1:2:1
$\chi^2 = 8.91$
Probability value for $\chi^2 = 0.05$-0.01

Table 67: Phenotypic Expression of Fruit pubescence in cross Uhie (Very smooth) x Agwu (Intermediate smooth) Okra genotypes

	PHENOTYPES						
Fruit pubescence	**P_1 (UHIE)**	**P_2(AGWU)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Very smooth	81	0	0	69	21	0	**171**
Intermediate smooth	0	69	73	15	45	74	**276**
TOTAL	**81**	**69**	**73**	**84**	**66**	**74**	**447**

Table 68: Chi-Square Estimate of Fruit pubescence in F_2 progenies progenies in cross Uhie (Very smooth) x Agwu (Intermediate smooth)

	Observed	**Expected**				
Fruit pubescence	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Very smooth	69	63	6	36	0.57	0.48
Intermediate smooth	15	21	-6	36	1.71	2.01
Total	84	84	0	72	2.28	2.49

Expected ratio = 3:1 $\chi^2 = 2.28$ Corrected $\chi^2 = 2.49$
Probability value for $\chi^2 = 0.05$-0.01
Probability value for corrected $\chi^2 = 0.05$-0.01

Table 69: Phenotypic Expression of Fruit pubescence in crosses Uhie (Very smooth) x Clemson (Very smooth) Okra genotypes

	PHENOTYPES						
Fruit Pubescence	**P_1(UHIE)**	**P_2(CLEMSON)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Very smooth	81	71	49	81	89	52	**426**
Intermediate smooth	0	0	0	3	0	11	**14**
TOTAL	**81**	**71**	**49**	**84**	**89**	**63**	**437**

Table 70: Chi-Square Estimate of Fruit pubescence in F_2 progenies progenies in cross Uhie (Very smooth) x Clemson (Very smooth) Okra Genotypes

	Observed	**Expected**				
Fruit pubescence	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Very smooth	81	63	18	324	5.14	4.86
Intermediate smooth	3	21	-18	324	15.43	16.30
TOTAL	**84**	**84**	**0**	**648**	**20.57**	**21.16**

Expected ratio = 3:1
χ^2 = 20.57
Corrected χ^2 = 21.16
Probability value for χ^2 = 0.05-0.01
Probability value for corrected χ^2 = 0.05-0.01

Table 71: Phenotypic Expression of Fruit pubescence in crosses Uhie (Very smooth) x LD88 (Intermediate smooth) Okra genotypes

	PHENOTYPES						
Fruit Pubescence	**P_1(UHIE)**	**P_2(LD88)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Very smooth	81	0	0	38	40	63	**222**
Intermediate smooth	0	85	58	45	38	23	**249**
TOTAL	**81**	**85**	**58**	**83**	**78**	**86**	**471**

Table 72: Chi-Square Estimate of Fruit pubescence in F_2 progenies progenies in cross Uhie (Very smooth) x LD88 (Intermediate smooth) Okra Genotypes

	Observed	**Expected**				
Fruit pubescence	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Very smooth	38	20.75	17.25	297.56	14.34	13.52
Intermediate smooth	45	62.25	-17.25	297.56	4.78	5.06
TOTAL	**83**	**83**	**0**	**595.12**	**19.12**	**18.58**

Expected ratio = 3:1 χ^2 = 19.12 Corrected χ^2 = 18.58
Probability value for χ^2 = 0.05-0.01
Probability value for corrected χ^2 = 0.05-0.01

Inheritance Pattern of Fruit Colour

In Tables 73 and 74, the cross between Agwu (intermediate green) and Clemson (yellow green) produced all yellow green F_1s. The F_2 segregated into 65 yellow green and 15 intermediate green. Corrected chi square value of 1.85 at probability level of 0.25-0.10 was obtained. The observed ratio fit into the expected ratio of 3:1, thus indicating there was no significant difference.

In Table 75, the cross, Agwu (intermediate green) x LD88 (dark green) produced all intermediate green F_1s. The F_2 fruits segregated into 53 intermediate green and 15 dark green. At probability level of 0.50-0.25, corrected chi square value of 0.41 was obtained. The observed ratio fit into the expected ratio of 3:1, thus indicating there was no significant difference (Table 76).

In Table 77, the cross between Clemson (yellow green) and LD88 (dark green) produced all 62 F_1s as yellow green. The F_2s segregated into 38 yellow green and 20 dark green. Corrected chi square of 2.55 at probability level of 0.10-0.05 was obtained. There was significant difference because the observed ratio did not fit into the expected ratio of 3:1 (Table 78).

In Table 79, the cross between Ogwu (dark green) and Agwu (intermediate green) produced all intermediate green F_1 fruits. The F_2s segregated into 17 dark green and 53 yellow green. Corrected chi square value of 94.69 at probability level of 0.05-0.01 was obtained. The observed ratio fit into the expected ratio of 3:1, thus indicating there was no significant difference (Table 80).

In Table 81, the cross between Ogwu (dark green) and Clemson (yellow green), produced all 69 yellow green F_1 fruits. The F_2 fruits segregated into 19 dark green and 37 yellow green. The corrected chi square value of 2.17 at probability level of 0.10-0.05 was obtained. The observed ratio did not fit into the expected ratio of 3:1, thus implying that there was significant difference (Table 82).

In Table 83 and 84, the cross between Ogwu (dark green) and LD88 (dark green) resulted in all dark green F_1s. The F_2s segregated into 66 dark green and 5 intermediate green. At expected ratio

of 3:1, corrected chi square value of 12.71 at 0.05-0.01 probability level was obtained. The observed ratio did not fit into the expected ratio, thus implying that there was significant difference.

In Table 85, the cross Ogwu (dark green) and Uhie (green with pink patches) gave F_1s of green with pink patches. The F_2s segregated into 24 dark green, 34 green with pink patches and 7 with pink with green patches. Chi square estimate value of 9.04 at 0.05-0.01 probability level was obtained. The observed ratio did not fit into expected ratio of 1:2:1, thus implying that there was significant difference (Table 86).

In Table 87, the cross between Uhie (green with pink patches) and Agwu (intermediate green) resulted in F_1s of green with pink patches. The F_2s segregated into 72 green with pink patches and 12 dark green. At corrected chi square value of 4.76 and probability value of 0.05-0.01, the observed ratio did not fit into the expected ratio of 3:1, thus implying there was significant difference (Table 88).

In Table 89, the cross Uhie (green with pink patches) x Clemson (yellow green) resulted in all F_1s with green and pink patched fruits. The F_2 segregated into 60 green with pink patches and 24 yellow green fruits. The corrected chi square estimate value of 0.48 at 0.50-0.25 probability level was obtained. The observed ratio fit into the expected ratio of 3:1. There was no significant difference (Table 90).

In Table 91, the cross between Uhie (green with pink patches) and LD88 (dark green) resulted in F_1s of green with pink patches. The F_2s segregated into 49 green with pink patches, 18 with dark green and 16 with pink with green patches. The chi square estimate value of 2.81 at probability level of 0.25-0.10 was obtained. The observed ratio did not fit into the expected ratio of 1:2:1, thus indicating that there was significant difference (Table 92).

Table 73: Phenotypic Expression of Fruit colour in cross Agwu (intermediate green) x Clemson (Yellow green) Okra genotypes

	PHENOTYPES						
Fruit colour	**P_1(AGWU)**	**P_2(CLEMSON)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Yellow green	69	0	48	65	43	60	**356**
Intermediate green	0	71	0	15	13	7	**35**
TOTAL	**69**	**71**	**48**	**80**	**56**	**67**	**391**

Table 74: Chi-Square Estimate of Fruit colour in F_2 progenies progenies in Agwu (Yellow green) x Clemson (Yellow green) Okra Genotypes

	Observed	**Expected**				
Fruit colour	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Yellow green	65	60	5	25	0.42	0.34
Intermediate-green	15	20	-5	25	1.25	1.51
TOTAL	**80**	**80**	**0**	**50**	**1.67**	**1.85**

Expected ratio = 3:1 $\chi^2 = 1.67$ Corrected $\chi^2 = 1.85$
Probability value for $\chi^2 = 0.25\text{-}0.10$
Probability value for corrected $\chi^2 = 0.25\text{-}0.10$

Table 75: Phenotypic Expression of Fruit colour in cross Agwu (intermediate green) x LD88 (Dark green) Okra genotypes

	PHENOTYPES						
Fruit colour	**P_1(AGWU)**	**P_2 (LD88)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Intermediate green	69	0	78	53	62	27	**289**
Dark green	0	85	0	15	4	41	**145**
TOTAL	**69**	**85**	**78**	**68**	**66**	**68**	**434**

Table 76: Chi-Square Estimate of Fruit colour in F_2 progenies progenies in Agwu (intermediate green) x LD88 (Dark green) Okra Genotypes

	Observed	**Expected**				
Fruit colour	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Intermediate green	53	51	2	4	0.08	0.04
Dark green	15	17	-2	4	0.24	0.37
TOTAL	**68**	**68**	**0**	**8**	**0.32**	**0.41**

Expected ratio = 3:1
$\chi^2 = 0.32$
Corrected $\chi^2 = 0.41$
Probability value for $\chi^2 = 0.50\text{-}0.25$
Probability value for corrected $\chi^2 = 0.50\text{-}0.25$

Table 77: Phenotypic Expression of Fruit colour in cross Clemson (Yellow green) x LD88 (Dark green) Okra genotypes

	PHENOTYPES						
Fruit colour	**P_1(CLEMSON)**	**P_2 (LD88)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Yellow green	71	0	62	38	50	38	**259**
Dark green	0	85	0	20	14	25	**144**
TOTAL	**71**	**85**	**62**	**58**	**64**	**63**	**403**

Table 78: Chi-Square Estimate of Fruit colour in F_2 progenies progenies in Clemson (Yellow green) x LD88 (Dark green) Okra Genotypes

	Observed	**Expected**				
Fruit colour	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Yellow green	38	43.50	-5.50	30.25	0.70	0.83
Dark green	20	14.50	5.50	30.25	2.09	1.72
TOTAL	**58**	**58**	**0**	**60.50**	**2.79**	**2.55**

Expected ratio = 3:1
$g^2 = 2.79$
Corrected $g^2 = 2.55$
Probability value for $g^2 = 0.100.05$
Probability value for corrected $g^2 = 0.10\text{-}0.05$

Table 79: Phenotypic Expression of Fruit colour in cross Ogwu (dark green) x Agwu (intermediate green) Okra genotypes

	PHENOTYPES						
Fruit colour	**P_1(OGWU)**	**P_2(AGWU)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Dark green	78	0	0	17	35	0	**130**
Intermediate green	0	68	61	53	28	75	**285**
TOTAL	**78**	**68**	**61**	**70**	**63**	**75**	**415**

Table 80: Chi-Square Estimate of Fruit colour in F_2 progenies progenies in cross Ogwu (dark green) x Agwu (intermediate green) Okra Genotypes

	Observed	**Expected**				
Fruit colour	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Dark green	17	52.5	-35.5	1260.25	24	24.69
Intermediate green	53	17.5	35.5	1260.25	72.01	70
TOTAL	**70**	**70**	**0**	**2520.5**	**96.01**	**94.69**

Expected ratio = 3:1 $g^2 = 96.01$
Corrected $g^2 = 94.69$

Probability value for $g^2 = 0.05$

Probability value for corrected $g^2 = 0.05\text{-}0.01$

Table 81: Phenotypic Expression of Fruit colour in cross Ogwu (Dark green) x Clemson (Yellow green) Okra genotypes

	PHENOTYPES						
Fruit Colour	**P_1(OGWU)**	**P_2(CLEMSON)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Dark green	78	0	0	19	25	11	**133**
Yellow green	0	71	69	37	36	74	**287**
TOTAL	**78**	**71**	**69**	**56**	**61**	**85**	**420**

Table 82: Chi-Square Estimate of Fruit colour in F_2 progenies progenies in cross Ogwu (Dark green) x Clemson (Yellow green) Okra Genotypes

	Observed	**Expected**				
Fruit colour	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Dark green	19	14	5	25	1.79	1.45
Yellow green	37	42	-5	25	0.60	0.72
TOTAL	**56**	**56**	**0**	**50**	**2.39**	**2.17**

Expected ratio = 3:1
$\chi^2 = 2.39$
Corrected $\chi^2 = 2.17$
Probability value for $\chi^2 = 0.10$ Probability value for corrected $\chi^2 = 0.10\text{-}0.05$

Table 83: Phenotypic Expression of Fruit colour in cross Ogwu (Dark green) x LD88 (Dark green) Okra genotypes

	PHENOTYPES						
Fruit colour	**P_1(OGWU)**	**P_2(LD88)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Dark green	78	85	57	66	61	69	**359**
Intermediate green	0	0	0	5	0	13	**75**
TOTAL	**78**	**85**	**57**	**71**	**61**	**82**	**434**

Table 84: Chi-Square Estimate of Fruit colour in F_2 progenies progenies in cross Ogwu (Dark green) x LD88 (Dark green) Okra Genotypes

	Observed	**Expected**				
Fruit colour	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Dark green	66	53.25	12.75	162.56	3.05	2.82
Intermediate green	5	17.75	-12.75	162.56	9.16	9.89
TOTAL	**71**	**71**	**0**	**325.12**	**12.21**	**12.71**

Expected ratio = 3:1
$\chi^2 = 12.21$
Corrected $\chi^2 = 12.71$
Probability value for $\chi^2 = 0.01$
Probability value for corrected $\chi^2 = 0.05\text{-}0.01$

Table 85: Phenotypic Expression of Fruit colour in cross Ogwu (Dark green) x Uhie (Green with pink patches) Okra genotypes

	PHENOTYPES						
Fruit colour	**P_1(OGWU)**	**P_2(UHIE)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Dark green	78	0	0	24	35	7	**144**
Green with pink patches	0	81	61	34	27	34	**227**
Pink with green patches	0	0	0	7	2	15	**24**
TOTAL	**78**	**81**	**61**	**65**	**64**	**56**	**405**

Table 86: Chi-Square Estimate of Fruit colour in F_2 progenies progenies in cross Ogwu (Dark green) x Uhie (Green with pink patches) Okra Genotypes

	Observed	**Expected**			
Fruit colour	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**
Dark green	24	16.25	7.75	60.06	3.70
Green with pink patches	34	32.50	1.50	2.25	0.07
Pink with green patches	7	16.25	-9.25	85.56	5.27
TOTAL	**65**	**65**	**0**	**147.87**	**9.04**

Expected ratio = 1:2:1
$\chi^2 = 9.04$
Probability value for $\chi^2 = 0.05$-0.01

Table 87: Phenotypic Expression of Fruit colour in cross Uhie (Green with pink patches) x Agwu (intermediate green) Okra genotypes

	PHENOTYPES						
Fruit colour	**P_1 (UHIE)**	**P_2(AGWU)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Green with pink patches	81	0	73	72	44	48	**318**
Intermediate green	0	69	0	12	0	17	**98**
Pink with green patches	0	0	0	0	22	9	**31**
TOTAL	**81**	**69**	**73**	**84**	**66**	**74**	**447**

Table 88: Chi-Square Estimate of Fruit colour in F_2 progenies progenies in cross Uhie (Green with pink patches) x Agwu (Yellow green) Okra Genotypes

	Observed	**Expected**				
Fruit colour	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Green with pink patches	72	63	9	81	1.29	1.15
Yellow green	12	21	-9	81	3.86	3.61
TOTAL	**84**	**84**	**0**	**162**	**5.15**	**4.76**

Expected ratio = 3:1 $\chi^2 = 5.15$ Corrected $\chi^2 = 4.76$
Probability value for $\chi^2 = 0.01$ Probability value for corrected $\chi^2 = 0.05$-0.01

Table 89: Phenotypic Expression of Fruit colour in cross Uhie (Green with pink patches) x Clemson (Yellow green) Okra genotypes

	PHENOTYPES						
Fruit colour	**P_1 (UHIE)**	**P_2(CLEMSON)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Green with pink patches	81	0	49	60	38	29	**257**
Yellow green	0	71	0	24	14	22	**131**
Pink with green patches	0	0	0	0	37	12	**49**
TOTAL	**81**	**71**	**49**	**84**	**89**	**63**	**437**

Table 90: Chi-Square Estimate of Fruit colour in F_2 progenies in cross Uhie (Green with pink patches) x Clemson (Yellow green) Okra Genotypes

	Observed	**Expected**				
Fruit colour	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**	**$(/O-E/-0.5)^2/E$**
Green with pink patches	60	63	-3	9	0.14	0.19
Yellow green	24	21	3	9	0.43	0.30
TOTAL	**84**	**84**	**0**	**18**	**0.57**	**0.49**

Expected ratio = 3:1 $\chi^2 = 0.57$ Corrected $\chi^2 = 0.49$
Probability value for $\chi^2 = 0.50\text{-}0.25$
Probability value for corrected $\chi^2 = 0.50\text{-}0.25$

Table 91: Phenotypic Expression of Fruit colour in cross Uhie (Green with pink patches) x LD88 (Dark green) Okra genotypes

	PHENOTYPES						
Fruit colour	**P_1 (UHIE)**	**P_2 (LD88)**	**F_1**	**F_2**	**BC_1**	**BC_2**	**TOTAL**
Green with pink patches	81	0	58	49	21	64	**273**
Dark green	0	85	0	18	0	9	**112**
Pink with green patches	0	0	0	16	57	13	**86**
TOTAL	**81**	**85**	**58**	**83**	**78**	**86**	**471**

Table 92: Chi-Square Estimate of Fruit colour in F_2 progenies progenies in cross Uhie (Green with pink patches) x LD88 (Dark green) Okra Genotypes

	Observed	**Expected**			
Fruit colour	**(O)**	**(E)**	**(O-E)**	**$(O-E)^2$**	**$(O-E)^2/E$**
Green with pink patches	49	41.50	7.50	56.25	1.36
Dark green	18	20.75	-2.75	7.56	0.36
Pink with green patches	16	20.75	-4.75	22.56	1.09
TOTAL	**83**	**83**	**0**	**86.37**	**2.81**

Expected ratio = 1:2:1
$\chi^2 = 2.81$
Probability value for $\chi^2 = 0.25\text{-}0.10$

DISCUSSION

The significant differences that occurred in all the parental accessions and the hybrids for the traits of interest studied showed that appreciable diversity existed in the parents and their related hybrids. The occurrence of significant genotypic differences among the parents and their hybrids is in line with the views of Rao (1972), Kuleung *et al*. (2006), Moncada *et al*. (2007), Shengbin *et al*. (2007) and Abdel-Moneam (2009), who posited that the success of any plant breeding programme is dependent to a very large degree on the genetic diversity of the available germplasm. Similarly, Eshiet and Brisibe (2015), were of the opinion that significant differences in some of the traits is an indication that genetic diversity exists among the varieties, thereby providing a basis for selection. Joshi (1979) and Lee *et al*. (2008) opined that involving genetically diverse parents in crossing could be advantageous in the sense that it would provide an opportunity for bringing together gene constellations of divergent origin. óAgwu earlyô parent that initiated flower buds, flowered and fruited earlier than all the parental accessions indicated earlier maturity. The results agreed with the report of Reddy *et al.* (2012) that days to 50% flowering, first flowering node, and first fruiting node are indicators of earliness in okra. Early flowering not only gives early pickings and better returns but also widens fruiting period of the plant. On the other hand, the late maturing parents, õEle Uhieô, õEle Nduô and õEle Ogwuô had higher total fruit yield of 32.56 t/ha, 30.59 t/ha and 11.51 t/ha, respectively, though they matured later than the other parents. The results agreed with the report of Udengwu (2008) that, late maturing okra vareties, with longer critical day length (CDL) as influenced by high photoperiodic sensitivity had enlongated vegetative and reproductive growth, especially when early planting is made. This subsequently results in increased fruit size, fruit length, fruit girth, number of fruits/plant as well as increased fruit yield. Agwu early with lower plant height at maturity, had the smallest fruit size. It indicated that plant height at maturity is a good indicator of fruit size of okra plants. The F_1 hybrids which comprised of mostly crosses between local parents and improved parents were intermediate in days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruit appearance, days to maturity, plant height at maturity and number of fruits/plant. These suggest an occurrence of incomplete dominance as the local parents were mostly favoured. The results agreed with the report of Adiger *et al.* (2013), that hybrids obtained from crosses between local and exotic varieties were intermediate in productivity to their related parents. On the other hand, the mean values of hybrids were lower

than those of their local parents for traits such as plant height at maturity, number of fruits/plant, number of branches/plant, number of fruits/stem, number of fruits/branch and total fruit yield. These suggest that the local parents performed better than the resulting hybrids for the aforementioned traits. Most of the hybrids generated matured earlier, owing to their lower days to germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting and days to edible fruit maturity. This suggests that the early maturing parents were mostly favoured in these traits. Reddy *et al*. (2012a) reported similar trend in their studies.

Heterosis

Heterosis is the phenomenon observed when the F_1 progeny of a cross exhibit improved or transgressive values for growth or other traits when compared to their parents. In plants, heterosis is often considered to be a complex and multigenic trait, involving alterations to numerous quantitative traits.

The magnitude of heterosis depends on the accumulation of favourable dominant alleles in the F_1 population (Amaefula *et al*., 2014). High positive mid parent heterosis (MPH) observed in the growth and yield attributes for most of the hybrids, suggests that those crosses performed better than their mid parents. The negative MPH obtained in days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting and days to edible fruit maturity for crosses involving local and improved parents, were desirable traits, indicating that those crosses matured earlier than their mid parents. Positive MPH was observed in all the fruit traits with the exception of ‘OGW x AGW’, ‘OGW x CLM’ and ‘OGW x LD88’. It could be a result of narrow genetic differences for the fruit traits among most of the hybrids generated.

The negative better parent heterosis (BPH) observed in days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruit appearance and days to edible fruit maturity in most of the hybrids, especially those involving local and improved parents, showed that those hybrids matured earlier than the better parents that were mostly photoperiodically sensitive. It coheres with the report of Njoku (1958), Oyolu (1977), and Udengwu (1998) that days to flower opening in crosses involving local and improved okra, all exhibited negative heterosis. It implies that, days to germination, days to flower bud initiation,

days to anthesis, days to 50% flowering, days to first fruiting and days to fruit maturity determine the earliness or lateness of a variety. Shorter days to the aforementioned traits indicate earliness, while longer days indicate lateness. Abdelmageed (2010) observed similar trend in his studies. In general, earliness is associated with earlier days to anthesis, days to 50% flowering and days to maturity. In general, negative heterosis is highly desirable for all the attributes of earliness. The relative positive BPH observed in number of branches/plant, number of fruits/plant, number of flowers/plant, number of fruits/stem and total fruit yield observed in most of the hybrids, having the local parent as the better parent was apparently due to preponderance of fixable gene effects. This suggests that number of fruits/plant, number of branches/plant, number of flowers/plant and number of fruits/stem influence total yield/plant, and are thus good indicators. For those traits, positive heterosis was desirable. Similar results were reported by Ahmed *et al.* (1999) and Jaiprakashnarayan *et al.* (2008) who reported positive BPH in number of branches/plant, number of branches/plant and number of fruits/plant. It also conformed with the report of Reddy *et al.* (2012) that high heterosis for total fruit yield observed in most hybrids could probably be due to combined heterosis of their component characters, such as branch length, number of branches/plant, number of fruits/branch and number of fruits/plant as those hybrids were not only heterosis in respect of total fruit yield but were also found superior for one of the corresponding yield components. It is obvious that high heterosis for yield was built up by the yield components. Hybrid vigour of even small magnitude for individual components may result in significant hybrid vigour for yield *per se.* Thus, the observed high heterosis for total fruit yield seems to be due to increase in the total number of fruits/plant, number of flowers/plant and number of branches/plant which are desirable requirements in okra improvement. Reddy and Kumar (2016) also reported similar trend in their studies.

Most of the hybrids exhibited negative BPH in plant height at maturity. It could be as a result of long distance in the traits between the local parents and the improved parents of which the local parent were not favoured. The result is in conformity with the report of Reddy and Kumar (2016) that most crosses between local okra and dwarf natured okra, displayed negative standard heterosis for plant height. Negative heterosis in some instances is desirable for plant height as it aids in development of short statured plants which helps in controlling lodging as well as ensuring ease in harvesting. It is in agreement with the findings of Eshiet and Brisibe (2015) that,

plant height at flowering and fruiting are of particular interest for breeding programmes because the presence of plants with tall and thin stems will increase the rate of lodging near harvesting and this could lead to loss of dry matter and subsequent decrease in fruit yield. It also conforms with the report of Abdul-Wahab *et al.* (2006) that, shorter plants with robust structure, possessing increased numbers of branches are considered more tolerant to winds hence, are more productive. In general, shorter plants are associated with resistance to lodging (Reddy *et al*., 2012b), although in some instances, for appreciable total fruit yield/plant, positive heterosis is desirable for plant height. This is because higher plant height mostly influence higher branching capability and increased production of fruit pods (Wammanda, 2007). Reddy and Kumar (2016) observed similar trend in their studies, whereby they reported that fruit size had positive BPH for most of the hybrids obtained. The positive BPH observed in fruit length for the crosses, óAGW x LD88ô, óCLM x LD88ô and óUHIE x CLMô showed that those crosses had higher fruit length than their better parents. Reduced fruit girth with increased fruit length are highly desirable traits required for okra improvement as they enhance acceptability, marketability, exportation and efficient processing (Udengwu, 2015). Similarly, according to Kumar *et al*. (2004), slender long varieties have higher demand and sales rate compared to other varieties because of ease of processing, relative glabrous fruit texture and high drawability when used in preparing African soup delicacies. Similarly, Mohapatra *et al.* (2007) reported that hybrids with positive heterosis are desirable for fruit length but negative heterosis for fruit diameter. The negative BPH recorded in 100 seed weight, number of ridges/pod and number of seeds/pod in all the hybrids generated showed that none of the crosses had increment in 100 seed weight, number of ridges/pod and number of seeds/pod. These factors contributed massively to the overall reduced fruit and seed yield of most of the hybrids compared to their better parents The result differs with the report of Udengwu (2008), who observed positive heterosis in 100 seed weight and number of seeds/pod. All the hybrids, with the exception of óOGW x UHIEô, óUHIE x AGWô and óUHIE x CLMô showed positive BPH in fruit weight and dry fruit weight. It was an indication that most of the hybrids had higher fruit weight and dry fruit weight than their better parents (Akhtar *et al*., 2010). The weight of fruits and the number of fruits/plant have been consistently identified as very important components of total fruit and seed yields (Reddy and Kumar, 2016).

Heritability

Heritability provides an idea of the extent of genetic control for the expression of a particular trait and the reliability of the phenotype in predicting its breeding value (Chopra, 2000). High heritability indicates less environmental influence in the observed variations (Mohanty, 2003; Eid, 2009). Broad sense heritability is the ratio of genotypic variance to phenotypic variance. High broad sense heritability (>70%) was obtained in most of the plant attributes studied in the crosses, with the exception of 100 seed weight, with lower broad sense heritability (<70%) in all the crosses.

Narrow sense heritability is the ratio of additive variance to phenotypic variance, and it is of great importance to breeders. The high narrow sense heritability (>50%) observed in different traits for the hybrids generated, showed that those traits were highly heritable with higher degree of variability in the various crosses. It further indicates that, the higher the heritability of a trait, the easier it is to modify that trait by selection. It agreed with the report of (Khanorkar and Kathiria, 2010), that the higher values of narrow sense heritability for a particular character indicated that it is controlled largely by genes acting in an additive fashion.The result also agreed with the reports of Nwangburuka *et al.,* (2012), who observed higher narrow sense heritability (>50) in number of branches/plant, total number of fruits/plant, total weight of fruits/plant which was an indication of high variability for those traits. High heritability estimates were also observed in days to 50% flowering, fruit length and fruit weight for most of the hybrids. It suggests that the genotypic factor had greater effect on the phenotypic performance of these traits. Hence selection based on the genotypic performance of these characters will be reliable and effective.

Moreso, days to 50% flowering, fruit weight, fruit length, number of branches/plant, number of fruits/plant and number of seeds/pod with high estimates of heritability observed in many of the hybrids, may be good predictors of improved fruit and seed yields in crops (Udengwu, 2008). Furthermore, high estimates of heritability observed in these traits, could be explained by additive gene action. It conforms to the report of Khanorkar and Kathiria (2010) who reported that the higher values of narrow-sense heritability for a particular character indicated that it is controlled largely by genes acting in an additive effect. In crops like okra, high narrow-sense

heritability estimates may be helpful for the development of improved varieties. With regards to number of fruits/branch and number of fruits/plant, high estimates of heritability was observed in some hybrids, which is due to the inflating effect of dominance and epistasis, which is usually associated with the latter and the dependency of narrow sense heritability on additive variance only (Nwangburuka *et al.* 2012).

Combining Ability

Knowledge of combining ability is essential for selection of suitable parents for hybridization and identification of promising hybrids in breeding programme (Adewusi *et al*., 2013). Additive and non-additive gene effects occurred in all traits studied except in days to 50% germination, number of flowers/plant and fruit girth in which only GCA effect was significant. Significant additive gene effect was exhibited in the following traits: number of branches/plant, number of fruits/branch, number of fruits/plant, number of flowers/plant, dry fruit weight and fruit girth and total fruit yield. Additive gene action was also predominant in dry fruit weight, fruit girth and fruit weight. It is in conformity with the report of Reddy *et al*. (2013) that both additive and non-additive gene actions were also important for both fruit width and fruit weight. It differed from the findings of Kumar *et al.* (2005) and Singh *et al*. (2006), who reported preponderance of non additive gene action. However, the result disagrees with the report of Reddy *et al*. (2013) that there was predominant role of non-additive gene action for total number of fruits and number of marketable fruits/plant. The result also disagreed with the findings of Dahake and Bangar (2006), Jaiprakashnarayan *et al.* (2008), Kumar *et al*. (2005) and Singh *et al.* (2006) who reported non-additive gene action on total number of fruits/plant.

Non additive gene action was predominant in days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting and days to edible fruit maturity. Those results agreed with the report of Reddy *et al.* (2013) that days to flower bud initiation and fifty percent flowering, suggests the preponderance of non additive gene action. Also, non additive gene effect was predominant in stem girth and plant height at maturity. The result conforms to the findings of Kumar *et al*. (2005) and Singh *et al*. (2006), who reported preponderance of non additive gene action. The current investigation further revealed that both

additive and non-additive gene effects were important in the genetic control of majority of the quantitative traits studied.

General combining and Specific combining abilities

General combining ability studies have led to making choices of suitable parents that will produce promising combination of the required traits (Singh *et al.,* 2011). Specific combining ability on the other hand, entails the manifestation of non-additive components of genetic variations that are not fixable in nature. There were significant differences in the GCA of the parents for all the growth, earliness and yield related traits. With regards to earliness, negative GCA and SCA values were good indicators that the parents and crosses were good combiners for the trait. óAgwu earlyô, óClemson spinelessô and óLD88ô were good combiners in days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting and days to edible fruit maturity. Similar results were reported by Arora (1993). óEle Uhieô was the best general combiner for number of branches/plant, number of fruits/branch, number of fruits/plant and number of flowers/plant and total fruit yield. óLD88ô was a good combiner for 100 seed weight. óLD88ô, óEle Ogwuô and óEle Uhieô were good general combiners for dry fruit weight, fruit girth and fruit weight. óClemson spinelessô was a good general combiner for fruit length while óLD88ô and óEle Uhieô parents were good general combiners for number of ridges/pod and number of seeds/pod. Those parents with good general combining abilities are considered possible donors for selection in a breeding programme to produce promising combinations for the desired traits.

SCA is often associated with interaction effect which may be due to dominance and epistatic components of variation that are non-fixable in nature. Hence, it is possible that crosses showing high *SCA* effects also had parents showing high *GCA* effects, in which case both additive and non-additive gene actions could be utilized (Adiger, 2013). Most of the hybrids generated were good specific combiners for earliness related traits such as days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting and days to edible fruit maturity, although, óCLM x LD88ô was the best specific combiner. Crosses with good specific combining ability had at least one of the parents as a good general combiner for the trait. This was similar to the findings of Udengwu (2008) who observed that better performing

hybrids had at least one of the parents with high GCA effect. The cross óUHIE x LD88ô was the best specific combiner in number of fruits/branch, number of fruits/plant, number of flowers/plant and total fruit yield. This is due to the fact that one of the parents was a good general combiner for those traits. For plant height at maturity, the crosses óAGW x CLMô, óOGW x AGWô, óOGW x CLMô, óOGW x LD88ô, õUHIE x AGWô, õUHIE x CLMô and õUHIE x LD88ô were good specific combiners, though the cross UHIE x CLM was the best combiner. óAGW x CLMô was the best specific combiner for 100 seed weight, fruit girth, fruit weight, number of ridges/pod and number of seeds/pod, while õUHIE x LD88ô was the best specific combiner for dry fruit weight and fruit length. That was probably because one of the parents was a good general combiner for those traits. Adiger (2013), Reddy *et al*. (2012a) and Udengwu (2008) reported similar trends in their studies.

Parents with high GCA are often generally considered for population improvement. This is due to the fact that traits with high GCA can be fixed while traits with high SCA cannot be fixed (Reddy *et al*., 2012a). Crosses with high SCA for a particular trait are mainly considered for heterosis breeding which is very important in commercial okra production where heterosis is exploited (Shengbin *et al*., 2007)

Gene Effects

The estimates of gene effects try to measure the effect of the variable loci. The magnitude of additive gene effects (*a*) was small relative to the corresponding dominance effects (*d*) in most cases, suggesting that pedigree selection method is a useful breeding programme for improving these populations. However, the negative value of (*d*) observed in most cases indicated that the alleles responsible for less value of the trait were dominant over the alleles controlling high value. These results are in harmony with those obtained by Alake *et al*. (2012), Adeniji *et al*. (2007) and Khattab *et al*. (2010). Similarly, the negative values of *d* observed in most cases indicated that the alleles responsible for less value of the trait were dominant over the alleles controlling high values. For days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting and days to edible fruit maturity, additive gene effect was positive and significant in all the crosses between two improved parents, while crosses involving improved and local parents were mostly not significant. The positive or negative signs of the

gene effects depend on which parent is used as the maternal or paternal parent. Those with better first parents were positive except for earliness related traits where better first parents were negative. In days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting and days to edible fruit maturity, *aa* and *ad* were positive and significant in the crosses, óAGW x CLMô, óAGW x LD88ôand óCLM x LD88ô. In number of branches/plant, number of fruits/branch, number of branches/plant, number of fruits/plant and total fruit yield, positive and significant *a, aa* and *ad* occurred mostly in the crosses involving local and improved parents. This could be due to the fact the traits were highly heritable and controlled by non-allelic gene action. It agreed with the findings of Nwangburuka *et al*., (2011) that gene effect is positive if the better performing parents are used as first parents in a breeding program. Dominance x dominance (*dd*) was significant in all the crosses. It conforms to the findings of Udengwu (2008) who reported significant *dd* in number of fruits/plant, stem girth, fruit length, fruit weight in his studies. It also agreed with the findings of Soher and Abd El-Aziz (2013) that, dominance x dominance effects were greater in magnitude than additive x additive and additive x dominance in most cases which recorded non-allelic interaction. Additive gene action was only significant for óCLM x LD88ôôOGW x CLMô, óOGW x UHIEô, óUHIE x CLMô and óUHIE x LD88ô for plant height at maturity in all the crosses made. Those findings corresponded with those of Alake *et al*. (2012), Adeniji *et al*. (2007) and Khattab *et al*. (2010), who reported only few crosses had significant *a* for plant height and branch length. When non-additive portion is larger than additive, the improvement of these traits needs intensive selection through later generations (Khattab *et al*., 2010).

Positive additive gene effect was observed in some crosses in all the fruit traits studied. It indicated that additive gene effect contributed to the genetic structure of hybrids generated. The mean effect (*m*) was significant in all the crosses for the traits studied. The result is in consonance with the report of Soher and Abd El-Aziz (2013) that, the mean effect (*m*) was significant for all crosses in number of seeds/pod, number of days to 50% flowering, plant height, number of branches/plant and number of leaves/plant traits. The positive or negative signs of the gene effects depend upon which parent is used as the maternal or paternal parent. According to (Mather and Jinks, 1982), opposite signs of additive x additive and dominance x dominance indicated prevalence of duplicate epistasis and complementary epistasis.

Inheritance Pattern of the Traits

The inheritance pattern of fruit colour showed that all the F_1s were green with pink patches in the hybrids involving OGW (dark green) x UHIE (green with pink patches); UHIE (green with pink patches) x AGW (light green) and UHIE (green with pink patches) x CLM (yellow green). The green with pink patched colour had complete dominant effect over the other fruit colours in the crosses. It agreed with the report of Nath and Dutta (1970) which revealed that fruit skin colour was controlled digenically by more dominant light green and pink colours that were dominant over the green colour. Though the reports of Kalia and Padda (1962) differed in this regard.

For fruit pubescence, crosses involving ôEle Ogwuô, which had very spiny fruits, resulted in F_1s with fruit pubescence ranging from intermediate smooth, intermediate spiny to slightly spiny fruits. It implied that, the character of spiny pods was partially dominant over the other traits. It is in conformity with the report of Abdelmajeed (2010) that a single gene was found to be responsible for the inheritance of spines on pods but with incomplete dominance. i.e. the character of spiny pods is partially dominant over the glabrous pods. The result also agreed with the report of Kalia and padda (1962), Nath and Dutta (1970) and Jambhale and Nerkar (1985), that fruit spininess was monogenically controlled with the absence of complete dominance of one allele over the other. Therefore, the desirable spineless fruits with other desirable characters can be attained through hybridization and selection in the segregating generations. Further experiments are needed at early and late season to confirm the mode of inheritance of this character due to the fact seasonal changes influence the degree of fruit pubescence in okra. Reduced fruit spineness is mostly observed during late season plantings, especially for genotypes with high potentials for yielding spiny fruits (Abdelmageed, 2010)

For fruit size, the crosses, óOGW x UHIEô, óUHIE x CLMô and óAGW x CLMô all had medium-long F_1 hybrids. It indicated that the medium-long shape had partial dominance over the other traits. The existence of diverse fruit sizes of okra is indicative of the existence of very wide recombination potentials in the plant and most interestingly the inheritance pattern of several traits studied in okra showed that the traits are governed by simple Mendelian genes. Erickson and Couto (1963) found okra to be extremely variable phenotypically and they observed that this plant-to-plant variability is suggestive of an excellent source of diverse genetic material.

SUMMARY AND CONCLUSION

Significant variation occurred among the parents and the F_1 hybrids of okra. The cross ôUHIE x LD88ô recorded significantly ($p < 0.05$) higher total fruit yield (38.25 t/Ha), number of branches/plant (7.00), number of fruits/branch (8.64), number of fruits/plant (35.63) and number of flowers/plant (10.16). óAgwu earlyô parent, had lower days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting, days to fruit maturity and plant height at maturity (4.00, 22.21, 47.13, 49.11, 48.13, 52.28 and 57.80 cm, respectively); though, it was statistically similar to the parent. The cross, ôUHIE x LD88ô had significantly ($p < 0.05$) higher 100 seed weight (4.66 g), dry fruit weight (11.51 g), fruit girth (8.50 cm), fruit weight (32.56 g) and number of ridges/pod (10.67). It was statistically similar to Ele Uhie in number of ridges/pod.

Heterosis, which indicates the better performance of the hybrids over their related parents, showed that the cross, óOGW x AGWô had higher negative MPH values for days to flower bud initiation (-40.04), days to anthesis (-27.96), days to 50% flowering (-26.21), days to first fruiting (-27.64) and days to edible fruit maturity (-30.24) while the cross óOGW x AGWô gave higher negative MPH value for days to 50% germination (-40.39). The cross óOGW x LD88ô had higher positive BPH value in total fruit yield/hectare (161.26).

Segregations among the F_2 hybrids and their parents showed that the cross, ôUHIE x LD88ô recorded significantly ($p < 0.05$) higher number of branches/plant, number of fruits/branch and number of fruits/plant and total fruit yield (5.38, 8.13, 35.66 and 37.51 t/Ha respectively). Ele Uhie was statistically similar in total fruit yield/hectare (35.51 t/Ha). Ele Uhie had significantly higher plant height at maturity (237.02 cm). It was statistically similar to óOGW x UHIEô (219.42 cm) and Ogwu (203.61 cm).

The generational means of the agronomic, yield and yield component traits of selected parents and crosses showed that the parent Clemson had significantly ($p < 0.05$) lower days to first fruiting, days to flower bud initiation, number of fruits/plant and number of flowers/plant and total fruit yield/hectare,. The cross ôUHIE x LD88ô of BC_1 recorded significantly higher fruit yield/hectare, number of branches/plant, number of fruits/branch, number of fruits/plant and number of flowers/plant.

Relatively high broad sense heritability was observed in all the crosses. However, high narrow sense heritability was observed in branch length, number of fruits/plant, fruit length and fruit weight in most of the crosses made.

Analysis of variance for combining ability of the agronomic, yield and yield component traits the okra genotypes showed a significant ($p < 0.05$) GCA variance in all the traits studied showed that significant SCA variance was observed in all the traits with the exception of days to 50% germination (0.59), number of flowers/plant (0.19) and stem girth (0.18). For fruit traits, there was non-significant GCA and SCA effect in 100 seed weight and number of ridges/pod. Fruit girth had non-significant SCA variance.

GCA/SCA ratio showed additive gene effect was dominant in magnitude in all the traits studied because the GCA/SCA was greater than one except in days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting, days to edible fruit maturity, number of fruits/plant, number of flowers/plant, plant height at edible maturity and total fruit yield which exhibited predominance of non-additive gene effect. Additive gene effect was predominant in all the fruit traits studied with the exception of 100 seed weight and number of seeds/pod.

Study of combining ability of the parental accessions showed that óAgwu earlyô, óClemson spinelessô and óLD88ô were good combiners in days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting and days to edible fruit maturity although, the LD88 parent was the best general combiner in these traits. óEle Ogwuô and óEle Uhieô were good combiners in number of branches/plant, number of fruits/branch, number of fruits/plant, number of flowers/plant and total fruit yield, but óEle Uhieô parent was the best combiner in these traits. The hybrids, óAGW x LD88ô, óOGW x AGWô, óOGW x CLMô, óOGW x LD88ô, óOGW x UHIEô, óUHIE x AGWô, óUHIE x CLMô and óUHIE x LD88ô were good specific combiners for earliness related traits such as: days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting and days to edible fruit maturity, but óAGW x LD88ô was the best specific combiner in these traits.

For fruit pubescence, crosses involving óEle Ogwuô, with very spiny fruits, the trait of spineness had partial dominance on both the stem and the fruit pods. For fruit size, the Robust-long size had incomplete dominance over other shape forms.

The hybrids, óAGW x LD88ô, óOGW x AGWô, óOGW x CLMô, õUHIE x AGWô, õUHIE x CLMô and õUHIE x LD88ô were able to combine adaptable features in both parents for such traits as days to 50% germination, days to flower bud initiation, days to anthesis, days to 50% flowering, days to first fruiting and days to edible fruit maturity; hence, it could be concluded that these crosses had higher potential for earliness, although the cross óAGW x LD88ô was the best specific combiner among all the hybrids for the aforementioned traits. For number of fruits/plant, number of branches/plant, number of flowers/plant and total fruit yield, the crosses óOGW x LD88ô, õUHIE x AGWô, and õUHIE x LD88ô were the best combiners for those traits, with õUHIE x LD88ô proving to be the best combiner for fruit yield traits compared to the other hybrids generated. However, there is still need for further selection in the genotypes for advanced genetic improvement for earliness, yield and overall productivity of the crop.

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SELECTED PARENTS USED FOR THE STUDY

LOCAL PARENTS



ELE OGWU



ELE UHIE



ELE NDU

IMPROVED PARENTS



CLEMSON SPINELESS



AGWU EARLY



LD88



LUDU V



ESCULENTUS V



V-21 IVRA



TAE 38 **V.35** **JOKOSO**



NHE 47.4 V

HYBRIDS



F1
(AGW X CLM)

BC1
(AGW X CLM X AGW)

BC2
(AGW X CLM X CLM)





F1 **BC1** **BC2**
(AGW X LD88) **(AGW X LD88 X AGW)** **(AGW X LD88 X LD88)**



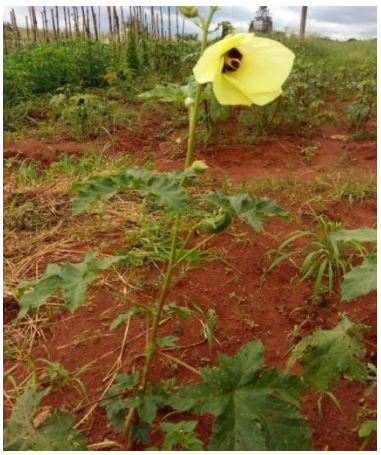


F1 **BC1** **BC2**
CLM X LD88) **(CLM X LD88 X CLM)** **(CLM X LD88 X LD88)**





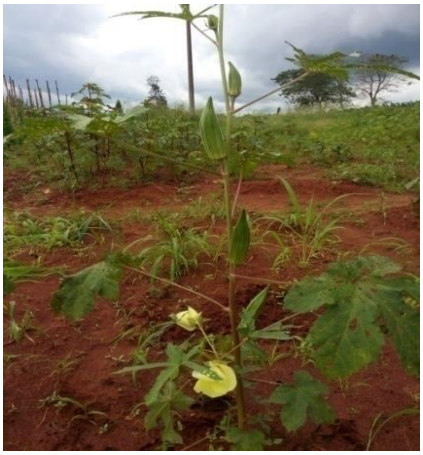
F1 **BC1** **BC2**
(OGW X AGW) **(OGW X AGW X OGW)** **(OGW X AGW X AGW)**



F1
(OGW X CLM)



BC1
(OGW X CLM X OGW)



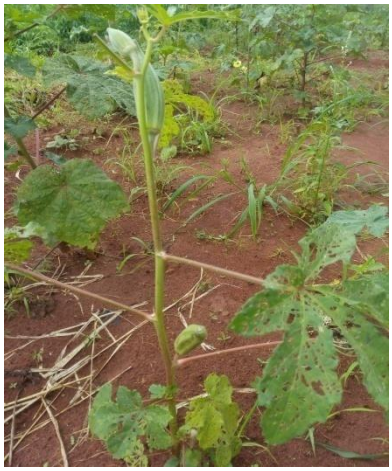
BC2
(OGW X CLM XCLM)



F1
(OGW X LD88)



BC1
(OGW X LD88 XOGW)



BC2
(OGW X LD88 X LD88)



F1
(OGW X UHIE)



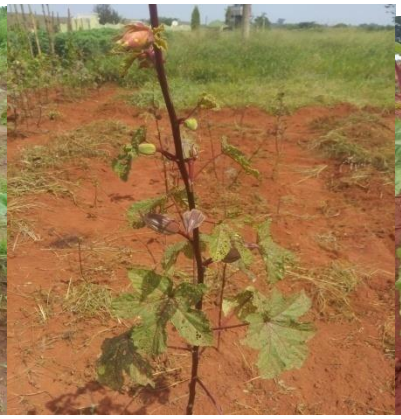
BC1
(OGW X UHIE X OGW)



BC2
(OGW X CLM X CLM)



F1
(UHIE X AGW)



BC1
(UHIE X AGW X UHIE)



BC2
(UHIE X AGW X AGW)



FI
(UHIE X CLM)



BC1
(UHIE X CLM X UHIE)



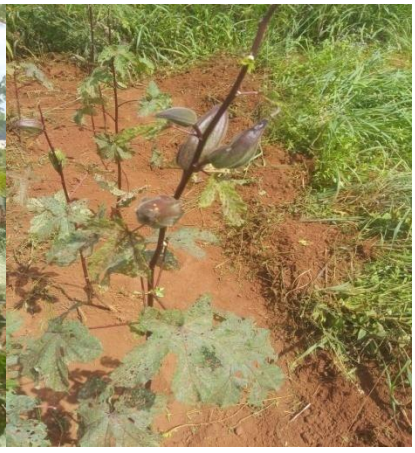
BC2
(UHIE X CLM X CLM)



F1
(UHIE X LD88)



BC1
(UHIE X LD88 X UHIE)



BC2
(UHIE X LD88 X LD88)