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Effect of New Improved Technology of Silkworm *Bombyx mori* L. Rearing on the Egg Production Capacity

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Experiments were held in Egypt to test a new package of practices for commercial cocoon production, including adding secondary macro and micronutrients to the mulberry garden, disease free rearing regime, low temperature rearing in young instars and natural mounting for silkworms. This package for seed silkworm rearing lead to increase in fecundity by 67-121eggs (15.12-26.22%) and yield of standard boxes per 1 parent egg boxes by 57-78 egg boxes (48.33-51.66%) respectively in comparison to the traditional cocoon production technology.

Key words : *Morus alba, Bombyx mori L.*, Macro-nutrients, Micro-nutrients, Acetic acid, Fecundity, Egg box

Introduction

The adoption of the high silk-yielding P_1 pure races in the field would improve greatly the quality of hybrid F1 seeds, however their was a legend that the high yielding pure races have very poor pupation, and low fecundity. Improving viability and fecundity and accordingly silkworm egg production shall increase the profits of both the farmers and the grainages, and improve the overall silk production of the hybrid F1 eggs. For this purpose as in other branches of animal breeding like poultry, parent silkworm growers must provide the optimum rearing conditions, highly nourishing food and strong prophylaxis against different pathogens. From the economic point of view, rearing risks should be minimized assuring stable cocoon production allover the year.

Due to continuous depletion of the micronutrients from the soil by the mulberry, the soils become deficient in trace elements (Singhvi *et al.*, 1998). However the information regarding the micronutrients for plant growth in general and mulberry growth in particular is very little (Lokanth and Shivashankar, 1986).

Baig (1987) stated that concentrating on prevention rather than trying to control the disease after the break could largely overcome the problem of silkworms diseases. Acetic acid is used for disinfections of *Bombyx mori* L. loose commercial eggs in the former CIS republics and some East European countries stated by Kirichenco *et al.* (1995). The egg disinfections by acetic acid from bacterial, viral and fungal influence up to 98-100%, it is high ecological method. Its germicidal effect has been proved from so long time. It is a cheap and readily available ecological material.

Ikegamy (1995) studied the effect of Chlorotic chemicals as a substitute to bleaching powder for disinfections of the silkworm rearing houses and equipment. Bleaching powder is the most suitable disinfectant for open type of rearing houses (Baig and Pradip Kumar, 1987). The higher value of silkworm pupation rate after egg surface disinfections is due to the effectiveness of used disinfectants against incorporation of pathogens on the egg surface and subsequently infecting the newly hatched larvae (Michailov, 1984; Baburashvilli *et al.*, 1988; Troitskaya, 1991; Golovko, 1995).

Manshev (1978) tested the efficiency of a mixture of active lime and bleaching powder 9 : 1 and reported its positive effect as a bed disinfectant. Barman (1991) studied the effect of some formulated chemicals composites as larval body disinfectants for controlling viral and bacterial diseases of the silkworm *B. mori* and reported the decrease of overall mortality over the control.

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The body temperature of the silkworms influences the physiological activities, food intake and economic parameters (Ajuzawa, 1972; Tzenov and Maldenov, 1996; Muniraju *et al.*, 1999). Tankov (1909) and Bastiani (1991) recommended rearing all instars at 23-24°C. Even if the silkworm crop is healthy, wrong mounting methods, spinning conditions, mounting density, pre or over matured larval mounting and bad type of mountages can result in spinning of inferior quality cocoons (Ullal and Narisimhanna, 1987). The self-mounting method is the natural urge of the matured silkworm to climb up to start spinning cocoons (Tzenov and Petkov, 1999).

In the recent years new silkworms *B. mori* L. races and hybrids having higher productivity have been selected in different countries (Petkov and Nacheva, 1996, 1999; Datta *et al.*, 1999). However these highly productive races and hybrids require providing excellent feeding and rearing conditions in order to manifest in full extent their potential (Datta *et al.*, 1999).

Materials and Methods

Practical experiments were held in the Agromier Co. SAE mulberry plantation and rearing houses located in Asyut province of Egypt 320 km south of Cairo in a desert area. The plantation is irrigated by river Nile water regularly at the plants needs, as there are no rains in this area. Total salinity of irrigating water is 300 PPM. Mulberry plantation is mainly of Kokuso 27 & Canva 2 varieties, shaped in bush type and pruned in fist form after 3 step up branch harvests every year. Soil is sandy loam, consisting of 51.4% silt, 8.8% clay and 39.8% sand. Soil pH is 8.1. The underground water table is below 3 meters. Moisture content at field capacity is 24%.

The control and each experiment were maintained in 4 replicates of 100 larvae each of eleven breeds of silkworms (Table 1) during spring rearing of years 1999 and 2000.

Control (Traditional Technology)

As described in literature (Ajuzawa, 1972; Ullal and Narisimhana, 1987), fertilization of the mulberry plantation by 1^{ry} macro-nutrients ($N_{300}P_{150}K_{120}$) and FYM_{15ton} was performed. Disinfecting the rearing house by spraying of Formol 3% solution plus 1 litter of active lime milk $Ca(OH)_2$/18 liter solution, till full wetting of the walls and appliances in an air tight chamber and temperature maintained above 20°C. Rearing houses were equipped with automatic temperature and humidity control devices and the rearing was done at standard regimes of temperature and humidity Table 2.

Rearing was performed using plastic trays (70 cm × 40 cm × 30 cm) accommodating 100 larvae counted just after

Table 1. Qualitative characters of the breeds used for the experiments

Breed	Type	Egg color	Larval marking	Cocoon shape
E2	Japanese	Gray blue	Marked	Dumbbell
E6	Japanese	Gray blue	Marked	Dumbbell
E15	Japanese	Gray blue	Marked	Dumbbell
E1	Chinese	Greenish	Plain	Oval
E5a	Chinese	Greenish	Plain	Oval
E14	Chinese	Greenish	Plain	Oval
E4b	European	Gray blue	Marked & Plain	Elongated
E8	European	Gray blue	Marked & plain	Elongated
E9	European	Gray blue	Marked & plain	Elongated
E22	Chinese	M: Yellow, Fe: Greenish.	Light marking	Oval
E23	Japanese	M: Brown yellow, Fe: Gray blue.	Marked	Dumbbell

Table 2. Rearing temperature and humidity

Age	Temp.	Humidity	Light	Air speed
1&2 instars	27°C	85% RH	25 Lux	0.1 m/sec
3 instar	25°C	80% RH	25 Lux	0.1 m/sec
4&5 instars	23°C	70% RH	25 Lux	0.3 m/sec
Mounting & spinning	27°C	60% RH	25 Lux	0.5 m/sec

2^{nd} moult. During each experiment all the larvae were fed by equal amounts of leaves of the same variety. Bed spacing was performed every day before morning feed, and bed cleaning was performed once after each moult. First instar larvae were fed by leaves number 1&2, chopped at 5mm strips. Largest Glossy Leaf (LGL) was counted as leaf number 1. Second instar larvae were fed by leaves number 3&4, chopped at 10mm strips. Beds were covered by nylon sheet to preserve humidity in the beds during the first two instars. Third instar larvae were fed by shoot lets with the upper seven leaves. Forth and fifth instar larvae were fed by whole branches, 50-70 days old. Mounting by bottlebrush type plastic mountages by picking.

Oviposition was done on cardboard sheets divided into 5 rows and 4 columns to give 20 equal squares 5 cm × 5 cm. Fertilized moths are encaged into iron funnels and allowed to oviposit. Iron funnels are having a lower diameter 5 cm and upper diameter 4 cm. Mother moths were put in paper bags to lay eggs when loose eggs were needed.

Experiment (Improved Technology)

These modifications were superimposed on the control; Application of 2^{ry} macro-nutrients (Ca_{230}, S_{50} & Mg_{55}) and micro-nutrients (Mn_3, $Fe_{4.5}$, $Zn_{3.5}$, $Cu_{0.4}$, $B_{0.5}$, $Mo_{0.54}$ & Cl_{200}) to mulberry garden beside the 1^{ry} macro-nutrients ($N_{300}P_{150}K_{120}$) and adding FYM_{15ton} only for young instar rearing garden. Double disinfecting by bleaching powder 5% W/V and acetic acid 0.2% for house and appliances. Eggs disinfecting by acetic acid 0.04% for 15 minutes at room temperature. Bed & larval disinfections by a dust mixture of Calcium Oxide 88%, Bleaching powder 10%, Benzoic acid 1% and Diathane M_{45} 1%, after every moult at 250 gm/m^2 for young instars and 500 gm/m^2 for late instars of bed area.

Rearing temperature maintained at 23°C, light intensity 25 Lux all over the larval period. Air speed and relative humidity at 0.1 m/sec & 85% for young instars and 0.3 m/sec & 70% for late instars respectively. During molting the humidity was reduced to 50% RH in all instars, and in the case of young instar larvae, nylon covers were removed from the beds. Natural mounting and spinning at 27°C, light intensity 25 Lux, air speed 0.5 m/sec and RH 60%.

Quantitative calculation

Egg box yield per 1 egg box (EY)

It was calculated using the formula (Result in egg boxes of same category):

$$EY = \frac{H \times PR \times ME \times F}{2}$$

Where EY=Egg box yield per 1 box, H=Hatchability, PR= Pupation rate, ME=Moth emergence percentage and F= Fecundity.

Results and Discussion

Data in Table 3 show that the tested element of the new technology (egg surface disinfections with 0.04% acetic acid for 15 min at room temperature) was not of any significant influence on egg hatchability (I). Hatchability show insignificant very slight increase or decrease over

Table 3. Egg production capacities

Exp \ Breed	E2	E6	E15	E1	E5a	E14	E4b	E8	E9	E22	E23
(I) Exp	95.43	95.49	95.3	95.35	95.32	95.69	95.37	95.22	95.28	95.12	95.01
Cont (%)	95.66	94.92	95.83	95.99	95.55	95.28	95.71	95.49	95.32	95.34	95.17
TD	-0.23	0.57	-0.53	-0.64	-0.23	0.41	-0.34	-0.24	-0.07	-0.22	-0.16
(II) Exp	98.13	98.13	98.50	98.25	98.38	98.38	98.00	98.13	98.00	98.00	98.00
Cont (%)	81.25	80.62	80.87	82.00	81.87	82.00	81.37	82.00	81.62	80.50	81.00
	***	***	***	***	***	***	***	***	***	***	***
TD	17.13	17.51	17.63	16.25	16.51	16.38	16.63	16.13	16.38	17.50	17.00
(III) Exp	583	518	574	578	582	567	545	510	515	467	454
Cont (egg)	462	441	472	482	477	450	436	443	435	370	370
	***	***	***	***	***	***	***	***	***	***	***
TD	*121*	77	*102*	96	105	117	109	67	80	97	84

*P<0.05, **P<0.01, ***P<0.001

I, Hatchability experiment; II, Pupation experiment; III, Fecundity experiment.

TD, True difference.

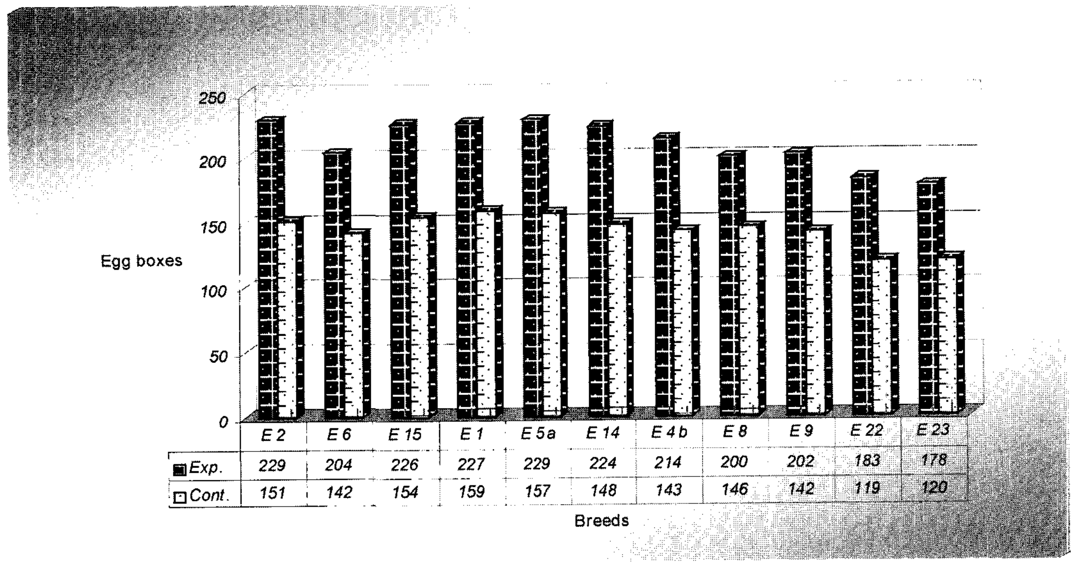

Fig. 1. Egg yield per 1 box.

the control ± 0.7%. This proves once again that the new method for egg surface disinfections did not exert any harmful effect on the embryos inside the eggs or the newly hatched larvae.

The new technology leads to significant increase in the pupation value. In average for the period of investigation in comparison to the traditional technology, silkworms pupation ratio (II) was increased by 16.13-17.63%. Comparatively highest differences were recorded in breeds with Japanese origin E2, E6 & E15, and genetically sex limited breeds E22 & E23.

The proposed improved technology lead to significant increase in fecundity (III) and accordingly to the egg yield per 1 box of parent silkworms. On average for the period of investigation in comparison to the traditional technology, and irrespective to the genetic and geographic origin of the tested breeds the fecundity increased by 77-121egg (17.46-26.19%) for Japanese breeds, 96-117egg (19.92-26.00%) for Chinese breeds, 67-109egg (15.12-25.00%) for European breeds and 84-97 egg (22.70-26.22%) for sex-limited breeds.

The improved technology increased the calculated yield of egg boxes per 1 egg box by 54-72 egg boxes (36.99-47.37%) (Fig. 1), due to the increase of the pupation ratio together with fecundity. It should be noted that our formula for calculation gives the result in the same standard egg box used, irrespective of standard number of eggs per box used, as standard number of eggs per box is different in different countries.

In conclusion implementation of improved technology for seed silkworm rearing lead to increase in fecundity by 67-121eggs (15.12-26.22%) and yield of standard boxes per 1 parent egg boxes by 57-78 egg boxes (48.33-51.66%).

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