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GENETIC VARIABILITY STUDIES AMONG OKRA (*ABELMOSCHUS ESCULENTUS (L.) MOENCH*) VARIETIES GROWN IN SUDAN SAVANNAH AGRO-ECOLOGICAL ZONE OF NIGERIA

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ABSTRACT

The research was carried out at the teaching and research farm Gaya, Kano University of science and technology Wudil, Kano State and Kiyawa, Jigawa State Nigeria, during 2019/2020 dry season using irrigation to evaluate the genetic variability among some okra varieties grown in Sudan savannah agro-ecological zone of Nigeria. The experiments were laid out in a randomized complete block design (RCBD) with four (4) replications. The treatments consisted of eight Okra varieties (G207, LD88-1, NHAE47-4, Kunchin Biri, Clemson, 'Yar yamidi, G989, and NHBIA-13). Data obtained were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1967), and mean were separated by (SNK) at 5% level of significance using the Statistical Application for the Sciences software (SAS, 2003). Analysis of variance indicated that 9 varieties of okra under study differ significantly for 11 quantitative characters such days to 50% germination, days to 50% flowering, days ta first harvest, duration of fruiting, mean pod diameter, mean pod length, number of leaves, number of branches, plant canopy, number of pods per plant, and pod yield per plant in combined analysis across two locations. Taking a simultaneous investigation of the three important genetic parameters together such as genotypic co-efficient of variation, heritability and predicted genetic advance at a glance at phenotypic and genotypic level, characters like days to 50% germination, days to 50% flowering, days to first harvest, duration of fruiting, mean pod diameter, mean pod length, number of leaves at harvest and number of pods per plant showed higher values for heritability and genetic advanced.

Keywords: Fruit yield, Genetic advance; Heritability, Okra, Variability.

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INTRODUCTION

Okra *Abelmoschus esculentus* and *Hibiscus esculentus* (Kumar *et al.,* 2010), and it is commonly called gumbo in Southern USA, lady's finger in England and Kubewa in Northern Nigeria (Ndunguru & Rajabu 2004). Okra is reported to be an important vegetable crop in Nigeria and is cultivated in both dry and rainy seasons for the green tender pods. In Africa, production is carried during raining season (June – October), irrigation (October - April). It is commonly self-fertilized crop but crossing naturally. The breeders and the geneticists have interest in this crop because of the stamens and large flowers and its capsule bears large number of seeds. Two generations can be grown in a year because the duration of the crop is short. Okra is suggested to originate from the Tropical Africa from where it has been distributed to Asia, America, Southern Europe and other countries (Muhammad *et al.,* 2013).FAOSTAT 2016 reported that worldwide production for okra was put at 8.90 million tons grown on 2.15 hectares. As at 2016, the highest okra producing countries include Cote d'Ivoire (112,966 tons), Egypt (55,166 tons), Ghana (66,360 tons), India (5.50 million tons), Iraq (123,583 tons),Malaysia (55,856 tons), Mali (241,033), Nigeria (1.97 million tons), Pakistan (117,961 tons), and Sudan (287,000 tons), [FAOSTAT 2016]. The five best okra producing countries were Iraq, Nigeria, Togo, Sudan and India in 2008 (FAOSTAT, 2010). However, Nigeria ranks third in okra amid fruit vegetables based on production and consumption, succeeding pepper and tomato (Ibeawuchi, 2007). The fruits of Okra are good for soups and stews thickening because of mucilaginous and tender texture nature, (Ijoyah & Dzer, 2012; Das *et al.,* 2013). The okra pods contents are comprises of 9.7 % carbohydrate, 86.1 % water, 1.0 % fiber, 0.8 % vitamin, 0.2 % fat and 2.2 % protein (Saifullah & Rabbani, 2009). In addition, the unripe fruits are important sources of vitamin, potassium, calcium, and other minerals. Fruits of Okra are also good in curing ulcers and preventing the pains and effects of haemorrhoids. The mucilage in Okra has medicinal values like plasma replacement or blood volume expander (Siemonsma & Kouame, 2004). Okra also have beneficial alkaline pH which assist to ease effect in gastrointestinal ulcer by neutralizing digestive acid (Wamanda, 2007). Paper industries are using mature fruits and stem because it contains more crude fiber. It is also an excellent source of iodine apart from other minerals and vitamins. It is also adaptable to the Nigeria agro ecology and tolerant to various climatic conditions. Substantial morphological degree of variance in the West African okra varieties have been reported by researchers (Adeniji, *et al.,* 2007; Akanbi *et al.,* 2010; Ade Oluwa & Kehinde, 2011).The knowledge of different varieties determines basis for selection of desirable genotypes for augmentation of yield and other agronomical attributes. Such investigation calculates the feasibility of using available genetic resources for effective improvement. The pods yield in Okra is the most valuable and economic character which is relying on many other attributes. In addition to pods yield, other yield attributing characters like plant height, number of nodes per plant, number of fruits per plant, fruit weight etc. are genetically transmits quantitatively and

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their expression is governed by polygenes which are highly influenced by environment & lowly heritable. The studies show high genetic variability of important characters among okra varieties. The differences possess in a population is divided and distributed into heritable and non-heritable parameters employ genetically interact components including heritability, the genotypic coefficient of variation and genetic advanced, which are important for selection (Seth *et al.*, 2016).

MATERIELAS AND METHODS

The experiments were conducted during 2019/2020 dry season at two locations; the Faculty of Agriculture and Agricultural Technology Research Farm Gaya (Farmers Farm); Kano State University of Science and Technology Wudil. Gaya situated at 11.86^0 North Latitude, and 9.01^0 East and 400 meter elevation above sea level. The mean annual temperature is between 27^0C to 30.6^0C and soil type is sandy loam. The second locations were conducted at the Kiyawa local government area, Jigawa State. Kiyawa lies between Latitude 11.41'' 30^0N and 11.43'' 30^0 E. Most part of Jigawa lies within the Sudan savannah with element of Guinea Savannah in the Southern part. The climate of the location is characterized by two seasons: the rainy season (May-September) and the dry season (October-April), and soil type are sandy loam. The experimental materials used were Four improved varieties of okra (LD88-1, NHAE47-4, NHBIA-13 and CLEMSON) sourced from the National Horticultural Research Institute (NIHORT) Bagauda substation, Kano, two inbred lines 207 and G989 were source from Federal University Dutse, while two local variety Kunchin Biri , and 'Yar yamidi were sourced locally from Dutse and Hadejia in Jigawa State, Nigeria.

Table 1: The descriptions of eight okra varieties studied

S/NO	VARIETIES	DESCRIPTIONS
1	LD88-1	It has a short stem, small leaves with many flowers and spiny fruits.
2	NHAE47-4	This variety has many flowers, big capsules with spinesand dark green fruit.
3	NHBIA-13	The purple leaves are attractive and the pods are ready for harvest in two months.
4	CLEMSON	Grow to around 4 feet (1.2 meters) tall and mature in about 56 days.
5	KUNCHIN BIRI	It has tall, wine-red stems that match the veining in the leaves, mature in 65days.
6	'YAR YAMIDI	Okra is equally productive, but one of the more compact kinds of okra and ready to harvest in 50 days.
7	G207	The variety has medium leaves, spiny capsules, short and white stem, mature in 45-50 days.
8	G989	It has a tall stem, small leaves with many flowers and matures in 55-60 days.

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The experiments were laid out in a Randomized Complete Block Design (RCBD) with four (4) replications. The two experimental sites were ploughed and harrowed to obtain favourable condition for crop establishment. The entire lands were razed and assemble into seed beds; water channels were also assembled to facilitate good and free water movement and uniform distribution on the plots. The experimental fields were harrow to obtain good tilt and seed beds were made by using small hoes and furrow irrigation to create a favourable condition for plant establishment. The gross field size was 40m x 11m ($440m^2$), while the net plot size and the plot size were 2m x 2m ($4m^2$). A distance of 0.5m and 1m was left between plots and replication, respectively. The seeds were sown 30 cm intra and 75 cm inter row spacing respectively. Two seeds were sown on each spot to acquire adequate germination. The crops were irrigated immediately after planting, and subsequently irrigation was done at 3 – 4 days interval. The 15:15:15 NPK fertilizer at the rate of 60 kg N/ha was applied at two split application, three weeks after planting and at flowering stages. Hand hoeing was used to control weeds at 3 and 6 WAS and occasional hand pulling was done to ensure weed free plots and to avoid competition for soil moisture, nutrients, light and gases (oxygen and carbon dioxide). Pods were harvested at every three days interval after first picking. Pods were harvested through hand picking at tender and marketable stage. Data was collected for eleven characters from five centered plants tagged. The eleven characters studied include days to 50% germination, days to 50% flowering, days to first harvest, duration of fruiting, plant canopy (cm), number of leaves, number of branches, number of pods per plant, pod length (cm), pod diameter (cm), and pod yield/ plant (kg/ha). Combined analysis (ANOVA) across the two locations was done with the use of SAS statistical package. However, genotypic variance, phenotypic variance, genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated based on the formula reported by Burton (1952).The heritability in broad sense was calculated as proposed by Johnson *et al.* (1955). The expected genetic advance for each character estimate was established using the procedure of Allard (1960). The estimated genetic advance as percentage of mean was determined by the approach of Comstock & Robinson (1948), to assess genetic variability of some okra varieties.

RESULTS AND DISCUSSION

The result revealed significant ($p < 0.05$) variation among the okra varieties studied for days to 50% flowering (299.42), days to first harvest (68.82), duration of fruiting (591.07), plant canopy (53.3), mean pod length (31.03), mean pod diameter (7.23), number of leaves (60.66), number of branches (1.35), and number of pods per plant (10.39) in but locations (Table 2), Indicating substantial variability among the varieties for the affected traits. The variation provides sufficient scope for selection of good varieties by the plant breeder for crop advancement or growth. On other hand, non-significant variation in the varieties for days to 50% germination (1.57) and pod

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yield per plant (0.0014) revealed that the varieties were the same for the affected traits. The result also showed variations in the studied varieties for almost all the characters. This variation could be used to select okra characters studied for improvement. Previous researchers supported this result (Düzyaman, 2005; Salesh *et al.,* 2010; Nwangburuka *et al.,* 2012; Hazem *et al.,* 2013; Amoatey *et al.,* 2015). The mean performance for the studied okra varieties indicated a significant variation in days to 50% flowering (Table 3). The highest number of days to 50% flowering (61 days) was recorded for Kunchin biri, while the lowest number of days (49 days) was obtained in G207. The average number of days to 50% flowering was 46.25 days. It indicated that the estimated varieties differed structurally from one another especially on flower producing habits, similar to the findings of Muluken *et al.* (2016). At the other side, all the okra varieties studied differed in days to first harvest with 'Kunchin biri' being the highest while G207 (41.00 days) variety was the shortest. Plant canopy significantly differed in 'G207' (39.01) possessing the higher plant canopy, whereas Clemson (31.61) was observed the lowest. The numbers of leaves per plant were significantly differed; the highest number was recorded for NHBIA-13 (23.21) whereas the lowest value was observed in Clemson (13.81). The number of branches was significant differed in the variety 'Yar yamidi occupy the highest number (3.76), whereas 'LD88-1' shows the least (2.38). There was a significant difference among the varieties in mean pod length. The highest value was recorded in NHAE47-4 (6.98) variety whereas the lowest value was observed in G207 (12.76) variety. There was a significant difference among the varieties with respect to mean pod diameter. The highest value was recorded in NHAE47-4 (8.88) variety whereas the lowest value was observed in G989 (5.69) variety. There was a significant difference among the varieties with regard to duration in fruiting. The highest value was recorded in Kunchin biri (104.88) variety whereas the lowest value was observed in G207 (77.63) variety. There were significant differences among the varieties with regard to number of pods per plant. The highest rate was recorded in Clemson (11.65) variety whereas the lowest value was observed in NHBIA-13 (8.43). There were significant differences among the varieties with respect to pods yield per plant. The highest value was recorded in 'Yar yamidi (0.23) variety whereas the lowest value was observed in G989 (0.19). The genetic parameters estimates such as genotypic coefficient of variation, phenotypic coefficient of variation, broad sense heritability, and genetic advanced and genetic advance as percentage of mean studied characters are show in Table 4. The small variation with large extent of PCV and GCV between the two genetic parameters revealed the smaller amount of environmental influence on the phenotypic expression. Muluken *et al.* (2016) earlier buttressed this extrapolation. The studying data in Table 4, discovered that, phenotypic co-efficient of variation (PCV) were higher than genotypic co-efficient of variations (GCV) in all the studied characters. The PCV were highest (48.86) in mean pod length followed by number of leaves at harvest (39.31). The characters like days to 50% germination (20.18), days to first harvest (11.34), duration of fruiting (20.22), mean pod

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length (48.86), number of leaves at harvest (39.31), and number of pods per plant (27.99), shows high values. Other characters, like days to first harvest (11.34) and pod yield per plant (19.04) showed moderate value for this parameter. Many researchers described the consistent variation of okra varieties due to varieties and environmental situations (Thirupathi *et al.*, 2012; AdeOluwa & Kehinde, 2013; Ehab *et al.*, 2013; Adekoya *et al.*, 2014). The estimate of heritability in broad sense was started from 77.72 % for days to 50% germination to 99.98 for days to 50% flowering (Table 4). Reported by Robinson *et al.* (1955), heritability was classified as low with a range of 0-30 %, moderate (30-60 %) and higher (above 60 %). The present investigation shows that, heritability in broad sense of greater than 60 % were recorded in all the characters studied such as days to 50% germination 77.72, days to 50% flowering 99.98, days to first harvest 97.84, duration of fruiting 99.57, mean pod diameter 87.53, mean pod length 89.63, number of leaves 90.0, number of branches 95.63, number of pods per plant 94.95, plant canopy 91.62, and pod yield per plant 83.83) across locations. When a character is having heritability of 80 % or more, such character would be selected easily. Thus, selection for these characters might arise in in pod yield of okra increment. A very good heritability also indicate good genetic base. (Jagan *et al.*, 2013; Muluken *et al.*, 2016). As reported by Johnson *et al.* (1955), genetic advance in percent of mean was classified as high (above 20 %), moderate (10 to 20 %) and low (0 to 10 %). Based on the classification of Johnson *et al.*, days to 50% flowering (22.52), days to first harvest (48.92), mean pod length (36.40), number of leaves (82.72), number of branches (23.40), number of pods per plant (48.24) and plant canopy (28.36) occupied the genetic advance of greater than 20 % (Table 4). This shows the domination of additive gene effects for these characters. Moderate genetic advance was recorded in Mean pod diameter (16.68), pod yield per plant (17.27) and days to 50%germination (17.67) respectively. The genetic advance coupled with high estimates of heritability in broad sense gives adequate information on individual character and shows genotypic response to selection (Pradip *et al.*, 2010; Sibsankar *et al.*, 2012). All the characters studied shows high heritability and genetic advance like days to 50% flowering (99.98 & 22.52), days to first harvest (97.84 & 48.92), mean pod length (89.63 & 36.40), number of leaves (90.0 & 82.72), number of branches (95.63 & 23.40), and number of pods per plant (94.95 & 48.24), plant canopy (91.62 & 28.36)). (Table4). This finding indicates that variations in the genetic history would endow great change for advancement in selection. Lastly, this shows the bias of additive gene effects for these characters, instead of the environmental influences. Thus, for the improvement of yield selection can be made based on the phenotypic expressions of okra characters (Muluken *et al.*, 2016).

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Table 2: Combined mean square values for 11 studied okra character in Gaya and Kiyawa, Nigeria across locations.

Source of variation	Days to 50% germination	Days to 50% flowering	Days to first harvest	Duration of fruiting	Mean pod diameter	Mean pod length	Number of leaves	Number of branches	Number of pods/ plant	Plant canopy	Pod yield / plant
Replication	0.25	18.06	3.52	21.39	2.85	6.13	38.6	0.58	2.85	77.88	0.0039
Varieties	1.57NS	299.42**	68.82**	591.07**	7.23**	31.03**	60.66**	1.35**	10.39**	53.3**	0.0014
Error	0.45	0.06	1.52	2.54	0.33	1.65	7.02	0.15	0.95	7.59	0.0003

** Highly significant at 5% level, NS = Non significant difference @ 5% level.

Table 3: Combined mean performance for 11 characters studied okra across locations in Gaya and Kiyawa, Nigeria.

Variety	DG	DF	DFH	PC	NOL	NOB	MPL	MPD	DOF	NPP	PYP
G207	7.63b	**41.00g**	**49.88e**	**39.01a**	16.44bc	2.84c	**12.76a**	6.00c	**77.63e**	10.36b	0.20c
LD88-1	7.15b	49.50d	53.75c	36.59ab	15.81bc	**2.38d**	7.55de	7.10b	84.25d	9.30cd	0.21bc
NHAE47-4	7.00b	50.50c	52.38d	34.33bc	16.66bc	3.40ab	**6,98e**	**8.88a**	89.63b	8.43d	0.22ab
KUNCHINBIRI	7.25b	**61.00a**	**59.25a**	37.29a	17.39b	3.21bc	7.20e	7.26b	**104.88a**	9.96bc	0.22ab
CLEMSON	7.13b	55.00b	55.63b	**31.61c**	**13.81c**	2.94c	8.80cd	6.93b	86.88c	**11.65a**	0.19c
'YAR YAMIDI	7.38b	46.25e	53.25cd	31.93c	18.58b	**3.76a**	7.88cde	7.01b	90.25b	8.70d	**0.23a**
G989	7.63b	45.50f	50.88e	34.25bc	18.51b	2.96c	10.56b	**5.69c**	78.25e	8.76d	**0.19c**
NHBIA-13	**8.38a**	50.50c	52.38d	34.03bc	**23.21a**	3.00bc	9.03c	7.03b	90.13b	**8.43d**	0.21bc
MEAN	7.44	53.42	53.42	34.88	17.55	3.06	8.84	6.96	87.80	9.45	0.21
SE±	8.99	2.32	2.32	7.90	15.10	12.70	14.53	8.20	1.81	10.32	7.96

Means with the same alphabet(s) are not significantly different at 5% level of probability by SNK.

NB: DG = Days to 50% germination, DF = Days to 50% flowering, DFH = Days to first harvest, PC = Plant canopy, NOL = Number of leaves, NOB = Number of branches, MPL = Mean pod length, MPD = Mean pod diameter, DOF = Duration of fruiting, NPP = Number of pods per plant, PYP = Pod yield per plant.

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Table 4: Estimates of GCV, PCV, H^2b,GA and GA (%) mean for eight characters studied across locations in okra in Gaya and Kiyawa, Nigeria.

Characters	GCV (%)	PCV (%)	H^2b(%)	GA (%) mean	GA
Days to 50% germination	16.84	19.10	77.72	17.67	1.31
Days to 50% flowering	32.39	32.40	99.98	22.52	12.03
Days to first harvest	15.53	15.70	97.84	48.92	6.17
Duration of fruiting	27.69	27.75	99.57	19.39	17.02
Mean pod diameter (cm)	104.89	112.12	87.53	16.68	5.81
Mean pod length (cm)	88.10	93.06	89.63	36.40	6.39
Number of leaves at harvest	18.56	6.98	90.00	82.72	1.00
Number of branches at harvest	87.87	89.85	95.63	23.40	2.07
Number of pods per plant	58.95	60.49	94.95	48.24	4.26
Plant canopy at harvest (cm)	9.24	9.65	91.62	28.36	2.68
Pods yield per plant (g)	17.82	19.46	83.83	17.27	0.04

NB: GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of variation, H^2 B = Heritability in broad sense, GA (%) mean = Genetic advanced as percentage of mean, GA = Genetic advance

CONCLUSION

Based on the findings of this research it can be concluded that for the improvement of yield selection can be done through the phenotypic expressions of okra characters and days to first harvest, duration of fruiting, days to 50% flowering, and number of pods per plant to be considered for further crop advancement in pod yield of okra.

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