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Influence of Weather on the Incidence and Severity of Lesser Mulberry Pyralid and Mulberry Looper in Kashmir, India

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ABSTRACT
This study was conducted at Pampore in Kashmir valley, India during 2009-2011 cropping seasons to measure the incidence and severity of lesser mulberry pyralid, *Glyphodes pyloalis* Walker (Lepidoptera: Pyralidae) (LMP) and mulberry looper, *Hemerophila atrilineata* Butler (Lepidoptera: Geometridae) (ML). Fortnightly observations were made on incidence and severity from May to October. Influence of weather parameters on the seasonality and severity LMP and ML was quantified. LMP was recorded from July onwards until leaf fall in October during 2009 and 2010. It was recorded early during 2011 by May 2nd fortnight. Incidence and severity levels of ML were relatively lower compared to that of LMP. During 2009 and 2010 mulberry looper prevailed from July onwards till leaf fall in October. In contrast, during 2011 ML appeared a month late from August 2nd fortnight onwards with a steep increase during last two intervals of observation. Correlations were negatively significant at $p = 0.01$ for LMP incidence with minimum and maximum temperatures and number of rain days during same fortnight (SFN). Severity of LMP with preceding second fortnight's morning relative humidity was negative and significant at $p = 0.01$. Correlations for both incidence and severity of ML with minimum temperature of SFN were negatively significant at $p = 0.01$. Multiple regression modules with weather parameters of SFN had higher probability and R^2 values. There is need to continue the studies to establish precise relations with weather and pest incidence and severity.

Key words: Kashmir, lesser mulberry pyralid, mulberry looper, incidence, severity, weather

INTRODUCTION
Jammu and Kashmir state has a unique feature among the Indian states which is bestowed with the salubrious climate in line with China and Japan, the giants in global silk production at present and in the past, respectively. This traditional sericultural state lags behind Tamil Nadu, Karnataka and Andhra Pradesh in both production and productivity of bivoltine silk (Anonymous, 2011). It is a well established fact that mulberry biomass production per unit area per annum is highest in Jammu and Kashmir among the sericultural states of India. The reasons for not converting this huge mulberry wealth in to silk include the subsidiary nature of sericulture industry besides huge competition from the cash rich horticultural and agricultural crops. Monocropping nature of silkworm rearing and lack of backward and forward linkages are equally limiting the state from harnessing the huge potential. Jammu and Kashmir has witnessed a drastic

decline in silk production since last three decades until recent past, when it stagnated. The present production of silk in the state is 8.32 lakh kg compared to 16.00 lakh kg during 1960 (Nika, 2010). The decline is mainly due to reduction in number of sericultural farmers influenced by leaf shortage and leaf quality due to mulberry diseases and insect pests besides silkworm diseases (Khan *et al.*, 2004). Lot of efforts are being pumped in to introduce a second crop of silkworm rearing in the state with a summer crop for Kashmir valley and an autumn crop for Jammu region in addition to the existing sole spring crop (Malik *et al.*, 2010; Khan *et al.*, 2010; Raina *et al.*, 2011; Mohan *et al.*, 2011). In Kashmir valley which enjoys the temperate climate, Lesser Mulberry Pyralid (LMP) (*Glyphodes pyloalis* walker (Lepidoptera: Pyralidae)), leaf spot and powdery mildew being the major biological threats (Anonymous, 1996; Illahi *et al.*, 2011). Besides, mulberry looper (ML) (*Hemerophila atrilineata* butler (Lepidoptera: Geometridae)) is emerging as another bottleneck (Mittal *et al.*, 2011). Therefore, a sound knowledge of insect pests and diseases, their seasonality and severity are essential to evolve suitable crop management strategies to revive and explore the silk production and productivity in the state to the fullest potential. In this background, efforts were made to understand the influence of weather on the seasonality and severity of LMP and ML in Kashmir valley during 2009-2011 cropping seasons.

MATERIALS AND METHODS

Observations were made from mulberry dwarf plantations of Goshoerami and TR-10 varieties, established during 2004 March at 120×120 cm spacing in Central Sericultural Research and Training Institute, Pampore located at 33°59'50"N latitude, 74°55'5"E longitude and 1574 m altitude, Jammu and Kashmir, India from April to October during 2009, 2010 and 2011 cropping seasons. Pest incidence and severity PDI measured as the percent leaf area damaged were collected from three tagged branches from 15 randomly selected and tagged plants adopting the standard procedures with modifications (FAO, 1967; Gunasekhar and Govindaiah, 1994) at fortnightly intervals. The severity was measured using 0-5 damage scale, where 0 = no damage, 1 = <5% leaf area damage and similarly 2, 3, 4 and 5 for 5-10, 10-25, 25-50 and >50% leaf area damage, respectively. Thereafter, PDI was worked out by using the formula:

$$\text{PDI} = \sum \frac{\text{No. of infested leaves} \times \text{Damage grade}}{\text{Total No. of leaves observed} \times \text{Maximum damage grade}} \times 100$$

Weather parameters viz., maximum and minimum temperatures (T_{min} and T_{max}, °C), morning relative humidity (RH_{mor}, %), rainfall (RF) (mm) experienced during the study period and number of rainy days (RD) were obtained daily from the meteorological observatory of the institute.

Statistical analysis: Influence of above said weather prevailed during the same fortnight (SFN) and preceding fortnights of observation on fortnightly basis on the insect pest incidence and severity were analyzed by deploying the Pearson correlation and multiple regression using enter method of calculation in SPSS 10.0® software. Same fortnight (SFN) weather referred to the weather prevailed during 15 days prior to the observation. Preceding first (P1FN) and second (P2FN) fortnight weather means the weather prevailed during 16-30 and 31-45 days prior to the day of observation, respectively.

RESULTS

Incidence of LMP varied from year to year but in general it could be recorded from July onwards until leaf fall in October with a gradual increase during first two years (2009-2010) while, during 2011 it appeared a month early in May 2nd fortnight itself (Fig. 1). During 2010, incidence declined a fortnight ahead to the end of season while, it continued to increase through the season during 2009 and 2011. Incidence levels of LMP ranged from 0.83-28.83% in 2009 with a mean of 10.60% when compared to a mere 1.43 and 3.42% during 2010 and 2011, respectively with the incidence levels ranging from 0.08-7.91 and 0.53-13.18%. The severity levels too followed the incidence trend but, the quanta of increase in severity were relatively lower and not in proportion to that observed with that of incidence levels (Fig. 2). The mean severity levels for 2009, 2010 and 2011 were 5.24, 0.97 and 1.10%, respectively. During 2009, LMP severity crossed Economic Threshold Level (ETL) in September to reach a peak of 10.50% by October. During 2010 severity was below the ETL while during 2011 LMP crossed ETL at the last observation.

Incidence and severity levels of ML were relatively lower compared to that of LMP. During the years 2009-2010, mulberry looper prevailed from July onwards until leaf fall in October while during 2011 it appeared a month late from August 2nd fortnight onwards with a very steep increase by the end of the season (Fig. 3). During 2009 there were two peaks; one during September 1st fortnight (9.15%) and another a month later (7.76%) while, during 2010 there was only a peak during August 2nd fortnight which declined with advancement of the season. During the third year of study, the peak incidence of ML was observed towards the end of the season (15.50%). The severity levels of ML followed the same trend of incidence levels and it did cross the ETL only at the end of the season in 2011 (Fig. 4). The mean severity levels indicated that ML was below ETL even though the incidence levels were considerable.

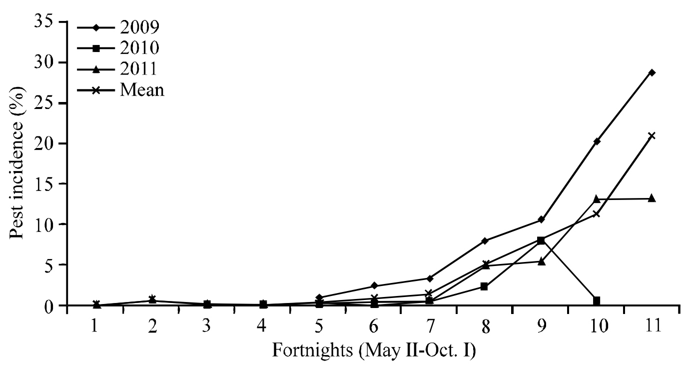

Fig. 1: Incidence of lesser mulberry pyralid at Pampore, Kashmir, India during 2009-11

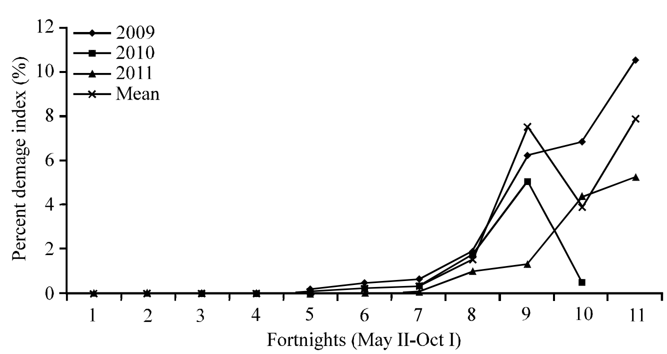

Fig. 2: Severity of lesser mulberry pyralid at Pampore, Kashmir, India during 2009-11

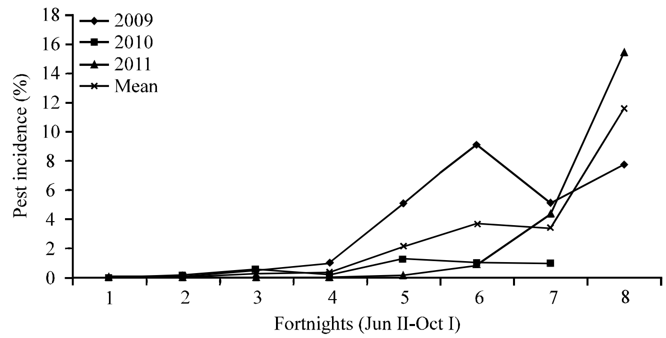

Fig. 3: Incidence of mulberry looper at Pampore, Kashmir, India during 2009-11

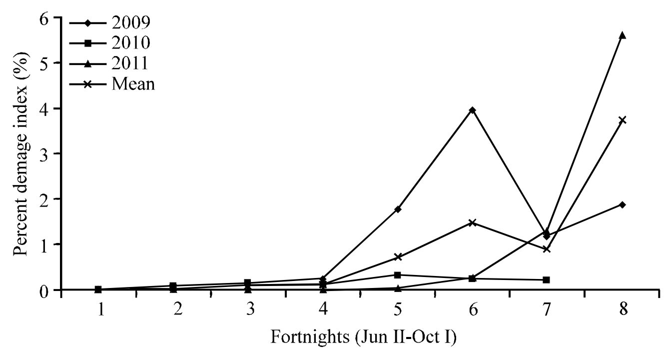

Fig. 4: Severity of mulberry looper at Pampore, Kashmir, India during 2009-11

Table 1: Correlations of weather parameters with incidence and severity of mulberry insect pests during 2009-11 at Pampore, Kashmir, India

	TM_{max}	TM_{min}	RH_{mor}	RF	RD
Lesser mulberry pyralid incidence					
SFN	-0.520**	-0.572**	0.022	-0.370	-0.498**
P1FN	-0.088	-0.103	-0.274	-0.169	-0.372
P2FN	0.259	0.288	0.466*	-0.106	-0.273
Lesser mulberry pyralid severity					
SFN	-0.493*	-0.463*	0.105	-0.359	-0.474*
P1FN	-0.027	-0.063	-0.408*	-0.110	-0.201
P2FN	0.321	0.368	0.528**	-0.128	-0.205
Mulberry looper incidence					
SFN	-0.455*	-0.593**	-0.024	-0.263	-0.355
P1FN	-0.041	-0.177	0.209	-0.165	-0.362
P2FN	0.294	0.347	0.365	-0.086	-0.159
Mulberry looper severity					
SFN	-0.400*	-0.532**	-0.018	-0.236	-0.316
P1FN	-0.005	-0.167	0.202	-0.144	-0.321
P2FN	0.303	0.355	0.334	-0.071	-0.128

*,**Significant at $p = 0.05$ and $p = 0.01$, respectively, SFN: Same fortnight weather, P1FN: Preceding first fortnight weather, P2FN: Preceding second fortnight weather, RF: Rainfall, RH_{mor}: Morning relative humidity, RD: No. of rainy days, T_{max}: Maximum temperature, T_{min}: Minimum temperature

Incidence as well the severity of both the mulberry defoliators was influenced by weather at Pampore in Kashmir valley. Majority of weather parameters negatively influenced the incidence and severity of both LMP and ML (Table 1). A highly significant and negative correlations were

Table 2: Multiple regression modules for incidence and severity of mulberry insect pests with weather parameters during 2009-11 at Pampore, Kashmir, India

Particulars	Module	R	R^2 (%)	Adjusted R^2	F-value	p-value
Lesser mulberry pyralid incidence						
SFN	$0.811-0.925\ RD+0.468\ RH_{mor}-0.363\ T_{max}+0.029\ Rf-1.076\ T_{min}$	0.743	55.2	44.0	4.925	0.004**
P1FN	$-17.601-1.408\ RD+0.04\ T_{max}+0.483\ RH_{mor}+0.058\ Rf-0.513\ T_{min}$	0.559	31.3	14.1	1.821	0.154
P2FN	$-34.407-1.236\ RD-0.139\ T_{min}+0.570\ RH_{mor}+0.05\ Rf+0.399\ T_{max}$	0.633	40.1	25.1	2.673	0.005**
Lesser mulberry pyralid severity						
SFN	$0.321-0.529\ RD+0.263\ RH_{mor}-0.335\ T_{max}+0.01\ Rf-0.375\ T_{min}$	0.706	49.8	37.3	3.974	0.012*
P1FN	$-19.375-0.375\ RD-0.488\ T_{max}+0.350\ RH_{mor}+0.008\ Rf+0.226\ T_{min}$	0.573	32.8	16.0	1.955	0.130
P2FN	$-24.998-0.378\ RD-0.042\ T_{min}+0.32\ RH_{mor}+0.007\ Rf+0.294\ T_{max}$	0.665	44.2	30.2	3.168	0.029*
Mulberry looper incidence						
SFN	$-2.396-0.198\ RD+0.225\ RH_{mor}+0.029\ T_{max}+0.017\ Rf-0.781\ T_{min}$	0.694	48.2	35.2	3.721	0.015*
P1FN	$-12.893-0.631\ RD+0.277\ T_{max}+0.247\ RH_{mor}+0.027\ Rf-0.512\ T_{min}$	0.555	30.8	13.5	1.781	0.163
P2FN	$-15.534-0.276\ RD-0.089\ T_{min}+0.19\ RH_{mor}-0.005\ Rf+0.18\ T_{max}$	0.501	25.1	6.4	1.341	0.288
Mulberry looper severity						
SFN	$-1.035-0.059\ RD+0.074\ RH_{mor}+0.018\ T_{max}-0.005\ Rf-0.251\ T_{min}$	0.625	39.0	23.8	2.558	0.060
P1FN	$-5.25-0.196\ RD+0.129\ T_{max}+0.088\ RH_{mor}+0.008\ Rf-0.201\ T_{min}$	0.532	28.3	10.3	1.576	0.212
P2FN	$-5.261-0.071\ RD+0.041\ T_{min}+0.059\ RH_{mor}-0.003\ Rf+0.065\ T_{max}$	0.473	22.4	2.9	1.152	0.366

*,**Significant at p = 0.05 and p = 0.01, respectively, SFN: Same fortnight weather, P1FN: Preceding first fortnight weather, P2FN: Preceding second fortnight weather, RF: Rainfall, RH_{mor}: Morning relative humidity, RD: No. of rainy days, T_{max}: Maximum temperature, T_{min}: Minimum temperature

observed for the incidence LMP with both minimum and maximum temperatures and number of rainy days during the same fortnight besides a significant positive correlation with the morning RH of second preceding fortnight. The relations for the severity of LMP were negative and significant for temperatures and rainy days of same fortnight and morning relative humidity of first preceding fortnight. A highly significant and positive correlation was observed with the incidence of LMP and morning relative humidity of second preceding fortnight.

The negative influences of maximum temperature and minimum temperature of same fortnight were significant and highly significant, respectively with both incidence and severity of ML (Table 1). Correlations with morning relative humidity of first preceding fortnight and the maximum and minimum temperatures and morning relative humidity of the second preceding fortnight were positive but, were not significant.

The multiple regression modules comprising of five weather parameters of same fortnight and second preceding fortnight had higher probability and fairly reliable R^2 and adjusted R^2 values compared with that of first preceding fortnight for both incidence and severity of LMP (Table 2). Module obtained with the weather parameters of the same fortnight for ML incidence had a higher probability as well as reliable R^2 and adjusted R^2 values.

DISCUSSION

Incidence as well as the severity levels of LMP registered a profound increase by three to four folds with the advancement in season clearly indicates the increasing threat by this major mulberry defoliator in Kashmir valley for the proposed second silkworm crop in summer season. The infestation and severity of LMP observed in the present study followed the same trends well documented earlier during 1990's and 2000's (Anonymous, 1997, 2008). While the incidence and severity of ML reached its peak once during mid late season and another at the end of the season is in full agreement with the findings of Mittal *et al.* (2011). They have observed infestation of ML gradually increasing from July to first fortnight of September and then receded slightly during second fortnight of September to reach the peak at the end of the season. Since, the incidence as well as the severity of these two mulberry defoliators is limited and distinct during the post commercial season; spring crop of silkworm in the Kashmir valley escapes unhurt by the pest menace as on date. But, it is very important to take note of these in future ventures as second and third crops are being explored in backdrop of established ill effects on the cocoon parameters witnessed by feeding the silkworm with LMP damaged mulberry leaves (Anonymous, 1998). The resultant loss in cocoon yield by weight, single cocoon weight, single shell weight and shell ratio were 9.03 and 18.11, 10.36 and 15.06, 19.14 and 24.75 and 9.92 and 11.32%, respectively over control during summer and autumn seasons.

Information on the influence of the weather on the LMP as well as the ML is totally lacking owing to limited geography to temperate India as well the economic importance of these two pests of mulberry. We can borrow the support from the well studied leaf roller, *Diaphania pulverulentalis* (Hampson) (Lepidoptera: Pyralidae), a major defoliator pest of mulberry in tropical India which belongs to the same family and inflicts comparable damage. The pest registered an incidence level of over thirty percent during the monsoon months from June to October and was totally absent during February and March months at Mysore, Karnataka. Maximum temperature had a significant and negative correlation with the pest incidence as well as damage severity at Tumkur and Mysore, Karnataka where other weather parameters influenced positively (Hemalatha and Pai, 2009; Rahmathulla *et al.*, 2012). Even at Krishnagiri, Tamil Nadu the population of *D. pulverulentalis* was influenced negatively by the average temperature (Samuthiravelu *et al.*, 2010). In the present study, majority of the weather factors influenced the incidence and severity negatively and few correlations were significant too. There is a scope for improving the understanding of weather influences on the incidence and severity of these two pests by intensifying the observation schedule from fortnight to weekly intervals.

CONCLUSION

From the studies it is clear that the pest menace in mulberry is increasing day by day during summer and autumn seasons in Kashmir valley which needs to be noted with caution as the process for expanding the commercial rearing in to these unexplored seasons has been initiated. A continued study is expected to help in evolving more precise weather based pest prediction modules which will be of greater utility in days ahead in the sericulture industry of this traditional sericulture state of India, Jammu and Kashmir.

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