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Screening of Mulberry Genetic Resources for Incidence of *Tukra* Caused by *Maconellicoccus hirsutus* Green

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Studies were conducted to screen selected 199 mulberry genetic resources for pink mealy bug *Maconellicoccus hirsutus* Green causing *Tukra* disease. The method suggested for screening is suitable for assessing large collections of accessions/varieties and also better than the method of percentage of leaf damage assessment adopted in small-scale pot culture experiments as also Percent Disease Index (PDI) scale in the All India Coordinated Experiments (AICE) trials. Data collected for six crops during different seasons following the grading system formulated and *Tukra* Resistance Index (TRI) has been worked out for individual crop. Based on the average TRI, the accessions were grouped into No incidence (G0) with 12 accessions, low incidence (G1) with 36 accessions, moderate incidence (G2) with 72 accessions, high incidence (G3) with 72 accessions and very high incidence (G4) with 7 accessions. Resistant mulberry accessions can be utilized for further breeding programmes.

Key words: *Maconellicoccus hirsutus, Tukra*, mulberry genetic resources, phytotoxiemea

Bombyx mori L., is host specific and feeds exclusively on mulberry (*Morus* spp.) which is cultivated in tropical and temperate countries of the world. In India, it is cultivated mostly in the tropical region, evergreen throughout year. Mulberry is a perennial plant producing luxuriant foliage, attracts various insects and non-insect pests. Due to continuous crop improvement in the field of mulberry breeding and genetics, many new mulberry varieties have been evolved, much better than the local varieties in respect of quality and quantity of leaf produced. At the same time these improvements paved way for their susceptibility to attack by pests and diseases. Almost 100 species of insects have been found to attack mulberry and only few of these insects have attained the status of major pests like the pink mealy bug (*Maconellicoccus hirsutus*), leaf webber (*Diaphania pulverulentalis*) and Bihar hairy caterpillar (*Spilosoma obliqua*.) in southern states of India namely Karnataka, Andhra Pradesh and Tamilnadu. The two important pests causing more economic damage to mulberry are *Tukra* mealy bug (*M. hirsutus)* and leaf webber (*D. pulverulentalis).* The average incidence of *Tukra* in the southern sericultural states is estimated to be 34.24% (Manjunath *et al.,* 2003). The attack of pink mealy bug, *M.hirsutus* is known to cause malformation of the apical stem, wrinkling of leaves, flattening of stem giving bunchy appearance, which affect the apical growth of the main stem and branches. Affected leaves are generally deep green in colour and crisp in nature. The affected shoot becomes brittle and can be broken off easily from the plant and these symptoms are popularly called as *Tukra.*

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Rajadurai and Thiagarajan (2003) estimated the loss due to *Tukra* to sericulture industry to the tune of 4500 kg/ha/year depriving the farmer a brushing capacity of 450 dfls/ha/year, leading to reduction in cocoon production to about 150 kg/ha/year. Further feeding of *Tukra* affected leaves to silkworm affects larval weight, effective rate of rearing, cocoon weight, shell weight and silk ratio percentage compared to silkworm reared on healthy mulberry leaves (Pradeep Kumar *et al.,* 1992). *M. hirsutus* is a polyphagous insect reported to infest 346 host plants in India and more than 125 plant species, the world over. Its wide host range favours rapid spread and makes the control measures difficult. The incidence of *Tukra* varies according to seasons (Manjunath *et al.,* 2003), it is the highest during summer (February-May), moderate during winter (October-January) and least during rainy season (June-September). It is directly influenced by the population density of the mealy bug and the age of mulberry plant it attacks.

The difficulty in the management of mealy bug is manifold. Application of insecticide proves to be less effective against eggs, late age nymphs and adult females of mealy bug even, if these stages are exposed to insecticides spray as all these stages are protected by waxy filamentous secretions. Further, spraying of insecticides on mulberry leaves will have deleterious effect on silkworms if safety period is not maintained and hence alternate mechanism of management of the pest becomes important.

Host Plant Resistance is the most effective and environmentally safe strategy to manage the pests and diseases, it is an easy way to adopt. There are reports of mulberry varieties differing in their susceptibility to infestation by *M.hirsutus* (Srinivas *et al.,* 1996). Because of the superiority of the genotype, bio chemical composition and higher phenolic compounds, V1 variety suffered less incidence over other varieties (Shree *et al.,*1989). Sathyaprasad *et al.,* (2000b) screened mulberry germplasm and found that the mulberry variety Togowase (Acc.No.257) tolerant to mealy bug, thrips and jassids. Also attempts were made to screen certain ruling mulberry varieties namely, S-36, S-34, K-2 and V-1 for their tolerance to *Tukra* through induction method, symptoms was least in V-1 (44.3%) followed by K-2 (66.8%), maximum incidence of *Tukra* was observed in S-36 (87.8%) and S-34 (87.3%). The results indicated that V-1 is relatively tolerant to *Tukra* compared to other varieties (Sathyaprasad *et al.,* 2000a).

Materials and Methods

A total of 199 selected mulberry genetic resources were planted in the Augmented Block Design with 12 plants per accession in nine blocks with 23 accessions per block with V1 as border rows all around each block. In each block one national check (V1, MI-0308) and one local check (MR2, MI-0025) are included whereas in the exotic accessions block exotic check (Kosen, ME-0066) has been included in addition to national check. The incidence of *Tukra* was recorded by visual observation of individual plants on the 60th day after pruning.The intensity of occurrence of *Tukra* is recorded following the specific grading system with 0-5 grades (Table 1). The data on the incidence was recorded for six crops during 2005-06 in six seasons. This grading system adopted is based on the incidence of *Tukra* and also the intensity of damage to the plants, which is suitable for large scale screening of germplasm accessions. *Tukra* incidence for different seasons in CSGRC, Hosur was also recorded (Table 2).

Based on the above grading system and observations the *Tukra* Resistance Index (TRI) has been worked out similar to the jassid resistance index in cotton following the grades developed by Indian Central Cotton Committee (Nageswara Rao, 1973). The formula for working out the *Tukra* resistance index is as follows.

Where,

$$TRI = \frac{G0xP0 + G1xP1 + G2xP2 + G3xP3 + G4xP4 + G5xP5}{P0+P1+P2+P3+P4+P5}$$

G- represents number of grade

P- represents population under that grade for each accession.

The *Tukra* Resistance Index (TRI) for each accession was calculated by multiplying the number of plants falling into each grade, by grade number, and then adding the product to each grade by dividing the sum with number of plants rated. TRI for individual crop was worked out following the above formula and based on the average resistance index of six crops accessions were grouped into five categories of resistance (Table 3).

Results and Discussion

The studies on the incidence of *Tukra* during six seasons revealed very high incidence in June (3.08) followed by November (2.42) and May (2.17) and it as very low in February (1.17) and August (1.75 and 1.80) which is similar of the earlier reports. Manjunath *et al*., (2003) reported that the incidence was high in the months of summer and moderate in the months of winter and very low in the rainy seasons. The slightly higher incidence in months of August than in the winter months was due to the very low rainfall received during the years. In all the seasons studied many accessions showed nil incidences. The index for the seasons for accessions were worked out and from the average index of the six crops the accessions studied were grouped into different categories of resistance Table 3.

Table 1. Grading system for screening of *Tukra* incidence

Details	Grade
Plants free from infestation	0
Apical shoot tip showing crinkling in less than two branches.	1
Crinkling and curling extending further in not more than two branches.	2
Crinkling, curling and deformation of leaves extending further to more than three branches.	3
Crinkling, curling and deformation of leaves extending further to more than four branches with mealy growth and mealy bugs.	4
Extreme crinkling of more than five shoots, stunted growth, flattened stem and deformation.	5

In the no incidence category eight accessions from the indigenous and four from exotic collections were recorded. Similarly in the low incidence category 19 indigenous, 17 exotic accessions were recorded, while in the moderate incidence 62 indigenous and 10 exotic accessions were recorded. Sixty-seven accessions figured in the high incidence category out of the indigenous accessions and five accessions are of exotic nature. None of the exotic accessions showed very high incidence category whereas seven indigenous collections fall in this group. Both the indigenous control accessions national check MI-0308 (V1- 0.33) and the local check MI-0025 (MR2- 0.47) recorded moderate incidence and the exotic check ME-0066 (Kosen-0.13) showed low incidence category. The list of 5 incidence

Table 2. Season and crop wise *Tukra* incidence along with TRI range

Crop and season	TRI range
I crop (Summer)	0 - 3.08
II crop (Rainy)	0 - 1.75
III crop (Winter)	0 - 2.42
IV crop (Spring)	0 - 1.17
V crop (Summer)	0 - 2.17
VI crop (Rainy)	0 - 1.80

category are (Table 4) ME-0178 (Moretti), MI-0337(Nellathene), MI-0420(Rorighat), MI-0366 (Resham majri-1), MI-0423(Srinagar), MI-0220 (T-24), MI-0396 (ERRC-81), ME-0022(Japanese), ME-0102(Tusimakawa), ME-0136(Zimbabwe-11) and MI-0335 (Gorimedu).

The method of screening adopted is better than the percentage of leaf damage assessment adopted in small-scale pot culture experiments with a grading system of 0-5 based on the percent of leaf affected (Morris, 1955) which is laborious and time consuming and hence cannot be followed in large-scale screening. The grading system is advantageous over the Percent Disease Incidence (PDI) scale system followed in the All India Coordinated Experiments (AICE). It is based on the number of affected and unaffected shoots from randomly selected 10 plants. The grades (1-5) given depending on the percent shoot tips affected and the PDI is

Table 3. Classification of the accessions based on average TRI

TRI range	Grading	Category
0 - 0.10	G0	No incidence
0.11 - 0.25	G1	Low incidence
0.26 - 0.50	G2	Moderate incidence
0.51 - 1.00	G3	High incidence
More than 1.00	G4	Very high incidence

worked out as the ratio of numeric grades divided by the product of total number of plants and maximum grading multiplied by 100 (Anonymous, 1997). In this system the affected and unaffected shoots have to be counted from 10 plants and there is no provision for plants free from infestation.

From the preliminary studies it is inferred that the 12 accessions out of 199 accessions studied (Table 4) showed resistance to the incidence of mealy-bug. These accessions have to be studied further in pot culture experiments by introducing the

Table 4. Ranking of the accessions based on average TRI

TRI Range	Category	Number of Accessions	
		Indigenous	Exotic
0 - 0.10	No incidence	8	4
0.11 - 0.25	Low incidence	19	17
0.26 - 0.50	Moderate incidence	62	10
0.51 - 1.00	High incidence	67	5
> 1.00	Very high incidence	7	-
	Total	163	36

mealy bugs, also hot spot studies to assess their resistance. Since resistance to insect pests is centered around the morphological and other traits such as presence of pigmentation, pubescence,

Table 5. Details of accessions with no incidence of *Tukra*

Accession No.	Name
ME-0178	Moretti
MI-0337	Nellathene
MI-0420	Rorighat
MI-0366	Resham Majri-1
MI-0423	Srinagar
MI-0220	T-24
MI-0396	ERRC-81
MI-0399	ERRC-85
ME-0022	Japanese
ME-0102	Tusimakawa
ME-0136	Zimbabwe-11
MI-0335	Gorimedu

allelochemicals *viz.,* tannin and higher phenolic compounds and nectarilessness (Shree *et al.*,1989) requires further study on these traits. The above morphological and the biochemical characters of these accessions have to be studied to improve these resistant traits in promising mulberry varieties.

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