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Implications of High Temperature and Low Humidity on the Hatching in the Silkworm, *Bombyx mori* L. Under LD 12 : 12 Condition

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The implications of temperature (25, 30 and 35°C) and relative humidity (RH; 60, 70 and 80%) on the hatching rhythmicity and hatching parameters (percentage and duration) were studied in the silkworm, *Bombyx mori* L. under natural photoperiod (LD 12 : 12). Disease free layings (DFLs) of two pure silkworm breeds, Pure Mysore (PM, a multivoltine breed) and NB_4D_2 (a bivoltine breed), and their hybrid, PM × NB_4D_2 were introduced into the experimental conditions on the 3rd day of oviposition till completion of hatching. The hatching rhythm was predominantly diurnal under all temperature and humidity conditions, with peaks just after 'lights-on' phase (6 hrs). Extreme temperature and humidity conditions did not alter the hatching rhythmicity, but prolonged the hatching durations, extending it to the next day, coupled with reduced hatching percentage in PM and PM × NB_4D_2. In NB_4D_2, on the other hand, hatching did not extend to the next day. Hatching percentage in this breed, however, reduced below the economic level under high temperature and low humidity conditions. The high temperature and low humidity together, though did not alter the rhythmicity, seems to exert synergetic effect on the hatching percentage and its duration in the silkworm, *B. mori*.

Key words: Silkworm, *Bombyx mori*, Temperature, Humidity, Hatching patterns

Introduction

Environmental conditions such as temperature and humidity have been the main factors in rearing the silkworm, *Bombyx mori*. Procurement and incubation of silkworm eggs at the optimum temperature (25°C) and relative humidity (80%) for economical hatching of more than 90% (Krishnaswami, 1986) was greatly emphasized. Andhra Pradesh has the distinction in Indian sericulture for its second position in the silk production, next to Karnataka. The climatic conditions, especially high temperature (over 40°C) and low relative humidity (less than 30%) prevailing during prolonged summer season in the sericultural areas of the State, are not, obviously, in favour of sericulture. As a result, hatching of silkworm eggs is reported to be very low, leading to poor cocoon crop and therefore, poor profits.

Sivarami Reddy and Sasira Babu (1990) reported good hatching in *B. mori* under certain photoperiodic conditions, however under optimum temperature and humidity conditions. Also, reports are available on the effect of temperature alone on the hatching of silkworm eggs (Kato *et al.*, 1989). Effects of both temperature and humidity on *B. mori* moulting (Lakshminarayana Reddy *et al.*, 2003), pupation (Lakshminarayana Reddy *et al.*, 2002a) and eclotion (Lakshminarayana Reddy *et al.*, 2002b) are available. However, reports on the combined effect of temperature and relative humidity on the hatching in the silkworm, *B. mori* are scanty. The present study depicts the decisive involvement of temperature and humidity on the hatching in the silkworm, *B. mori*.

Material and Methods

Disease Free Layings (DFLs, each DFL consisting 350 to 450 eggs laid by single Silk moth in a single day) of two pure breeds, PM (Pure Mysore, a multivoltine breed) and NB_4D_2 (a bivoltine breed) and their hybrid, PM × NB_4D_2 of the silkworm, *Bombyx mori* were procured from the

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Government Grainage, Hindupur and Madakasira (Anantapur District, Andhra Pradesh, India) on the third day of oviposition. The bivoltine DFLs were treated (Narasimhanna, 1988) for avoiding egg diapause. The eggs were transported during cool hours of the day to the laboratory and incubated immediately in Kolarstat Environmental Chamber, under the natural photoperiod (LD 12 : 12, photophase; 50 lux from 6 hrs to 18 hrs, Sivarami Reddy and Sasira Babu, 1990). The scotophase lapsed from 18 hrs. to 6 hrs Three incubation temperatures (25, 30 and 35°C) and three relative humidity (RH) conditions (60, 70 and 80%) were imposed. In brief, the experimental design was 3 silkworm races × 3 temperatures × 3 humidity conditions. Five DFLs, separately, were maintained in each condition as replications. Precise timings, in hour, for hatching was determined and recorded based on which, data on hatching rhythmicity, total hatching (%), hatching (%) at peak hour and hatching duration were derived. The experiment was conducted five times in a year and the data were pooled. The data on all the above overt parameters were analysed statistically (ANOVA, 2-way classification with 5 observations per cell).

Results and Discussion

A. Hatching rhythmicity

The hatching rhythmicity of the three silkworm varieties, PM, NB_4D_2 and PM × NB_4D_2 are depicted in Fig. 1 to 3 respectively. Hatching occurred just after "lights-on" (6 hrs to 9 hrs), indicating the diurnal predominance. The peak of hatching occurred in the initial part of the photophase of the day. In PM, it occurred for two consecutive days under high temperatures (30 and 35°C) and low humidity (60% and 70% RH, Fig. 1) conditions. Similar hatching patterns were observed for the hybrid, PM × NB_4D_2 under high temperature and low humidity conditions (Fig. 3). Hatching in the bivoltine breed, NB_4D_2, though confined to a single day (Fig. 2), occurred a day later than that observed in the other two breeds (PM and PM × NB_4D_2).

The rhythmic hatching patterns in the eggs have been studied only in limited insects (see Saunders, 1982). Hatching patterns were shown to be the direct response to the environmental factors such as photoperiod. Hatching peaks in the *Bombyx* silkworm were reported to be closely and directly associated with the lights-on (Sivarami Reddy and Sasira Babu, 1990). Saunders (1982) viewed that the temperature may not affect the rhythm directly, but it broadens the peak appearance. The reduced hatching amplitude under high temperature and low humidity conditions in the present study (Fig. 1 to 3) is supported by the above statement. Under low temperature (25°C) and high humidity (80%), all the three races have shown hatching on a single day. Except NB_4D_2, the other 2 races (PM and PM × NB_4D_2) have shown hatching for two consecutive days under high temperature and low humidity, with reduced amplitude of hatching. The reports on the

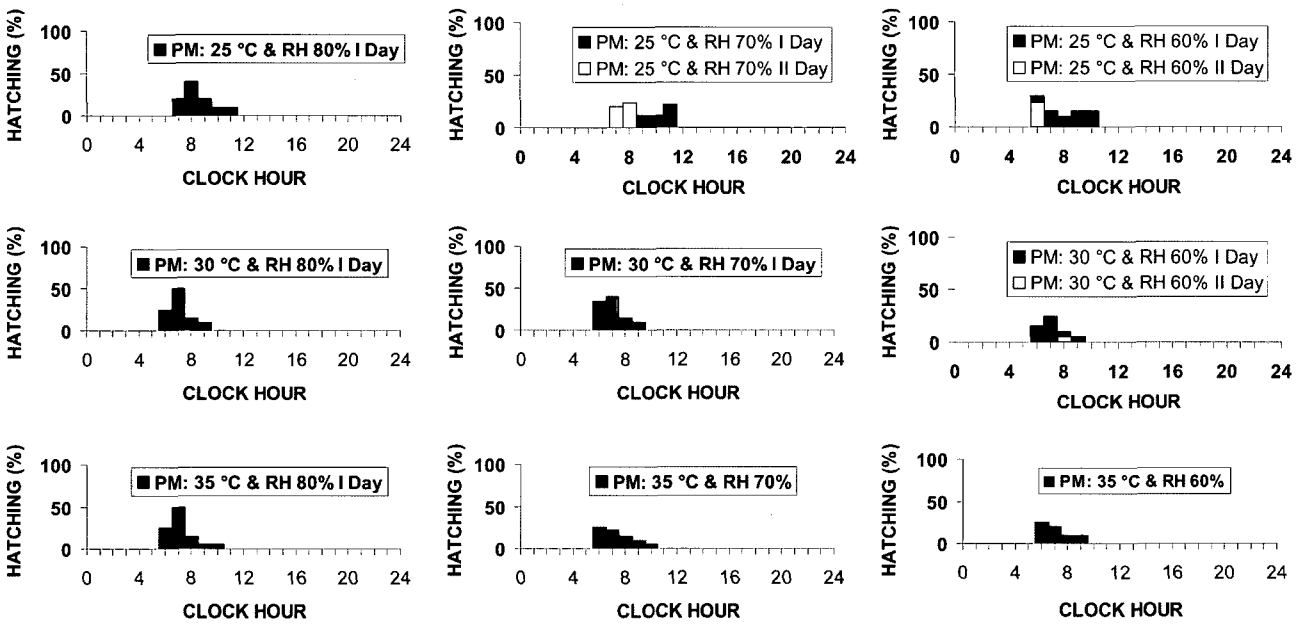

Fig. 1. Graphic representation of hatching in PM (Pure Mysore) breed of *B. mori* at different incubation temperatures (25, 30 and 35°C) and relative humidity (60, 70 and 80% RH) conditions under LD 12 : 12 photoperiod condition (light phase from 6 hrs to 18 hrs and dark phase from 18 hrs to 6 hrs; not shown in the picture).

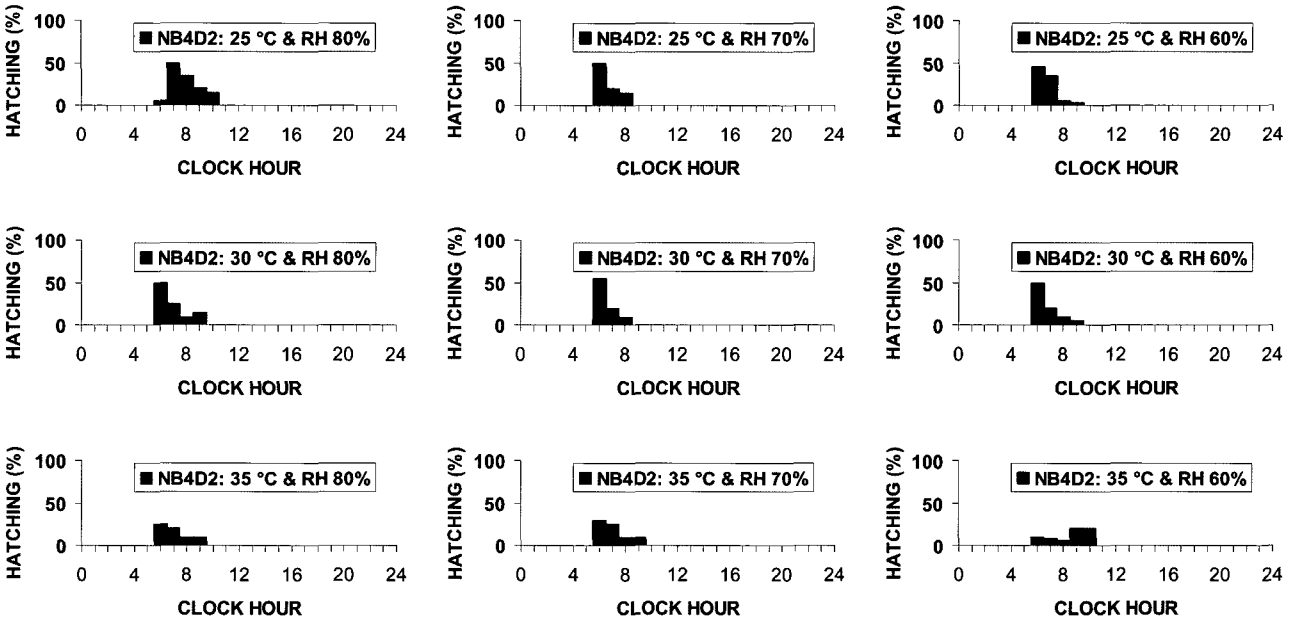

Fig. 2. Graphic representation of hatching in NB_4D_2 breed of *B. mori* at different incubation temperatures (25, 30 and 35°C) and relative humidity (60, 70 and 80% RH) conditions under LD 12 : 12 photoperiod condition (light phase from 6 hrs to 18 hrs and dark phase from 18 hrs to 6 hrs; not shown in the picture).

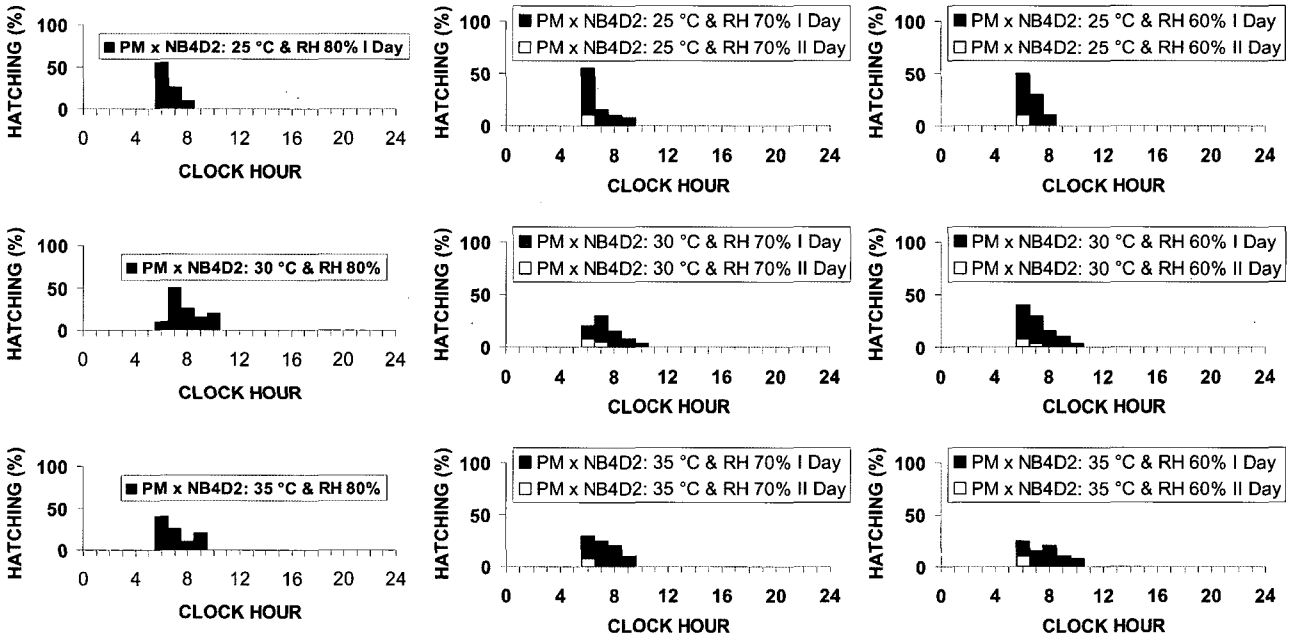

Fig. 3. Graphic representation of hatching in PM × NB_4D_2 of *B. mori* at different incubation temperatures (25, 30 and 35°C) and relative humidity (60, 70 and 80% RH) conditions under LD 12:12 photoperiod condition (light phase from 6 hrs to 18 hrs and dark phase from 18 hrs to 6 hrs; not shown in the picture).

effects of humidity on hatching rhythmicity are still scanty.

B. Hatching parameters

i. Total hatching (%): Total hatching percentage under all the incubation conditions in three silkworm races studied is depicted in Fig. 4. Hatching percentage was near economical level (≥ 90%) in PM and PM × NB_4D_2 even under high temperature and low humidity conditions. However, hatching in the bivoltine breed, NB_4D_2 was

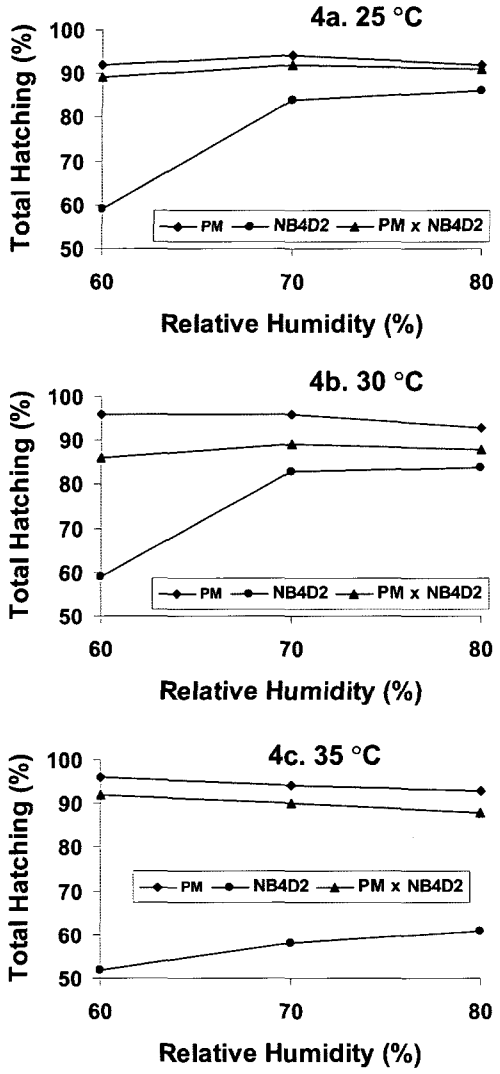

Fig. 4. Graphic representation of total hatching (%) in PM, NB_4D_2 and PM × NB_4D_2 of *B. mori* at different temperatures and relative humidity.

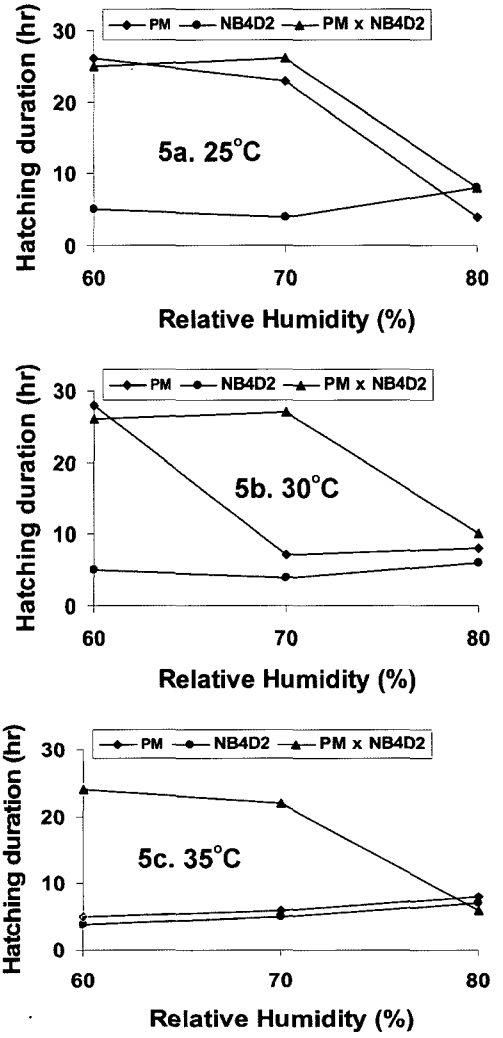

Fig. 5. Graphic representation of hatching duration in PM, NB_4D_2 and PM × NB_4D_2 of *B. mori* at different temperatures and relative humidity.

very low under low humidity conditions (62% and 69%, Fig. 4a, b and c). The hatching in this breed has gradually increased to reach near economic level when the humidity increased and temperature decreased. The observations were statistically significant ($P < 0.05$).

ii. Hatching duration: The hatching duration, from the initiation of hatching to its completion, is given in Fig. 5. NB_4D_2 alone has shown less hatching duration (5 to 9 hrs), as hatching in this breed has not extended into the second day. On the contrary, total hatching (%) was very poor (Fig. 4). At 30°C of incubation temperature (Fig. 5b), hatching durations in PM and PM × NB_4D_2 exceeded 24 hours. Later it decreased to 5 hrs in PM and NB_4D_2. The extreme temperature (35°C) and humidity (60 and 70%, Fig. 5c), has maximum effect on the hatching.

High temperature was reported to increase embryo mortality (Vemananda Reddy *et al.* (2003). They also reported that the eggs may also die at any stage during embryonic developmental stage due to high temperature. Reporting on the effects of humidity, they (Vemananda Reddy *et al.*, 2003) opined that low humidity results in water loss in the egg and result in heavy mortality, as the silkworm egg has no mechanism through which they can substitute the water deficit due to low humidity. High temperature and low humidity has been reported in lessening the hatching percentage as also increasing the hatching duration, as observed in the present study. Therefore, the extreme temperature and humidity conditions exert no effect on the rhythmic patterns. However, they (temperature and humidity) seem to exert synergetic effects on the silkworm, *B. mori* through low, prolonged and uneconomical hatching.

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