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ULTRASTRUCTURAL STUDY ON THE LEAF SURFACE OF FOUR MULBERRY (*MORUS* SP.) GENOTYPES AND THE INFLUENCE OF FOLIAR TRICHOMES ON EGG LAYINGS BY *SPILOSOMA OBLIQUA* (WLK.) (LEPIDOPTERA ARCTIIDAE)

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Kumar V. – Ultrastructural study on the leaf surface of four mulberry (*Morus* sp.) genotypes and the influence of foliar trichomes on egg layings by *Spilosoma obliqua* (Wlk.) (Lepidoptera Arctiidae).

A scanning electron microscopic study on the micro-morphology of four mulberry genotypes viz., *Kanva2 (K2), Morus multicalis, Morus lavigata* and *Morus serrata* was under taken to find out the influence of oviposition by the gravid females of *Spilosoma obliqua* (Wlk.). The results of the present study reveal that the genotype *K2* was observed with minimum number of foliar non-glandular and glandular trichomes resulting in the highest number of eggs laid by the moths. On an average, a total number of eggs laid were recorded 533.44±96.02. The genotype of *M. multicalis* has more number of trichomes than *K2* genotype and the number of eggs laid by the pest was 486.22±70.56. The genotype *M. lavigata* ranked third in respect of number of trichomes and oviposition and the number of laid eggs were 340.93±39.96. The leaves of *M. serrata* genotype were highly pubescence, therefore, in choice tests, the moths of *S. obliqua* did not prefer the genotype for oviposition, and this may be because of finding difficulty for the feeding organs of neonate larvae to reach the site of feeding. Statically significant difference was found among four mulberry genotypes in respect to the preference of oviposition by the moths of *S. obliqua.* These findings indicate that *M. serrata* is a source of trichome-based resistance to *S. obliqua* and may be of value to mulberry breeding programs attempting to expand the genetic base of host plant resistance to insect pests.

KEY WORDS: Leaf surface, genotypes, *Morus* sp., egg laying, *S. obliqua*, ultrastructure.

INTRODUCTION

Plants have developed their own defence against herbivores and the defensive or resistance mechanism profoundly influence the relative success or failure of a pest species to reside, survive, develop and reproduce in/on a plant species or its cultivar/genotype. Interactions between the host plant and phytophagous insects play a significant role in the building up of phytophagous populations. The mechanism of resistance, as categorized by PAINTER (1951), is non-preference or antixenosis, as proposed by KOGAN and ORTNAM (1978) antibiosis and tolerance. The pseudo resistance which results from the expression of transitory characters of potentially susceptible host, comprising induced resistance, host evasion and escape were established. KOGAN (1975) proposed the term 'phenetic resistance' for the impairment of oviposition, feeding and/or mobility by morphological characters. The morphological characters include contact plant characters such as trichomes, surface waxes, hardness of plant tissues, thickening of cell walls and cuticle, rapid proliferation of tissues, anatomical modifications of plant organs and remote factors such as color and shape.

Trichomes are unicellular or pluricellular outgrowths from the epidermis of leaves, shoots and roots of plants. Plant trichomes are of several kinds (UPHOF, 1962; JOHNSON, 1975) and have several physiological and ecological functions. The significance of trichomes in plant defense against herbivory has been long recognized (CALLAHAN 1957; BECK, 1965) and is dealt with in recent literature (NORRIS and KOGAN, 1980; JERMY, 1984; NAVASERO and RAMASWAMY, 1991). Pubescence affects locomotion, attachment, shelter, feeding, digestion and oviposition of insects. Non-glandular trichomes entrap, immobilize or impade many insect pests. The exudates of glandular trichomes cause entrapment and immobilization of some phytophagous insects, apart from their toxic effects. When cell wall of these trichomes are ruptured by contact with insects, a clear water-soluble liquid oozes out which on reaction with atmospheric oxygen, changes into an insoluble black substance that hardens around the appendages of insects. The immobilized aphids *Myzus persicae* and *Macrosiphum euphorbiae* die in a short time (GIBSON, 1971). Type – B exudates is viscous and may physically limit aphid mobility, resulting in abnormal feeding behavior. Type – A trichome gland appears to be the major source of the phenolic substrate and phenalases involved in the phenomenon of aphid entrapment and mortality (LAPOINTE and TINGEY, 1986). Pubescent plants are not generally preferred by herbivores as it is difficult for their feeding organs to reach the site of feeding.

Oviposition, a prime component in plant-herbivore relationship, involves a series of behavioral events, the initiation or termination of which may be influenced by plant characteristics (BECK, 1965). Antexenosis could be an effective control strategy against many species of insects, because protection is effected before the occurrence of damage from feeding larvae. Leaf trichomes interfere with the oviposition of *Amrasca devastans* on cotton (TELI and DALAYA, 1981) and on Okra (UTHAMASAMY, 1979). Effective hair length on the ventral surface of mid veins showed a significant negative correlation with the number

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of eggs laid (KHAN and AGARWAL, 1984). LUKEFHR *et al.*, (1975) found that a cotton strain with a glabrous character reduced a *Heliothis* population by 68%. On the other hand, the spotted bollworm *Earias vitella* prefers *Gossypium hirsutum* leaves over bolls for oviposition in view of the high density of hairs on the leaves as described by MEHTA, (1971).

Mulberry (*Morus* sp.) is the only food plant for the silkworm, *Bombyx mori* Linn., which is an economically sericigenous important insect for sericulture industry. Mulberry is attacked by a large number of insect pests, parasites, predators and pathogens round the year which not only affect the leaf quality but are also responsible for poor yield (KUMAR *et al.*, 2001). Mulberry is reported to be attacked by more than 200 species of insects belonging to various orders (ZHENG *et al.*, 1988). The total loss of mulberry foliage crop due to these natural enemies is about 20% per year (GUPTA *et al.*, 2000). *Spilosoma obliqua* Wlk., is one of the major pest of mulberry which is commonly known as Bihar hairy caterpillar and usually infest mulberry crop from July to February in Karnataka state of India. A total foliage crop loss in mulberry by this pest was estimated around 4.90% (SHREE and MANJUNATH, 1998) and an individual larva of *S. obliqua* consumes 1195.19 gm of mulberry leaves in its entire larval period (SHARMA and TARA, 1988). Keeping in view of the severe damage caused by the larvae of *S. obliqua* to mulberry foliage, the present study was undertaken to determine the physical attributes that may influence oviposition of gravid females of *S. obliqua* on four different mulberry genotypes, and whether females exhibit an oviposition preference hierarchy in response to the various genotypes. An additional objective of this study was to describe leaf morphology and determine its impact on oviposition preference of *S. obliqua*.

MATERIALS AND METHODS

EXPERIMENTAL DESIGN

Seedlings of four mulberry genotypes viz., *Kanva2* (*K2*), *Morus multicalis*, *M. lavigata* and *M. serrata* were grown in pots containing the mixture of soil and compost in a ratio of 3:1. They were maintained in the glass house and used as host plants for oviposition for consecutive nine days. Three potted plants of each disease free mulberry genotype with approximately equal leaf areas, were provided to gravid females of *S. obliqua* moths for oviposition in a cage (5'x 10'x 4'). The number of eggs laid on each potted plant of all four genotypes was recorded every day morning during the seasons 2003-2004 at Central Sericultural Research and Training Institute, Mysore, India. The experiment was conducted in a 25°C temperature, 85±5% RH and 16 h daylight using laboratory reared gravid females of *S. obliqua* with each three potted plants of four genotypes.

PROCEDURE FOR SCANNING ELECTRON MICROSCOPY

To study the surface micro-morphology and cross sections of four different mulberry genotypes, under scanning electron microscope, samples of 3 x 3 and 3 x1 mm sizes, respectively, were fixed for 4 hours in glutaraldehyde prepared in 0.2 M sodium cacodylate buffer (pH 7.2). The fixed samples were washed thrice in sodium cacodylate buffer and then dehydrated in an alcohol-acetone series. The dehydrated samples were dried in a critical point drier (EMS - 850) using CO_2 as a transition fluid. The dried samples were mounted on to copper stubs using double side stick cellophane tape. To observe cross sectional area, the 3 x 1 mm sized leaf tissues were vertically mounted exposing their cut surfaces. The dried samples were gold coated (20 nm thickness) in a Sputter coater (EMS – 550). The coated samples were observed under a Transmission electron microscope (JEOL 100 CX II, Tokyo Pvt. Ltd. Japan) attached with scanning device (ASID 4 D) at 20 kV and photographs were taken at different magnifications. Five samples from each genotype were examined to confirm the results.

STATISTICAL ANALYSIS

The data were subjected to statistical analysis employing the analysis of variance (ANOVA) to ascertain the significance difference among the four mulberry genotypes viz., K-2, *M. multicalis*, *M. lavitaga* and *M. serrata*, in respect of preference of oviposition by the gravid females of *S. obliqua*.

The preference of oviposition behavior of the gravid females of *S. obliqua* on the abaxial leaf surface of four mulberry genotypes viz., *K2*, *M. multicalis*, *M. lavigata* and *M. serrata* were observed in glass house conditions and the data were statically analyzed and presented in table 1.

Table 1 – Preference of ovipositional behavior of the gravid females of *S. obliqua* on the abaxial leaf surface of four different mulberry genotypes.

S. No.	Name of the genotypes	Total number of eggs laid
1.	*Kanva - 2 (K2)*	553.44±96.82
2.	*Morus multicalis*	486.22±70.56
3.	*Morus lavigata*	340.93±39.96
4.	*Morus serrata*	Nil

Critical difference at 5% level = 38.73

RESULTS AND DISCUSSION

The result of the present study reveals that the gravid females of *S. obliqua* showed strong ovipositional preference for the mulberry genotypes studied. The females of *S. obliqua* unexceptionally laid their eggs on the abaxial leaf surface of the host plant and this may be because of many reasons like to avoid the sunlight to the developing embryos and the neonate larvae may commence immediate feeding on the chlorophyllous tissue soon after hatching without much affords in search of food. Further, the pubescence of both the surfaces of host plant leaf i.e., abaxial and adaxial surfaces also may have some significance on the preference of the oviposition. AMPOFO (1985) has shown that the lower surfaces of maize plants (host for *Chilo partellus*) are relatively smooth and that moths oviposit preferentially on the lower surfaces. It is possible that in this case, the eggs are better protected on the undersurface with a relatively smooth surface than the upper hairy surface. The greater densities of trichomes occurred on the abaxial surfaces than the adaxial surfaces of leaves of most of the plant species as emphasized by NAVASERO and RAMASWAMY (1991).

During the experiment it was observed that the gravid females of *S. obliqua* most preferred smooth surface of *K2* genotype of mulberry and on an average the number of eggs laid by the pest was recorded 533.44±96.82 (fig. I, 1). The next to *K2* genotype was *M. multicalis* where the pest laid 486.22±70.56 eggs (average of nine days oviposition)

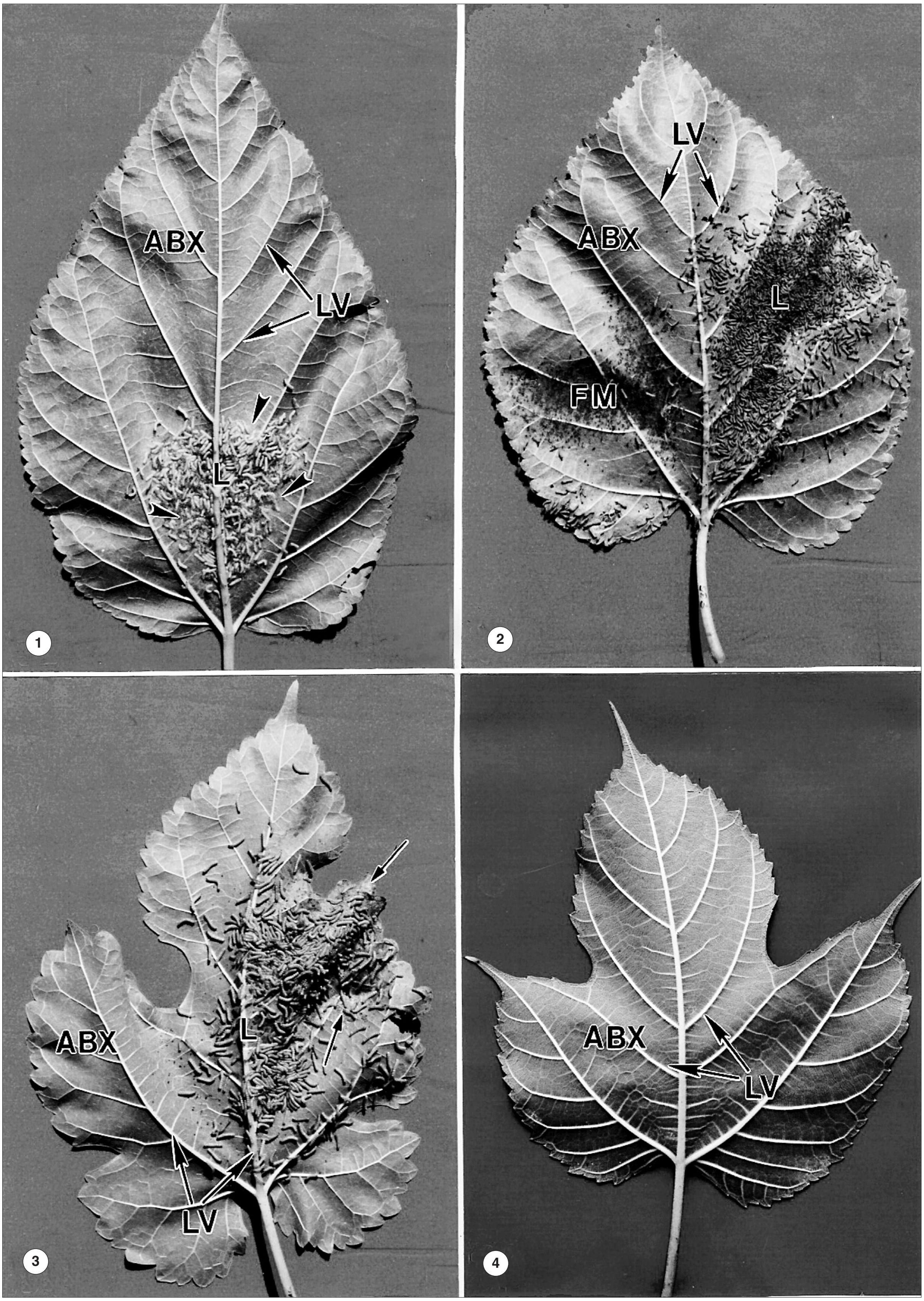


Fig. I – Mulberry leaves of four genotypes of *K2*, *Morus multicalis, M. lavigata* and *M. serrata* reveals the larvae of *Spilosoma obliqua* which were hatched out from a single egg laying on the abaxial leaf surface. 1. Early stage larvae (L) of *Spilosoma obliqua* which were hatched out from a single egg laying on the abaxial leaf surface (ABX) of *K2* genotype of mulberry. Arrow heads indicates the mesh work of thread like structure wherein the larvae settled before moulting. (LV = leaf veins). 2. Photograph of *Morus multicalis* genotype of mulberry showing the larvae (L) of *Spilosoma obliqua* which were hatched out from a single egg laying on the abaxial leaf surface (ABX). Area indicated, the mesh work made up of threads, secreted by the larvae, and the faecal matter (FM). The larvae settled in this mesh work before moulting and later sifted to the near by area of the leaf for feeding. 3. Photograph of *Morus lavigata* genotype of mulberry showing the larvae (L) of *Spilosoma obliqua* which were hatched out from a single egg laying on the abaxial leaf surface (ABX). The larvae feed on the chlorophyll tissue leaving the epidermis (Arrows). 4. Photograph of *Morus serrata* genotype of mulberry showing abaxial leaf surface (ABX) with no laying of *Spilosoma obliqua*.

(fig. I, 2). The genotype *of M. lavigata* ranked third in respect of oviposition and on an average the number of eggs laid by gravid females of *S. obliqua* was noted 340.93±39.96 (fig. I, 3). The females of *S. obliqua* completely avoided the leaf of *M. serrata* genotype for its oviposition, which clearly indicate that the less number of epidermal appendages viz., different types of non-glandular and glandular trichomes, influences the precise site of oviposition (fig. I, 4). After conducting the experiment, on the choice of oviposition for four mulberry genotypes in glass house conditions, the leaf samples of four genotypes were studied under scanning electron microscope to find out the causes of preference of oviposition by the moths. The results of the scanning electron microscopic study reveals that the leaf surface of the genotype of *K2* was found relatively smooth and the number of non-glandular and glandular trichomes was very less (figs. II, 1 and II, 6). The present results are in conformity with our earlier study on the leaf surface trichomes of mulberry, where it was mentioned that the total density of trichomes per mm^2 of mulberry leaves has sufficient variability among the genotypes with respect to glandular trichomes, non-glandular and total trichomes. A total number of glandular trichomes (per mm^2) were recorded 57 and non-glandular trichomes 58 on both the surfaces of *K2* genotype of mulberry (KESAVACHARYULU *et al.*, 2004). NAVASERO and RAMASWAMY (1991) described the leaf morphology of various plants and its influence on *H. virescens* egg laying and revealed that abaxial leaf surface of all test plants, except velvet leaf, received more eggs than the adaxial surface. The reason for increased oviposition on the abaxial surfaces is probably due to higher densities of trichomes.

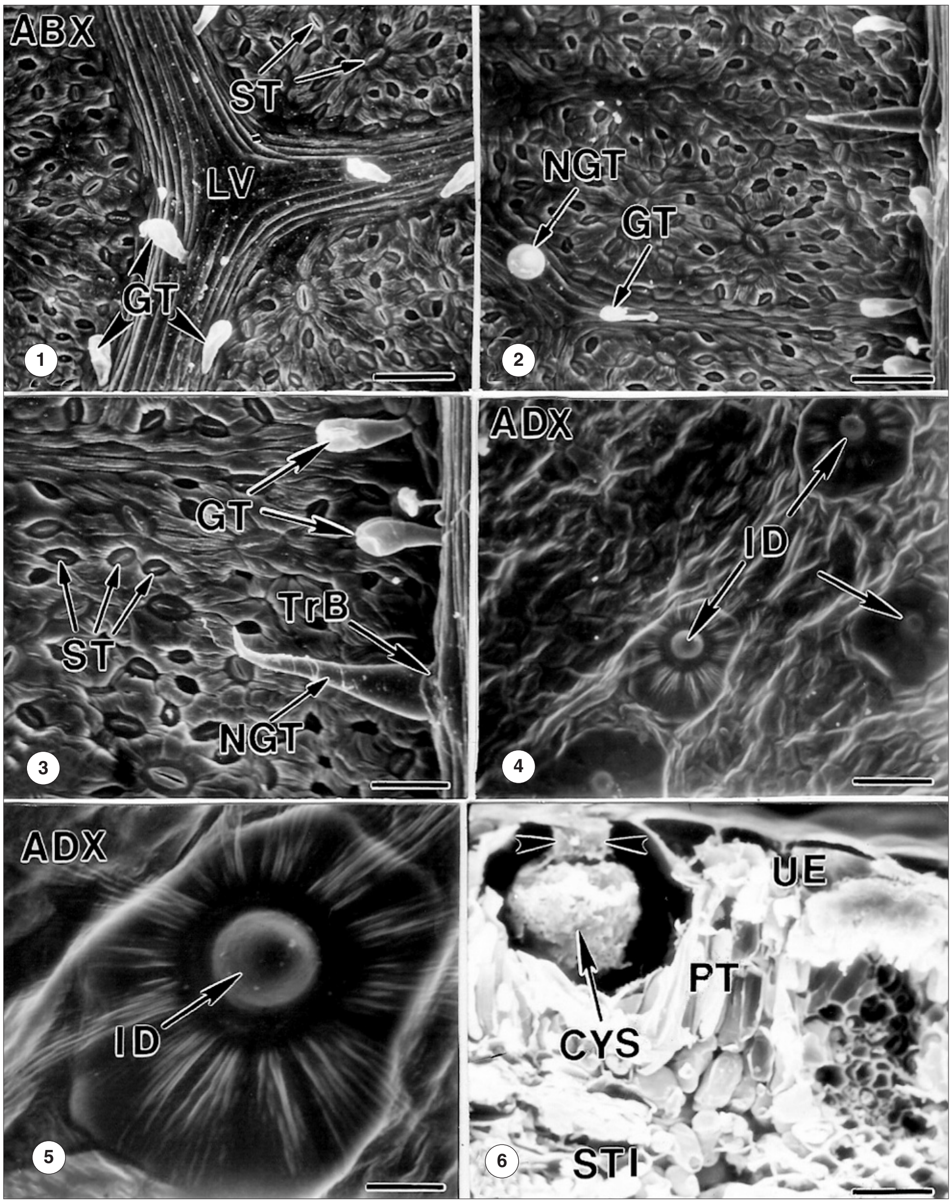
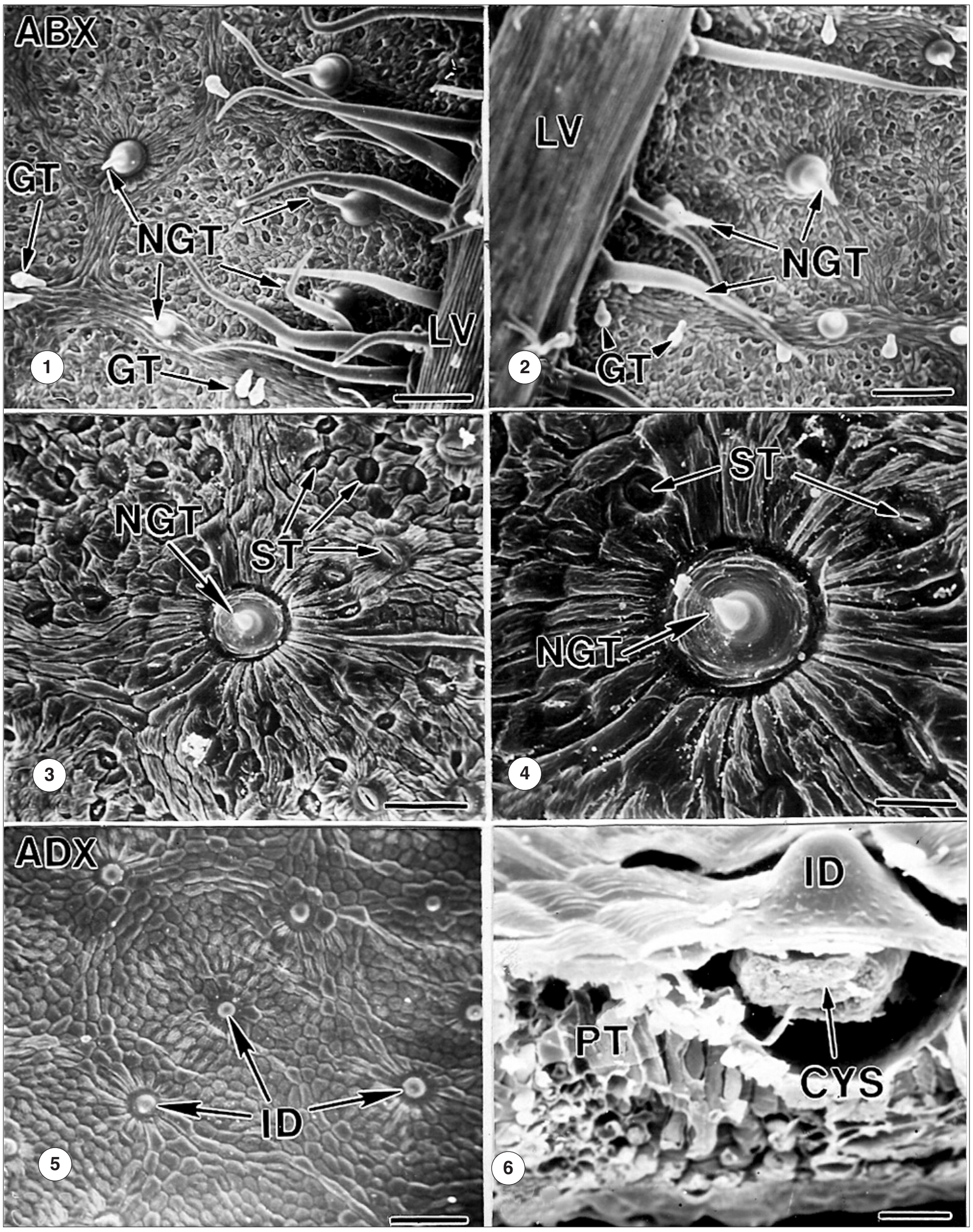


Fig. II – Scanning electron microphotographs of abaxial and adaxial leaf surfaces and cross section of *K2* genotype of mulberry. 1. Abaxial leaf surface (ABX) of *K2* genotype reveals the capitate glandular trichomes (GT) with a prominent head and a small stalk, stomata (ST) and leaf vein (LV). (Scale bar = 20 µm). 2. Microphotograph showing the glandular (GT) and non-glandular trichomes (NGT) on the abaxial leaf surface of *K2* genotype. (Scale bar = 20 µm). 3. Leaf surface of *K2* genotype reveals the glandular (GT) and non-glandular trichomes (NGT), stomata (ST). Note non-glandular trichomes have a base (TrB) of racially oriented 10-12 humped cells. (Scale bar = 12 µm). 4. Adaxial leaf surface (ADX) of *K2* genotype showing the frequency of idioblast (ID). (Scale bar = 20 µm). 5. Magnified view of a single idioblast (ID) on the adaxial leaf surface. (Scale bar = 6 µm).

Similarly, Jackson *et al.*, (1983) suggested that difference in moth preference for leaf location and position on tobacco can be partially attributed to differences in trichomes densities, the abaxial surface having more trichomes than the corresponding adaxial surface. In general, two types of trichomes were found distributed on both the surfaces of leaves. Glandular trichomes in some cases were reported to synthesize, metabolize, accumulate and secrete a variety of substances (Norris and Kogan 1980; William and Healey 1984; Purushotaman and Vasanth 1988; Pedro *et al.*, 1991; WErker, 1993). Navasero and Ramaswamy (1991) described the morphology of leaf surface trichomes and revealed that the trichome type did not influence oviposition by *Heliothis virescens*. Mulberry (*Morus* sp.) is a feed crop for silkworm, *B. mori*, develops cystolith composed of calcium carbonate crystal within idioblast of the adaxial leaves (Esau 1965; Katsumata 1971). Recently, Sugimura (1999) have described the mature idioblast of mulberry plant which was characterized as large rounded idioblast and present on the adaxial leaves, which were clearly distinguishable from the epidermal trichomes and parenchyma cells. The outer most part of the idioblast was situated on the adaxial surface as a dome-shaped protrusion (cap region) (figs. II, 4 and 5; III, 5 and 6; IV, 6; V, 5 and 6). It was thought that idioblast was localized only on adaxial leaves but when the abaxial surfaces of the

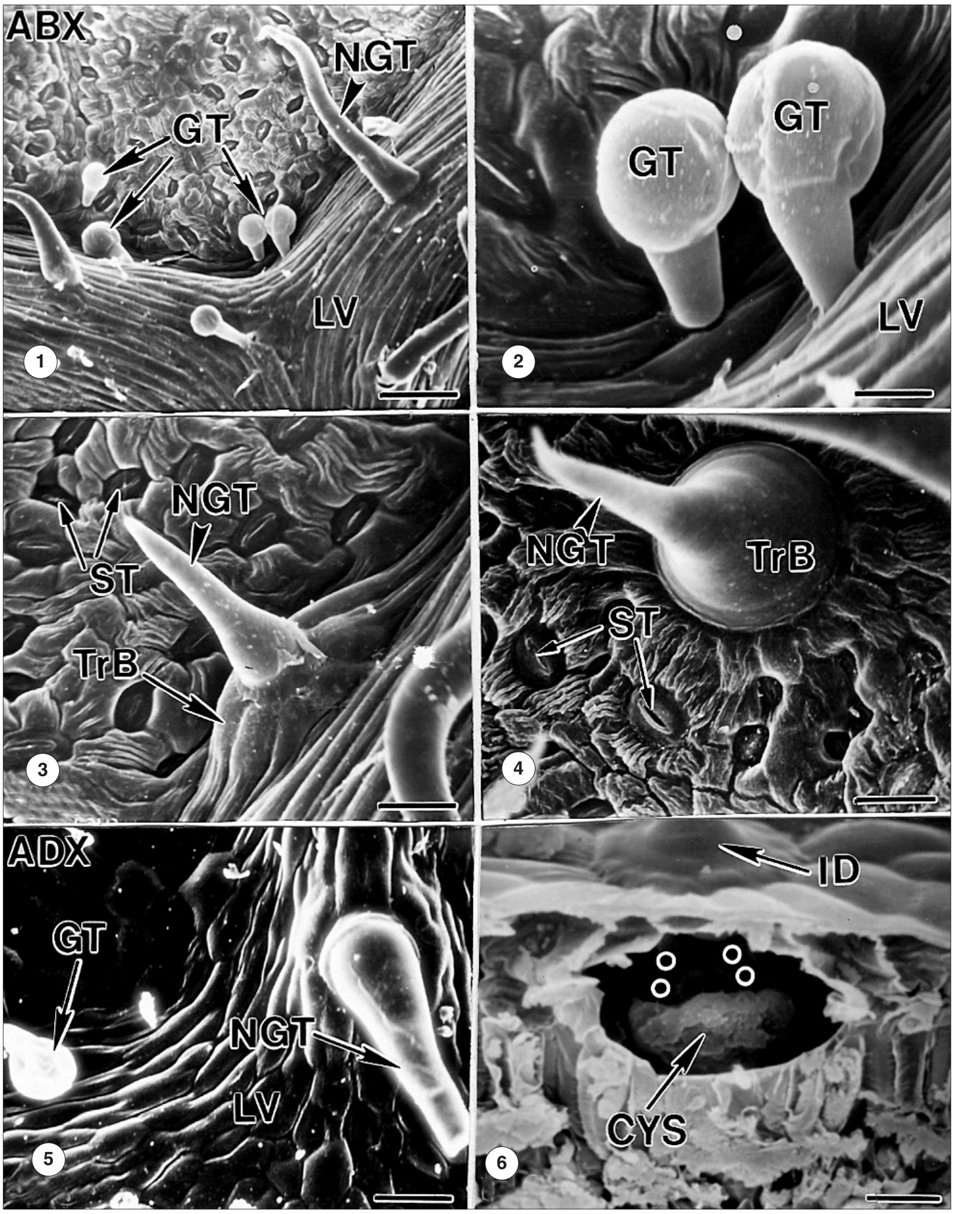


Figs. III – Scanning electron microphotographs of abaxial and adaxial leaf surfaces and cross section *Morus multicalis* genotype of mulberry. 1-2. Microphotographs of abaxial leaf surface (ABX) of *M. multicalis* genotype reveals a large number of long non-glandular trichomes (NGT) on leaf vein (LV), however, short broad non-glandular trichomes and glandular trichomes (GT) located in inter vein area of leaf. (Scale bars = 30 µm for each microphotograph). 3. Short and broad non-glandular trichome (NGT) situated on the abaxial leaf surface of *M. multicalis* genotype of mulberry. (Scale bar = 12 µm). 4. Magnified view of a non-glandular trichome (NGT) of *M. multicalis* genotype. (Scale bar = 6 µm). 5. Adaxial leaf surface (ADX) of *M. multicalis* genotype showing the frequency of idioblast (ID). (Scale bar = 30 µm). 6. Leaf cross section of *M. multicalis* genotype reveals the short with blunt tip idioblast (ID) which is internally connected to the cystolith (CYS). Adaxial leaf surface (ADX) of *M. multicalis* genotype showing the frequency of idioblast (ID). (Scale bar = 7.5 µm).

younger leaves were observed by SEM, two types (E,F) of protrusions identical to those observed on adaxial surface of mulberry leaf (SUGIMURA *et al.*, 2001) were revealed.

The leaf surface of genotype *M. multicalis* was found comparatively rough than the surface of *K2* genotype and non-glandular trichomes were long and situated on the leaf veins (fig. III, 1 and 2). However, the small non-glandular trichomes and glandular trichomes were distributed in inter veins of the genotype (fig. III, 1-4). KESAVACHARYULU *et al.*, (2004) described the trichome density of various mulberry genotypes and revealed that the number of glandular and non-glandular trichomes were 56 and 81 per mm^2, respectively on the leaves of genotype *M. multicalis*. The total number of trichomes per mm^2 was quite high in *M. multicalis* than the genotype of *K2*, which is also in support of our observations in the test choice of ovipositional preference of *S. obliqua*. The choice of oviposition site is partly dependent on the trichomes characteristics of the substrate (RAMASWAMY *et al.*, 1987). The possible involvement of pubescence as a mechanism of defense or resistance to insects is obvious. Pubescence can affect the activity of insects by mechanical and chemical means. The mechanical effect of pubescence depends on the characteristics of the trichomes, including density, erectness, length and shape (RAMALHO *et al.*, 1984).

The genotype *M. lavigata* ranked third in respect of ovipositional preference and this may be because of the presence of third highest number of non-glandular and



Figs. IV – Scanning electron microphotographs of abaxial and adaxial leaf surfaces and cross section *M. lavigata* genotype of mulberry. 1. Abaxial leaf surface of *M. lavigata* genotype shows the long hairy non-glandular trichomes (NGT) located on the leaf vein (LV). Note the captitate glandular trichomes present on the leaf vein and in inter veins areas. (Scale bar = 20 µm). 2. Magnified view of two captitate glandular trichomes on the leaf vein. (Scale bar = 4 µm). 3. Non-glandular trichome (NGT) with a base of radiated oriented 10-12 humped cells (TrB) situated on the leaf vein. (Scale bar = 7.5 µm). 4. Non-glandular trichome (NGT) is set on a smooth base made up a single concentric ring (TrB) situated on the inter vein leaf surface. (Scale bar = 6 µm). 5. Adaxial leaf surface (ADX) of *M. lavigata* genotype reveals the glandular (GT) and non-glandular trichomes (NGT) located on the leaf vein (LV). (Scale bar = 12 µm). 6. Three dimensional cross section mulberry genotype of *M. lavigata* reveals the idioblast (ID) which is connected to cystolith (CYS) below the upper epidermis (UE). (Scale bar = 7.5 µm).

glandular trichomes on the abaxial leaf surface of the genotype (fig. IV, 1-6). Kesavacharyulu *et al.*, (2004) recorded 100 glandular and 120 non-glandular trichomes on both the surfaces of *M. lavigata* genotype of mulberry which is further in support of our observations, *M. lavigata* being the third place in preference of oviposition.

The leaf surface of *M. serrata* genotype was found highly pubescence and the number of non-glandular and glandular trichomes was observed maximum on both the leaf surfaces (fig. V, 1-7). Kesavacharyulu *et al.*, (2004) have found a total number of non-glandular and glandular trichomes 303 per mm2 on both the surfaces of *M. serrata.* Further, they also recorded that the total number of the non-glandular trichomes were almost five times higher than the glandular trichomes. Due to the presence of a large number of trichomes on both the surfaces in general, and on lower surface of the leaf in particular, the females of *S. obliqua* might have avoid the oviposition on the leaves of *M. serrata* genotype because it is difficult for the neonate larvae to feed on high pubescence leaf as their feeding organs may not reach the site of feeding. Statically significant difference was found in respect of oviposition preference by the moths of *S. obliqua* on four mulberry genotypes. Sharma and Agarwal (1983) have observed that leaf hairiness correlated significantly and positively with the number of eggs laid by *Earias vitella* under both field and laboratory conditions. Difference in trichome density also affects oviposition and nymphal weight of *Lygus hesperus* on cotton. Rajapakse and Walter (2007) conducted an experiment on oviposition preference versus

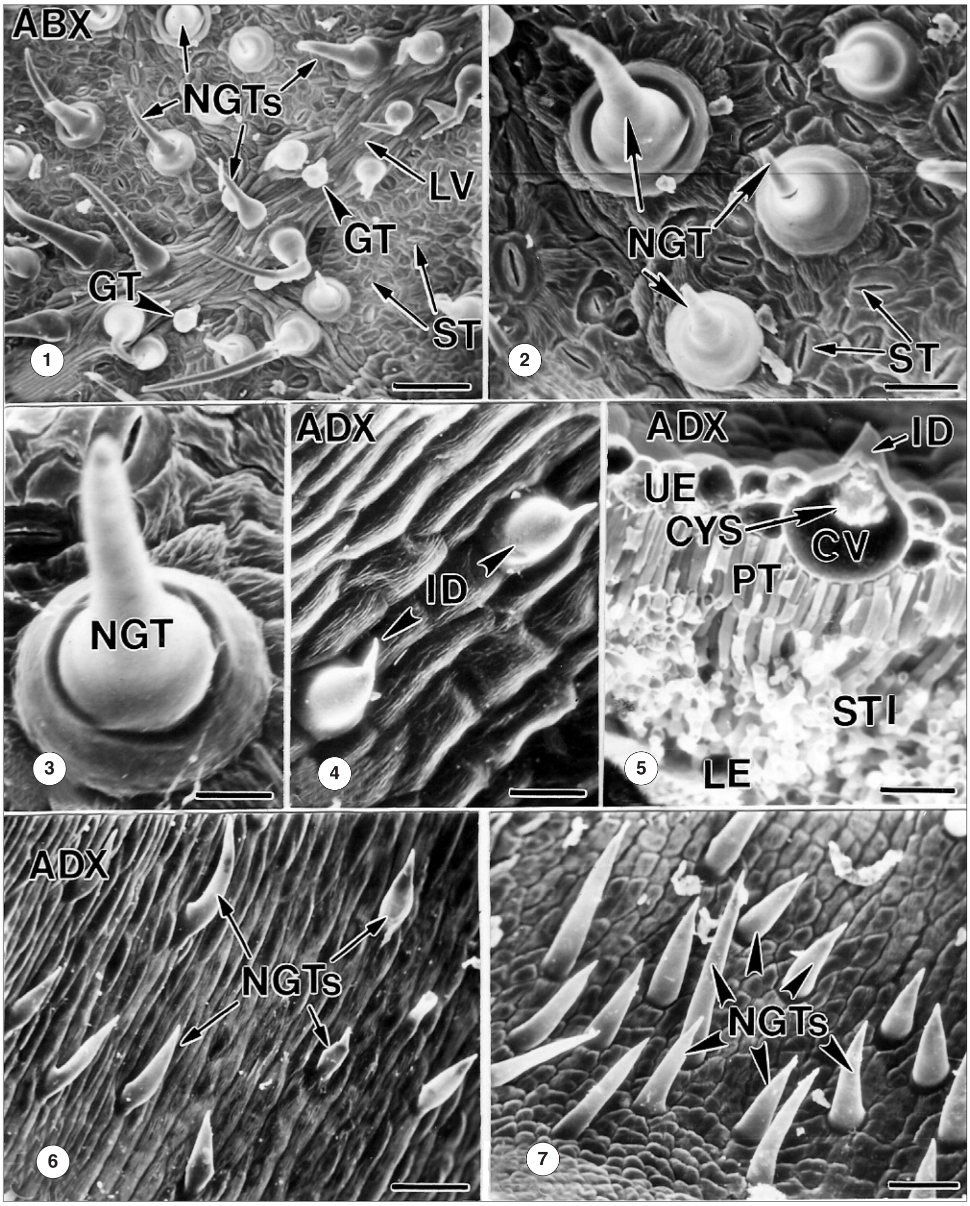


Fig. V. – Scanning electron microphotographs of abaxial and adaxial leaf surfaces and cross section *M. serrata* genotype of mulberry. 1. Microphotographs explain the abaxial leaf surface of *M. serrata* genotype with non-glandular and glandular trichomes located on leaf vein. ST = stomata. (Scale bar = 30 µm). 2. Non-glandular trichomes are set on a raised smooth base made up of a single concentric ring and present in inter vein area. (Scale bar = 12 µm). 3. Magnified view of non-glandular trichomes. (Scale bar = 6 µm). 4. Adaxial leaf surface of *M. serrata* genotype reveals the idioblast with small pointed tip. (Scale bar = 12 µm). 5. Leaf cross section of *M. serrata* genotype reveals the short, with pointed tip idioblast (ID) which is internally connected to cystolith (CYS) in a cystolith cavity (CV). (Scale bar = 20 µm). 6-7. A large number of short to long pointed non-glandular trichomes located on the adaxial leaf surface of *M. serrata* genotype. (Scale bars = 20 µm for fig. V, 6 and 12 µm for fig. V, 7).

performance in the *Helicoverpa armigera* using flowering stage of six different host plants and revealed that, among the host plant species tested, only flowering pigeon pea supported a good relationship between preference of *H. armigera* and its subsequence off springs performance. KESAVACHARYULU *et al.*, (2004) emphasized that the higher density of trichomes reduces the acceptability of leaf by the silkworm, *B. mori*. This appears to be mechanical only and relates to the defense mechanism, which protects the plant from herbivory by reducing acceptability towards the insects (LEVIN, 1973).

Plants exhibit wide variations in types of trichomes within families and the trichomes have been used to classify genera and species and to differentiate inter specific plant hybrids (METCALF and CHALK, 1979; MEHTA *et al.*, 1979). DUFFEY (1986) categorized the mode of defense against insect invasion into (i) physical protection by reducing plant accessibility (ii) toxicity by contact, ingestion, or inhalation of toxic chemicals, and (iii) impediment to insect movement by gummy and sticky exudates upon fracture of glands by insects (NAVASERO and RAMASWAMY, 1991). Pubescence is considered as a resistant factor that interference with insect feeding. The purely mechanical effect of the pubescence depends on four main characteristics of the trichomes viz., density, erectness, length and shape (NORRIS and KOGAN, 1980). The foliar trichomes when present in high density are reported to cause physical hindrance and discourage phytophagous insects and affects acceptability of foliage (SINGH *et al.*, 1971; LEVIN, 1973). In addition, glandular trichomes exude secondary plant metabolites which may interfere the insect locomotion. These are also toxic and exert disruptive effects by the production of allelochemics.

The glandular trichomes are widely distributed over the aerial reproductive and vegetative organs of plants and these trichomes are the primary secretory organs of the plants and their structures can vary widely among species (VALENTI *et al.*, 1997). The essential oil produced by these glandular trichomes may act to protect the aerial parts of the plant against herbivores and pathogens (WERKER, 1993), and the biological activity of the secondary metabolites in the secreted products is of interest to the pesticide, pharmaceutical, flavoring and fragrance industries (DUKE, 1994). ASCENSAO *et al.*, (1999) described the functional significance of the glandular trichomes and suggested that their secretions may be involved in the chemical defense of plants or may act as floral rewards to pollinators. However, the specific function of each trichome type is not known. Glandular trichome exudes chemicals that are toxic to insects. The exudate of trichomes on tobacco leaves contains nicotine, anabasine and probably nornicotine (THURSTON *et al.*, 1966 a) and is toxic to aphids (THURSTON and WEBSTER, 1962) and to the larvae of the tobacco hornworm *Manduca sexta* (THURSTON *et al.*, 1966 b). According to GIBSON (1971), glandular hairs occur abundantly on *Solanum polyadenium*, *S. tarijense* and *S. berthaultii* and exudates is discharged from the glandular hair when an aphid mechanically ruptures the cell walls. On contact with atmospheric oxygen, a chemical reaction is initiated and the clear water-soluble material contained in the hair changes to a black insoluble material which is precipitated on the aphid's limbs. This initially impedes its movements and further accumulations eventually stick the aphids to the plant so that they are immobilized and starve to death. GIBSON (1971), described about 30% of infesting aphids were completely immobilized within 24 h.

CONCLUSION

The results of the present study on ovipositional preference of moths of *S. obliqua* and the distribution of foliar trichomes of four mulberry genotypes were found highly and positively significant. Similarly to the observations of the past work on different insects, the moths of *S. obliqua* preferred smooth surface of leaf for laying the eggs. While considering the ovipositional preference of *S. obliqua* it was observed that sufficient variability exists among the four mulberry genotypes, hence, the character like a pubescence of a particular genotype must be consider while developing a new and resistant genotype to insect pests of mulberry in mulberry breeding programmes.

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