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Genetic assessment for seed yield, agronomic and quality characters in okra (*Abelmoschus esculentus* (L.) Moench)

Amandeep Kaur and Sonia Sood

Abstract
The present investigation was carried out to generate information for quantitative and quality traits in seed crop of okra (*Abelmoschus esculentus* (L.) Moench). The experiment material consisted of 30 genotypes of okra that were evaluated in Randomized Complete Block Design (RCBD) during summer-rainy season, 2018. The observations were recorded on days to 50 per cent flowering, node at which the first pod set, plant height (cm), nodes per plant, internodal length (cm), days to seed maturity, seeds per pod, seed yield (q/ha), 100-seed weight (g), seed germination (%) and seed vigour. Significant differences were observed among the genotypes for all the traits, indicated sufficient variation for all the traits. Among all, genotypes DPO-5, Kashi Satdhari, Palam Komal, 9801 and Punjab Suhawani were the highest seed yielder. The PCV was invariably higher than their corresponding GCV for most of the characters, indicated close association between phenotype and genotype. High to moderate PCV as well as GCV was observed for seed yield followed by node at which the first pod set, seed vigour, plant height, nodes per plant, seed germination and internodal length depicting the presence of substantial variability and would respond better to selection. High heritability along with high genetic advance was observed for seed vigour, node at which the first pod set and seed yield, respectively revealing the importance of additive gene action for the inheritance of these traits, and further improvement could be done through phenotypic selection.

Keywords: Okra, PCV, GCV, heritability, genetic advance

Introduction
Okra (*Abelmoschus esculentus* (L.) Moench) belongs to the family Malvaceae of the plant kingdom. It is one of the three species of the genus *Abelmoschus* used for cultivation, the other two being *Abelmoschus manihot* (L.) Medikus and *Abelmoschus moschatus* (Medikus). Okra is native to Ethiopia with secondary center of origin in India (Vavilov, 1951) [20]. However, according to recent reports it is considered of African or Asiatic origin (Markose and Peter, 1990) [13]. It has high nutritive value and export potential. It is an annual herbaceous vegetable crop that is grown for its tender fruits often consumed as vegetable (Chattopadhyay *et al.* 2011) [6] and other meal. It is one of the most important warm season fruit vegetables grown in tropical and sub-tropical regions of world including West Africa, South-East Asia, Southern United States of America, Brazil, Turkey and North Australia. Owing to its floral structure and absence of self-incompatibility, okra produces much of its progeny through selfing. However, cross-pollination is frequently mentioned in the literature. The seeds of okra are round, greyish and quite large. Okra ripe seeds can be dried, roasted and ground to be used as a coffee substitute (Gemede *et al.* 2015) [9] besides being rich in protein (Karakoltisdis and Constandinides, 1975) [11]. The oil from its seeds is utilized in perfume industry (Clopton *et al*. 1948) [7]. The dried pod shell and stem containing crude fibre are used in paper industry.

In Northern Indian Plains, usually two crops i.e. spring-summer and rainy season are raised. The spring-summer crop is sown from the beginning of February till end of March. The rainy season crop is sown from May to July. In the hills, the crop is sown from May to June (Anonymous, 2016) [3]. The most important success determined factor in the production of vegetables is the quality of seed and its availability at a reasonable rate. Seed production of okra in the mid-hills of Himachal Pradesh offers a great opportunity as white fly, the major insect vector, is not in abundance and it can also be easily controlled, thus making the crop free from yellow vein mosaic.

To develop superior and disease resistant cultivars of okra, assessment of genetic diversity in the available gene pool is of utmost importance (Morey *et al.* 2012) [14] and knowledge of PCV and GCV is very helpful in predicting the amount of variation in the available in the given set of genetic stocks. The usefulness of selection depends on the amount of genetic variation present (Adunga and Labuschangne, 2003) [1]. A large amount of variability increases the chance of selecting desired types (Vavilov, 1951) [20]. Most traits of interest to plant breeders are quantitative in nature and influenced by environment for their expression. According to Fisher, (1918) [8], quantitative traits exhibiting continuous variation are under control of heritable and non-heritable factors. Response to selection depends on the relative proportion of the heritable component in the continuous variation. The heritable component is due to genotype, whereas the non-heritable portion is mainly due to environmental factors. Assessment of genotypes is possible through assessment of phenotypic expression, the results of genotype, and the environmental expression. Heritability and genetic advance help in determining the influence of the environment in the expression of the characters and extent to which improvement is possible through selection (Robinson *et al*. 1949) [17]. Higher the heritable variation, greater will be the possibility of fixing the characters by selection methods. Hence, the first step in okra improvement should involve evaluation of the germplasm to assess the existing genetic variability for yield related traits. The knowledge on nature and magnitude of variation existing in available breeding materials would help in choosing characters for effective selection of potential parents for further use in breeding programme. A better understanding of the extent of genetic diversity among okra germplasm is necessary for planning selection programme aimed at improvement of yield. Realizing the importance of developing high yielding okra genotypes, the present study was undertaken to assess the genetic variability for quantitative and quality traits under sub-temperate conditions of North-Western Himalayas.

Material and Methods

The present investigation was envisaged to gather information about the potential and characteristics of the experimental material of okra at the Experimental Farm, Department of Vegetable Science and Floriculture, College of Agriculture, CSK Himachal Pradesh Agricultural University, Palampur (HP) during summer-rainy season of 2018.

Experimental site

Location

The experimental site is located at an altitude of about 1290.8 m above mean sea level. Geographic position of the experimental site lies between 32º6' N latitude and 76º3’ E longitude under mid hill zone of Himachal Pradesh, India.

Climate

The climate is humid sub-temperate. The mean monthly minimum and maximum temperature varied between 2.0 to 22.0 and 9.5 to 34.5 ºC, respectively during the cropping season. The experimental site experienced average rainfall of 250 cm annually, out of which about 80% is received during monsoon period. Monsoon arrives in the second fortnight of June and ends in September. The summer is mild and winter is very severe.

Soil

The soil of the experimental block was acidic with pH ranging from 5.0 to 5.6 and soil texture is silty clay to silty loam.

Experimental materials

The experimental materials comprised of 30 genotypes of okra (Table 2).

Experimental design and layout plan

The trial was laid out on June 5, 2018 comprising of 30 genotypes of okra planted in Randomized Complete Block Design (RCBD) with three replications in plot size of 2.7×1.95 m. The genotypes were spaced at 45 cm between row to row and 15 cm plant to plant. The experiment field was prepared by ploughing twice with power tiller upto a depth of 20 cm followed by levelling. The Farm Yard Manure (10 t/ha) was mixed in the soil at the time of field preparation with first ploughing. The chemical fertilizer (75 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha) were applied as basal dose at the time of final field preparation. Half of N, full dose of P_2O_5 and K_2O is applied at the time of final field preparation. Remaining half of N was top dressed in two equal amounts and added after 30 and 45 days of sowing respectively. The observations were recorded on five randomly selected plants for days to 50 per cent flowering, node at which the first pod set, plant height (cm), nodes per plant, internodal length (cm), days to seed maturity, seeds per pod, seed yield (q/ha), 100-seed weight (g), seed germination (%) and seed vigour.

The mean values of the data collected were used for analysis of variance (Table 3) for RCBD was estimated (Panse and Sukhtame, 1984) [16].

The phenotypic and genotypic coefficients of variation were estimated following Burton and De Vane, (1953) [5] as follows:

$$\text{Phenotypic coefficient of variation (PCV)\%} = \frac{\sigma p}{\bar{X}} \times 100$$

$$\text{Genotypic coefficient of variation (GCV)\%} = \frac{\sigma g}{\bar{X}} \times 100$$

where σp, σg and $\bar{X}$ are phenotypic standard deviation, genotypic standard deviation, grand mean, respectively.

Heritability in broad sense (h^2_{bs}) was calculated as per the following formula given by Burton and De Vane, (1953) [5] and Johnson *et al.* (1955) [10].

$$\text{Heritability } (h^2_{bs}) = \frac{\sigma^2 g}{\sigma^2 g + \sigma^2 e} \times 100$$

Where, σ^2g, σ^2e and $\sigma^2g + \sigma^2e$ are genotypic variance, environmental variance and phenotypic variances, respectively.

The expected genetic advance (GA) resulting from the selection of 5% superior individuals was calculated as per Burton and De Vane, (1953) [5] and Johnson *et al.* (1955) [10].

$$GA = K.\sigma p.h^2_{bs}$$

where, K = 2.06 (selection differential at 5% selection intensity), σp = phenotypic standard deviation and h^2_{bs} = heritability (broad sense), respectively.

$$\text{Genetic advance as percentage of mean (GA\%)} = \frac{\text{Expected GA}}{\text{Grand mean}} \times 100$$

Limits used for categorizing the magnitude of different parameters are presented in Table 1.

Table 1: Magnitude of differences for parameters

	High (%)	Moderate (%)	Low (%)
PCV and GCV	More than 20	10-20	Less than 10
Heritability (%)	More than 80	50-80	Less than 50
Genetic advance	More than 30	20-30	Less than 20

Statistical analysis

The mean values of different genotypes for various traits were statistically analysed using OPSTAT programme. OPSTAT (developed by CCS Haryana Agricultural University, Hisar, India) software was used for statistical analysis.

Results and Discussion

Analysis of Variance

The analysis of variance revealed that mean squares due to genotypes were significant for all the traits (Table 3) indicating the presence of good amount of genetic variability and considerable scope for improvement. Sufficient genetic variability for many of the traits had also been reported by earlier workers with different genetic material under their environmental conditions (Kaul *et al*. 1978; Arya *et al*. 1994; Akinyele and Osekita, 2006; Sood, 2006 and Simon *et al.* 2013) [12, 4, 2, 19, 18]. The extent of variability present in the okra genotypes was measured in terms of mean, range, phenotypic (PCV) and genotypic (GCV) coefficients of variation, heritability (broad sense), genetic advance as per cent of mean for all the traits are presented in Tables 4, 5 and 6.

Mean Performance of Genotype

Genotypes influenced some qualitative and quality traits (Table 4 and 6). Days to 50 per cent flowering and days to seed maturity are the traits which determine the earliness of a variety, whereas nodes per plant, seeds per pod and 100-seed weight are the major seed yield contributing traits. Based on mean values, genotypes *viz.*, 9801 (45.33 days), DPO-2 (45.67 days), Kashi Vibhuti (46.33 days), DPO-1 (46.33 days), Palam Komal (46.33 days), DPO-20 (47.00 days), DPO-7 (47.33 days), Kashi Satdhari (47.67 days), Arka Anamika (47.67 days), DPO-13 (48.00 days), DPO-8 (48.33 days), DPO-19 (48.33 days), Punjab Suhawani (48.67 days), Kashi Pragati (49.00 days) and DPO-18 (49.00 days) were early in bearing 50 per cent flowering and genotypes *viz.*, 9801 (102.67 days), Punjab-8 (103.00 days), Kashi Vibhuti (103.33 days), Palam Komal (103.67 days), Kashi Satdhari (103.67 days), DPO-1 (104.00 days), DPO-2 (104.00 days), DPO-20 (104.67 days), DPO-19 (105.00 days), Punjab Suhawani (105.67 days), DPO-7 (105.67 days) and DPO-8 (106.00 days) took less number of days to seed maturity. These results are in consonance with the findings of Kaul *et al*. (1978) [12], Arya *et al*. (1994) [4], Akinyele and Osekita, (2006) [2] and Sood, (2006) [19] for days to 50 per cent flowering and days to seed maturity.

Okra is grown during the rainy season, taller plants are preferred. In the present study maximum plant height was found in Punjab Suhawani (130.33 cm) followed by Arka Anamika (120.00 cm), Punjab-8 (116.33 cm) and Palam Komal (116.00 cm). Similar findings were reported by (Arya *et al*. 1994, Sood, 2006 and Akinyele and Osekita, 2006) [4, 19, 2] Higher pod yield in dwarf plants could be attributed to shorter intermodal length. The minimum internodal length found in 9801 (6.79 cm) followed by Shitla Uphar (7.72 cm), DPO-5 (7.74 cm), DPO-10 (7.79 cm), Shitla Jyoti (8.06 cm), DPO-8 (8.13 cm), Kashi Pragati (8.37 cm), DPO-6 (8.45 cm), DPO-11 (8.48 cm), Kashi Vibhuti (8.60 cm), DPO-17 (8.62 cm), Palam Komal (8.70 cm) and DPO-18 (8.82 cm). Arya *et al*. 1994 [4] and Sood, 2006 [19] also reported the similar results.

The genotypes DPO-5 (38.33 q/ha), Kashi Satdhari (37.69 q/ha), Palam Komal (35.02 q/ha), 9801 (34.55 q/ha) and Punjab Suhawani (34.28 q/ha) were the highest yielder. These findings are in conformity with Kaul *et al*. (1978) [12], Arya *et al*. (1994) [4], Akinyele and Osekita, (2006) [2] and Sood, (2006) [19]. Barring DPO-5, these genotypes also took the minimum days to 50 per cent flowering. Among these Kashi Satdhari produced higher number of seeds per pod and seed yield. The genotypes Palam Komal (13.33), Punjab Suhawani (13.00), Kashi Vibhuti (13.00), 9801 (12.67), DPO-6 (12.00) and DPO-10 (12.00) produced the maximum nodes per plant.

Higher number of seeds per pod was recorded in Kashi Satdhari (75.00), DPO-20 (64.00) and 9801 (60.00). Kaul *et al*. (1978) [12], Arya *et al*. (1994) [4], Sood, (2006) [19] and Akinyele and Osekita, (2006) [2] also have been reported similar results. Palam Komal (6.92 g) followed by Arka Anamika (6.71 g), 9801 (6.70 g) and DPO-18 (6.41 g) had maximum 100-seed weight. These results are found to be similar with the findings of Kaul *et al*. (1978) [12], Arya *et al*. (1994) [4], Sood, (2006) [19] and Akinyele and Osekita, (2006) [2]. Maximum seed germination and vigour reflects the ability of those seeds to produce normal seedlings under less than optimum or adverse growing conditions similar to those which may occur in the field. Maximum seed germination was found in DPO-20 (90.00%), 9801 (89.33%), Kashi Satdhari (88.00%), DPO-16 (88.00%) and DPO-1 (86.67%) and seed vigour was high in Kashi Satdhari (33.40), DPO-20 (32.68), DPO-11 (31.85), Punjab-8 (31.15) and 9801 (30.92). These results are found to be similar with the findings of Kaul *et al*. (1978) [12], Arya *et al*. (1994) [4], Sood, (2006) [19] and Chattopadhyay *et al.* (2011) [6] for seed germination and seed vigour.

Parameters of Variability

Variability was partitioned into genotypic and environmental components. The estimates of PCV were higher than corresponding GCV for all the characters studied (Table 5) which indicated that the apparent variation is not only due to genotypes but also due to the influence of environment. However, the differences between the genotypic and phenotypic variances were relatively low for most of the traits studied. This indicated highly heritable and comparatively stable nature of the characters and thus, the selection based on phenotypic performance would be quite effective in the improvement of these traits.

The magnitude of PCV and GCV were high for seed yield (25.54% and 23.49%) indicated that there is substantial variability ensuring ample scope for improvement of this trait through selection. It was moderate for node at which the first pod set (19.98% and 18.39%), seed vigour (17.90% and 16.91%), plant height (14.85% and 13.78%), nodes per plant (14.60% and 11.69%), seed germination (14.01% and 13.61%) and intermodal length (12.97% and 10.38%). GCV was also moderate for seeds per pod (11.08%). The moderate estimates suggested cautions approach while following direct selection for these traits. These results are in broad conformity to those of earlier researchers Kaul *et al*. (1978) [12] and Sood, (2006) [19].

The rest of the traits namely, days to seed maturity (2.58% and 1.60%), days to 50 per cent flowering (5.79% and 3.55%) and 100-seed weight (7.06% and 6.69%). GCV was also low for seeds per pod (9.55%). These traits can be improved through hybridization.

Heritability and Genetic Advance

Heritability in broad sense is a parameter of tremendous significance to the breeders as its magnitude indicates the reliability with which a genotype can be recognized by its phenotypic expression.

Most of the traits studied showed high (>80%) to moderate (50-80%) heritability. The Heritability (in broad sense) estimates were recorded high for seed germination (93.16%) followed by 100-seed weight (89.75%), seed vigour (89.30%), plant height (86.10%), node at which the first pod set (84.70%) and seed yield (84.55%) indicating that these traits were less influenced by the environment. This suggested that the large proportion of phenotypic variance has been attributed to the genotypic variance and hence reliable selection could be made for these traits on the basis of phenotypic expression.

Johnson *et al*. (1955) [10] stressed that for estimating the real effects of selection, heritability alone is not sufficient and genetic advance along with heritability is more useful.

High heritability along with high genetic advance observed for seed vigour (89.30% and 32.92%), node at which the first pod set (84.70% and 34.86%) and seed yield (84.55% and 44.49%), whereas high to moderate heritability coupled with moderate genetic advance for plant height (86.10% and 26.35%) and seed germination (93.16% and 27.06%) indicates preponderance of additive gene action which implies that these traits can be improved through pure line selection. The finding are in line for node at which the first pod set and seed vigour by Arya *et al*. (1994) [4].

Moderate heritability with low genetic advance noticed for the traits nodes per plant (64.13% and 19.29%), internodal length (64.02% and 17.10%), seeds per pod (74.31% and 16.96%) and 100-seed weight (89.75% and 13.06%). Low heritability was found to be associated with low genetic advance for days to 50 per cent flowering (37.54% and 4.48%) and days to seed maturity (38.53% and 2.05%). The association of moderate to low heritability with low genetic advance indicated that these traits are strongly governed by non-additive gene action. The improvement of these traits can be achieved by partitioning the genetic variance further and making selection for suitable types in segregating generations or through recombination breeding. Improvement of these traits through straight selection might not give desirable results.

Table 2: List of okra genotypes and their sources

Genotype	Source
Punjab Suhawani, Punjab-8	Punjab Agricultural University, Ludhiana (Punjab)
Kashi Vibhuti, Kashi Pragati, Shitla Uphar, Shitla Jyoti, Kashi Satdhari	Indian Institute of Vegetable Research, Varanasi (UP)
DPO-1, DPO-2, DPO-3, DPO-4, DPO-5, DPO-6, DPO-7, DPO-8, DPO-9, DPO-10, DPO-11, DPO-12, DPO-13, DPO-14, DPO-15, DPO-16, DPO-17, DPO-18, DPO-19, DPO-20, 9801, Palam Komal	CSK Himachal Pradesh Krishi Vishvavidyala, Palampur (HP)

Table 3: Analysis of variance for quantitative and quality traits in seed crop of okra

Source of variation Traits df → ↓	Replication 2	Treatment 29	Error 58
Days to 50% flowering	13.144	14.131*	5.041
Node at which the first pod set	0.012	0.240*	0.014
Plant height (cm)	12.211	570.659*	29.154
Nodes per plant	0.744	5.321*	0.836
Internodal length (cm)	0.497	3.385*	0.534
Days to seed maturity	6.544	13.355*	4.636
Seeds per pod	21.811	92.613*	9.570
Seed yield (q/ha)	9.843	109.887*	6.305
100-seed weight (g)	0.039	0.480*	0.017
Seed germination (%)	8.133	317.548*	7.582
Seed vigour	0.760	61.169*	2.349

*Significant at 5% level of significance

Table 4: Estimates of mean values for quantitative and quality traits in seed crop of okra

Genotypes/Traits	DF	NFPS	PH (cm)	NPP	IL (cm)	DSM	SPP	SY (q/ha)	SW (g)	SG (%)	SV
Punjab Suhawani	48.67	1.85	130.33	13.00	10.09	105.67	61.33	34.28	5.93	68.67	21.30
Kashi Vibhuti	46.33	1.40	111.67	13.00	8.60	103.33	54.00	32.20	5.43	84.00	29.34
Kashi Pragati	49.00	1.67	85.67	10.33	8.37	106.33	51.33	23.95	5.86	68.33	19.41
Shitla Uphar	50.33	1.52	84.67	11.00	7.72	107.33	49.33	19.96	5.84	82.00	25.54
Shitla Jyoti	50.67	2.03	86.00	10.67	8.06	108.00	56.33	22.88	5.76	70.00	21.51
Kashi Satdhari	47.67	1.32	90.00	9.33	9.63	103.67	75.00	37.69	5.80	88.00	33.40
Arka Anamika	47.67	1.53	120.00	11.00	10.96	106.67	53.33	25.79	6.71	61.67	18.90
DPO-1	46.33	1.57	106.00	9.67	10.99	104.00	53.67	26.19	5.84	86.67	30.57
DPO-2	45.67	1.26	93.00	9.00	10.39	104.00	54.67	20.58	5.64	83.33	28.60
DPO-3	55.00	1.53	113.00	10.00	11.36	111.67	53.33	25.25	5.97	80.67	26.69
DPO-4	51.33	1.83	114.67	11.33	10.12	109.67	51.00	27.90	6.14	75.00	28.73
DPO-5	49.33	1.13	84.67	11.00	7.74	106.67	61.33	38.33	5.73	77.67	26.48
DPO-6	49.67	1.67	101.00	12.00	8.45	107.33	54.67	25.24	5.95	73.33	22.82
DPO-7	47.33	1.87	82.67	8.33	9.94	105.67	57.33	20.74	5.72	80.67	29.30
DPO-8	48.33	2.17	86.67	10.67	8.13	106.00	55.33	21.24	5.25	70.67	22.45
DPO-9	52.00	1.47	112.33	11.33	9.95	109.33	48.33	24.04	5.43	74.67	24.28
DPO-10	49.67	1.23	93.33	12.00	7.79	107.00	50.33	23.19	5.88	77.00	23.70
DPO-11	50.33	1.72	93.00	11.00	8.48	108.33	56.00	19.73	5.57	66.67	31.85
DPO-12	50.00	1.19	110.00	10.67	10.41	107.67	50.67	22.43	6.30	52.00	22.82
DPO-13	48.00	1.07	90.00	9.33	9.82	106.33	56.33	14.71	5.38	82.33	28.36

DPO-14	51.67	1.03	89.67	9.33	9.59	108.00	52.00	16.84	5.75	82.00	27.75
DPO-15	49.67	1.31	82.67	9.00	9.25	106.67	50.67	15.30	5.78	65.33	19.01
DPO-16	50.00	1.52	94.33	9.67	9.77	107.67	57.33	19.54	5.11	88.00	30.60
DPO-17	49.33	1.07	80.33	9.33	8.62	106.33	61.33	25.66	5.96	80.67	29.42
DPO-18	49.00	1.47	85.00	9.67	8.82	107.00	50.67	22.70	6.41	59.67	20.76
DPO-19	48.33	1.72	90.67	8.67	10.48	105.00	59.33	25.90	5.52	54.00	29.30
DPO-20	47.00	1.43	94.67	9.00	10.56	104.67	64.00	29.29	6.22	90.00	32.68
9801	45.33	1.40	86.00	12.67	6.79	102.67	60.00	34.55	6.70	89.33	30.92
Palam Komal (c)	46.33	1.47	116.00	13.33	8.70	103.67	49.33	35.02	6.92	78.00	29.97
Punjab-8 (c)	52.33	1.37	116.33	11.33	10.27	103.00	54.00	30.48	6.29	80.67	31.15
SE(m)±	1.30	0.07	3.12	0.53	0.42	1.24	1.79	1.45	0.08	1.59	0.89
SE(d) ±	1.83	0.10	4.41	0.75	0.60	1.76	2.53	2.05	0.11	2.25	1.25
C.V. (%)	4.58	7.81	5.54	8.75	7.78	2.03	5.62	10.04	2.26	3.69	5.85
C.D. 5%	3.68	0.19	8.85	1.50	1.20	3.53	5.07	4.12	0.22	4.51	2.51
Grand Mean	49.08	1.49	97.48	10.46	9.40	106.31	55.08	25.02	5.87	74.70	26.18

DF-days to 50 per cent flowering, NFPS-node at which the first pod set, PH-plant height, NPP-nodes per plant, IL-internodal length, DSM-days to seed maturity, SPP-seeds per pod, SY-seed yield, SW-100-seed weight, SG-seed germination, SV-seed vigour

Table 5: Estimate of genetic parameters for quantitative and quality traits in okra genotypes

Traits	Grand Mean±SE(m)	Range	*PCV (%)	**GCV (%)	#h^2 (%)	±GA as percent of mean
Days to 50% flowering	49.08±1.30	45.33-55.00	5.79 (L)	3.55 (L)	37.54 (L)	4.48 (L)
Node at which the first pod set	1.49±0.07	1.03-2.17	19.98 (M)	18.39 (M)	84.70 (H)	34.86 (H)
Plant height (cm)	97.48±3.12	80.33-130.33	14.85 (M)	13.78 (M)	86.10 (H)	26.35 (M)
Nodes per plant	10.46±0.53	8.33-13.33	14.60 (M)	11.69 (M)	64.13(M)	19.29 (L)
Internodal length (cm)	9.40±0.42	7.72-11.36	12.97 (M)	10.38 (M)	64.02(M)	17.10 (L)
Days to seed maturity	106.31±1.24	102.67-111.67	2.58 (L)	1.60 (L)	38.53 (L)	2.05 (L)
Seeds per pod	55.08±1.79	48.33-75.00	11.08 (M)	9.55 (L)	74.31(M)	16.96 (L)
Seed yield (q/ha)	25.02±1.45	14.71-38.33	25.54 (H)	23.49 (H)	84.55 (H)	44.49 (H)
100-seed weight (g)	5.87±0.08	5.11-6.92	7.06 (L)	6.69 (L)	89.75 (H)	13.06 (L)
Seed germination (%)	74.70±1.59	52.00-90.00	14.10 (M)	13.61 (M)	93.16 (H)	27.06 (M)
Seed vigour	26.18±0.89	18.75-33.40	17.90 (M)	16.91 (M)	89.30 (H)	32.92 (H)

*PCV = Phenotypic coefficient of variation
**GCV = Genotypic coefficient of variation
#h^2 = Heritability
±GA = Genetic Advance
H = High, M = Medium, L = Low

Table 6: Mean performance of top high yielding genotypes for qualitative and quality traits in seed crop of okra

Sr. No.	Traits	Mean performance of top ranking genotypes along with checks in seed crop					
		DPO-5	Kashi Satdhari	Palam Komal (check)	9801	Punjab Suhawani	Punjab-8 (check)
1	Days to 50 per cent flowering	49.33	47.67	46.33	45.33	48.67	52.33
2	Node at which the first pod set	1.13	1.32	1.47	1.40	1.85	1.37
3	Plant height (cm)	84.67	90.00	116.00	86.00	130.33	116.33
4	Nodes per plant	11.00	9.33	13.33	12.67	13.00	11.33
5	Internodal length (cm)	7.74	9.63	8.70	6.79	10.09	10.27
6	Days to seed maturity	106.67	103.67	103.67	102.67	105.67	103.00
7	Seeds per pod	61.33	75.00	49.33	60.00	61.33	54.00
8	Seed yield (q/ha)	38.33	37.69	35.02	34.55	34.28	30.48
9	100-seed weight (g)	5.73	5.80	6.92	6.70	5.93	6.29
10	Seed germination (%)	77.67	88.00	78.00	89.33	68.67	80.67
11	Seed vigour	26.48	33.40	29.97	30.92	21.30	31.15

Conclusion
There was adequate genetic variability within the germplasm evaluated for the improvement of seed yield and quantitative and quality traits. The genetic variation observed suggests that a positive response to direct selection is possible for seed vigour, node at which the first pod set, seed yield, plant height ad seed germination as these traits showed high heritability with high/moderate genetic advance.

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