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[Article]

Effects of Thrips (*Pseudodendrothrips mori* Niwa) Infested Mulberry Leaves on Silkworm Growth and Commercial Cocoon Parameters

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ABSTRACT
In mulberry orchards in northern part of Iran, thrips is a dominant pest and causing a lot of damage to the mulberry. The effect of pest on bio-chemical parameters of mulberry leaf of two varieties *viz*. Kenmochi and Ichenoise and also the effect of feeding of infested leaves on rearing performances have been studied. For the study, six plots of 200 m^2 area of both the varieties were selected and three of them, of each variety, were sprayed with 0.5% Metasystox at a peak period of occurrence of nymph population to obtain the good healthy leaf without thrips infestation. Another 3 plots were left without pesticide spray to obtain infested leaves so as effect of infestation on chemical parameters of leaf and effect of infested leaves on rearing performance could be studied. During rearing, larvae were fed with good quality of mulberry leaf while another lot were fed with infested leaves. The results showed that there was a decrease in nitrogen, phosphorus, potassium and protein contents of leaves by 2.5, 10.8, 18.7 and 12.5%, respectively due to infestation and the decrease in these parameters was more in Kenmochi. There was also a significant decrease in total cocoon production, cocoon weight, pupal weight, and shell weight due to feeding of infested leaves. However, there was no significant difference in shell ratio between the lots fed with healthy and infested leaves.

Keywords: *Bombyx mori,* Crop loss assessment, Mulberry Thrips, *Pseudodendrothrips mori,* Silkworm

INTRODUCTION

Infestation of mulberry garden by different species of thrips were reported by different scientists (Etebari *et al.*, 2000 b; Mound, 1999; Wan and Zhang, 1997; Palmer, 1990), However, *Pseudodendrothrips mori* Niwa (Thysanoptera; Thripidae) was found to be most dominant species in different parts of world. Thrips, is a highly oligophagous pest and a native of northern hemisphere (Mound, 1999). It was first collected in Maryland, USA by Crawford in 1937 (Stannard, 1968; Woo, 1974) and noticed in Italy in 1975 as serious pest of mulberry trees (Cappellozza and Mitto, 1975). It is also reported from Africa, Australia, China, India, Japan, Korea Sri Lanka, and Vietnam (Etebari *et al.*, 2004; Mound, 1999; Wan and Zhang, 1997; Palmer, 1990). *P. mori* is introduced as dominant species in the insect fauna of mulberry field in the north of Iran, whereas this species was dispersed in all regions of Iran with mulberry orchards (Etebari *et al*., 1998).

Mulberry, *Morus alba* L. is the sole food plant for silkworm, *Bombyx mori* L. and is grown under varied climatic conditions ranging from temperate to tropical. Mulberry leaf is a major economic component in sericulture since the quality and quantity of leaf produced per unit area have a direct bearing on cocoon harvest (Eteabri, *et al.*, 2000 a). *P. mori* feed on fully expanded leaves and young tissue in the bud. Infested leaves dry out and have a stippled or silver-flecked appearance. Small brownish specks of excrement will usually be noticed on the underside of the leaves (Lewis, 1997).

Estimation of crop losses are required to determine the relative importance of particular pests, and thus decide upon the level of resources that should be devoted to research and pest management inputs and provide a basis for understanding the often complex interaction between pest and its host plant. Attempts were made to find out the losses due to thrips infestation on different morpho-physiological parameters of mulberry at West Bengal in few years

ago. The losses in dry weight and leaf area increased progressively from 3rd leaf downward and reached highest level in 17th amounting to 53.97 and 58.45% respectively, while losses in fresh weight did not show any significant difference in normal and infested leaves (Das *et al.*, 1994 a).

P. mori has 6-8 generations per year in Iran (Etebari *et al.*, 2000 a; Jalali *et al.*, 2002). In mid-March, when there are 2-3 leaves on the mulberry trees, the overwintered adults emerge to damage the leaves. In north of Iran mulberry thrips has high population in late-July to mid-August (Etebari, 2002). Jalali *et al.*, (2002) reported that spring crop rearing of silkworm is not affected by thrips but some negative effects on autumn rearing yield were assumed. In the present study effect of feeding of thrips infested leaves on rearing performance and on biochemical parameters of mulberry were studied in autumn season.

Materials and Methods

Treatment

Effect of infestation on two dominant mulberry varieties of the area *viz* Kenmochi and Ichenoise were selected at mulberry orchards of Iran Sericulture Research Center (*ISRC* Rasht, Iran) for the present study. For each mulberry variety, six plots of 200m² area in randomized block design were utilized. Three of them were sprayed with 0.5% Metasystox at the peak period of occurrence of second nymph population to obtain healthy leaf without any infestation while another three plots of both the varieties were left without any spray to obtain the infested leaves and also to study the effect on chemical characteristics of mulberry.

Silkworm Rearing

Seed of Bivoltine silkworm hybrid 103×104 was obtained from *ISRC* and reared in the laboratory with standard rearing technique (Lim *et al.*, 1990) under 25°C with RH of 75 ± 5% and photoperiod of 16L: 8D. Silkworm larvae were divided in two lots, each having 300 larvae. First instar larvae in first lot was fed with the healthy leaves (thrips free) obtained from the garden after 30 days of spraying of Metsystox, while another lot was fed with infested leaves. This experiment was conducted for both the varieties separately. Data on larval and cocoon parameters and mortality in last instar larvae was recorded. The cocoon weight, cocoon shell weight, cocoon shell ratio and pupal weight were determined by using standard technique in sericulture (Lim *et al.*, 1990).

Biochemical and mineral constituents of mulberry leaves

The mulberry leaves from both the varieties were collected during silkworm rearing period and the collected leaves dried in shadow and prepared for chemical analysis. Total organic nitrogen and pro-tein were dtermined by Micro-Kajeldal method. Potassium was measured by flame photometry uing a lithium internal standard. Phosphorus was determined using the Molybdate blue method according to Bray and Kurtz (1945).

Statistical Analysis

Data were subjected to statistical analysis of variance test for significant differences in the measured parameters of the control (thrips free) and thrips infected groups. For analysis of variance the tukey 's test in SAS software and the t-test were used (SAS, 1997).

Results and Discussions

Mulberry Leaves' Chemical Properties

The results showed that the thrips infestation has negative effects on quality and nutritive value of mulberry leaves of both the varieties (Fig 1). The mean amount of Nitrogen, Phosphorus, Potassium and Protein of the leaves showed 2.5, 10.8, 18.7 and 12.5% decrease, respectively and this decrease was much more evident in Kenmochi variety. The decreases in phosphorus(%) in Kenmochi and the amount of total protein in leaves of Ichenoise variety were not significant after thrips infestation (Fig 1). Decrease in Nitrogen content was more prominent in Kenmochi variety as there was 13% decrease.

Different authors reported the reduction of protein content in mulberry leaves by 17.8% (Etebari *et al.*, 1998), 12.5% (Paik and Lee, 1984) and 75.21% (Das *et al.*, 1994) due to mulberry thrips infestation. Decrease in protein content in infested leaves may be partly due to utilization by thrips at a faster rate for its multiplication. Hydrolysis of protein by proteolytic enzymes secreted by the pest itself may be the other cause of lowering the protein (Sengupta *et al.*, 1999). Paik and Lee, (1984) reported that total carbohydrate was reduced more than 16% in

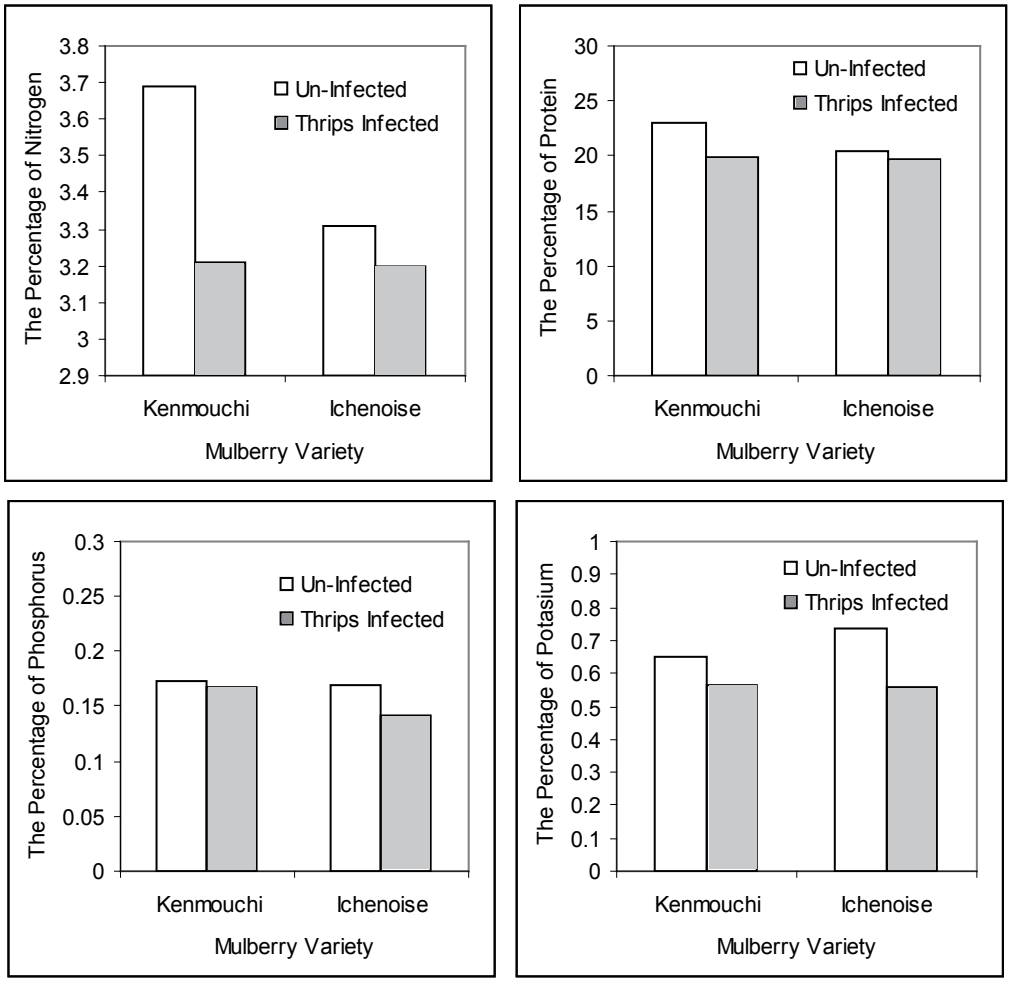

Fig 1. Effect of thrips infection on biochemical and mineral constituents of the leaves in two mulberry varieties

infected leaves while this amount is various in different varieties of mulberry.

It has been reported that most of the mulberry varieties were susceptible for the thrips attack (Naik, 1997) and severe attacks lead to different morpho-physiological changes in the leaves (Das *et al*., 1994). But mulberry thrips show a certain host preference in their feeding activity. There are large numbers of variation in the numbers of thrips on different mulberry varieties (Xi and Zhu, 1991). Planting the mulberry varieties that are less susceptible to *P. mori* may also affect the level of infestation.

Etebari *et al.,* (2000b) recorded the number of thrips individuals in one cm^2 of leaf area as a density index in four varieties of mulberry. It has been recorded that the KM variety bearing an average of 3.48±0.3 insects/cm^2 leaf, is significantly different from the other varieties. The results of recent research confirm our pervious study.

The nymphs and adults of the mulberry thrips lacerate the tissue and suck the oozing cell sap from the upper and lower surfaces of the leaves. So, the usual evaporation process of the leaves is quickened, especially during high temperature seasons, by additional evaporation through these wounds (Ye and Gu, 1990). This is most harmful in dry climates and seasons when heavily attacked plants lose moisture heavily. In these conditions infestation can seriously deplete yields. Paul *et al*., (1992) reported that leaves moisture is one of the most important factors in silkworm nutrition. Mulberry thrips reduces the moisture by 3.57%, therefore has a negative impact on the quality of the leaves consumed by silkworm (Etebari *et al*., 1998). Damage by mulberry thrips in spring at China, may also be relatively serious due to the region's different climate, a 10% decrease

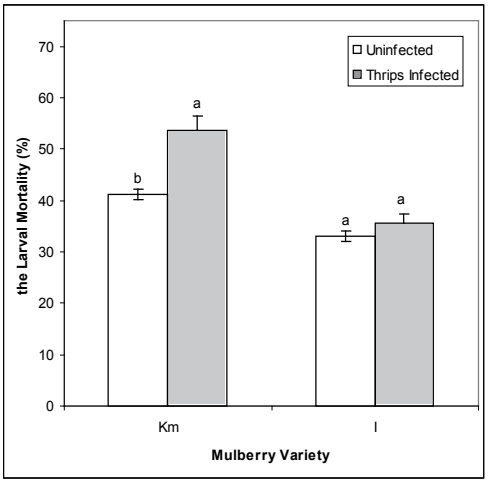

Fig 2. Effect of feeding thrips infected mulberry leaves over the larval mortality of silkworm

in the production of mulberry leaves was reported by Xi and Zhu (1991). Also in India, the estimated loss is about 40-50% of total leaf production (Venugopala and Krishnaswami, 1983).

Venugopala and Krishnaswami (1983) reported that mulberry thrips have caused serious damage to sericulture in the southern states of India. The thrips infestation affects the qualitative and quantitative characters of mulberry leaf. Das *et al.*, (1991) reported that chlorophyll a/b ratio was lower in infested leaves in most cases. Decrease in chlorophyll and carotenoid contents in infested leaves may have been due to loss in chlorophyll synthetase activity in response to thrips infestation (Das *et al.*, 1994 b).

Effects on silkworm rearing

The result showed that the mortality rate is high with the feeding of infested mulberry leaves. The percentage of mortality in the larvae fed on thrips infected leaves of Kenmochi variety was higher than other variety (Fig 2).

The number of cocoon and cocoon weight were decreased considerably in the lot fed thrips infested leaf of Kenmochi variety. However there was no significant difference in these parameters in larvae, which fed on, healthy or infested leaves of Ichenoise variety (Fig 3). The cocoon characteristics of silkworm fed on thrips infected mulberry leaves showed in Table 1.

As shown in Table 1 the decrease in male cocoon weight and cocoon shell weight was more than female cocoon weight and cocoon shell weight in the larvae fed with thrips infested groups in both varieties. While the percentage of decrease in female pupa weight of thrips infected treatment is more than male pupa. So, it is clear that the reduction in quality of mulberry leaves due to thrips infection in both varieties had negative effects on female reproductive system. Also the male larva of silkworm is susceptible to feeding of thrips infested leaves, as there were decreases in their cocoon and shell traits.

Infestation of thrips was more prominent in Kenmochi than Ichenoise since depletion in chemical properties was more in Kenmochi and also there were significant differences on rearing performance. The decrease in cocoon parameters was more in the larvae fed with Kenmochi leaves. However, as far as shell ratio is concerned there was no significant difference between two varieties (Fig 4).

There are no sufficient information available on the effects of thrips damage on silkworm rearing but Paik and Lee (1984) reported that mulberry thrips caused 12% reduction in cocoon weight. In current

Table 1. The cocoon characteristics of *Bombyx mori* fed on thrips infected mulberry leaves

Treatment	Mulberry varieties	Female			Male		
		FCW	FPW	FSW	MCW	MPW	MSW
Un-Infected	KM	1.146 ab	0.945 ab	0.230 a	0.965 a	0.752 a	0.213 ab
Thrips Infected	KM	1.014 b	0.815 b	0.198 a	0.847 a	0.665 a	0.181 b
Differences (%)		(-11.5)	(-13.7)	(-13.9)	(-12.2)	(-11.5)	(-15.0)
Un-Infected	I	1.191 a	0.956 a	0.235 a	0.976 a	0.743 a	0.233 a
Thrips Infected	I	1.138 ab	0.913 ab	0.225 a	0.808 a	0.742 a	0.216 ab
Differences (%)		(-4.5)	(-4.5)	(-4.2)	(-17.2)	(-0.1)	(-7.3)
F-value		2.88	3.58	2.39	1.21	3.16	5.33
P		0.05	0.03	0.09	0.33	0.04	0.01
C.V.		9.73	9.11	11.5	20.8	7.72	10.8

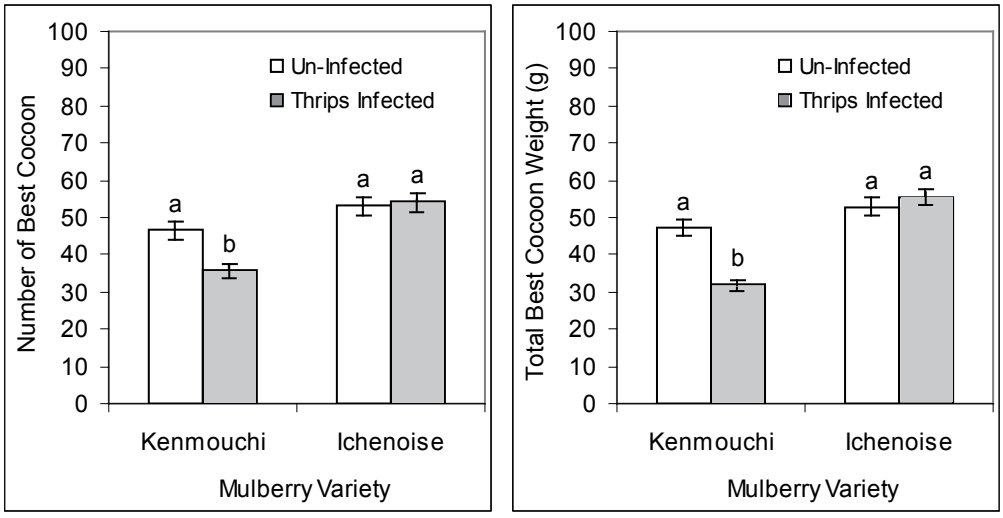

Fig 3. Effect of mulberry thrips infection on cocoon parameters of silkworm fed on two varieties of mulberry

There are no significant differences in each column which shown with same letter in each varieties

research the cocoon weight decreased more than 31% in the larvae fed with Kenmochi infested leaves.

It was assumed that in Iran and some countries in Europe and America that the production of silk is very limited; the damage of pest could be reduced with some non-chemical methods, which are economically tolerable (Etebari and Matindoost, 2004). But in some sub-tropical regions like south of India, planning an accurate IPM for this pest and utilizing all the management methods of pest control is very important (Singh and Saratchandra, 2002). Misra *et al.* (2003) have reported the effective control of thrips with the usage of Quinalphos (0.2%) and found no adverse effect on rearing of silkworms with the treated mulberry leaves.

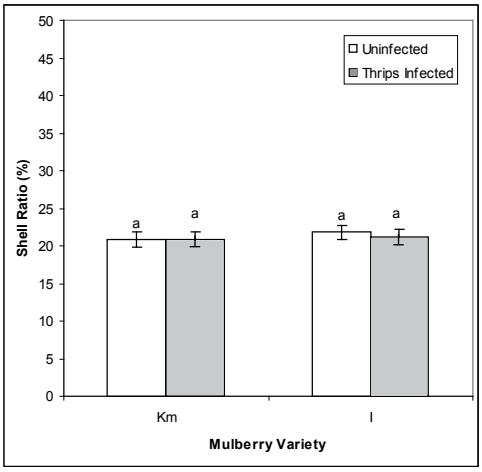

Fig 4.The effect of mulberry thrips infection on shell ratio characteristics of silkworm fed on two varieties of mulberry

With respect to our current results we recommend the using of non-susceptible varieties of mulberry for development of sericulture as one of most important tools in integrated pest management. The evaluation of host preferences of *P.mori* in different regions is very useful study to develop a suitable package for pest management.

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