International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(6): 1004-1007

Received: 13-09-2019
Accepted: 15-10-2019

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Variability parameters in okra [*Abelmoschus esculents* (L.) Moench.]: Short communication

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Abstract
Okra also known as lady's finger is one of the most important vegetable crops in the world. It belongs to family Malvaceae having chromosome number 2n=8x=72 or 144 and is polyploidy in nature. It is the preferred vegetable grown extensively in the tropical, subtropical and warm area of the temperate zones of the world.Generally the success of any crop improvement program largely depends on the magnitude of genetic variability, genetic advance, character association, direct and indirect effects on yield and yield attributes. Genetic diversity is important for selection of parents to recover transgressive segregants. Studies in this direction are very less and can not to be generalized for every climatic condition and with other genetic materials. Hence, the information in a collection of some genotypes of okra in order to formulate a sound breeding plan for its improvement has been reviewed here. Fruit yield in okra is a complex trait that is governed by several yield components that are interrelated. The significance of number of pods per plant, early flowering and fruit weight in determining fruit yield in okra cultivars has been widely investigated by several workers (Demrany and Faraq, 1994; Khan *et al*., 2002; Chaudhary *et al*., 2006; Rahman *et al*., 2012). Jamala *et al.* (2011) compared the yield performance of a local variety and an improved cultivar in Mubi and found that the improved cultivar was superior to the local in terms of pod yield. To date, there is paucity of data on the yield potentials of some new okra cultivars that are cultivated in makurdi. Thus, this study was designed to investigate the yield potentials of new cultivars that can replace the existing ones for increased productivity.

Keywords: Okra, quantitative traits, varieties/hybrids and harvest index

Introduction
Okra [*Abelmoschus esculentus* (L.) *Moench*] Okra is a polyploid, belonging to the family Malvaceae with 2n = 8x =72 or 144 chromosome. According to Vavilov (1951) [10], it was probably domesticated in the Ethopian region. Okra is often cross pollinated crop, occurrence of out crossing to an extent of 4 – 19 % pollination. Okra is cultivated comprehensively in the tropical, subtropical and warm areas of the world like India, Africa, Turkey and other neighbouring countries.

It is a short duration crop propagated through seeds, cherished for its tender and scrumptious green fruits used in curries, soups or in canned, dehydrated or frozen forms for off-season consumption (Neeraja *et al.*, 2004) [9]. Okra is more remunerative than the leafy vegetables, while crop has not adapted in India as leafy vegetable as in for East countries. Its ripe seeds are roasted, ground and used as a substitute for coffee in Turkey (Mehta, 1959) [6]. The fruits are a green capsule containing numerous white seeds when immature (Jesus *et al.*, 2008) [5] and the flowers and upright plants give okra an ornamental value (Duzyaman, 1997) [4]. The okra fruit can be classified based on the shape, angular or circular (Mota *et al.*, 2005) [7].

Edible fresh and mature fruits contain 88% moisture and large number of chemical components including Vit. A 88 IU, Vit. B 63 IU and Vit. C 13 mg/100 gm. unripe okra fruits contain 3100 calorie energy, 1.8gm Protein, 90 mg Calcium and 1.0 mg iron. Seeds of okra had the oil content 17.3% It strike out the nutritious ingredient of cattle feed. It has Ayurvedic medicinal properties. Its leaves are used for preparing a medicament to reduce inflammation. It is an excellent source of Iodine for control of goiter (Chadha, 2001) [1]. It is also very useful against genito-urinary disorders, spermatorrhoea and chronic dysentery (Nandkarni, 1927) [41].

Heritability and genetic advance estimates help the breeder to apply appropriate breeding methodology in the crop improvement programme. (Johnson *et al.*, 1955 [42] and Darvhankar *et al.*, 2013). Thrust of any crop improvement programme is to enhance economic yield which is a complex dependent character, mostly inherited quantitatively and is determined by a number of yield components, greatly affected by environmental factors.

The component traits which have high heritability and positive correlation with yield can be used in the indirect selection for improvement of yield. In determining the potential of genetically different lines and cultivars, breeders have to observe various traits that influence yield. Accurate evaluation of these characters is made more difficult by the genotype by environment interaction (Tadesse and Bekele, 2001) [40]. Thus, enabling the plant breeder for the variation and the estimates of the heritability and genetic advance are the important parameters on which the success of selection lines.

Genetic improvement mainly depends on the amount of genetic variability present in the population. In any crop, the germplasm serves as a valuable source of base population and offer major source of variability (Ramya and Senthil Kumar 2009) [39].

Variability Parameters

Selection of superior genotypes at one stage or the other is the most important aspect in any plant improvement programme and the effectiveness of the selection is dependent upon the existence of genetic variability within or among the population subjected to selection (Tikka *et al*., 1974) [33]. Therefore, a quantitative measure of genetic variability would be extremely beneficial in breeding for improvement of quantitative traits. Heritability is an important parameter of great importance for the plant breeder as its magnitude indicates the accuracy with which a genotype can be recognized by its phenotypic expression. Alam and Hossain (2008) [14] evaluated 50 accessions of okra and observed wide range of variation for spread of plant, height of plant, length of petiole. They also observed highest genotypic coefficient of variation and phenotypic coefficient of variation for number of primary branches/plant. High heritability in okra were recorded for plant height, fruit width, fruit length, number of fruits per plant and weight of fruit per plant by Kumar *et al*. (2011) [37]. Prakash *et al*. (2011) [38], observed high PCV and GCV in okra for plant height, inter-nodal length, first flowering node, average fruit weight, number of seeds per fruit, first fruit producing node and height of first flowering node. They also observed high genetic advance for plant height, average fruit weight, number of seeds per fruit and total yield per plant. Nwangburuka *et al*., (2012) [36] recorded high genotypic coefficient of variability, broad-sense heritability and genetic advance for plant height, fresh pod length, fresh pod width, mature pod length, branching per plant and pod weight per plant.

Kerure (2009) [32], observed high genotypic coefficient of variation and phenotypic coefficient of variation for characters like plant height, inter-nodal length, first flowering node, first fruit producing node, average fruit weight and number o seeds per fruit. Akotkar *et al*. (2010) [13], reported high genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance (% mean) for number o fruiting nodes, number of ridges per fruit, plant height and number of fruiting nodes. Shanthakumar and Salimath (2010) [19], observed moderate to high phenotypic and genotypic coefficient of variation for all the characters except days to first flowering, stem diameter (in double cross), fruit length and 100 seed weight in okra. Gangashetty *et al*. (2010) [19] observed high GCV and PCV for characters like number of branches per plant, number of fruits per plant, fruit yield per plant and moderate GCV and PCV for inter-nodal length, fruit length, fruit diameter and fruit weight. Prakash and Pitchaimuthu (2010) estimated high GCV and PCV for characters like plant height, inter-nodal length, first flowering node, first fruit producing node, height of first flowering node, average fruit weight and number of seeds per fruit. High GCV and PCV in okra were noticed by Jindal *et al*. (2010) [27], for characters like number of primary branches per plant. They also noticed high heritability coupled with genetic advance for number of branches per plant, total yield per plant and marketable yield per plant and high heritability coupled with low genetic advance for days to first picking, average fruit weight, plant height, inter-nodal length, number of fruits per plant, fruit diameter and average fruit length.

Correlation coefficient

The study on correlation will help in identifying the traits which have strong association with yield. So, the knowledge of association of various characters helps the breeder in determining the relative importance of yield components to be considered to improve yield. The correlation values decide only the value and degree of association existing between pairs of characters. It is important to have the study of variability in the population in order to select the desirable types. The variability observed for any character is due to differences in genes carried by individual of the population as well as due to differences in the environments. So it is necessary to have an idea about the environment and genetic variability. Therefore, the proportion of a heritable variance of a character is of much importance. Kumar *et al*. (2011) [37], observed that fruit yield was negatively correlated with fruit length and positively correlated with weight of fruits per plant, fruit length was positively correlated with weight of fruit per plant. Guddadamath *et al*. (2011) [21], reported that the GCV showed more significant relationship between the pairs of characters such as average fruit weight, number of fruits per plant, 100 seed weight, and number of branches per plant. Guddadamath *et al*. (2012) [22] taken up character association studies in okra and reported that the characters like fruit length, average fruit weight, number of fruits per plant, number of branches per plant and plant height showed significant positive association with fruit yield per plant and also showed significant positive association among themselves. From a correlation study Nwangburuka *et al*. (2012) [36] recorded the positive and significant phenotypic and genotypic correlation in okra between plant height at maturity, fresh pod width, seeds per pod and pods per plant, branches per plant with seed weight per plant and pod weight per plant. In a character association study for thirteen quantitative characters in okra.

Reddy *et al*. (2013) [26, 30] observed significant positive phenotypic and genotypic correlation for plant height, fruit length, fruit width, fruit weight, total number of fruits per plant, number of marketable fruits per plant and total yield per plant. Jagan *et al*. (2013) [26] reported that fruit yield per plant showed highly significant positive association with a number of branches per plant and number of fruits per plant at phenotypic and genotypic levels. Adiger *et al*. (2011) [31] reported that fruit weight had maximum direct contribution towards fruit yield followed by number of fruits per plant (0.852), plant height (0.024) and number of branches per plant (0.020). They also reported that days to 50% flowering exhibited highest negative direct effect (-0.013) followed by test weight (-0.009) and fruit diameter (-0.003). While studying the correlation and path analysis of quantitative characters in okra Reddy *et al*. (2013) [26, 30] observed that fruit weight, total number of fruits per plant and number of marketable fruits per plant had positively direct effect on

marketable pod yield per plant. They also observed that the fruit weight, total number of fruits per plant and number of marketable fruits per plant not only had positively significant association with marketable pod yield per plant, but also had positively high direct effect on marketable pod yield per plant and are regarded as the main determinants of marketable pod yield per plant. Simon *et al*. (2013) [29] suggested that the seed size has high positive direct effect on seed yield (0.703). Yonas *et al*. (2014) [28], studied correlation between various quantitative characters in okra and reported that fruit yield had positive and highly significant genotypic correlation with fruit length, average fruit weight, fruit diameter, seed per pod, hundred seed weight and number of pod per plant. They also suggested that the number of seeds per pod had the highest significant correlation effect on seed yield (0.846) as well as highest negative direct effect with seed yield (-1.00) indicating that selection of number of seeds per pod will increase seed yield. Co-efficient of variation is useful in the assessment of genetic variability for the particular character. Heritability denotes the proportion of phenotypic variation due to genotypes and thus help the breeders to select the elite variety for a character. Genetic advance denotes the improvement in the mean genotypic values of selected families over base population and thus helps the breeder to select the progenies in the earlier generation itself ((Chauhan, 1972)) [3].

Path analysis study in okra conducted by Yonas *et al*. (2014) [28], at genotypic level revealed that internodes number had highly positive direct effect on fruit yield (p = 6.90) followed by average fruit weight (p = 6.89) which had positively genotypic correlation with yield. PCV over GCV also suggest that genetic component is equally responsible for the expression of these traits and warranted further improvement through selection. Heritability estimates along with genetic advance would be more useful in achieving genetic gain under phenotypic selection than heritability estimate alone (Darvhankar *et al*., 2016) [18]. The selection based on variability studies does not always lead to expected genetic gain because of the presence of G × E interaction and the association of different characters with yield. Unfavourable association among the yield attributes under selection may results in genetic slippage and limits the genetic advance. Knowledge of association between yield and yield related traits is very useful for efficient selection of desirable plant type. Therefore, genetically divergent genotypes can be utilized for crop improvement in okra.

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