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Impact of varying different abiotic factors on the survivability of tasar silkworm in outdoor rearing fields

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Abstract
Due to outdoor rearing of tasar silkworm, the larvae are amenable to different abiotic and biotic stress conditions which lead to severe mortality of the larvae. Three different tasar silkworm rearing fields were selected for the present study. The a-biotic factors viz., Temperature, Relative humidity and rainfall were recorded regularly along with dead larvae due to different diseases and pests. The data collected were thoroughly analyzed. The results revealed that, fluctuation in the environment leads to increased disease incidence. The pest infestation was severe during the early instars of the silkworm. Existing field conditions along with fluctuating a-biotic factors play important role in the survivability of tasar silkworm larvae in outdoor condition.

Keywords: A-biotic factors, temperature, humidity, diseases, pests

Introduction
Tasar culture a forest-based industry reared mostly by tribal population involves crop loss due to parasites, predators and climatic vagaries. The traditional rearing of *Antheraea mylitta* D., tasar silkworm on forest grown trees resulted in 80-90% crop loss due to pests, predators, natural calamities and diseases. The majority of crop loss in tasar silkworm rearing is resulting due to viral disease. As the rearing is conducted completely outdoors in the forest, there is no control over the climatic conditions (temperature and humidity) and thereby the rearing of tasar silkworms are subjected to many fluctuations in the climatic conditions that often lead to viral attacks. There are several predators of tasar silkworm like Ichneumon fly, Eocanthecona bug, reduvid bug, *Hierodulla bipapilla* (Praying mantis) etc., which are natural enemies in abundance in the rearing field which cause crop loss. The tasar industry is being affected by the incidence of diseases at the larval stage of the silkworm. Among the diseases, bacterial diseases are causing considerable yield loss to the tasar silk farmers [1].

The seasonal differences in the environmental components considerably effect the genotype expression in the form of phenotypic output of silkworm crop such as cocoon weight, shell weight and shell ratio [2]. The cocoon of *A. mylitta* shows considerable variation in their size, shape, pupal weight, shell weight and silk output. Such variations of cocoons mainly occur due to the variation of race, climatic conditions, food plants, etc. Temperature influences everything that an organism does, humidity effects embryonic development and rainfall effects both. The success of the sericulture industry depends upon several variables but environmental conditions such as biotic and abiotic factors are of particular importance [3].

Silkworms are Poikilotherms, hence temperature plays a vital role on the growth of the silkworm, as it directly effects on various physiological activities. In general the early instars larvae are resistant to high temperature which also helps in improving survival rate and cocoon character. The temperature has a direct correlation with the growth of silkworm; wide fluctuation of temperature is harmful to the development of the silkworm. Increased temperature during the silkworm rearing particularly in late instars accelerates larval growth. At low temperature the growth is slow and larval period is prolonged [4].

Several factors influence the development and incidence of diseases. This may be biotic including those inbuilt in silkworms and a-biotic available in the environment, i.e., the infectious agent with its variable virulence and ineffectively, the susceptibility or resistance of the individual that compose the population at risk and an efficient means of transmission [5].

Environmental temperature being the major abiotic factor regulates the body temperature of silkworm that determines the rates of feeding, fecundity and mortality. Temperature is probably the single most important environmental factor that influences behaviour, development, survival, reproduction. Temperature regimes and different levels of Relative Humidity are known to play an important in the life cycle of silkworm [6].

Second abiotic factor that has significant impact is Relative Humidity. Humidity interacts with free water availability and with the water content of the food plants. Under too dry conditions the leaves wither very fast and become unsuitable for silkworm resulting in retarded growth of larvae. Humidity plays a vital role in silkworm rearing and its role is both direct and indirect. The combined effect of both temperature and humidity largely determines the satisfactory growth of the cocoons. It directly influences the physiological functions of the silkworm [7].

Rainfall alters the functioning of microhabitat which along with soil and other environmental factors affects foliage and water levels with consequent affect on performance of larvae. In unfavorable abiotic conditions disease causing entities goes latent and after the arrival of favorable conditions the pathogens become active. Bacteria and viruses cause the diseases individually or in combination. Fluctuating temperature and humidity and poor quality predispose the disease development.

With this background, the present research work was carried out to evaluate role of different factors for survivability of silkworm during rearing.

Materials and Methods

Selections of Disease Free Layings (DFLs)

Preparation of disease free layings was done by employing three tier system of Mother Moth examination. After oviposition for 72 hours (3days continuously) the mother moth were examined for diseases. In all the methods 3 tier examination is required to screen out the diseased layings to avoid further multiplications of the pathogens.

Brushing of the larvae

After eight to ten days of oviposition the silkworm larvae hatch out from the eggs. The newly hatched larvae were brushed thoroughly on disinfected plot. The larvae were brushed within 3 days carefully with the help of camel brush. Apical leaves of the twigs were removed because tannin content is much more in these tender leaves than the older ones.

Recording and evaluation of dead and disease larvae

The dead and disease infected larvae were collected regularly and pathogen confirmation was done by microscopic examination. Similarly, larval mortality due to pest infestation was also recorded regularly.

Results

The results of the present study gives insight on the role of different environmental factors on the survivability of tasar silkworm larvae in different rearing plots of CTR&TI, Ranchi. The larval mortality due to bacteriosis, virosis and pests was recorded in different plots (Plot no. 11, 17 and 21). The data analysis revealed that, larval mortality rate increases with the fluctuation in the temperature and Relative Humidity existing in the previous three or four days. Hence, the environmental factor which exists during 3 to 4 days earlier plays a major role in deciding the survivability of the larvae in outdoor condition.

The highest mortality rate in tasar silkworm larvae was noticed in plot no. 17 in comparison with other two fields studied in the present study. Due to the presence of infected larvae in the rearing plots, the disease spreads quickly to the healthy larvae in the particular field with the presence of favorable condition.

The results of the present study confirms that, more larval mortality was noticed in young age larvae as compared to late age larvae during the onset of favorable condition for spread of the diseases. During the study period, no more rainfall was noticed. More larval mortality due to viral disease was noticed in plot number 17 when compared to other plots (11 and 21). Similarly, more bacterial disease infected larvae were noticed in the plot number 17 only (Figs. 1 & 2).

Mortality due to pest infestation was also more in plot number 17 in comparison with other two plots. More Eocanthecona and uzifly infestation was noticed in comparison with other pests studied in the present work (Figs. 3-6).

Discussion

Silkworm rearing is an extensively month long exercise starting from egg stage and terminating in adults laying eggs and dying their natural death. Silkworm rearing effectively means the culturing of fifth instars larva. Prevailing environmental conditions especially, temperature and relative humidity conditions are vital in determining silkworm physiology as it is a cold blooded organism. Hence maintenance of recommended temperature and humidity, light and ventilation conditions for every stage of rearing are of utmost importance for successful silkworm rearing. The seasonal variation in the environmental components will considerably affects the genotypic expression in the form of phenotypic output of silkworm crop such as cocoon weight, shell weight and cocoon shell ratio. The variations in the environmental conditions day to day and season to season emphasize the need of management of temperature and relative humidity for sustainable cocoon production [7].

Temperature plays a vital role on the growth of the silk-worms. As silkworms are cold-blooded animals, temperature will have a direct effect on various physiological activities. In general, the early instar larvae are resistant to high temperature which also helps in improving survival rate and cocoon characters. The temperature has a direct correlation with the growth of silkworms; wide fluctuation of temperature is harmful to the development of silkworm. Rise in temperature increases various physiological functions and with a fall in temperature, the physiological activities are decreased. Increased temperature during silkworm rearing particularly in late instars accelerates larval growth and shortens the larval period. On the other hand, at low temperature, the growth is slow and larval period is prolonged. The optimum temperature for normal growth of silkworms is between 20ºC and 28ºC and the desirable temperature for maximum productivity ranges from 23ºC to 28ºC. Temperature above 30ºC directly affects the health of the worm [5]. If the temperature is below 20ºC all the physiological activities are retarded, especially in early instars; as a result, worms become too weak and susceptible to various diseases. Temperature has a direct effect on the growth development and physiological activity, nutrient absorption, digestion, egg hatching, growth and quality cocoons. With the increase in temperature the larval growth and development is accelerated resulting reduction in larval duration, cocoons of lower weight and quality while at low temperature growth and development is slow leading to prolong larval period abnormal growth and sensitivity against several diseases. Among the abiotic factors, temperature plays a major role on growth and productivity of silkworms. There is ample literature stating that good quality cocoons are produced within a temperature range of 22–27 ºC and that cocoon quality are poorer above these levels. High temperature adversely affects nearly all biological processes including the rates of biochemical and physiological reactions, and can eventually affect the quality or quantity of cocoon crops in the silkworm and subsequently silk produced. Several studies demonstrated that silkworms were more sensitive to high temperature during the fourth and fifth stages [7]. Humidity plays a vital role in silkworm rearing and its role is both direct and indirect. The combined effect of both temperature and humidity largely determines the satisfactory growth of the silkworms and production of good quality cocoons [3]. It directly influences the physiological functions of the silkworm. The young-age silkworms can withstand to high humidity conditions than later age worms and under such condition, the growth of worm is vigorous. Humidity also indirectly influences the rate of withering of the leaves in the silkworms rearing beds. Under dry conditions especially winter and summer the leaves wither very fast and consumption by larvae will be less [6]. In the present study correlation analysis revealed that the abiotic factors such as, temperature, humidity and rainfall showed significant and positive correlation between maximum temperature and reduviid bug during tasar silkworm rearing fields.

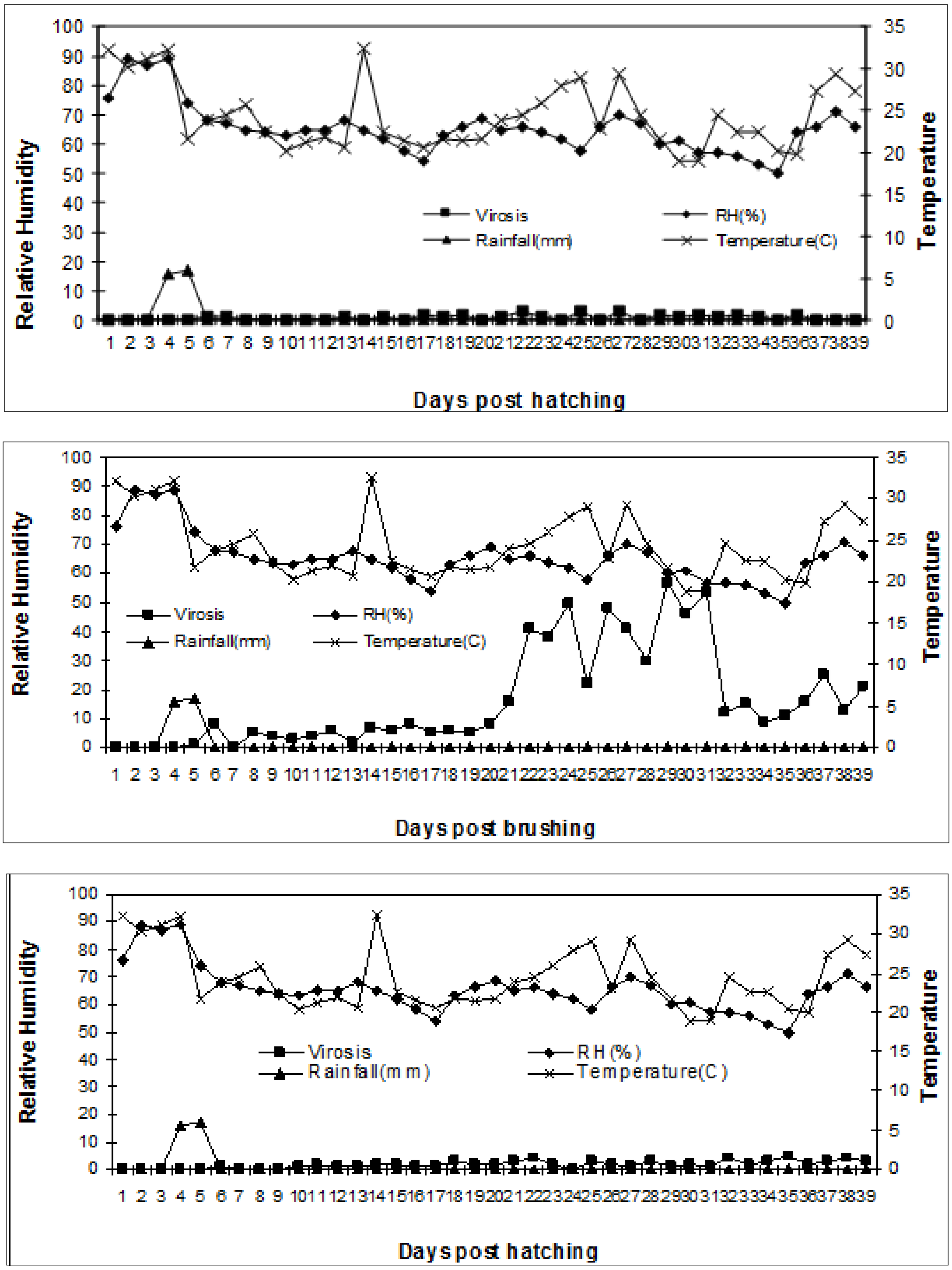


Fig 1: Day wise mortality of tasar silkworms in rearing plot no. 1, 2 & 3 due to virosis infection and its relation with a-biotic factors

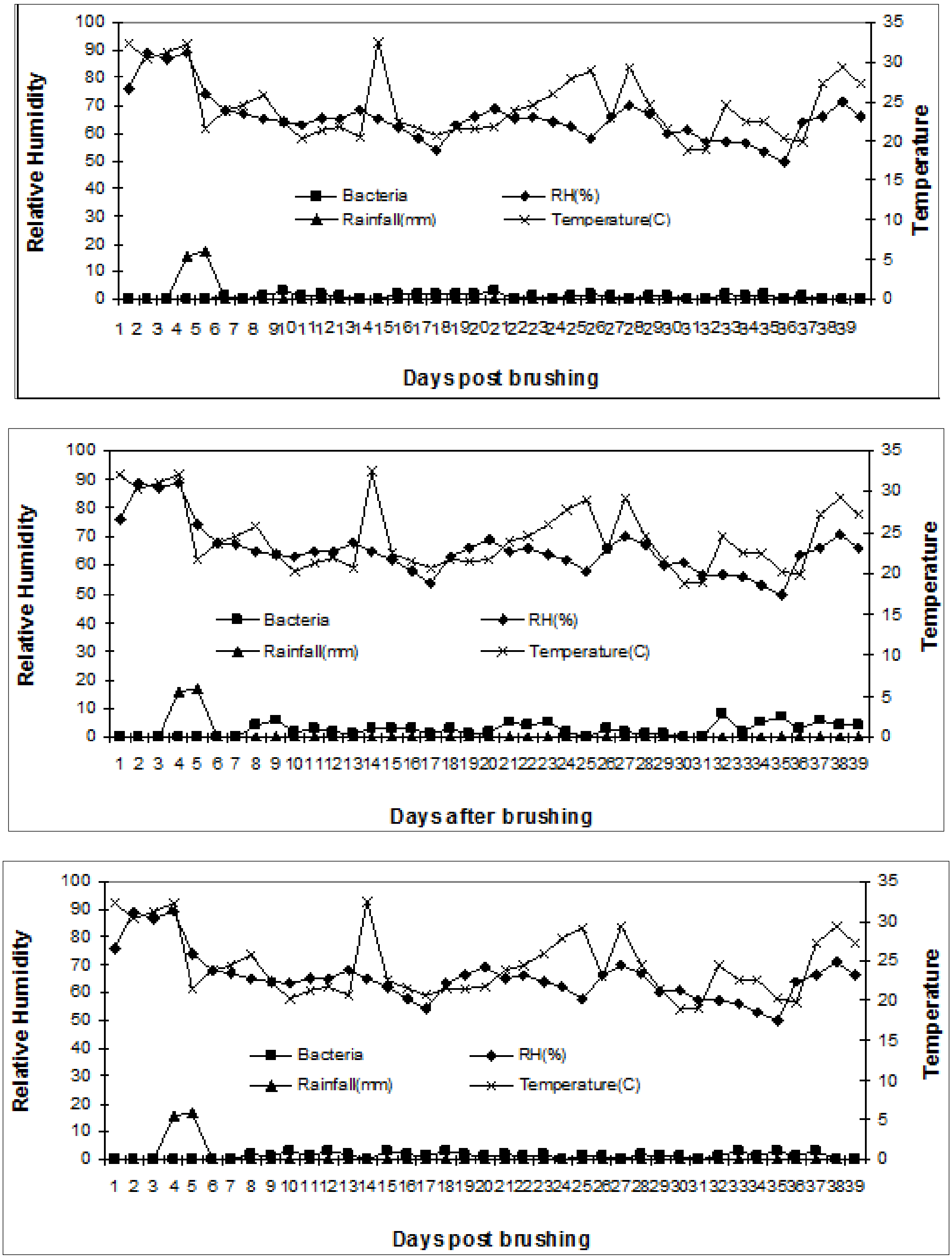
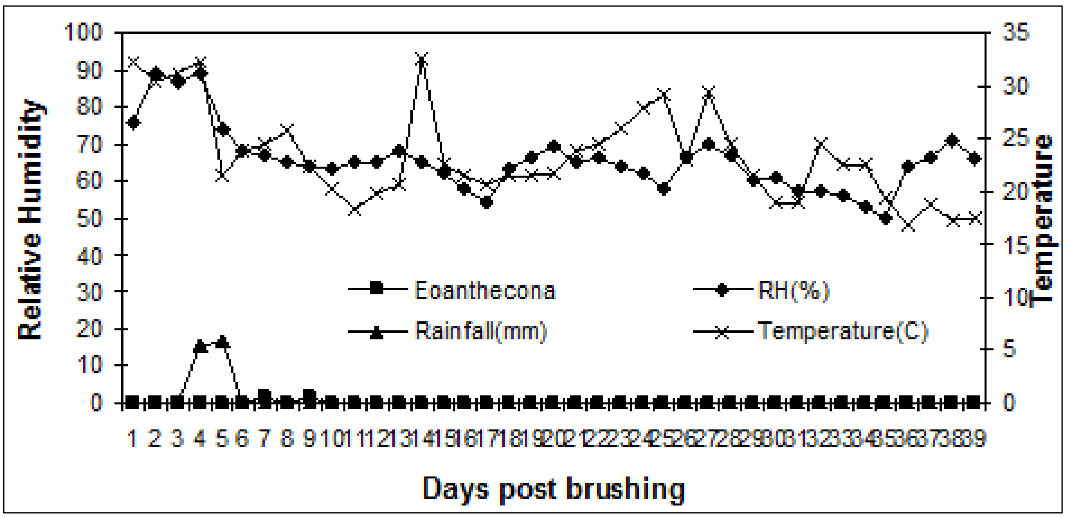
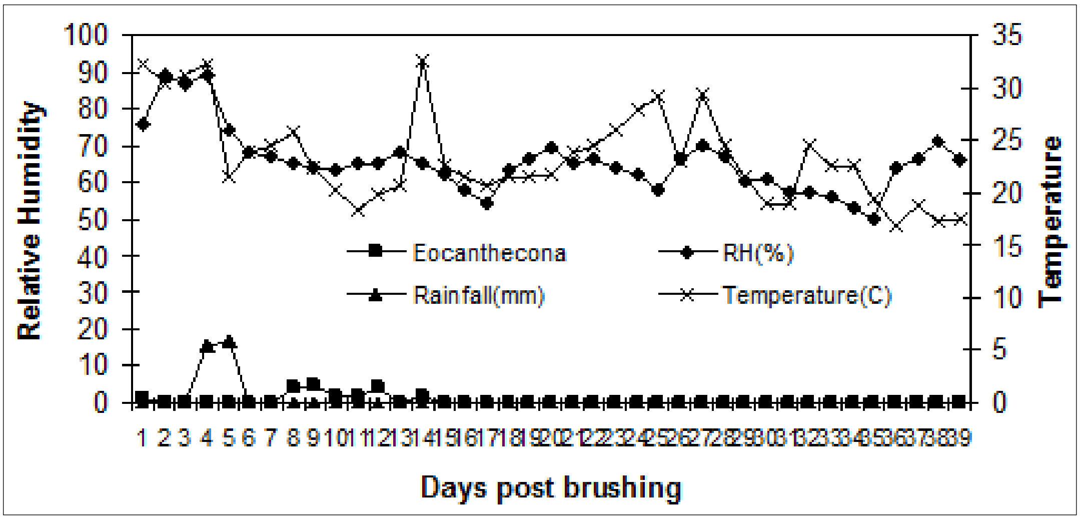


Fig 2: Day wise mortality of tasar silkworms in rearing plot no. 1, 2 & 3 due to bacteriosis infection and its relation with a-biotic factors





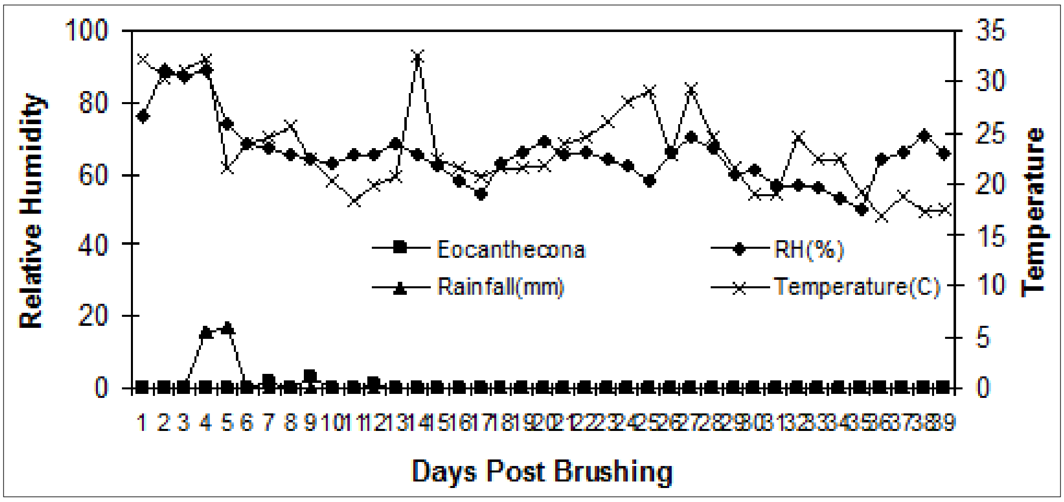
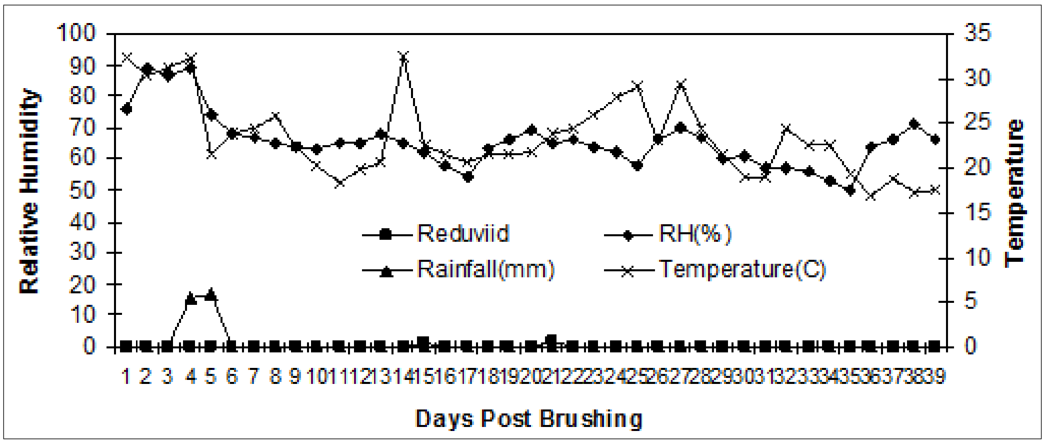
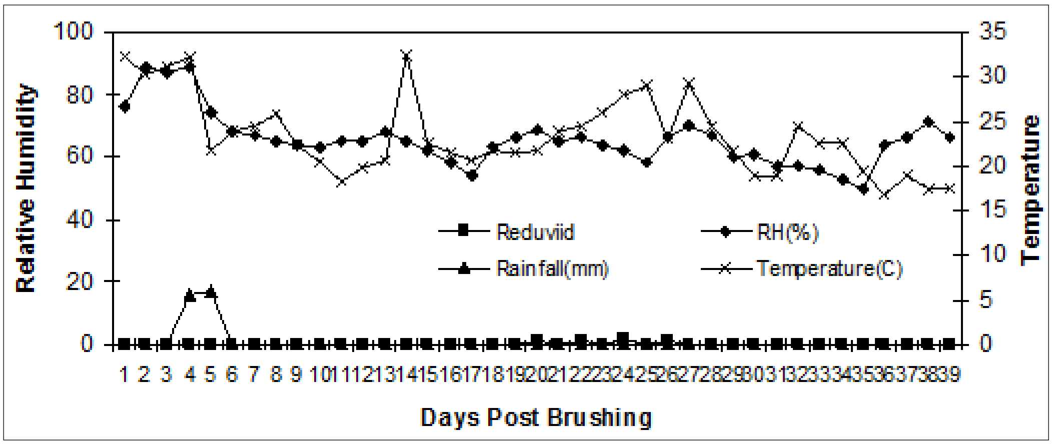


Fig 3: Day wise mortality of tasar silkworms in rearing plot no. 1, 2 & 3 due to Eocanthecona infestation and its relation with a-biotic factors





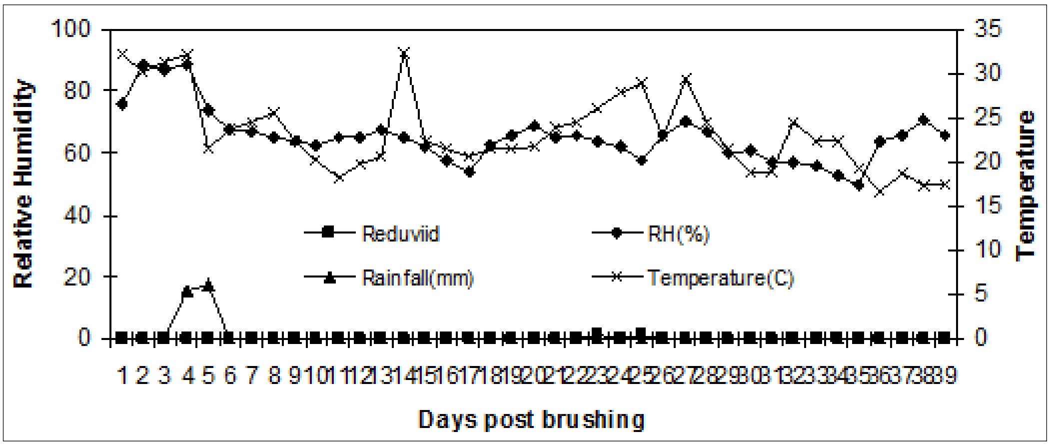


Fig 4: Day wise mortality of tasar silkworms in rearing plot no. 1, 2 & 3 due to Reduviid Bug infestation and its relation with a-biotic factors.

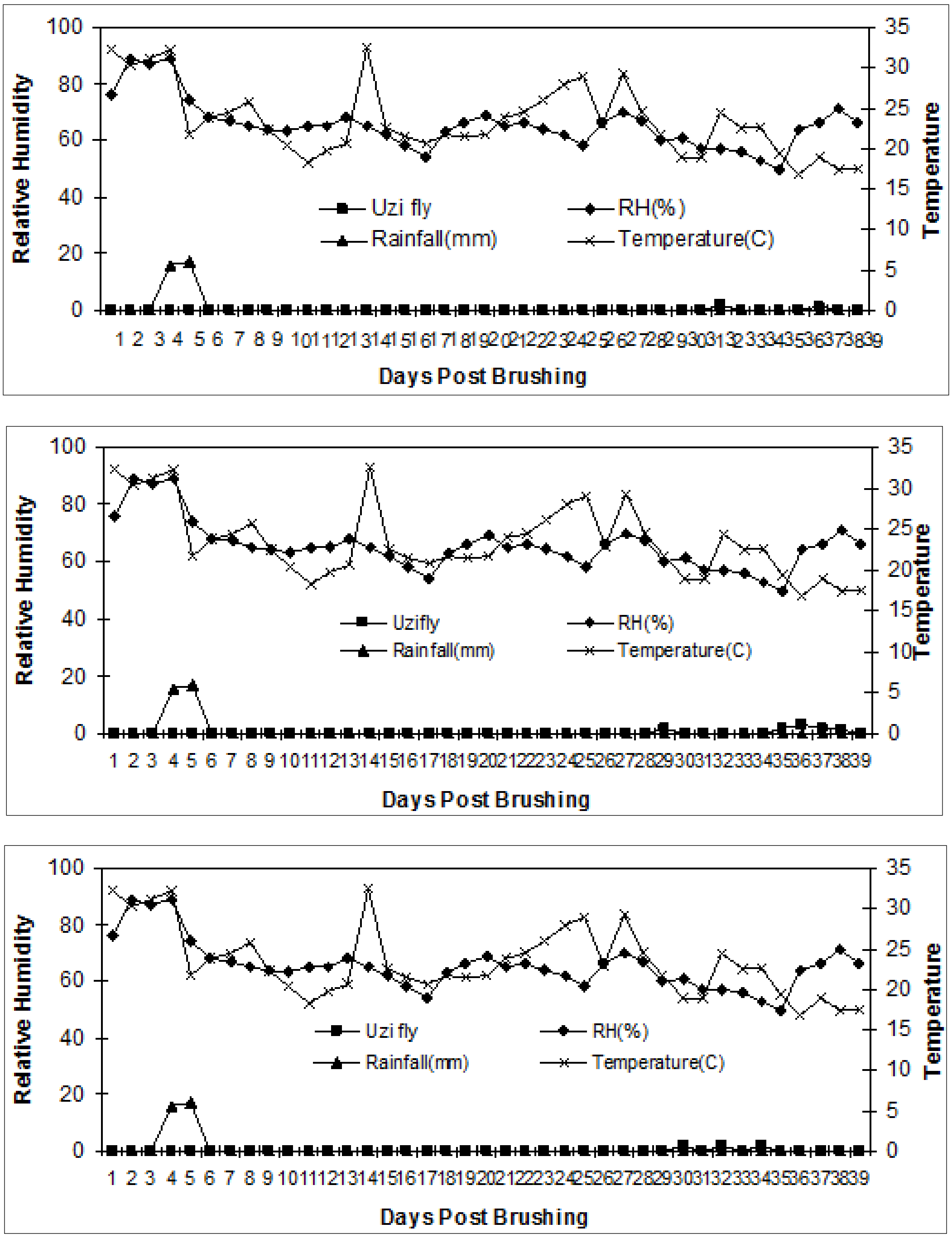


Fig 5: Day wise mortality of tasar silkworms in rearing plot no. 1, 2 & 3 due to Uzi fly infestation and its relation with a-biotic factors

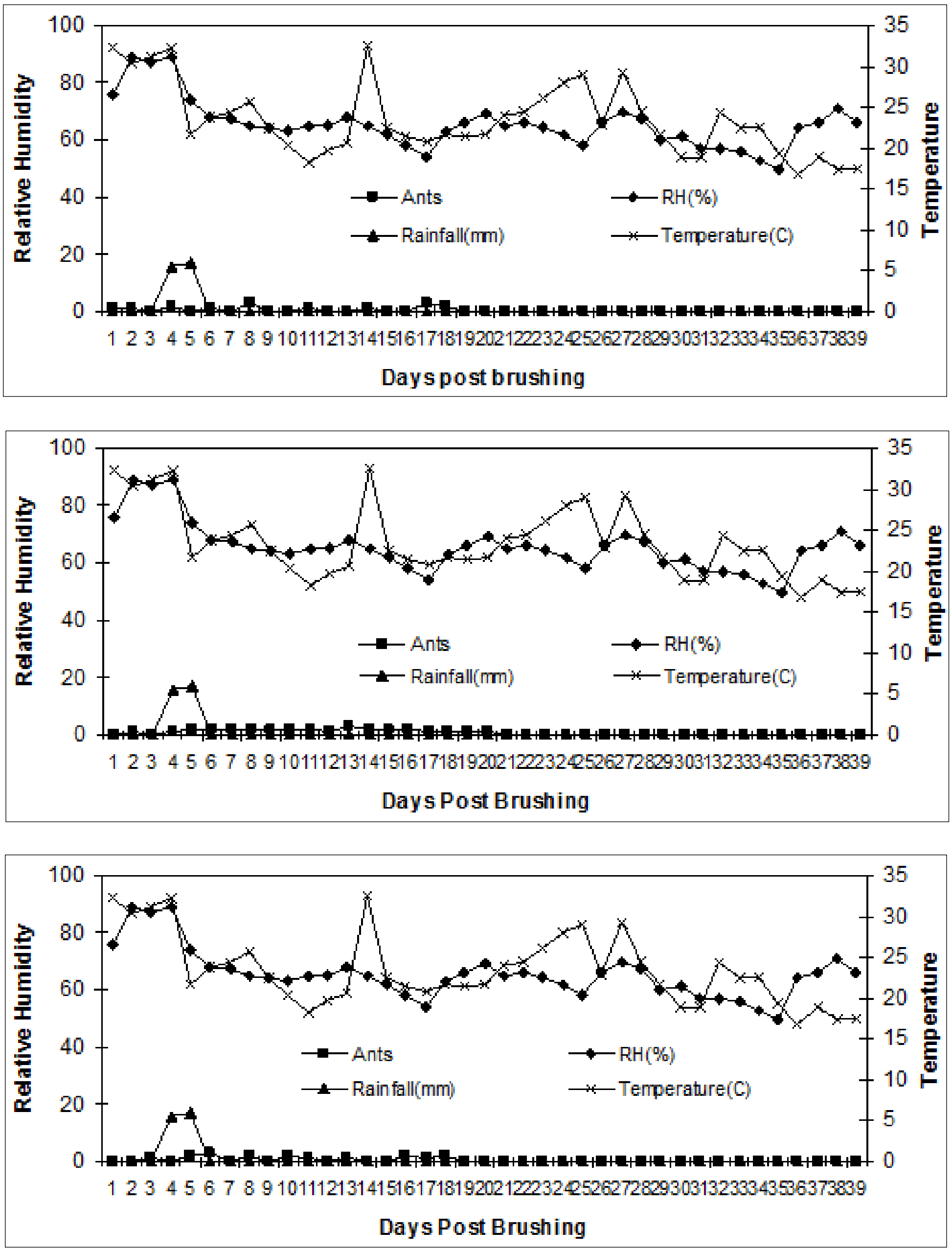


Fig 6: Day wise mortality of tasar silkworms in rearing plot no. 1, 2 & 3 due to red ants incidence and its relation with a-biotic factors.

Conclusion

The mortality rate increased with continuous variation in different a-biotic factors. The larval mortality rate due to pest infestation was severe during the early instars of the silkworm. The disease spread from one larva to another might have occurred through secondary sources of infection. Along with different a-biotic factors existing field condition also plays important role in the survivability of tasar silkworm larvae.

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