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Impact Of The Magnetic Field On The Fecundity Of Mulberry Silkworm, *Bombyx Mori* (L.)

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Abstract: The effect of magnetic field exposure on the fecundity of the silkworm, Bombyx mori (L.) was studied. The larvae of the pure multivoltine (PM) race were exposed to a magnetic field of 0.35 T during each instar separately and also successively at the interval of 24 hrs. for 20 min. The experimental and control groups of larvae were allowed to spinning and their cocoons were used for fecundity studies.

Various parameters of the fecundity were altered due to magnetic field exposure. A gain in the male and female pupal weight was seen after exposure of first to fifth instar larvae separately. Exactly opposite results were obtained when first to fifth instars larvae were exposed successively. Magnetic field exposure, when carried out separately, changed the prepupa-adult emergence period, sex ratio, and the number of eggs produced.

Results indicating consistency to a certain extent and improvement in different parameters of fecundity were obtained when the fourth and fifth instars were exposed successively.

Index Terms **- Magnetic field, *Bombyx mori*, Fecundity**

I. Introduction

The egg laying capacity of insects have profound impact on the economy and welfare. Reports on the experimentally induced variations in the egg laying capacities are available. There was a change in the sex ratio of *Drosophila melanogaster* after their exposure to the magnetic field (Markuze *et al*., 1973). Compared to the males, the females of *Glossina palpalis* and *Bombyx mori* were more susceptible to gamma radiation (Singh *et al*., 1990). Variations in the fecundity in some species of insects, under the ideal and identical situations are recoded (Hasan *et al*., 1989).

In silkworms, a liner relationship exists between the pupal weight and number of eggs laid (Pillai and Krishnaswami, 1989). The pupal weight in *Antheraea polypenmus* serves as an indicator of the number of mature eggs produced (Miller *et al*., 1982). The number of mature eggs in an ovariole correspond proportionately with the number of eggs laid by the moth (Kotikal *et al*.,1989).

The fecundity in insects is influenced by a variety of factors in the environment. During developmental stages, the insects renew their cells and tissues and one of the stages determines their radio sensitivity to ionizing radiation (Allotely, 1985). In silkworms the growth rate, survival rate and other quantitative characters are changed by gamma irradiation (Singh *et al*., 1990). A decrease in egg production after treatment with gamma rays also occurs in *Corcyra ceophalonica* (Allotey, 1985). Exposure of the silkworms to different photo periods has failed to change the fecundity and fertility in *B. mori* (Benchamin *et al*., 1990).

Exposure of a biological system to the magnetic field induces morphological (Pittman and Anstey, 1967), physiological and biochemical (Pittman and Ormord, 1970;) changes. It has increased rate of seed germination (Pittman, 1965), crop yield (Todoron *et al*., 1967) and has changed cotton fiber characters (Kalantrov and Melikova, 1973). In *Bombyx mori* the magnetic field treatment has altered the activities of different enzymes (Chougale and More, 1993; Chougale *et al*., 1995(a)), Sonar *et al*., 2021) and has increased the RNA/DNA ratio (Chougale *et al*.,1995(b)). It also resulted in an increase in silk gland proteins (Chougale, 1992). Englemann (1970) has claimed the egg laying and or total egg production in insects does not give necessarily a true picture of actual reproductive potential, unless various environmental conditions during mating period, oviposition and the type of substratum of egg laying are considered, either individually or on a cumulative basis along with other factors influencing the egg production. The present paper is a step in that direction and describes the influence of magnetic field on the fecundity of *B. mori*.

II. Materials and Methods

The quality disease free layings (DFLs) of PM strain of silkworms were obtained from C.S.B. Grainage Centre, Gandhinglaj (Dist. Kolhapur). The DFLs were incubated at 25℃. During incubation a relative humidity of 80% to 85% was maintained. The larvae hatched from them were fed with the mulberry leaves (variety M5) as per the regimen of Krishnaswami et al. (1973).

The larvae from each DFL were divided into two groups; A and B. The groups A served as a control and B as an experimental group. The larvae of B group were further divided into subgroups (seven) and exposed to magnetic field. Magnetisation was done during:

i) each instar separately,

ii) first to fifth instars successively (first, second, third, fourth and fifth instar).

iii) fourth and fifth instar (i. e. their earlier stages were not exposed).

The larvae were exposed to a continuous and homogenous magnetic field, as per the method devised by Chougale (1992) and Chougale and More, 1993.The magnetisation was done at 0.35 T. The first to fourth instar larvae were separately exposed to 20 min. at an interval 24hrs, during the entire larval duration of each instar. The fifth instar larvae were exposed for 20 min. at an interval of 24hrs during the first three days only.

After exposure the larvae were allowed to develop as usual up to the adult emergence. For the observations on fecundity, 40 randomly selected cocoons of each group- both control and experimental were used. The shell from each cocoon was removed for observing and recording the pupal weight and male and female ratio. Such naked male and female pupae were preserved separately using the technique of Krishnaswami et al. (1973). The prepupa to adult emergence periods was recorded for each group. After emergence, the weight of the male and female moths was recorded and they were kept together in dark with a relative humidity of 75% to 80% and at a temperature of 25℃ for pairing. Three hours after pairing the female was kept in a cellule (a device used for production of silkworm laying) in dark on a brown craft paper for egg laying for a period of 18 hrs. to 20 hrs. The number of eggs laid during this period was recorded. The egg laying capacity was observed in the female moths emerged during the first three days. The results were replicated five times.

The observations along with the parameters indicated above, were also made on the adult emergence period and the number of eggs per female moth.

III. RESULTS AND DISCUSSION

Pupal weight:

An appreciable but gradual gain in the pupal weight, was seen in the larvae exposed separately during first to fifth instars. Exposure of larvae during fourth and fifth instars successively also resulted in gain in the pupal weight. The magnetisation done successively from first to fifth instars resulted in a loss of the weight (Table 1 and Fig. 1). The above was true for both male and female pupae.

Male moth weight:

There was as increase in weight of the male moth after magnetisation of larvae, separately in each instar and also in the fourth and fifth instars exposed successively. The larvae successively exposed during each instar indicated a slight decrease in weight. (Table 1 and Fig. 1). In separately exposed larvae; the increase was gradual (Table1, Fig. 1).

Female moth weight:

Magnetisation of larvae separately during first to fifth instar stages resulted in a gradual increase in weight than in controls (Table1, Fig. 1). Successive exposure during fourth and fifth instars also indicated increase in weight, which was less than the larvae exposed separately during the same instar stages. The decrease in weight occurred in the larvae magnetised successively.

Number of eggs per moth:

The moths of control group laid an average of 457/moth (Table1 and Fig.2). The egg number decreased in larval group which was magnetised during first instar. The number of eggs gradually increased when their larvae were magnetised separately during second to fifth instar. Magnetisation of larvae successively during fourth and fifth instars (Table 1 and Fig. 2) also resulted an increase in egg number. However, this increase was less than that in magnetisation of larvae during fourth and fifth instars separately. First to fifth instar successive magnetisation appeared to be responsible for reduction in egg number per female (Table 1 and Fig. 2).

Sex ratio:

Exposure of larvae separately during first and fifth instar resulted in resulted in an increase in the male and female ratio. (Table 2). It was also the case after successive magnetisation during fourth and fifth instars. However, in remaining experimental groups (larval exposure), there was a decrease in the ratio.

Prepupa- adult emergence period:

Magnetisation during first instar and second instar showed no change in the prepupa- adult emergence period (Table 2). Separate magnetisation during third, fourth and fifth instars resulted in a gradual reduction in prepupa- adult emergence period. It varied between 10hrs. -18hrs. After magnetization during fourth and fifth instars successively, a reduction of 6 hrs. was seen (Table 2 and Fig. 3).

Adult emergence period:

The adult period was increased by 1 hrs. when their larvae were magnetised during first instar (Table 2 and fig.3). The separately exposed larvae from second to fifth instar stages indicated a gradual decrease in the emergence period. The successive magnetisation during fourth and fifth instars resulted reduction of 8 hrs. (Table 2 and fig. 3).

Adult emergence percentage:

Practically no change in the adult emergence percentage was observed (Table 2).

An increase in the male and female pupal weight is seen when the larvae were exposed during each instar stage separately. Similar increase in weight of male and female moths, is also evidenced. The number of eggs laid increases after magnetic field exposure. A reduction in prepupa-adult and adult emergence period is obtained. Thus, there is reduction in the total emergence period. The male: female ratio is decreased.

As indicated above, the female pupal weight and the egg laying capacity increased by 9.34% and 10.94% respectively. Thus, it could be concluded that the magnetic field exposure induces the increases in pupal weight and egg laying capacity of the silkworms. The increase in pupal weight means more silk synthesis and hence, its production. Another important feature observed is the reduction in the total emergence period. This results in the reduction in the life cycle period.

Pillai and Krishnaswami (1989), advocate that the pupal weight is the best parameter to estimate the number and nature of mature eggs in an ovariole. The number of eggs laid by the female is proportional to the number of mature eggs present in an ovariole (Miller *et al*., 1982). After the magnetic exposure the mature egg number has seen to be increased in the present study; i.e. the fecundity has been increased and it has laid to be production of good quality cocoons. Hassan et al. (1989) have come to a similar conclusion and they have stated that the oviposition and fecundity of silkworm are directly proportional to the production of cocoons. The nutritional and environmental conditions during rearing of the silkworms have an influence on the egg laying capacity (Pillai and Jolly, 1985).

More feeding (Chougale and More, 1992) and increased midgut enzymes activity (Chougale and More,1992;Chougale *et al*.1995(a); Sonar *et al*., 2020) have been seen after magnetisation of silkworms. Feeding the silkworms with thyroxin and minerals has increased the fecundity (Joshi, 1981; Majumdar, 1989). According to Pillai *et al*.; 1980 the rate of growth and egg laying capacity of various strains of silkworms is mainly influenced by number of feedings per day. In view point of all this the magnetic field treatment enhances the feeding activity and which might have reflected in increased fecundity.

Table 1: Silkworm PM: Pupal weight (wt.), moth wt. and fecundity after magnetisation

Sr. No.	Group	Pupal Wt. gm		Moth Wt. gm		Fecundity (No. of eggs/moth)
		Male	Female	Male	Female	
1	Control	0.636	0.795	0.220	0.453	457
2	I instar M.	0.655 +2.95	0.827 +4.00	0.223 +1.36	0.455 +0.44	455 -0.44
3	II instar M.	0.660 +3.77	0.821 +3.32	0.223 +1.36	0.465 +2.65	473 +3.50
4	III instar M.	0.674 +6.00	0.829 +4.30	0.228 +3.64	0.466 +2.87	476 +4.16
5	IV instar M.	0.689 +8.35	0.852 +7.12	0.235 +6.32	0.476 +5.08	500 +9.41
6	V instar M.	0.700 +10.00	0.869 +9.34	0.236 +7.27	0.488 +7.73	507 +10.94
7	IV & V instars Successively M.	0.669 +5.17	0.828 +4.13	0.224 +1.82	0.470 +3.75	472 +3.28
8	Each instar Successively M.	0.624 -1.87	0.773 -2.83	0.218 -0.91	0.451 -0.44	440 -3.72
	F test	**	***	***	***	**

M. = Magnetisation **+ percent increase** **- percent decrease**
**** Significant at P≤0.01 level** ***** Significant at P⩽0.001 level**

Table 2: Silkworm PM: Sex ratio (male:female), prepupa- adult emergence period, adult emergence period and adult emergence % after magnetisation

Sr. No.	Group	Sex ratio (male:female)	Prepupa - adult emergence period (hrs.)	Adult emergence period (hrs.)	Adult emergence %
1.	Control	1:0.818	260	79	100
2.	I instar M.	1:0.667	260	80	100
3.	II instar M.	1:0.818	260	77	100
4.	III instar M.	1:1.909	250	75	100
5.	IV instar M.	1:1.000	253	72	100
6.	V instar M.	1:0.739	242	71	100
7.	IV & V instars	1:0.739	254	75	100
8.	Successively M.	1:0.905	262	78	100
	Each instar	**	***	***	NS

M. = Magnetisation **+ percent increase** **- percent decrease**
**** Significant at P≤0.01 level** ***** Significant at P⩽0.001 level**

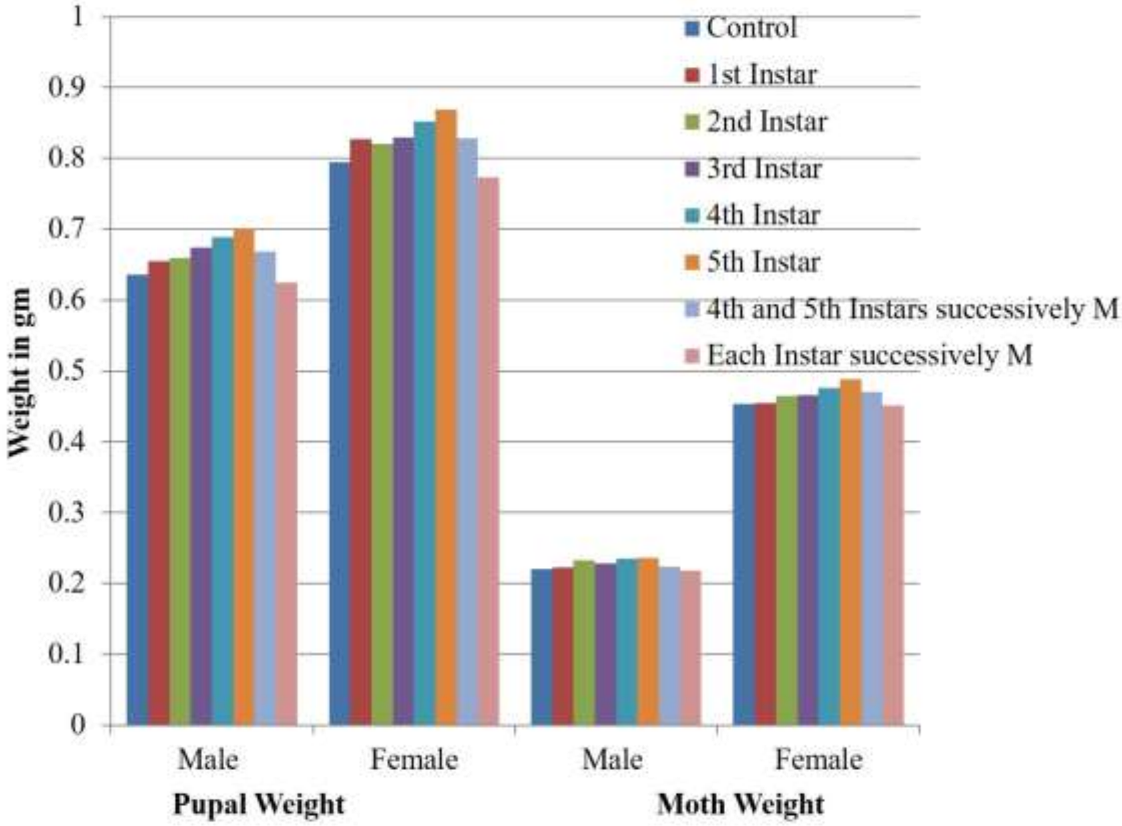

Fig. 1: Silkworm PM: Pupal weight (wt.) and moth wt. after magnetisation

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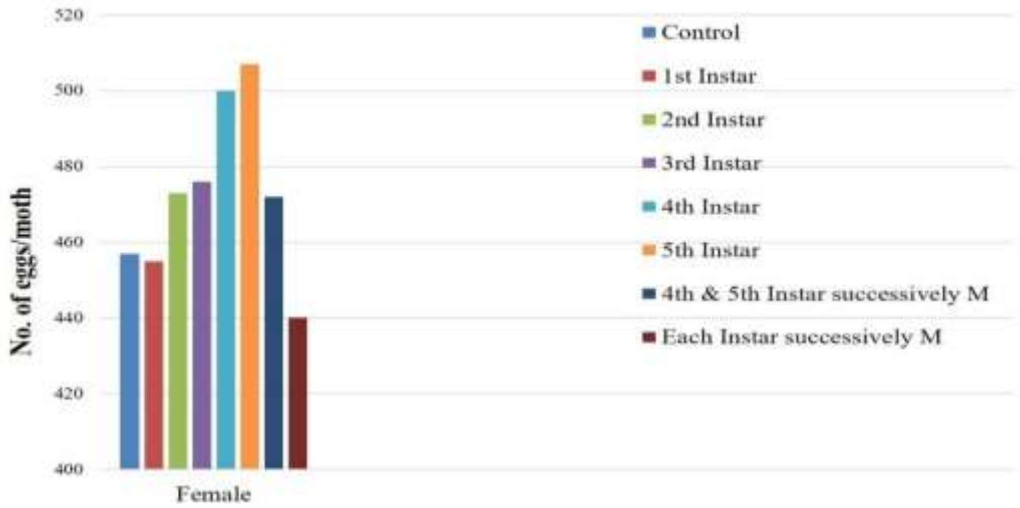

Fig. 2: Silkworm PM: fecundity after magnetisation (M.)

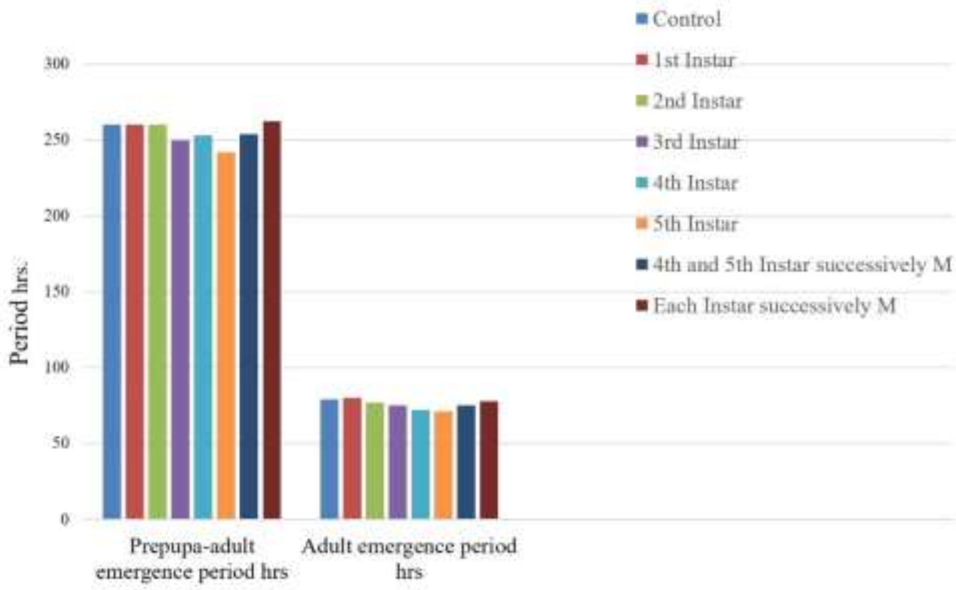

Fig. 3: **Silkworm PM: Prepupa-adult emergence period and adult emergence period after magnetisation (M.)**

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