Influence of abiotic factors on population dynamics of leaf webber *Diaphania pulverulentalis* and its natural enemies in mulberry

P. Samuthiravelu, J. Ravikumar, S. M. H. Qadri, L. Hemanthkumar and S. Jayaraj

ABSTRACT

Mulberry the only host plant for rearing silkworms (*Bombyx mor*i) is affected by tukra mealy bug *Maconellicoccus hirsutus* and leaf webber *Diaphania pulverulentalis* among many other pests. The incidence of tukra mealy bug *M. hirsutus* and leaf webber *D. pulverulentalis* and its natural enemies coccinellids and spiders (Nos./20 plants) were subjected to survery and surveillance for four years. The infestation of tukra mealy bug *M. hirsutus* and leaf webber *D. pulverulentalis* was observed through out the year and high (8.18% and 17.13%) in July and November respectively. The population of coccinellids and spiders was high (6.5 and 10.32/20 plants) during November. The infestation of leaf webber (above ETL of 10%) and population of its natural enemies on three varieties (local, MR2 and V1) were correlated with abiotic factors viz., temperature, relative humidity, rainfall and rainy days. Results indicated that the population of parasitoids had significant positive correlation with rainfall. The population of coccinellids, spiders and parasitoids had positive correlation with rainy days and leaf webber infestation. The natural enemies observed in the study were mostly the ladybird predators *Chilomenus sexmaculatus* and unidentified species of spiders and braconid parasitoids. The braconid parasitoid was marked only in the V1 variety, where leaf webber incidence was higher. Spiders and ladybird were common on both V1 and MR2 varieties during the peak incidence of both tukra mealy bug and leaf webber during October to December.

Keywords: Leaf webber, Tukra mealy bug, Natural enemies, Coccinellids, Spiders, Braconid parasitoids

INTRODUCTION

As mulberry is perennial producing luxuriant foliage, it attracts various insects and non insect pests. The leaf webber *Diaphania pulverulentalis* has been observed as a severe pest of mulberry since 1995 in Karnataka state (Geetha Bai *et al.* 1997). It has also been spread to the neighbouring states of Tamil Nadu and Andhra Pradesh. This pest has been recorded earlier in Malaysia (Sengupta *et al.*, 1990) and Nagaland, India (Gupta, 1994). *Diaphania pyloalis* (Glyphodes) is reported from Jammu (Sharma and Tara, 1985), Kashmir (Dar,1993) and Punjab (Mavi *et al.* 1996) and also from China (Howard and Buswell, 1925) and Japan (Rangaswami *et al.*, 1976). The infestation is observed in plantation of local, MR2, S36, and V1 varieties. Up to 100% infestation is recorded in several areas. Rajadurai *et al.* (2000) reported the pest to cause a leaf yield loss to the tune of 12.8% with an average incidence of 21.77%. Farmer – participatory research was undertaken in the drought prone areas of Krishnagiri District, Tamil Nadu state to evolve suitable Integrated Pest Management systems in mulberry for sustainable sericulture development. The present study was undertaken on the seasonal incidence of leaf webber *Diaphania pulverulentalis* and tukra mealy bug *M. hirsutus* in the selected project villages *viz*. Kollapalli, Kokkanur and Avathanapatti with its natural enemies compex.

MATERIALS AND METHODS

The study was conducted under farmer – participatory research at Krishnagiri district, Tamil Nadu state from June 2002 to September 2004 in three village *viz.*, Kokkanur, Kollapalli and Avathanapatti. In each farmers holding five micro plot of 2.0 cent each 10 x 8 meters were fixed in the four corners and in the middle and from each such plot four plants were selected at random for the observation . Then 20 plants were observed every fortnightly in each holding.

The total number of predators (spiders and coccinellids) present on each selected plants was counted. Leaf webber affected shoot was counted and percentage to the total number of branchs worked out. One hundred leaf webber larvae were collected from mulberry garden at fortnightly intervals and held in separate container. The larvae were

reared continuously on mulberry leaves until emergence of parasitoid. Mean percent parasitism was worked out from the parasitoid emergence month wise and year wise. The total number of predators on each selected plants was also counted. The data were later subjected to regression analysis. The meteorological data for the observation period were also recorded.

RESULTS

The results on the incidence of leaf webber *D. pulverulentalis* and tukra *M. hirsutus* on three varieties of mulberry (Local, MR2 and V1) recorded in three villages during June 2002 to September 2004 are depicted in Fig 1-9 and the major weather data during the same period in Fig. 10 . Leaf webber infestation was highest during November 2002 on V1 variety in two villages (Fig. 3 & 9). In one week the pest recorded 78% infestation on V1 in one location. It crossed the suggested ETL of 10% for 5 months in a row from October '02 to February'03 on this variety in Kokkanur and in seven months both in Kollapalli and Avathanapatti villages. In most months the incidence was of 30-60%. On the other hand it was touching ETL for 1-3 months on local variety in all the villages studied and again the highest incidence was well below 15%.

In the case of MR2 variety the pest was crossing ETL in 3-4 months, but the maximum was only around 30% in

Table 1. Leaf webber X weather factors on three varieties (pooled correlation)

Variety – Local:

	Avg Temp	Avg RH	Rainfall	No. of days	Leaf webber	Coccinellids	Spiders	Parasitoids
Avg Temp	1.00	- 0.024	0.264	0.319	- 0.367	- 0.142	- 0.186	- 0.174
Avg RH		1.00	0.684**	0.727**	0.057	0.435	0.259	0.453
Rainfall			1.00	0.835**	0.229	0.755	0.451	0.631**
No. of days				1.00	- 0.008	- 0.487	- 0.230	0.446
Leaf webber					1.00	1.00	0.753	0.280
Coccinellids						1.00	0.753**	0.280
Spiders							1.00	- 0.075
Parasitoids								1.00

* Significant at 5% level, ** Significant at 1% level

Variety – MR2

	Avg Temp	Avg RH	Rainfall	No. of days	Leaf webber	Coccinellids	Spiders	Parasitoids
Avg Temp	1.00	- 0.024	0.26	0.319	- 0.543	- 0.341	- 0.192	- 0.484
Avg RH		1.00	0.684**	0.727**	0.005	0.412	0.111	0.006
Rainfall			1.00	0.835	0.257	0.619	0..428	0.131
No. of days				1.00	0.063	- 0.412	0.148	0.008
Leaf webber					1.00	0.558	0.601	0.782
Coccinellids						1.00	0.823	0.431
Spiders							1.00	0.418
Parasitoids								1.00

* Significant at 5 % level, ** Significant at 1% level

Variety – V1

	Avg Temp	Avg RH	Rainfall	No. of days	Leaf webber	Coccinellids	Spiders	Parasitoids
Avg Temp	1.00	- 0.240	0.264	0.319	- 0.602	- 0.366	- 0.285	- 0.476
Avg RH		1.00	0.684**	0.727**	0.003	0.278	0.387	0.168
Rainfall			1.00	0.835	0.304	- 0.600	0.649	0.307
No. of days				1.00	- 0.108	1.00	0.857**	0.675**
Leaf webber					1.00	0.751	0.640**	0.828**
Coccinellids						1.00	0.857**	0.675**
Spiders							1.00	0.665**
Parasitoids								1.00

* Significant at 5% level, ** Significant at 1% level

Kollapalli and Kokkanur villages. But in Avathanapatti, where chemical farming was practiced, the pest was having around ETL for nine months and excepting in November' 02 it was in the range of 10-20% on MR2 variety Fig. 8. V1 was most susceptible to this dreaded pest in all the three villages observed. The pooled value on the infestation of tukra mealy bug *M. hirsutus* and leaf webber *D. pulverulentalis* was observed and found through out the year and high (8.18% and 17.13%) in July and November respectively. The population of coccinellids and spiders was high (6.5 and 10.32/20plants) during November (Fig.10). Path way analysis on the interaction of mulberry pests (leaf webber and tukra) and natural enemies with major weather factor were carried out (Table 1). The results showed that when RH and rain fall increases, population of leaf webber and parasitoids were found more in all the three varities of mulberry, but they were negatively correlated with high temperature.

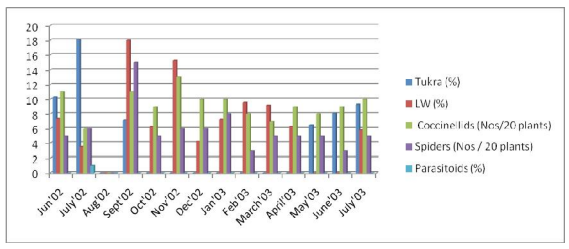

Figure 1. Incidence of pests and natural enemies on local variety (Kokkanur)

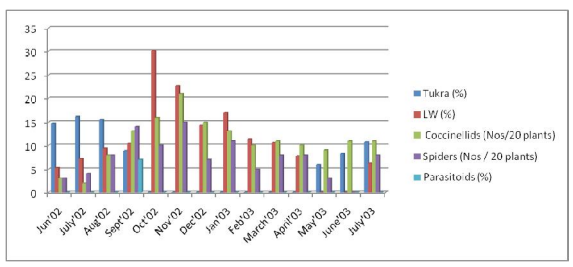

Figure 2. Incidence of pests and natural enemies on MR2 variety (Kokkanur)

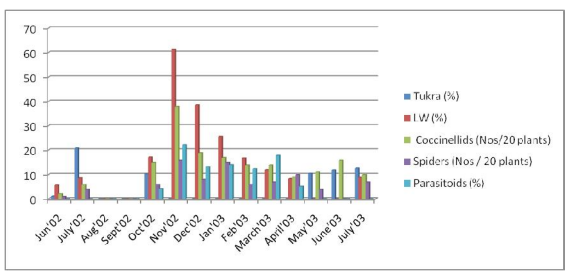

Figure 3. Incidence of pests and natural enemies on V1 variety (Kokkanur)

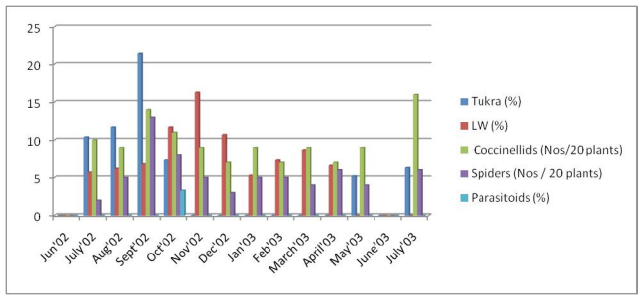

Figure 4. Incidence of pests and natural enemies on Local variety (Kollapalli)

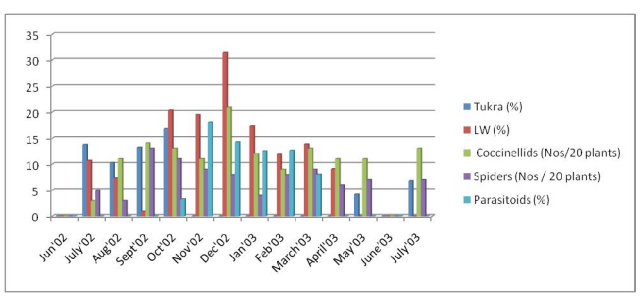

Figure 5. Incidence of pests and natural enemies on MR2 variety (Kollapalli)

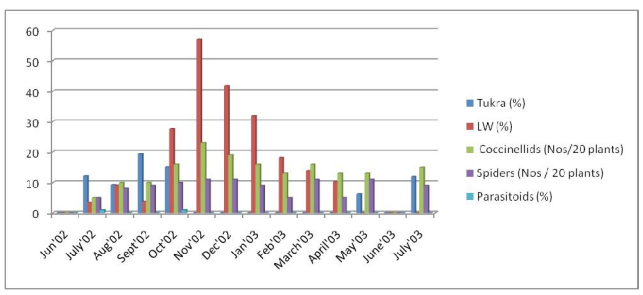

Figure 6. Incidence of pests and natural enemies on V1 variety (Kollapalli)

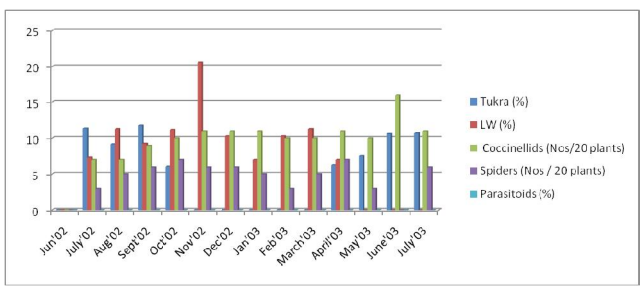

Figure 7. Incidence of pests and natural enemies on Local variety (Avathanapatti)

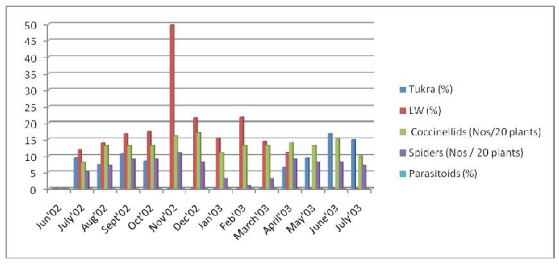

Figure 8. Incidence of pests and natural enemies on MR2 variety (Avathanapatti)

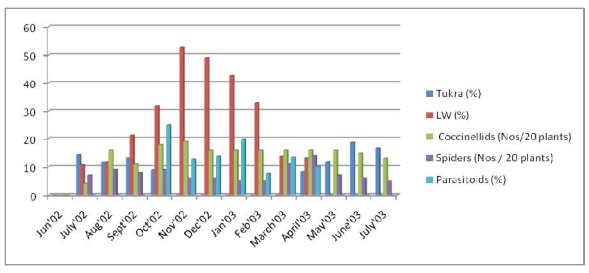

Figure 9. Incidence of pests and natural enemies on V1 variety (Avathanapatti)

NATURAL ENEMIES

The natural enemies observed in the study were mostly the ladybird predator *Chilomenes sexmaculatus*, and spiders and braconid parasitoids (*Apanteles taragamae* and Bracon *hebetor*). Their incidence was increased corresponding to the pest infestation particularly in leaf webber. The braconid parasitoid was marked only in the V1 variety in Avathanapatti, where leaf webber incidence was higher. Spiders and ladybirds were common on both MR2 and V1 varieties during the peak incidence of leaf webber during October- December months. However, they were not the key mortality factors affecting the pest population.

INFLUE NCE OF SEASONAL CONDITION

There were well spread rains in the study villages during June'02 in the South West monsoon period. The level to increase the pest load in the next month (Fig. 10). Some showers in October also resulted in higher leaf webber infestation in the subsequent weeks and months. Relative humidity in the rainy months was favourable to both pests and natural enemies. The braconid parasitoids were noticed only in wet months. The same drought and high temperatures that followed had their own impact on the pest and predators. Tukra was more during summer months 50.6% and declined in winter months (0-3.1%). Its place of Tukra was occupied by leaf webber during winter 78% which was least in summer (1.5%). Tukra mealy bug and leaf webber had an increase relationship. *C. sexmaculata* was present throughout the year in varying population levels.

DISCUSSION

Mulberry crop improvement in many studies has also paved way for their susceptibility to attack by pests and diseases. It is therefore a need for evolving mulberry varieties tolerant to pest attack. Of the three mulberry cultivars studied in three villages the local variety was infested least by tukra and leaf webber followed by MR2. But the high yielding variety V1 was most susceptible to both pests (Figures 1-9). However, its productivity and quality are quite high resulting in greater farmer profitability, though greater quantities of chemical pesticides are used in this variety. Sathyaprasad *et al*. (2000 a) screened the germplasm to identify varieties resistant to pest attack and utilize the same in the breeding programme to evolve pest tolerant variety. The results indicated that the mulberry variety Togowase (ACC No. 257) is tolerant to all the three sap suckers, namely, mealy bug, thrips and jassids. The percent incidence of tukra ranged from 10-100, thrips 10-80 and jassids 10-50%.

Sathyaprasad *et al*. (2000 b) made an attempt to screen certain ruling mulberry varieties, viz., S36, S34, S13, K2, and V1 for their tolerance to tukra through induction method. Each of the tested mulberry varieties was introduced with five gravid female of *M. hirsutus* when the potted plants were 25 days old. Observations were made on the occurrence amd spread of tukra symptoms and population build up of *M. hirsutus*. Simultaneously, data were also collected on the incidence of tukra in these mulberry varieties in field plots. Noticeable symptoms of tukra appeared on the 16th day post inoculation of gravid females of mealy bug irrespective of the mulberry variety. The spread of tukra symptoms was least in V1 (44.3%) ($P < 0.005$) followed by K2 (66.8%). Maximum incidence of tukra was observed in S36 (87.8%) and S34 (87.3%). The population of *M. hirsutus* on the 30th day post induction was maximum in V1 (151) followed by S13 (74.6), K2 (73).S34 (53) and local (19.4). The results indicate that V1 is relatively tolerant to tukra compared to other varieties.

In the present observations, the ladybird predators, *Chilomenes sexmaculata* and few unidentified species of spiders and braconid parasitoids (*Apanteles taragamae* and *Bracon hebetor*) were recorded checking tukra and leaf webber of mulberry. Their incidence was increased corresponding to the pest infestation particularly the leaf webber. V1 variety of mulberry had recorded higher

incidence of pest and natural enemies (Fig.). However, they were not adequate to affect the pest population. Geetha Bai and Marimadaiah (2002) observed that the leaf webber infestation on mulberry begins after commencement of South- West monsoon during June and infestation was severe during North-East monsoon and winter, from October to December, and then declines and tapers off by next April. *Phanerotoma noyesi* is the most common and widespread parasitoid whereas *Apanteles agilis* occurred during winter, and *A. bisulcata* occurred sporadically during rainy seasons.

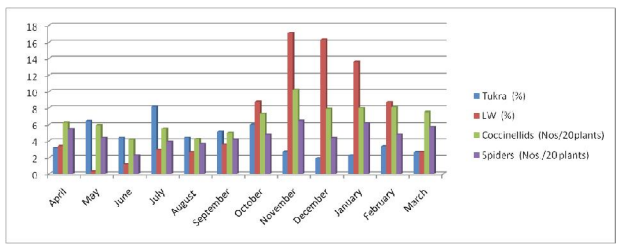

Figure 10. Pooled value of pest incidence and natural enemies in Mulberry (June 2002 to September 2004)

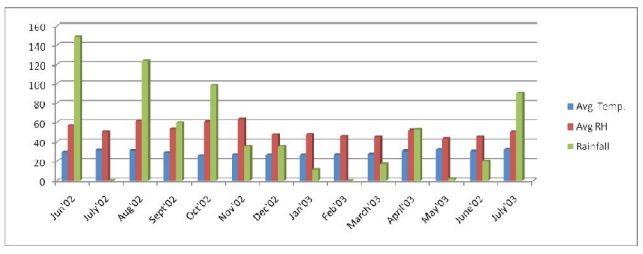

Figure 11. Meteorological data

Rajadurai *et al.* (2000) identified the natural enemy complex of the leaf roller in mulberry crop system so that suitable ones can be exploited to strengthen the available IPM package for its management. Survey has been conducted in the mulberry gardens at various localities of Karnataka for the natural enemies of leaf webber and its per cent parasitization / predation and it revealed that the presence of 15 species of parasitoids and predators. The larval parasitoids, *Apanteles taragamae* (71.18%), *A. machaeralis* (65.8%), *Bracon hebetor* (52.24%) and *Goniozus indicus* (42.9%), egg parasitoid *Trichogramma chilonis* (77.83%), pupal parasitoid *Tetrastichus howardii* (58.67%) and predators, *Calosoma* sp. (66.67%) and *Eucanthecona furcellata* (57.63%) showed considerable attack potential in the laboratory. Therefore, it might be possible to utilize these available natural enemies against leaf webber in mulberry ecosystems. In view of frequent application of DDVP for the control of mealy bug and leaf webber by farmers availing the subsidies provided by many Departments of Sericulture, the natural enemy fauna is very low to check the pest population. Frequent harvests of shoots also reduce the food availability to parasitoids and predators. Muthulakhsmi *et al*. (2003) observed that soil analysis (pH, EC, OC, mcro and micronutrients and microflora) was done to relate with pest and natural enemy population levels. Sustainable pest management practices were tested to suit the sericultural ecosystem for avoidance of major pests such as tukra mealy bug, *Maconellicoccus hirsutus* and leaf webber *Diaphani pulverulentalis* on mulberry. Samuthiravelu *et al*. (2003) observed different tactics of integrated methods for control of major pests of mulberry for their management. Inundative releases of the egg parasitoid *Trichogramma chilonis* were found to the effective in reducing the damage caused by leaf webber. Observations were made on its effective doses and the number of points at which it is to be released from a parasitoid release device per unit area. The larval parasitoid *Bracon brevicornis* was released in varying levels in different ecosystems. The use of the two parasitoids was integrated with neem-based botanica pesticides and mechanical control with much success. Field trials were conducted on the efficacy of Neem and Pongamia and compared with leaf extract (10%) of *Vitex negundo* and insecticide check dichlorvas (DDVP) against the mealy bug. Neem products were found to be better and economical. Imidacloprid stem swabbing application and foliar spray has been quite effective against all larval stages in both methods and dosages within two days of treatment.

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