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SEASONAL VARIABILITY IN OKRA (*Abelmoschus esculentus* (L.) Moench.)

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ABSTRACT

Genotypic and phenotypic variances, genotypic coefficients of variation, heritability and genetic advance were estimated for 11 traits in okra for two seasons, using 10 okra cultivars. Significant differences were recorded for most traits in the two seasons. All traits except plant height at maturity, plant height at flowering, days to flowering and number of branches/plant showed significant variety by season interaction. In early season, only plant height at flowering, number of ridges per pod and number of seeds per pod had relatively high G.C.V., heritability and genetic advance (29.97, 34.11, and 20.47), (12.23, 75.00, 22.26) and (19.72, 45.71, 29.30) respectively. In late season however, seed yield, pod length and plant height at maturity had relatively high G.C.V., heritability and genetic advance of (41.40, 54.94 and 98.88) (30.85 and 88.42, 50.01) and (28.01, 48.40 and 30.06) respectively. This result indicated the reliability of selection for such characters.

Keywords: Okra; Cultivars; Coefficient of variation; Heritability; Genetic advance; Seasons.

INTRODUCTION

Okra, *Abelmoschus esculentus* (L.) Moench is grown mainly for its long immature pods. It is cultivated throughout Nigeria mostly during the rainy season. The only common planting material known for okra is seeds. Lack of good quality seeds of improved genetic make-up has been reported to be a major reason for low annual yield (Olasantan, 1992). In order to overcome this problem, crop improvement with focus on seed is needed. Improvement in a crop depends mainly on the magnitude of the genetic variability within the species as well as the extent of involvement of environmental factors in the expression of each character. Okra shows high variability in its vegetative and fruit characters. Ariyo and Ake`Ova (1986) reported that many lines of okra considered had a wide genetic base. Gondane and Bhatia (1995) recorded high genetic variation in pod yield, plant height, pods per plant and nodes at first pod. Similarly, Chandra *et al.* (1996) observed high value for heritability and genetic advance for pod yield, plant height, and number of seeds per pod.

Once genetic variability has been established in a crop, improvement is possible by using an appropriate selection method and the expected genetic response to selection are determined by the magnitude of heritability estimate of trait for which selection is to be made.

The objective of this study was to analyse the seasonal variability in okra cultivars grown in South-Western Nigeria.

MATERIALS AND METHODS

The experiment was carried out during the early (June) and late (August) rainy seasons of 1996. The genotypes utilised for this purpose were grown in a single row plot in a Randomised Complete Block Design (RCBD) with three replications. Each genotype was planted at inter-row spacing of 90cm and within-row spacing of 45cm. Each row was 4.05 meters long to accommodate 10 plants. The accessions studied are presented in Table 1. Three weeks after sowing, plants were thinned to one plant per hole. Compound fertilizer, N.P.K 15.15.15 was applied at rate of 60kg N/ha in two doses. Insecticide was also applied fortnightly during the period of the experiment against insect pests. Weeding was carried out manually as necessary.

Data were collected on eight most competitive plants in each row for the following characters: days to 50% flowering, plant height at flowering, number of branches per plant, days to maturity, plant height at maturity, number of pods per plant, pod length, number of ridges per pod, number of seeds per pod, 100-seed weight and seed yield.

Days to maturity was determined as days from planting date to the date when the plants had shed their leaves and floral apparatus and 95% of the pods were dried. Pod length, number of ridges per pod and number of seeds

Table 1: Okra Varieties and their Sources/Origin

Number	Variety	Source	Origin
1	V35	IAR&T	IBADAN
2	LD88-1	UI	IBADAN
3	UI204-20	UI	IBADAN
4	NHAe47-4	NIHORT	ZARIA
5	NHAe95/2	NIHORT	IWO
6	NHAe95/3	NIHORT	IBADAN
7	JOKOSO	NIHORT	IBADAN
8	CLEMSON Spineless	NIHORT	USA
9	PUSA SAWANI	UNAAB	INDIA
10	INDIA SELECTION	UNAAB	INDIA

per pod were determined at maturity by measuring length of harvested pods, and counting the number of their ridges and seeds in each of 10 pods selected randomly. 100-seed weight was determined by weighing 100 seeds taken as a sample from each row in each replication. Seed yield was determined in grammes of clean and dry seeds from yield of eight inner plants.

The mean values of the collected data were used to work out two seasons analysis of variance (ANOVA) of the following model.

Yijk = U + &i + Bj + (& B) ij + Eijk.

Where U = population mean

&i = effect of ith season

Bj = effect of the jth genotype

(aB)ij = interaction effect of ith season on jth genotype

Eijk = Error term

The genotypic variance was obtained as the mean difference between genotype and error mean squares. The genetic coefficient of variation was calculated from the formula of Burton (1952) : C.V. = 100√g2/0

Where √g2 is the genetic variance and 0 is the sample mean.

Heritability (H) was also obtained from variance component analysis according to the formula of Allard (1960): H = $(\surd g)^2/(\surd g)^2 + (\surd e)^2$ where $(\surd g)^2$ is genotypic variance and $(\surd e)^2$ is environmental variance. The estimate of the expected genetic advance (%) was calculated from the formula of Johnson *et al.*, (1955) as G.A. = GCV x K x X

Where K estimated as 2.06 (for 5% selection in large samples from a normally distributed population) is the selection differential measured in terms of phenotypic standard deviations.

RESULTS

The mean values of the characters studied in both early and late seasons are presented in Table 2a. Analysis of variance for 11 traits in ten okra varieties is presented in Table 2b. The varieties showed significant variances for all characters except number of pods per plant. Season mean squares were also significant for all traits except plant height at maturity. Similarly, variety by season interaction mean squares were significant for seed yield, number of ridges per pod, number of seeds per pod, number of pods per plant, pod length, and days to maturity.

The mean, standard error, range, phenotypic variances of 11 characters of okra in the two seasons are presented in Table 3. The varieties showed considerable variability for all characters in both seasons. The variation exhibited by days to flowering, plant height at flowering, number of branches per plant, days to maturity, pod length, number of seeds per pod and seed yield differed considerably between seasons. However, plant height at maturity, number of ridges per pod and 100-seed weight did not show any appreciable variation between seasons as their variances in respect of the two seasons were relatively close.

Genotypic and phenotypic coefficients of variation, heritability and expected genetic advance for 11okra characters in two seasons are presented in Table 4. During early season, seed yield exhibited maximum phenotypic (84.79) and genotypic (33.35) coefficients of variation followed by number of pods per plant (68.48 and 28.40) and plant height at flowering (42.75 and 29.97). The least phenotypic and genotypic co-efficients of variation were observed for 100-seed weight (9.33 and 7.48).

Heritability estimate in broad sense was highest for number of ridges per pod (75%) followed by 100-seed weight (64.29%); days to flowering (53.05%) and number of seeds per pod (47.71%). In addition, genetic advance was the highest for number of seeds per pod (29.30%) followed by seed yield (22.91%), number of ridges per pod (22.26%) and plant height at flowering (20.47%). The remaining characters showed low genetic advance.

In late season, phenotypic and genotypic coefficient of variation were the highest for seed yield (55.34 and 41.04) followed by number of pods per plant (46.30 and 37.64). The lowest were recorded for days to maturity (9.46 and 7.03) followed by 100-seed weight (12.45 and 7.98).

Heritability estimate was highest for number of ridges per pod (90.13%) followed by pod length (88.42%), number of seeds per pod (55.21%), days to maturity (55.18%), seed yield (54.90%) and plant height at maturity (48.40%). Similarly genetic advance was highest for seed yield (98.88%) followed by pod length (50.01%) and plant height at maturity (30.06%).

TABLE 2: ANALYSIS OF VARIANCE FOR 11 TRAITS IN TEN OKRA VARIETIES, THE VALUES ARE MEAN SQUARES.

Source of variation	Df	Days to flowering	Plant height at flowering	Number of branches/plant	Days to maturity	Plant height at majority	Pod length	Number of ridges/ pod	Number of seeds/pod	100-seed weight	Number of pods/ plant	Seed yield
Replication	2	25.40	56.83	1.26	95.76	304.36	4.43	0.07	97.05	0.09	3.66	3849.66
Varieties	9	** 277.45	** 706.79	** 4.61	** 158.87	** 2084.10	** 46.31	** 6.17	** 1128.74	** 1.24	8.18	** 12734.63
Seasons	1	** 1152.82	** 1617.20	** 4.39	** 305.55	173.06	** 66.78	** 1.63	** 1301.07	** 1.70	** 75.49	** 50039.80
Var x Seasons	9	95.82	219.48	1.79	* 158.35	641.06	** 9.80	* 0.79	* 406	0.41	** 17.37	* 11934.53
Error	38	61.15	220.20	0.96	57.56	607.19	1.82	0.21	188.61	0.20	3.92	2983.79

*** Significant at 5 and 1% levels respectively

Table 2a: Mean values of the various characters studied in early and late seasons.

CULTIVARS	Season	Days to flowering	Plant Height at flowering (cm)	Number of Branches / plant	Days to maturity	Plant height at maturity (cm)	Pod length (cm)	No. of ridges / pod	Number of seeds/ pod	Seed weight (gr)	No. of pods/plant	Seed yield
V35	ES	59.67	43.73	2.59	98.00	67.17	5.23	8.20	7.87	86.53	6.10	142.81
	LS	55.33	32.73	2.17	103.00	53.17	5.47	9.33	7.30	76.70	6.33	143.33
LD-88-1	ES	69.67	56.27	2.03	112.00	91.93	5.80	8.03	7.97	97.47	5.13	149.70
	LS	58.33	30.73	3.07	104.33	82.17	6.27	8.87	8.57	107.93	4.83	162.09
UI 204 – 2G	ES	57.33	33.57	1.67	105.00	49.67	2.47	8.20	6.57	57.83	6.00	43.76
	LS	55.00	30.17	2.33	100.33	64.50	5.00	10.60	7.57	82.03	6.90	143.37
NH/47-4	ES	74.00	44.20	1.83	103.00	62.43	3.27	8.53	8.00	87.90	6.07	85.81
	LS	56.33	33.20	2.01	102.67	51.70	3.33	10.27	8.13	97.47	6.47	100.75
NH95/2	ES	71.00	67.37	2.43	107.00	84.13	3.57	8.83	7.30	79.67	5.93	84.56
	LS	64.67	58.37	4.00	105.67	108.03	6.50	11.37	7.30	91.50	6.07	210.41
INDIAN SELECTION	ES	78.67	21.33	3.07	103.00	30.27	9.00	9.30	7.60	44.43	4.70	28.73
	LS	57.00	29.70	5.00	117.00	71.00	12.00	17.90	9.60	88.60	6.20	329.59
JOKOSO	ES	83.67	70.93	3.60	101.00	94.27	6.57	8.67	8.00	87.13	5.53	171.08
	LS	63.33	40.00	5.00	124.00	108.23	6.07	7.23	7.87	77.17	5.57	178.46
CLEMSON	ES	55.33	41.93	1.77	98.00	60.90	3.05	7.93	8.00	72.07	5.43	61.08
	LS	57.67	45.10	2.43	98.67	55.87	4.63	10.40	8.30	86.80	5.63	111.75
PUSA SAWANI	ES	55.33	47.37	2.77	90.67	64.80	3.53	16.07	5.00	52.93	5.90	52.16
	LS	50.67	29.10	1.10	108.33	73.23	4.00	17.63	5.00	54.47	6.30	62.72
NH95/3	ES	56.67	39.83	2.70	98.00	68.70	2.70	8.47	7.30	18.37	5.93	61.26
	LS	53.33	33.50	2.57	97.33	40.23	6.30	9.73	7.20	74.80	5.80	135.99
LSD (5%)		13.03	24.71	1.63	12.64	41.04	2.25	0.76	0.74	22.88	3.30	90.98

TABLE 3: MEAN, STANDARD ERROR, RANGE AND PHENOTYPIC AND GENOTYPIC VARIANCES OF ELEVEN OKRA CHARACTERS IN TWO SEASONS.

Characters	Seasons	MEAN ± S.E.	RANGE	Phenotypic variance	Genotypic variance
Days to flowering	ES LS	65.93 ± 6.97 57.17 ± 5.76	55.33-83.67 50.67-63.33	154.98 51.12	82.21 1.37
Plant height at flowering	ES LS	46.67 ± 13.22 36.27 ± 9.94	21.33-70.93 29.10-58.37	397.73* 184.52	135.66** 36.30
Number of Branches/plant	ES LS	2.45 ± 0.63 2.97 ± 0.92	1.67-3.071 1.10-5.00	0.79 2.53**	0.09 0.19
Days to majority	ES LS	101.57 ± 7.05 106.07 ± 5.49	90.67-112.00 97.33-124.00	84.27 100.67**	9.80 55.55
Plant height at Majority	ES LS	67.43 ± 22.28 70.85 ± 16.73	30.27-94.27 40.23-108.33	871.13 813.63**	126.52 393.83
Pod length (cm)	ES LS	8.89 ± 1.88 11.33 ± 1.03	7.93-12.73 7.23-17.9	5.50 13.82	0.24 1.22
Number of Ridges/pod	ES LS	7.36 ± 0.42 7.69 ± 0.32	6.57-8.00 5.00-9.60	1.08** 1.52**	0.81** 1.37
Number of Seeds/Pod	ES LS	74.43 ± 13.06 83.72 ± 9.46	52.93-97.47 54.47-107.93	471.19* 299.91**	215.38* 165.57**
100-Seed weight (cm)	ES LS	5.67 ± 0.26 6.01 ± 0.47	4.70-6.10 4.83-6.91	0.28** 0.56*	0.18** 0.23
Number of Pods/plant	ES LS	3.71 ± 11.89 5.95 ± 1.40	0.90-6.57 3.33-12.00	6.44 7.59**	1.11 4.65**
Seed yield (gm)	ES LS	88.10 ± 56.08 157.85 ± 47.9	28.73-171.08 62.72-329.59	5580.67** 7631.22**	863.52** 4189.71**

ES = Early season, LS = Late season.
* * * = Significant at 5 and 1 percent levels of probability respectively.

TABLE 4: GENOTYPIC AND GENOTYPIC CO-EFFICIENTS .OF VARIATION, HERITABILITY AND EXPECTED GENETIC ADVANCE AS PERCENTAGE OF MAN FOR ELEVEN OKRA CHARACTERS IN TWO SEASONS.

	Characters	Season	Phenotypic coefficients of variation	Gentotypic coefficients of variation	Heriatability %	Genetic advance %
1.	Days to flowering	ES LS	18.88 12.51	13.81 2.05	53.05 2.67	13.69 0.06
2.	Plant height at Flowering	ES LS	42.75 37.45	29.97 16.61	34.11 19.67	20.47 1.71
3.	Number of branches Per plant	ES LS	36.28 53.56	17.79 37.64	24.05 49.41	8.38 4.00
4.	Days to maturity	ES LS	9.04 9,46	3.08 7.03	11.63 55.18	0.78 0.82
5.	Plant height at maturity	ES LS	43.77 40.26	16.68 28.01	14.52 48.40	0.32 30.06
6.	Pod length (cm)	ES LS	26.38 32.81	5.51 30.85	4.36 88.42	0.07 50.01
7.	Number of ridges Per pod	ES LS	14.12 16.03	12.23 15.22	75.00 90.13	22.2 1.69
8.	Number of seeds Per pod	ES LS	29.16 20.69	19.72 15.37	45.71 55.21	29.30 1.41
9.	100-Seed weight (gm)	ES LS	9.33 12.45	7.48 7.98	64.29 41.41	8.31 0.39
10.	Number of pods Per plant	ES LS	68.48 46.30	28.40 36.24	17.24 36.24	17.41 3.47
11.	Seed yield (gm)	ES LS	84.79 55.34	33.35 41.04	15.47 54.94	22.91 98.88

ES = Early season, LS – Late Season

* * * = Significant at 5 and 1 percent levels of probability respectively.

DISCUSSION

This study revealed that genotypic differences exist in the cultivars for the traits considered. It further suggested the possibilities of using their variations for further improvement of seed yield. Significant season mean squares suggested that the two environments were different and offered opportunity of two environments for evaluation.

Also, significant variety by season interaction for seed yield and number of pods per plant indicated that yield potential of varieties varied considerably with changes in growing conditions. Similar conclusion was made on seed yield by Adetunji and Chheda (1989). Mandal and Dana (1993) and Gondane and Bhatia (1995) reported similar observation in fruit yield. Their findings confirm the previous opinion of Ariyo (1990) on the need to breed okra for specific environments in a diverse agroecological condition.

The differences in the values of phenotypic and genotypic coefficient of variation, heritability and genetic advance with seasons suggested different responses of various characters to changes in environment. High G.C.V observed for seed yield and number of pods per plant in both seasons implied high genetic determination of these traits. In this study, number of pods per plant, number of seeds per pod and plant height at flowering in early season and seed yield and plant height at maturity in the late season had high to moderate G.C.V, heritability and genetic advance suggesting that selection for these traits in early generations will be reliable. These results agree with that of Ariyo (1990), Gondane and Bhatia (1995) and Chandra (1996).

This results contradicts Sood *et al.* (1995). The difference in the results might be explained on the basis of the differences in the genotypes evaluated as well as environmental differences of the experimental sites. Sriramchandra *et al.* (1980) suggested that traits with low genetic advance can be improved by method of recurrent selection.

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