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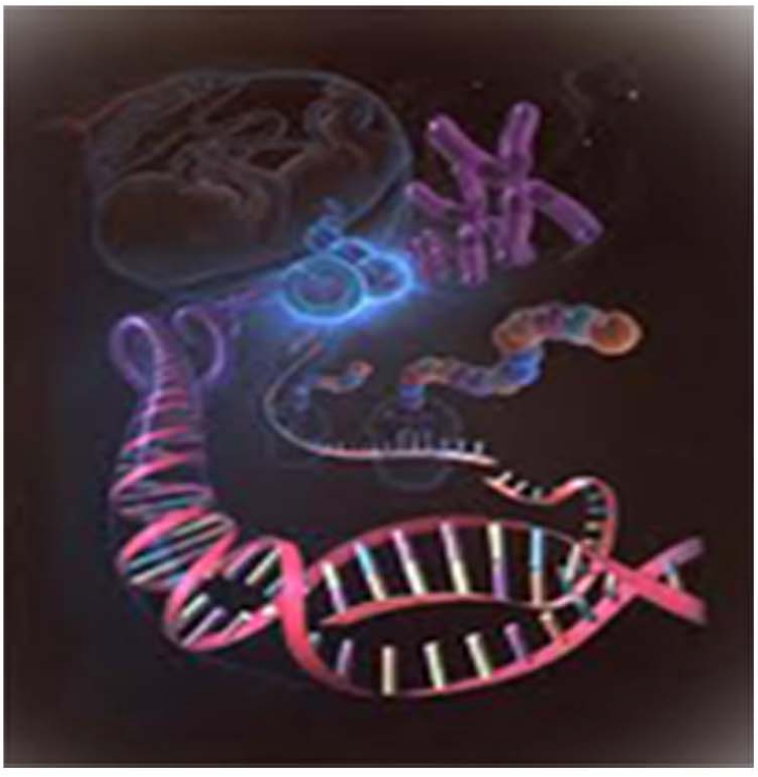

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Research Paper

EFFECT OF COCOON CHARACTERS, COPULATION AND OVIPOSITION DEVICES ON THE GRAINAGE PERFORMANCE OF *SAMIA CYNTHIA RICINI* (BOISDUVAL)

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Eri silkworm (*Samia Cynthia ricini* Boisduval) cocoon weight is varied from <1.5 g to >2.5 g. According to sizes of cocoon harvested from nine locations were graded into four categories viz., grade I- >2.5 g, grade II- 2-2.5 g, grade III-1.5 g-2.0, grade IV-mixture of all to study the grainage performance. Correlation studies between cocoon weight on the one hand and adult emergence, copulation potential, fecundity, eggs per gram and egg hatchability on the other separately revealed that the cocoon weight had significant positive correlation with fecundity and egg hatchability and negative correlation to eggs per gram. Egg hatchability was greater in the batches of Kollihills compared to other locations. Grainage experiment was conducted in three different months (Sep, Oct, and Dec 2004) on the cocoons harvested from seven locations. Among these selected cocoons kollihills, Coimbatore and kullappanaickanur batches were showed better performance in all grainage parameters and cocoon weights ranged from 2 to 2.5 g is ideal for better grainage parameters. The impact of different matting period revealed that the potential copulation period is 5 hrs. In an experiment, using ten oviposition devices for eri silkmoth, the highest egg laying was observed in jackfruit kharika (369.4) and others were statistically not different. Among the all devices tried, the nylon net bag has more advantageous due to the following parameters like keeping moth individually, harvesting of eggs, disinfection and saving the time and labour considerably.

Keywords: Cocoon weight, Correlation, Grainage performances, Kharika, Samia cynthia ricini

INTRODUCTION

Ericulture is far behind mulberry and other non-mulberry sericulture due to lack of improved technology except traditional practices. Sustenance of commercial grainages depends on the generation on the quality parent seed cocoons, which are utilized for the production of seeds. Eri silkworm seed, which forms the basic foundation for ericulture industry, plays a decisive role in the success of commercial cocoon crops and stabilization of ericulture industry. The

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domesticated nature of the eri silkworm makes grainage operations systematic and easy (Jolly *et al.,* 1979; and Sarkar, 1980). Sustenance of ericulture industry depends on the strength of quality seed, crop performance and productivity at farmer level. Though literature available on some aspects of rearing technology, host plant cultivation and grainage aspects of this insect there is a dearth of information on many aspects of ericulture in general and grainage activities such as synchronization of moth emergence and production of disease free, viable quality eggs in particular which are of paramount importance for timely supply of layings for successful ericulture practice. In mulberry sericulture, the usual device for egg laying is a paper sheet. Nylon net bags are used for egg laying in *Antheraea pernyi* in China. Kharika is used for egg laying in Eri as well as in Muga (Ojha *et al*. 1999). Devaiah *et al*., (1981) found small bamboo baskets to be quite convenient to prepare eri layings. Seed cocoons which forms the basic inputs for production of quality seed, needs to be generated on scientific lines by retaining racial character with higher pupation rate (>90%) besides less defective cocoons (<5%) with uniform shape and size and should be free from diseases. The loss in pupal weight of *S.c. ricini* increased gradually with advancement in pupal age and significantly more loss was noticed on the day prior to the day of moth emergence (Govindan *et al*., 1989). Govindan *et al*. (1980) too noticed that eri eggs could be refrigerated safely for 1 to 2 days. The eri silkworm rearing is being practiced in a large scale on the leaves of castor and tapioca. Castor and tapioca is grown on large scale in Salem, Dharmapuri, Nammmakal, Erode and Coimbatore districts of Tamilnadu where could be practiced successfully under the existing climatic conditions. Growing castor and tapioca crop for commercial purpose-cum-ericulture would increase the net income to the farmers.

The mating potential of autogenous insects like silkworm depends on the reserve food energy and the later will be gradually exhausted after the adult emergence. The male moth soon after its emergence shows maximum stridulations until reaching the female with its feathery antennae, which are very sensitive to femine sex. According to Joshi (1985), the antennae and wing fluttering play an important role in orienting the male towards the female located nearby. Studies on influence of mating duration (Thomas punitham *et al.,* 1987) and multiple matting (Krishnaprasad *et al*., 2002) in insects have been reported. Mating and producing hatachable eggs are two different, although connected events. In lepidopteron, mating stimulates no vitellogenesis but only oviposition since vitellogenesis and maturity of eggs (chorionated) are complete by the time of adult emergence. The study on this aspect in eri silkworms is little hence, the present finding was included the effect of mating duration on the fecundity and hatching percentage of *Samia cynthia ricini*.

MATERIALS AND METHODS

Production of quality seed is a vital step for successful ericulture. A grainage study was carried out on seed cocoons selected from nine crops (denoted as C1, C2, ..., C9) from seven different locations, viz., Koneripatty, Kullapanaickanur (Salem Dt.), Kolli Hills, Senthamangalam, Singalanthapuram (Namakkal Dt.), Dharmapuri and Coimbatore Districts. These cocoons (5 days old) were segregated according to the following categories. T1-Cocoon weights more than 2.5 g, T2-Cocoon weights between 2-2.5 g, T3-Cocoon weights between 1.5-2 g and

T4-Mixed cocoons (<1.5->2.5 g). Based on the weight of cocoons the silk ratio also varied (Table 2) but the present focus to study the impact of pupal weight on the grainage performance. Each treatment has 100 cocoons with triplicate. These experimental cocoons were kept in wide round type bamboo trays which covered with another tray. These experiments were carried out in a non disturbance room with normal room temperature. From fifth day onwards the moth emergence were noticed and the following parameters are observed the percentage of adults emerged, moths with ruffled wings, sex ratio, copulation potential, fecundity, number of eggs per gram and percentage of egg hatched.

For study the effect of matting period on fecundity and egg hatchability was done by means of selecting healthy seed cocoons of the eri silk moth *Samia cynthia ricini* with irrespective of weight were cut opened the shell to remove pupae for sex identification. These sex identified pupae were incubated for moth emergence. The freshly emerged male and female moths were allowed for copulation from 1 to 5 hours in a mating chamber to find out the ideal matting period compared with natural de-copulation. The pre-mating period had been ranged from 3 to 5 hours. Five replications were maintained for each treatment and each replication consists of 3 pairs. Maximum copulation is noticed in late evening between 5 to 7 PM. A relative humidity of 50-60% and temperature of 29-32°C were maintained in the oviposition room. The copulated moths were depaired at prescribed time intervals and the separated females were kept on the card- board for egg laying. The eggs of each experimental moth were collected separately and counted then incubated in the hydrodynamic incubator to study the hatching percentage.

In another experiment to study the impact oviposition devices, *viz*. nylon net bag, paper box, card board, silver oak, breadfruit, mulberry, guava, *Morinda*, Cassia and pomegranate kharika on the fecundity of eri silkworm were carried out. Fifty copulated moths were selected randomly from general stock. After decopulation the gravid females were kept individually in each treatmental device for oviposition. The egg laid by each female moth was recorded daily and proceed further. After the fecundity period the moths dissected to examine the un-laid eggs retained in the ovarioles.

RESULTS AND DISCUSSION

Moth Morphological Characters

Some morphological characters were observed to differentiate the male and female moths. The body size of the female i.e. body length, breadth, wing breadth was significantly greater than male but the wing length was more or less similar (Table 1).

Grainage Performance

The characters observed in this study the percentage of adult emerged, moths with ruffled wing, copulation potential and hatching, sex ratio,

Table 1: Morphometry of *Samia Cynthia ricini*

Observation	Body Length (cm)		Body Breadth (cm)		Wing Length (cm)		Wing Breadth (cm)	
	Male	Female	Male	Female	Male	Female	Male	Female
Mean	2.33	3.10	0.68	1.09	5.25	5.43	11.19	11.96
t-test ($p = 0.05$)	14.5		16		NS		2.6	

Figure 1: Correlation and Regression Between the Cocoon Weight and (%) Adult Emergence

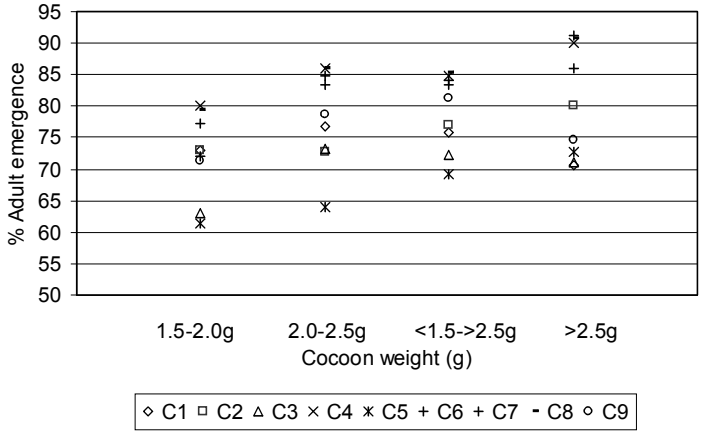


Figure 2: Correlation and Regression Between the Cocoon Weight and (%) Copulation Potential

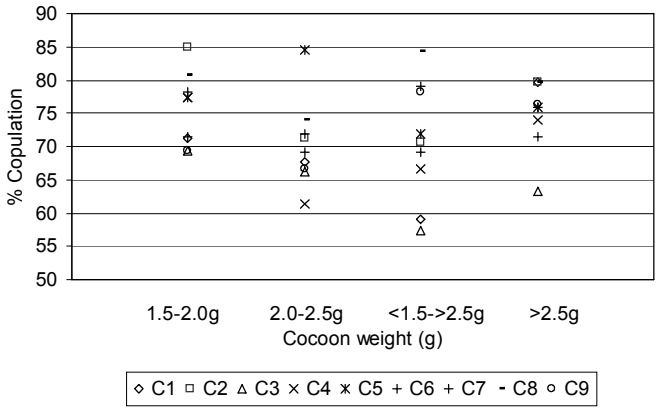


Figure 3: Correlation and Regression Between the Cocoon Weight and Fecundity of Eri Silk Moth

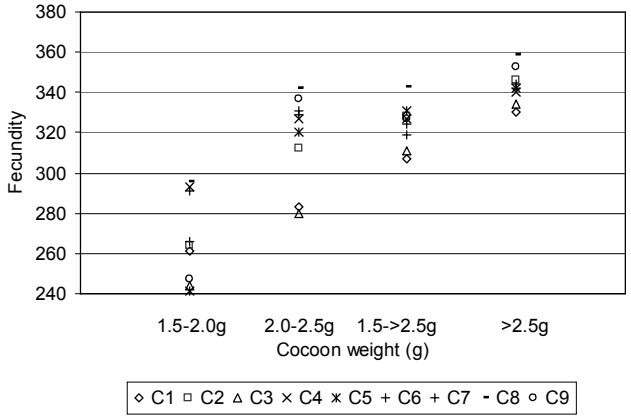


Figure 4: Correlation and Regression Between the Cocoon Weight and Number of Eggs per Gram

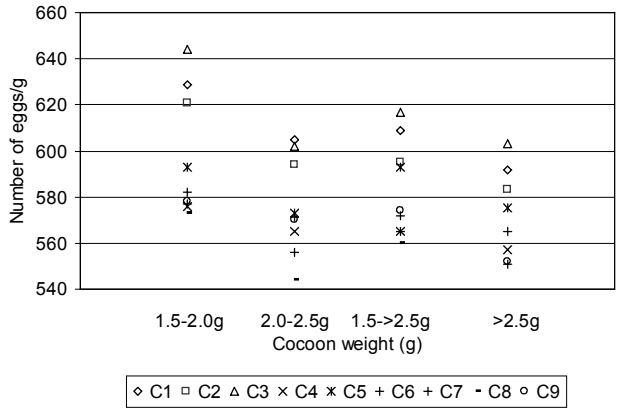
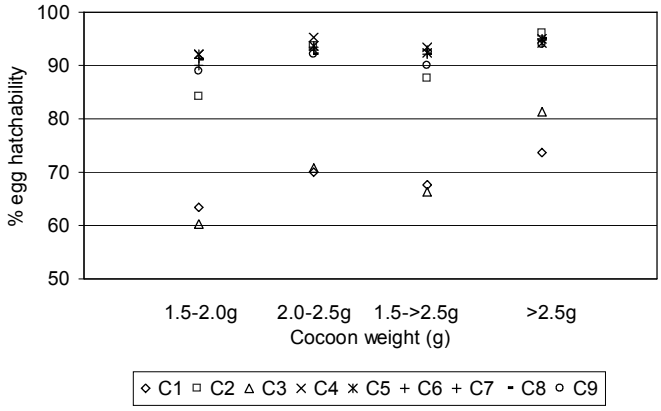


Figure 5: Correlation and Regression Between the Cocoon Weight and Egg Hatchability of Eri Silkworm



fecundity and number of eggs per gram were presented in Figures 1-5. The results of grainage studies revealed that adult emerged from the cocoons obtained in three different locations during September period was more or less similar except T3 (1.5-2.0 g cocoon wt.) in Koneripatty, where it was minimum. Maximum adult emergence was observed in T1 of Kolli hills. The required number of male and female moths would be available in the range of 2.0-2.5 g weighted cocoons. In all the nine batches tapioca was used as the host plant and the rearing was done during August - November 2004.

The data obtained in the grainage studies on seven crops from seven locations cocoons were statistically analyzed and presented in Figures 1-5. The percentage moths with ruffled wings occurred in the range from 7 to 14 depending on the locations and irrespective of treatments. Fecundity was maximum in moths emerged from maximum weighted cocoons and it was minimum from least weighted cocoons. Fecundity of moths emerged from Kollihills, Kullappanaickanur and Coimbatore batches were maximum in irrespective of treatments when compared to other

batches. Fecundity was significantly different among the locations in T3 of cocoon weight 1.5-2.0 grams. Fecundity of moths had a significant positive correlation with the cocoon weight. The pupal weight, pupal length and breadth were found to be genuine estimators of the fecundity. However, the pupal weight was the best estimator of fecundity (Kotikal *et al*., 1989). In the case of Tassar silkworm (*Antheraea mylitta*) the number of eggs laid could be attributed to the differences in the female pupal weight (Ashan and Khanna, 1976). Miller *et al.* (1982) reported that the weight of female pupae to be the best character to estimate the number of eggs laid in *A. polyphemus* and Ramakrishna *et al*. (2003) in eri silkworm.

The weight of eggs was maximum laid by moths that emerged from maximum weighted cocoons compared to those from minimum weighted cocoons. The number of eggs per gram was minimum in batches of Coimbatore, Kullappanaickanur and Singalanthapuram but this was maximum during the September season grainage studies. Hatchability of egg was maximum in T1 irrespective of locations compared to minimum weighted cocoons. Also the hatchability was more or less similar in T2, T3 and T4 except in the season of September batch, which might be due to high mean temperature and low mean humidity. Further, pupal weight in the range of 2.20 to 2.40 g yielded better results over other ranges of pupal weights (Govindan *et al*., 1993). Number of eggs per gram also varied depending on the treatments and locations. Hatchability of eggs was greater which obtained from the Kolli Hills compared to other locations. The number of eggs laid by the moths also varied considerably with highest being under Assam condition where 400-500 eggs were laid by each gravid moth (Jolly *et al*., 1979). While the number drastically reduced under Raichur (Karnatak) condition where the number varied from 173.80 – 347.30 eggs per female (Patil *et al*., 1986). As per Devaiah *et al*., (1978), hatching percentage ranged from 54.69-97.00 under Dharwad condition and 70.60-78.30 under Raichur condition (Patil *et al*., 1986).

Correlation Studies

Correlation studies between cocoon weight on the one hand and adult emergence, copulation potential, fecundity, eggs per gram and egg hatchability on the other separately revealed that the cocoon weights; fecundity; egg hatchability have significant positive correlation (Table 4 and Figures 1-5) and the cocoon weight and eggs per gram have significant negative correlation (Figure 3). Mukherjee *et al.* (1983) obtained a high correlation between the fecundity and weight of female pupae in the multivoltine silkworm, *Bombyx mori L.* Also, contradictory to the above. Fenemore (1979) opined that there is no correlation between the pupal weight and fecundity but fecundity is correlated with the number of mature eggs in the ovary. Hence, a study was carried out using different cocoon weight of the eri silkworm *Samia cynthia ricini* (Boisduval) to know the effect on some quantitative traits. The results are significant at 1% probability level for the variation among the locations in four categories and at 5% level for one category namely copulation potential of moth. Inter-correlation studies (Table 3) revealed that percentage adult emergence is positively correlated to the fecundity and egg hatchability and it has negative correlation to number of eggs/gram. If fecundity is maximum the number of eggs/gram is minimum and finally if the number of

Table 2: Characters of Seed Cocoons for Grainage Studies (Sep.-Nov. 04)

Cocoon wt. (g)	September			October			December		
	Cocoon wt. (g)	Shell wt. (g)	Silk Ratio (%)	Cocoon wt. (g)	Shell wt. (g)	Silk Ratio (%)	Cocoon wt. (g)	Shell wt. (g)	Silk Ratio (%)
T1(>2.5)	2.72± 0.13	0.35±0.03	13.05±1.15	2.69±0.19	0.37±0.03	13.79±0.8	2.66± 0.10	0.35 ±0.02	13.11 ±0.93
T2(2-2.5)	2.26±0.09	0.32±0.05	14.00±1.95	2.26±0.11	0.32±0.03	14.02±1.04	2.27 ±0.08	0.31 ±0.03	13.58 ±1.21
T3(1.5-2.0)	1.80±0.14	0.23±0.04	12.57±1.85	1.78±0.11	0.29±0.02	16.08±1.43	1.79 ±0.13	0.24 ±0.03	13.36 ±1.56
T4 (Mix.) (1.5->2.5)	2.17±0.24	0.31±0.04	14.12±1.78	2.49±0.24	0.36±0.04	14.39±1.47	2.22 ±0.22	0.30 ±0.04	13.63 ±1.25

Table 3: Correlation Activities of Various Physiological Parameters of Eri Silkworm During Grainage Study

Treatment	Particulars	Fecundity	Eggs/gram	% of egg hatched
Cocoon	% Adult emerged	0.9161**	-0.5205NS	0.3794 NS
Weight	Fecundity		-0.5257 NS	0.4165 NS
1.5-2.0 g	Eggs/gram			-0.9021**
Cocoon	% Adult emerged	0.3740 NS	-0.8659*	0.5414 NS
Weight	Fecundity		-0.6906 NS	0.7903*
2.0-2.5 g	Eggs/gram			-0.8569*
Cocoon	% Adult emerged	0.4858 NS	-0.5783 NS	0.2460 NS
Weight	Fecundity		-0.9184**	0.8925*
1.5-2.5 g	Eggs/gram			-0.7397*
Cocoon	% Adult emerged	0.6287 NS	-0.8870*	0.7160*
Weight	Fecundity		-0.7961*	0.7240*
>2.5 g	Eggs/gram			-0.6946 NS

Note: * Significant @ p= 0.05, ** Significant @ p = 0.01

Table 4: Effect of Mating Period on Fecundity and Egg Hatchability of Eri Silkworm

Copulation Period	Fecundity (Eggs/Moth)	Hatching %
T1 (1 hour)	182a	6.0a
T2 (2 hours)	294b	70.0b
T3 (3 hours)	289c	86.0c
T4 (4 hours)	289c	96.0d
T5 (5 hours)	358d	97.0d
T6 (Maximum)	349d	96.0d
CD P = (0.05)	18	3.5

Table 5: Oviposition Performance of Eri Silkmoth, *Samia cynthia ricini* in Different Devices

Treat.	Oviposition Devices	Fecundity	Unrealized Fecundity	Co-efficient of Egg Laying (%)
T1	Nylon net bag	344.1	60.0	83.1
T2	Paper box	326.4	45.4	87.8
T3	Card board	333.9	46.1	87.9
T4	Silver oak stick	357.3	41.3	89.6
T5	Jack fruit stick	369.6	35.2	91.3
T6	Mulberry stick	327.5	42.5	88.5
T7	Guava stick	326.4	48.6	87.0
T8	Morinda stick	305.7	64.3	82.6
T9	Cassia stick	323.2	61.2	84.1
T10	Pomegranate stick	317.3	54.7	85.3
	CD at 5%	13.18	NS	NS

eggs/gram is minimum the percentage hatchability of egg is maximum.

Similarly, the variation among the four treatments on the weight of cocoons influencing the five-grainage parameters was also significant at 5% level in all characters excepting copulation potential, which was significant at 5% level. Confirmatory results obtained in various parameters indicate that the pupae from cocoon weight 2.0-2.5 g had influenced all the grainage parameters. Hence, it is concluded that cocoons in the range of 2.0-2.5g is ideal for grainage. Basavaraja and Chandrashekaraiah (1988) have also expressed that heavy pupa in *Bombyx mori L* are bottleneck in selection process and only the pupae weight little above average will have to be selected for maintaining stability or causing elevation of the quantitative traits in future generations.

The potential copulation period was studied and the results revealed that the number of eggs laid by moth was vary less (182/moth) which allowed for one-hour mating and the egg hatchability also very poor (6.0%). The fecundity and percentage hatchability were gradually increased respectively with mating hours. These results are revealed that the moth should be allowed for copulation at minimum of 5hrs or up to natural decoupling leads to lay maximum numbers of egg. If the moths are decoupled less than 5hrs could be produce less number of egg with poor hatching percentage. The results were conformity with the earlier reports of Pope (1953) and Roth and Willis (1956) in other insect species. Roth and Willis (1956) in *Blatta orientalis* reported that mating stimulates egg laying and showed that mated females, on an average, laid 160 eggs while unmated lay only 114. Similar result was reported in *Hesperocimex sonarensis* (Ryckman, 1958).

The oviposition performance of eri silk moth in different devices is depicted in Table 5. It reveals that the maximum fecundity was recorded in Jack fruit kharika (369.6), followed by Silver oak (357.3) and nylon net bag (344.0) and in other devices it was ranged from 305 to 334. Further the unrealized and co-efficient of egg laid by moth was not showed statistically significant different among the treatments. The present findings also indicated that the egg-laying pattern of eri silk moth has not been influenced by the substratum. Of all the devices, the nylon net bag is having more advantage in some respect and performed at par with kharika. Similar results were reported in *A. mylitta* (Prasad *et al*., 2001) and *S. ricini* (Debaraj *et al*., 2003) where the device performed better than others in terms of more durable, convenient for washing, disinfection and harvesting.

CONCLUSION

This study on impact of cocoon characters, location and ovipositional devices on grainage performance of *Samia cynthia ricini* concluding that the ideal cocoon for seed production is ranged between 2 to 2.5 g. Further the nylon net bag used for egg laying is more convenient for egg collection and for other processing methods. This preliminary study report is useful to ericulture farmer to developing the ericulture crop.

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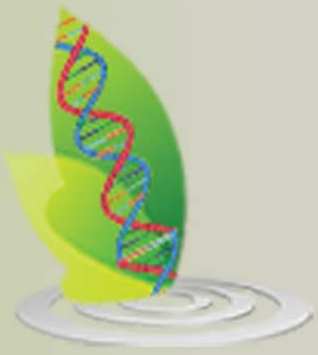

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