Study on diversity of foliar trichomes in thirty accessions of okra (Abelmoschus esculentus (L.) Moench.)

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ABSTRACT

Foliar epidermal features of thirty accessions of okra (Abelmoschus esculentus) were studied with the aim of using these features to identify them in the vegetative stage during hybridization experiments. Quantitative and qualitative micromorphological characters, distribution of both glandular and eglandular foliar trichomes in thirty accessions of okra were characterized. An indumentum of variable density and texture formed of wide variety of glandular and eglandular trichomes on both surfaces of leaves. Among the thirty accessions of okra studied, both glandular and eglandular foliar trichomes showed considerable diversity in their qualitative and quantitative micro morphological characters. Diversity of these epidermal appendages is separated into eight main types. Eglandular conical type trichomes were the most abundant on both leaf surfaces of all the accessions examined. Accessions like Pusasawani and IC-117251 could be demarked due to the occurrence of stellate trichomes. Forked type was delimited to accessions like Arkaanamika, IC-99746, IC-111514 and IC-111517. These variations in morphology and distribution of the foliar trichomes emerged as an important tool to identify the diverse accessions of okra during breeding programme.

Key words: Breeding, Foliar appendage, Malvaceae, Okra, Trichome.

INTRODUCTION

Okra is an economically important vegetable crop grown in tropical, sub tropical and warm temperate regions around the World. It is a nutritious vegetable and has several health benefits as it is rich in Vitamin A, vitamin C, Thiamin, Vitamin B6, folic acid, riboflavin, calcium, zinc, dietary fibres, amino acids like tryptophan, cystine and other sulphur aminoacids. It is also rich in carbohydrates, proteins, iron, magnesium and copper (IBPGR,1990). Chauhan (1932) reported the use of its roots and stems for cleaning the cane juice during the preparation of guar or brown sugar.

Some particular groups of plants to be characterized by specific type of epidermal features, which are Epidermis, Stomata, gland and Trichomes. Trichomes are epidermal appendages of diverse forms, structure and functions (Uphof, 1962). They may occur on all parts of a plant. Either they persist throughout the life of an organ or they are ephemeral. Some persisting hairs may alive; others become devoid of protoplasts and are retained in dry state. The epidermal trichomes usually develop early in relation to the growth of the organ. Leaf trichomes have been shown to reduce herbivory in a number of plant species (Levin,1973; Elle et. al., 1999; Hare and Smith, 2005) For plants in xeric habitats, epidermal appendages reflect light and can reduce transpiration rate (Ehlering,1984).

Trichomes may show wide variations within small families and the smaller plant groups, and even in the same plant (Esau, 1965). However in some times considerable uniformity in trichomes may occur within a plant group. Plant hair types have been successfully used in the classification of genera and even species in certain families and in the recognition of interspecific hybrids (Rollins, 1944; Heintzelmann and Howad, 1948).

Foliar trichomes are important in regulation of moisture exchange with the atmosphere, covering hairs for plant defence against phytophagous insects, secretory trichomes for providing chemical defence against insects and stinging hairs for protecting plants from animals(Pandey and Chadha,1996) Uphof (1962) classified trichomes on the basis of morphological character such as (1) Non-glandular trichomes (2) Glandular trichomes.

Presence of various types of glandular and eglandular trichomes is a characteristic feature of genus Abelmoschus (Inamdar et.al., 1983). Trichomes may serve a variety of defensive and physiological functions. Although the epidermal anatomy of leaves of a number of Malvaceae species has been described (Inamdar and Chohan,1969; Adedeji and Dloh, 2004; Celka et. al., 2006) and the emphasis was on general anatomical features, ontogeny of trichomes. Detailed study on comparative micromorphology...
of foliar trichomes within the same species are however very scarce.

In the present investigation we aimed to identify the 30 accessions of okra (*Abelmoschus esculentus* (L.) Moench) based on their comparative micromorphological characteristics of the foliar trichomes and which may help to identify different accessions of okra in vegetative stage during breeding experiments.

**MATERIALS AND METHODS**

Seeds of thirty accessions of okra (*Abelmoschus esculentus* (L.) Moench.) representing various agroecological zones of India were collected from NBGPR, New Delhi. The thirty accessions were

| Accession | Code          | Description                                |
|-----------|---------------|--------------------------------------------|
| 1         | IC-43023      | Type 1. Basal cells are smaller, upper 2-3 are slightly larger with small curvature. |
| 2         | IC-45730      | Type 2. Almost all cells are in the same size without any bending. |
| 3         | IC-45895      | Type 3. Biseriate, multicellular head formed of 4-5 cells. |
| 4         | IC-45932B     | Type 4. Similar to type 2, but among 4 upper cells 3 cells arranged in one row. |
| 5         | IC-99641      | Type 5. Stalked trichome with a multicellular slightly elongated oval shaped head. |
| 6         | IC-99693      | Type 6. Short, multicellular with rounded to oval shaped head. |
| 7         | IC-99746      | Type 7. Multicellular, among the three upper cells two cells arranged in biseriate. |
| 8         | IC-111014     | Type 8. Sessile, unicellular cup shaped or rounded with narrow apical opening. |
| 9         | IC-111319     | Type 9. A multicellular mass of tissue formed as a epidermal outgrowth. |

**RESULTS AND DISCUSSION**

The qualitative micromorphological study of the 30 accessions of okra revealed the following types of foliar trichomes.

In majority of plant breeding experiments intervarietal crosses were made to produce high yielding varieties (Chaudhari, 1971). It is difficult to distinguish the accessions in a collection of germplasm they are closely resembles (Anitha and Nandihalli, 2009). In the present investigation we focused on this and used qualitative and quantitative micromorphological characters to identify thirty accessions of kra in our experimental garden. Quantitative and qualitative micromorphological variation, distribution and anatomical measurements of the foliar trichomes were used as a main distinguishing character to identify accessions in various studies (Hardin, 1979). The anatomical features especially the plant epidermis is mildly influenced by environmental conditions and is of high structural diversity. These characters also represented genetic diversity (Adegbite, 1995; Ogunkunle and Oladele, 2008). The use of anatomical features has been incorporated along with the external features in delimiting species among a genus or genera in a family (Olowokudje and Pereira-Sheteolu, 1998; Adegbite, 1995; Abdurahman and Oladele, 2005).

Okra (*Abelmoschus esculentus* (L.) Moench.) was originally in the genus *Hibiscus* but later transformed in to

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Table 1: Types of trichomes in thirty accessions of okra (*Abelmoschus esculentus*).

| Types of Trichomes | Description |
|--------------------|-------------|
| Conical            | Axillary elongated, unicellular, broad at the base and tapering above. |
| Forked             | Two ray cells present in the same cavity. |
| Stellate           | Formed of considerable number of unicellular ray cells held together in the centre. |
| Flask shaped trichome | Unicellular, having more or less swollen base and narrowing upwards. |
| Uniseriate multicellular | Erect, formed of single row of cells. Number of cells vary 4-5. |
| Capitate           | Stalked trichome with a multicellular slightly elongated oval shaped head. |
| Peltate            | Sessile, unicellular cup shaped or rounded with narrow apical opening. |
| Papillate          | A multicellular mass of tissue formed as a epidermal outgrowth. |
the genus *Abelmoschus*. Some of the reasons for this transference include some micromorphological variation such as high percentage of paracritical stomata (42.67%) and high trichome density (243.42%) (Abdulrahman and Oladele, 2010). Features of hairs are broadly regarded as useful for establishing the systematic relations within the family Malvaceae (Iljin, 1974; Inamdar *et al.*, 1983; Dorr, 1990). Similarly the role of egranular trichomes in characterizing Malvales were reported by Bayer and Kubitzki (2003). In the present study we used eight major types of glandular trichomes (Table 2).

The accession Pusasawani (76.16 µm). The accession Pusasawani  is also the longest in the accession IC-117251 (537.88 µm), whereas the thickest ray cells was observed in the accession IC-45730 (1037.05 µm). Some were seen intermixed with forked and stellate trichomes as in the accessions Pusasawani, Arkaanamika, IC-99746, IC-117251. They represent non-glandular trichomes (Table 2).

Stellate trichomes a characteristic feature of the family Malvaceae (Garcia *et al.*, 2014) are variable in number of ray cells and their relative length and thickness. Anatomical measurements indicated that the presence of longest ray cells in the accession IC-45730 (1037.05 µm). Some were seen intermixed with forked and stellate trichomes as in the accessions Pusasawani, Arkaanamika, IC-99746, IC-111514, IC-111517 and IC-117251. They represent non-glandular trichomes (Table 2).

Among egranular trichomes, conical type, simple, stellate, and forked were reported in the family Malvaceae (Shaheen *et al.*, 2010). In the present study simple unicellular conical type trichomes were observed in all the thirty accessions of okra. Even if it is most frequent in all accessions they differ a great deal in their quantitative micromorphology. It indicates the presence of longest conical type trichomes in the accession IC-45730 (1037.05 µm). Some were seen intermixed with forked and stellate trichomes as in the accessions Pusasawani, Arkaanamika, IC-99746, IC-111514, IC-111517 and IC-117251. They represent non-glandular trichomes (Table 2).

### Table 2: Distribution pattern of various foliar trichome types in the thirty accessions of okra (*Abelmoschus esculentus* (L.) Moench).

| Accessions          | Conical | Forked | Stellate | Unisexual Multicellular type I | Unisexual Multicellular type II | Capped type I | Capped type II | Capped type III | Capped type IV | Flask | Peltate | Pappulate |
|---------------------|---------|--------|----------|--------------------------------|--------------------------------|---------------|---------------|-----------------|---------------|--------|----------|-----------|
| PUSASAWANI          | c       | -      | c        | o                              | o                              | -             | -             | -               | -             | c      | r        | o         |
| ARKAANAMKA          | c       | c      | -        | -                              | -                              | -             | -             | -               | -             | o      | o        | r         |
| SALLEKEERTHI        | c       | -      | -        | -                              | -                              | -             | -             | -               | -             | r      | o        | o         |
| VRO-5               | c       | -      | -        | -                              | -                              | -             | -             | -               | -             | r      | o        | o         |
| IC-39132            | c       | -      | c        | o                              | -                              | -             | o             | -               | -             | r      | o        | r         |
| IC-29136            | c       | -      | o        | -                              | -                              | -             | -             | -               | -             | o      | r        | o         |
| IC-9140             | c       | -      | c        | -                              | -                              | -             | -             | -               | -             | o      | o        | r         |
| IC-42456            | c       | -      | c        | o                              | -                              | -             | -             | r               | -             | -      | o        | r         |
| IC-45215            | c       | -      | c        | -                              | -                              | -             | o             | -               | -             | -      | o        | r         |
| IC-3023             | c       | -      | c        | -                              | c                              | o             | -             | -               | o             | -      | o        | o         |
| IC-45730            | c       | -      | o        | c                              | -                              | -             | -             | -               | -             | o      | o        | r         |
| IC-45895            | c       | -      | o        | -                              | r                              | r             | c             | -               | -             | r      | o        | r         |
| IC-45932B           | c       | -      | c        | r                              | -                              | -             | -             | -               | -             | -      | o        | o         |
| IC-99641            | c       | -      | -        | o                              | -                              | -             | o             | o               | -             | o      | o        | o         |
| IC-99693            | c       | -      | -        | -                              | o                              | -             | o             | o               | -             | o      | o        | o         |
| IC-99746            | c       | -      | o        | -                              | -                              | r             | c             | -               | -             | -      | o        | r         |
| IC-111014           | c       | -      | -        | -                              | r                              | o             | o             | o               | -             | o      | o        | r         |
| IC-111319           | c       | -      | c        | o                              | c                              | o             | -             | -               | o             | -      | o        | o         |
| IC-111366           | c       | -      | -        | o                              | -                              | -             | -             | -               | o             | -      | o        | o         |
| IC-111480           | c       | -      | -        | o                              | -                              | -             | r             | -               | -             | -      | o        | r         |
| IC-111511           | c       | -      | o        | -                              | o                              | o             | -             | -               | -             | -      | o        | r         |
| IC-111514           | c       | c      | o        | -                              | -                              | o             | -             | -               | o             | -      | o        | r         |
| IC-111517           | c       | c      | -        | o                              | -                              | -             | -             | r               | -             | -      | o        | r         |
| IC-111520           | c       | -      | c        | -                              | -                              | -             | -             | -               | -             | o      | o        | o         |
| IC-111536           | c       | -      | o        | -                              | -                              | -             | -             | -               | -             | o      | o        | o         |
| IC-117238           | c       | -      | c        | o                              | -                              | -             | -             | -               | -             | o      | r        | o         |
| IC-117251           | c       | -      | o        | -                              | -                              | -             | o             | -               | -             | -      | o        | o         |
| IC-265147           | c       | -      | -        | -                              | -                              | -             | o             | -               | -             | o      | o        | o         |

The reasons for this transference include some micromorphological variation such as high percentage of paracritical stomata (42.67%) and high trichome density (243.42%) (Abdulrahman and Oladele, 2010). Features of hairs are broadly regarded as useful for establishing the systematic relations within the family Malvaceae (Iljin, 1974; Inamdar *et al.*, 1983; Dorr, 1990). Similarly the role of egranular trichomes in characterizing Malvales were reported by Bayer and Kubitzki (2003). In the present study we used eight major types of glandular and egranular foliar trichomes (Fig.1) and their quantitative measurements were used to identify the thirty accessions of okra. The basic terminology used in trichome classification and description was according to Harris and Harris (2001).
in the leaves of a number of Malvaceous plants (Shaheen et al., 2010). In Malva alcea L., about 90% of the plants have 4-5 branched hairs (Celka et al., 2006).

Among glandular trichomes capitate, clavate capitulate and peltate were reported in the genus Hibiscus (Shaheen, et al., 2010). In the present study, uniseriate multicellular, capitulate and peltate glands were observed. Uniseriate multicellular type I was observed in all accessions studied except VRO-5, IC-45730 and IC-99693, IC-111014, IC-111517 and IC-265147. Both uniseriate multicellular type I and type II were quite similar to those reported by Shaheen et al. (2010) on the leaves of H. rosa-sinensis and Abutilon molle and described as clavate capitulate and capitulate trichome respectively. Peltate glands were observed in certain accessions such as Pusaaswani, VRO-6, IC-43023, IC-99693, IC-111014, IC-112457 and IC-111514. The papillate type trichome delimited to the accession Salkeerthi (Table 2).

Glandular capitulate trichomes observed in okra are of 4 main types. Type I is short, multicellular slightly elongated with oval shaped head. Type II, multicellular, among the three upper cells two cells arranged in biseriate which is different from type III having four upper cells formed in biseriate manner. Accessions IC-99641 and IC-111366 were demarked from other accessions by the presence of type IV trichomes (Fig. 2). Many of the accessions were characterized by the presence of capitulate type trichomes, but differ a great deal in their anatomical measurements such as length and width of the trichomes. These variation plays major role in identifying the different accessions of okra. Flask shaped trichomes were exclusively observed in accessions IC-39140 and VRO-6 are unicellular and slightly broader at the base and narrowing upwards forming a neck like portion with apical opening. The frequency of occurrence of stellate types and flask shaped are high in certain members of the family Malvaceae such as Abutilon bidentatum, A. fruticosum, A.indicum, A.molle etc. (Shaheen et al., 2010).

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