CHAPTER – I
INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. Okra was earlier included in genus *Hibiscus*, section *Abelmoschus* in the family *Malvaceae* (Schippers, 2000). *Abelmoschus esculentus* is found all around the world from Mediterranean to equatorial areas. Cultivated and wild species clearly show overlapping in Southeast Asia, which is considered as the centre of diversity. Eight *Abelmoschus* species occur in India. Out of these, *A. esculentus* is the only known cultivated species. *A. moschatus* occur as wild species and is also cultivated for its aromatic seeds, while the rest six are truly wild types. Okra is mainly propagated by seeds and has duration of 90-100 days. It is generally an annual plant. Its stem is robust, erect, and variable in branching and varying from 0.5 to 4.0 m in height.

It is widely cultivated as a *summer* season crop in North India and as a *kharif* and as a *summer* season crop in Gujarat, Andhra Pradesh, Karnataka and Tamil Nadu. It fails to grow on high hills and the areas, which experience very low temperatures. It grows well in the areas where day temperatures remain between 25°C to 40°C and that of night are over 22°C.

Okra plants are characterized by indeterminate growth. Flowering is continuous but highly dependent upon biotic and abiotic stress. This crop is suitable for cultivation as a garden crop as well as on large commercial farms. Okra is known by many local names in different parts of the world like bhindi and lady finger. It is grown commercially in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Burma, Japan, Malaysia, Brazil, Ghana, Ethiopian, Cyprus and the Southern United States.

During 2013-14, okra is grown in the world on an area of 11.17 lakh hectares with a production of 8.71 million tonnes and productivity of 7.8 t/ha (Anon., 2015b). India ranks first in the world with 6.35 million tonnes (70% of the total world production) of okra produced from over 5.33 lakh ha land with a productivity of 11.9 t/ha during 2013-14 (Anon., 2015a). In Gujarat, okra is grown during 2013-14 on an
area of 0.66 lakh hectares with a production of 0.76 million tonnes and productivity of 11.50 t/ha (Anon., 2015a).

The okra provides an important source of vitamins and minerals (Lamont, 1999). (Grubben et al. 1977) have also reported significant levels of carbohydrate, potassium and magnesium. The seeds of okra are reported to contain between 15 and 26% protein and over 20 % edible oil content (Berry et al. 1988). About 10-15 t / ha of fruit yield can be obtained under good management.

Among fruit vegetables, okra fruits have good demand throughout the year. India is the largest producer of okra (bhindi) in the world. The major okra growing states are U.P., Bihar, and West Bengal (Anon., 2015a). The once declining production due to yellow vein mosaic virus (Yvmv) is now on rise with release of resistant varieties and hybrids. (Chauhan, 1972).

Okra fruit can be cooked in a variety of ways. The roots and stems of okra are used for cleaning the cane juice from which gur or brown sugar is prepared (Chauhan, 1972). It’s ripe seeds are roasted, ground and used as a substitute for coffee in some countries. Mature fruits and stems containing crude fibre are used in the paper industry. Extracts from the seeds of the okra is viewed as alternative source for edible oil. The greenish yellow edible oil has a pleasant taste and odour, and is high in unsaturated fats such as oleic acid and linoleic acid. The oil content of the seed is quite high at about 40%.

Plant is an erect herbaceous annual 1-2 meter tall. Stem is green or exhibits reddish tinge. Leaves are alternate, broadly cordate, palmately 3-7 lobed, hirsute and serrate. Flowers are solitary, axillary with about 2 cm long peduncle; epicalyx up to 10. There are narrow hairy bracteoles, which fall before the fruit reaches maturity; calyx split longitudinally as flower opens. Petals 5, yellow with crimson spot on claw, 5-7 cm long. Staminal columns are united to the base of petals with numerous stamens. Ovary superior, stigma 5-9, deep red. Fruit is a capsule, light green or sometimes red in colour, pyramidal oblong, beaked, longitudibly furrowed, 10 -30 cm long, dehiscing longitudinally when ripe. Seeds are green to dark brown and rounded. The greatest increase in fruit weight, length and diameter occurs during 4th to 6th days after pollination. Generally, the fiber formation in the fruit begins at 5th or 6th day of fruit formation and a sudden increase in fiber content from the 9th day is observed (Lamont, 1999).
A flower bud appears in the axil of each leaf above 6th to 8th leaf depending upon the cultivars. There may be a period of 2, 3 or more days between the times of development of each flower but never does more than one flower appear on a single stem. The time of anthesis varies with the cultivar, temperature and humidity and it occurs during 8 to 10 am. The dehiscence of anther is transverse and occurs 15 to 20 minutes after anthesis. The dehiscence is complete in 5-10 minutes. It takes 2-6 hours for fertilization after pollination. The flowers remain open for a short time and they wither late in the afternoon. The stigma is receptive at opening of the flower. Experimentally it has been found that there is no significant difference in fruit set under open-pollinated, self-pollinated (by bagging alone) and self-pollinated (hand pollination of bagged flowers), indicating that it is potentially a self-pollinated crop. The pollen fertility is maximum one hour before and after the opening of flower (Grubben et al. (1977).

All the varieties of okra grown by farmer are more or less susceptible to yellow vein mosaic (Yvm) disease. The Vegetable Research Station of Gujarat Agriculture University has released one new variety Gujarat Bhinda 2 of okra in 1999. This variety is resistant to yellow vein mosaic virus. Breeding method is pedigree (S-18-20 x Manihot) x S-18-20. Growth and yield of this variety is better than others. However, no work has been carried out on its growth and yield. Because of its acceptability in the market and fetching higher prices, cultivators are eager to know about its scientific management practices and special treatments for obtaining higher yields.

It is known since long back that plants require nutrients for their growth and development. They may grow and survive even if little amount of nutrients is available. But for their reproductive phase, certainly an additional quantum of mineral nutrients is essential which should either be met with the application of nutrients through soil or foliar feed or through the both ways. Further, for augmentation of various physico-biochemical processes, growth regulators also prove beneficial.

Characterization of crops is a very essential first step in any crop improvement programme (De Vicente et al. 2005). Characterization of genetic resources, therefore, refers to the process by which accessions are identified, differentiated or distinguished according to their character or quality traits (Merriam-Webster, 1991). Characterization provides information on diversity, within and between crop collections. This enables the identification of unique accessions essential for curators
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of gene banks. Moreover, information obtained on genetic relatedness among genetic resources of crop plants is useful, both for breeding and for the purposes of germplasm conservation (Brown et al. 1990).

According to International Union for Protection of New Plant Varieties (UPOV), any new characteristics used in varietal characterization should be clearly defined, accepted and should have standard method of observation, least or not affected by environment, accessible to breeders, associated with reasonable costs and efforts. To identify okra genotypes, international bodies like UPOV and International Plant Genetic Resources Institute (IPGRI) have published relevant descriptors. Such types of classical taxonomic approach is still being employed by certification agencies for the purpose of grow out test to determine the genetic purity of seed lots. These morphological descriptors have a traditional significance and are immediately accessible on the spot without need of equipment. Thus, a clear basis for distinctness testing procedure prior to varietal registration can draw out of this. However, the approach demands a field assessment, which depends on the degree of experience of the operator.

Maintenance of genetic purity of varieties is primary importance for preventing varietal deterioration during successive regeneration cycles and for ensuring varietal performance at an expected level. The aspects of Distinctness, Uniformity and Stability (DUS) are fundamental for characterization of varieties. In countries having Plant Breeder’s Right (PBR) in operation, a new variety is registered only, if it is distinct from other varieties, uniform in its characteristics and genetically stable.

The morphological study includes the study of seed to the whole plant characterization. Seed, seedlings and full grown plant could be taken into account for morphological characterization. Grow Out-Test is conducted by growing the plants under field condition and growth features are observed in fixing genuineness. Different cultivars could be identified based on above said characterization.

Moreover, varietal characterization using morphological characters possess several undesirable features like seasonal dependence, large space requirement, time consuming, tedious and environmental influence. To overcome these limitations, there is a need for rapid and reliable method of varietal identification and genetic purity testing.
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So, it is essential to develop field and laboratory key characters to test the varietal purity. The methods are required on routine basis to have an effective check on seeds moving in commercial channels. So far only scanty reports are available to identify okra genotype using such methods.

In the light of the above facts, the present study on documentation of characters for okra genotype was planned with the following objectives.

1. To identify stable diagnostic characteristics of stem, flower, fruit, plant morphology and seed of okra genotypes.
2. To determine the association among yield and yield attributing traits and between seed vigour and its attributes.
3. To find out the path analysis between yield and yield contributing traits.