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MORPHOLOGICAL, ANATOMICAL AND REPRODUCTIVE PARAMETERS IN FEW VARIETIES OF MULBERRY (*MORUS SPP.*)

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ABSTRACT
Regarding anatomical, morphological and reproductive studies of four mulberry verities namely, Channapatna local, Thailand, *Morus cathyana* HEMSLEY and *Morus multicaulis* were selected. Height, internodal distance, colour of leaves, stem, stomatal frequency, length and number of inflorescence and pollen fertility were studied for these four varieties. Mulberry varieties studied exhibited considerable variations in height, internodal distance, leaf texture, stomatal frequency, length, breadth and pollen stain ability. Height, stomatal frequency and pollen stain ability was higher in diploid and uneuploid when compared to triploid and tetraploid varieties. Tetraploid and triploid varieties showed increased stomatal size, reduction in height, number of branches and internodal distance followed by diploid and triploid varieties.

KEY WORDS: Mulberry (*Morus spp*.), diploid, triploid, tetraploid, uneuploid, micro morphology.

INTRODUCTION

Morphology and reproductive studies on mulberry are essential for taxonomists to classify different species and varieties to assist plant breeders to evolve promising genotypes for commercial exploitation. Modern taxonomy is a synthetic entity which tries to align the related groups in an order, drawing information from various branches such as morphology, anatomy, reproductive characters, cytogenetics, *etc*., for better utilization of genetic resources. Most of the cultivated varieties of mulberry are diploid with 2n=28 chromosomes, a few are polyploids (Gill and Gupta, 1979; Venkatesh, 2007). The Cytogenetical information available in triploids and tetraploids is fragmentary (Venkatesh & Munirajappa, 2012; Venkatesh & Munirajappa, 2013). Venkatesh *et al*. (2012) studied the meiosis of some species of *Morus* and confirmed the extreme difference between the 13 small pairs and one large pair of chromosomes. Venkatesh *et al.* (2013) studied the micro morphology and reproductive characteristics of different ploidy level of the mulberry varieties. The present study represents an attempt to understand the anatomical, morphological and reproductive studies of four different mulberry verities.

MATERIALS AND METHODS

Four mulberry varieties, namely Channapatna local, Thailand, *Morus cathyana* HEMSL and *Morus multicaulis* which are maintained in the mulberry germplasm bank of Department of Sericulture, Bangalore University, Bangalore, India, were taken for present study. Cuttings of these varieties were planted in pots for experimental use. Morphological characters, stomatal frequency and size was calculated by using the formula and expressed as number of stomata/mm^2 (Sikdar *et al*., 1986; Aneja, 2001). Free hand sections of leaves were taken out for histological studies. Sections were stained with safranin and fast blue. Leaf thickness was measured microscopically after making slices of mature leaves fixed in 75% ethyl alcohol for 24 hours. Pollen fertility was also assessed by staining pollen grains with 2% aceto-carmine. Photo-micrographs were taken using labomed microscope fitted with Nikon cool fix digital camera.

$$\text{Stomatal frequency} = \frac{\text{Number of Stomata}}{\text{Area of microscopic field}} \times \text{mm}^2$$

RESULTS

Comparative account of morphological, anatomical and reproductive characters of four mulberry genotypes, some variations are recorded with respect to ploidy level, stem colour, stomatal frequency, pollen stain ability, *etc*. are summarized (Table. 1).

Variety Channapatna local

It is an evolved at Kanva silk farm located at Channapatna, Karnataka. This variety has been recommended for cultivation under rain fed condition. This is diploid cultivar with 2n=28 chromosomes (Venkatesh, 2007). This variety exhibited maximum height and shorter internodal distance and increase in number of stomata per unit area compared to triploid and tetraploid varieties. Stem is green to brown in colour. Leaves are thin, light green, lobed and smooth in texture. The thickness of the leaf was 128.4 ± 6.64 µm. Stomatal frequency and pollen stain ability were found to be 210.21/mm^2 and 97.24% respectively.

Variety Thailand

It is an exotic variety brought from Thailand to India. Stem is light green to brown in colour. Leaves are green, trilobed, dentate and acuminate. This is triploid cultivar with 2n=42 chromosomes (Venkatesh, 2007). This variety exhibited medium internodal distance, increase in height and number of stomata per unit area when compared to diploid. Leaves are thick, green, lobed and smooth in texture. The thickness of the leaf was 138.8 ± 2.34 µm.

Stomatal frequencies and pollen stain ability were found to be 188.42/mm^2 and 94.64 respectively.

***Morus cathyana* HEMSLEY**

It is an owing to the deficiency of observations on the pubescence of the plant, it is being one of the important characteristics for identifying this species. Stem is purple green to grey brown in colour. The leaves, upper surface is dark green and lustrous with a pale green under surface, integral or lobed, margin is crenate-dentate, acuminate and having long internodes. This is tetraploid cultivar with 2n=56 chromosomes (Venkatesh, 2007). This variety exhibited reduction in height and number of branches. The thickness of the leaf was 146.7 ± 3.22 µm. Stomatal frequency and pollen stain ability were found to be 160.88/mm^2 and 91.22% respectively.

Variety *Morus multicaulis*

It is an exotic mulberry variety. This is an uneuploid variety with 2n=30 chromosomes (Venkatesh 2007). Stem is light green to brown in colour. Leaves are small, thin, light green, chordate, unlobed serrate and acuminate. This variety exhibited medium height, short and thin petiole, shorter in internodal distance and increased in number of stomata per unit area. The thickness of the leaf was 132.4 ± 6.64 µm. Stomatal frequency and pollen stain ability were found to be 220.22/mm^2 and 96.00% respectively.

TABLE 1: Comparison of morphological characters in diploid, triploid, tetraploid and uneuploid

Characters	Diploid	Triploid	Tetraploid	Uneuploid
		Growth habit		
Height (cm)	302	280	240	290
Number of branches	09	07	06	08
Internodal distance (cm)	4.0	3.6	3.9	4.2
		Leaf		
Leaf size	192.76	200.35	170.45	202.00
Length of petiole (cm)	4.4	3.9	4.3	4.3
Width of petiole (cm)	0.39	0.42	0.35	0.40
No. of stomata per unit area (mm^2)	210.21	188.42	160.88	220.22
Length of stomata (µm)	13.90	17.40	19.64	12.22
Breadth of stomata (µm)	12.42	15.20	15.00	10.11
Leaf texture	Thin, Green, Chartaceous	Thick, Green, Chartaceous	Thick, Green, Coriaceous	Thin, Green, Chartaceous
		Flower		
Length of inflorescence (cm)	3.5	3.9	3.1	4.0
Diameter of inflorescence (cm)	1.3	1.4	1.0	1.4
No. of flowers per inflorescence	39	41	33	39
Length of flower (cm)	0.61	0.63	0.56	0.62
Pollen stain ability (%)	97.24	96.64	91.22	96.00

DISCUSSION

Tikadar and Dandin (2007) and Venkatesh *et al.* (2013) studied exomorphic features in some mulberry genotypes and recorded morphological variations. These variations are largely due to genetic flux operating on the evolution of different mulberry variants. In the present studies, Channapatna local, Thailand, *Morus cathyana* HEMSLEY and *Morus multicaulis* belonging to *Morus alba* are morphologically distinct and some similarities in their leaves with identical leaf margin and dissimilarities in their, leaves texture, height, internodal distance, stem colour, inflorescence, pollen stain ability, stomatal frequency and stomatal size were recorded. Cytologically Channapatna local, Thailand, *Morus cathyana* HEMSLEY and *Morus multicaulis* showed 2n=28, 2n=42, 2n=56 and 2n=30 chromosomes respectively. These different chromosome numbers has reflected on their micro morphology, anatomy and reproductive characters of diploid, triploid, tetraploid and uneuploid mulberry varieties. Varieties Channapatna local and *Morus multicaulis* have a similarity in their adaptation *i.e.* height, thin and light green leaves, stomatal frequency and size. Observation of uneuploid number along with the normal ones may be due to the vegetative propagation. The partial adaptation of a vegetative propagation has resulted in the maintenance of such altered nuclei in the somatic tissues as stated by Kundu and Sharma (1976). These varieties are inferior to triploid and superior to tetraploid varieties in most of the characters like, smooth texture of leaves, increase in height, pollen stain ability, reduction in number of branches and internodal distance. Triploid forms better rooting, grow more quickly and posses larger leaves when compared to diploid and tetraploid (Eswar Rao *et al.* 2000). Leaves of *Morus macroura* HEMSLEY are thick, coarse in texture, hirsutous, pubescence on the under surface of leaves, on the petioles and young shoots. Hence these leaves are unsuitable for silk worm feeding. The frequency of stomata per unit area was significantly less in triploid and tetraploid compared to diploid and uneuploid varieties. Stomatal frequency is an important parameter in selecting drought resistant genotype (Eswar Rao *et al.*, 2000). Stomatal frequency correlated with drought and disease resistant (Hatalli *et al.*, 1993; Nautiyal *et al.*,1994). Further lesser frequency per unit area is more suitable for rain fed conditions. However, reduction in the internodal and number of stomata per unit area indicates that the

increased dosage of genes does not always increase in size but may also reduce it (Dwivedi *et al*., 1986). Reduction in pollen fertility of triploid and tetraploid can be attributed as multivalents association during synapsis (Das *et al*., 1970, Gottschalk, 1978). This information will be of much use in establishing a phylogenetic relationship and evolution of mulberry and will also help in selecting mother plants for hybridization based on ploidy level, micro morphology and reproductive data.

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