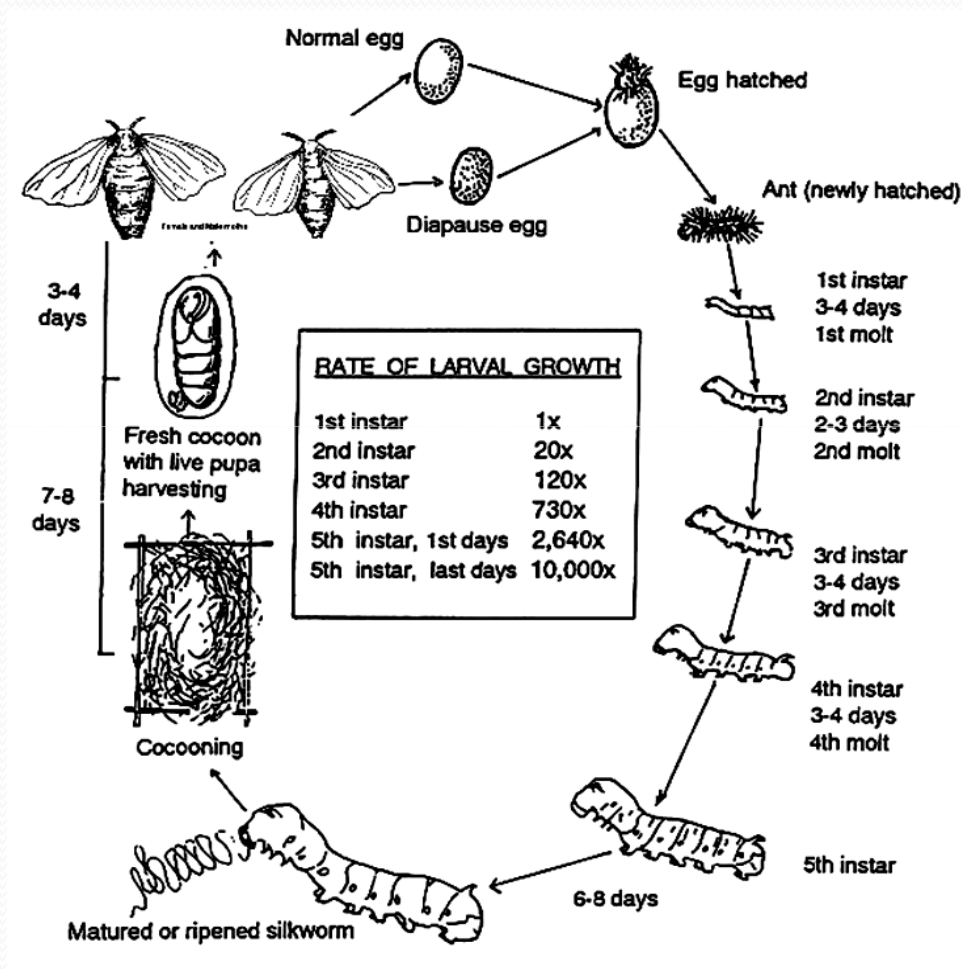




# **YOUNG AGE SILKWORM REARING**

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# LIFE CYCLE OF SILKWORM



**MV -----BV**  
**Egg- 9-12-----11-14 days**  
**Larva- 20-24--- --24-28 days**  
**Pupa- 10-12---- 12-15 days**  
**Moth- 3-6-----6-10 days**

## **Selection of Silkworm Races/Breeds for Rearing**

The silkworm rearing programme in a farm is determined by the following considerations.

- **Conditions of mulberry growth, yield of mulberry leaf, quality of mulberry leaves and time of availability.**
- **Availability of labour for leaf harvesting and rearing of silkworms.**
- **Facilities for rearing silkworms *i.e.*, type and size of rearing house, rearing equipments, disinfection and hygiene.**



## **Selection of Silkworm Breeds for Rearing**

**Silkworm hybrid varieties are preferred for commercial rearing to pure breeds.**

## **The Egg**

The quality of eggs to be used in rearing is very important factor determining the success of rearing. Quality silkworm seed may be defined as one which

- Is entirely free from diseases.
- Has maximum number of viable eggs
- Gives good uniform hatching
- Is prepared from healthy and robust parents
- Assures a stable and successful cocoon crop.

For details of Incubation please refer the earlier topic **INCUBATION**.

## INCUBATION

Incubation is an important process by which the activated silkworm eggs are maintained under proper environmental conditions to get hatching or preparation of eggs for hatching.

That is

Temperature-UV- 24-25 °C,

BV- 24-26 °C

MV- 21-24 °C.

Relative Humidity-75-85%.

Light Intensity- 16 hours per day light

Air flow- 0.3m/sec

### **Purpose**

- To get uniform hatching with high percentage.
- To ensure the hatching on the required day.
- **To ensure healthy and robust silkworms.**

## **Black Boxing**

Providing total darkness for a day or two before egg hatching is called **Black Boxing**.

### **Purpose**

This helps in uniform hatching in a single day. During black boxing those embryos in advanced stage of development will wait for light to hatch and developing embryos will continue their development and when exposed to light, all eggs will hatch uniformly. It helps in synchronized brushing. Simple black sheet of paper (thick craft paper) or cover, which gives total darkness, is good enough.

## Procedure for Black Boxing

Eggs are pin head stage are wrapped (25 or 50 dfls each) in a tissue paper and transferred to black boxes.

Such black boxes are placed under required humidity and temperature conditions.

The eggs are to be exposed to light between 7 and 8 AM on the expected day (10<sup>th</sup> or 11<sup>th</sup> day) to enable maximum hatching.





## **BRUSHING**

Brushing is the process of separating the newly hatched worms from the shells of their eggs, and collecting them for convenience of rearing.

## Brushing of loose eggs

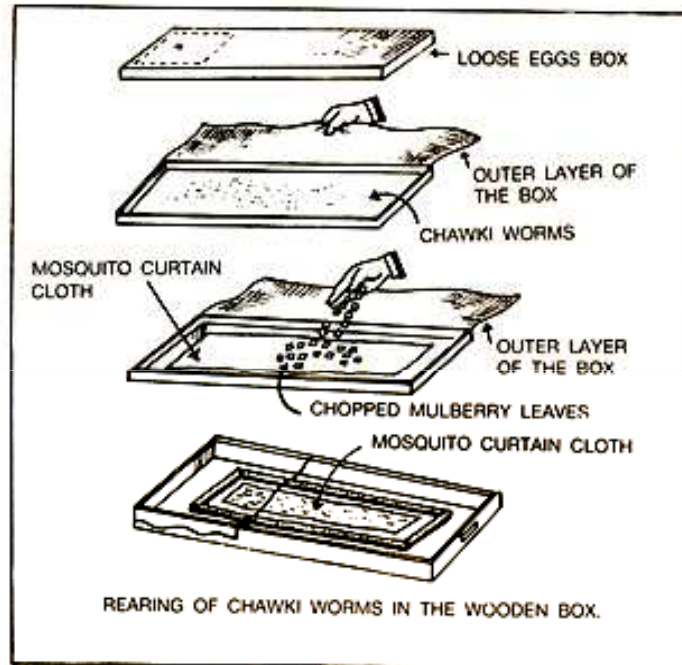


Fig-Brushing Loose Eggs

- Eggs are spread evenly in one layer in the egg box after removing the cover.
- At blue egg stage they are kept in black box or covered with black paper.
- When they change colour preparatory to hatching, black cover is removed and they are covered lightly over with a thin perforated cloth or a fine-meshed net or finely perforated thin paper (Fig.).
- Just before brushing, chopped mulberry leaves are sprinkled on the top of the net or cloth or paper-not for the worms to eat, but just to attract them to crawl on to the upper surface.
- When a sufficient number of worms have hatched out, the rearer takes out the cloth.

## **Brushing from Egg Cards**

In the case of layings, there are several methods of brushing. Most common ones are:

- (i) Brushing by husk method
- (ii) Brushing by cloth, paper or net
- (iii) Brushing by feather
- (iv) Brushing by net and feeding

## **Brushing by Husk method**

This is a very popular method of brushing is vogue in India.

In this method, charred powdered husk is spread on the newly hatched worms.

Later chopped mulberry leaves are spread on the card. The newly hatched worms crawl on to the top of the feed.

After half an hour of feeding, the silkworms are brushed off to the rearing tray with a feather.



## **Brushing by Cloth, Paper or Net**

This is only an adaptation of the method described in relation to loose eggs.

The layings are covered over with paper or net or cloth and the worms which crawl on to the underside are collected by tapping or transferring the paper with worms to the rearing tray.

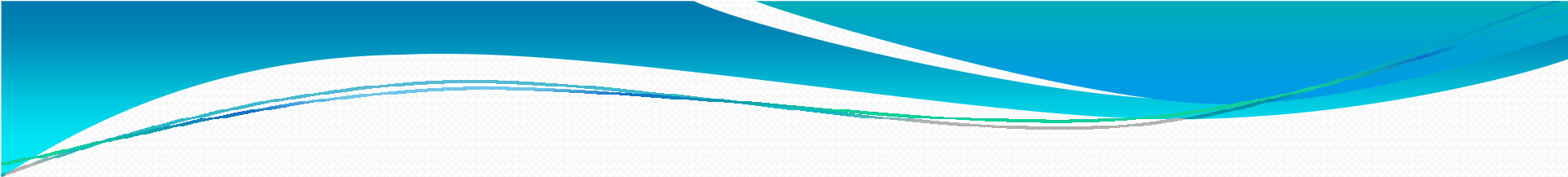
## **Brushing by Feather**

In this the egg card or paper is held vertically by one end over the rearing tray and the hatched worms are separated by gentle strokes with a feather.

This method is simple and easy but is apt to injure the worms which at this stage are tiny and delicate.

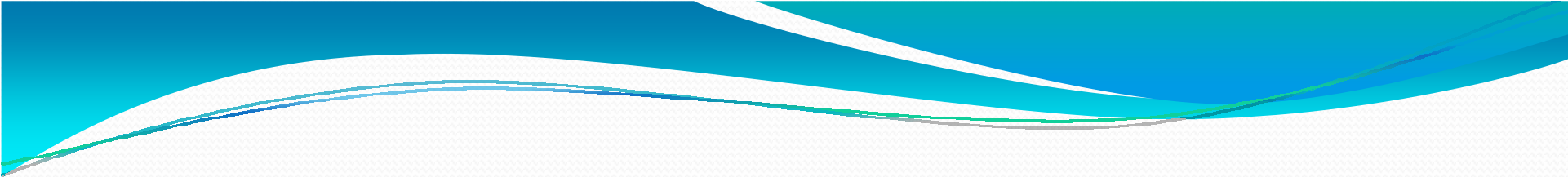
## **Brushing by Net and Feeding**

In this, instead of husk, a fine meshed net is employed. In other respects it resembles the method described above.



After brushing the silkworms, the bed is prepared by collecting the worms and mulberry leaves together by using a feather. The bed is spread uniformly using chopsticks. After about two hours of brushing, the first formal feed is given to the silkworms. Prior to the first feeding, as a precaution against muscardine the larvae may be treated with one per cent "Dithane M<sub>45</sub>" or "Capton".





Different methods of rearing early age silkworms have been evolved in recent years, all of which seek to prevent the driage of mulberry leaves and also maintenance of proper temperature and humidity in the rearing beds, and thus secure vigorous and healthy development of silkworms.

# Paraffin Paper Method of Chawki Rearing

In this method, paraffin paper is used both as a **bottom layer** and also as a **cover** for the rearing beds in the usual rearing trays. The paraffin paper for this purpose should be of a good quality, without the smell of petroleum.

**Significance: To Prevent Moisture Loss**

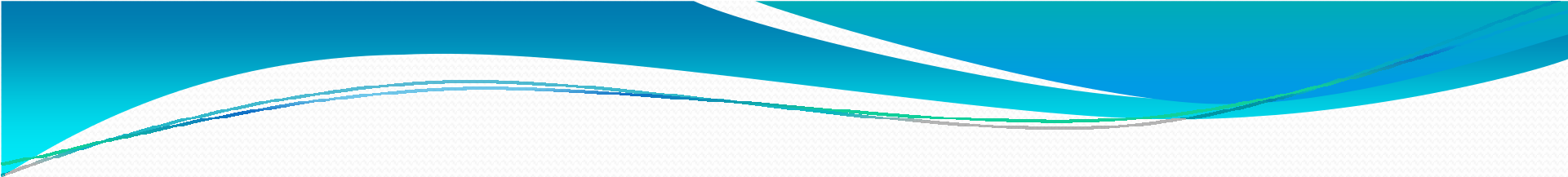
**A sheet of paraffin paper is spread on the base of the rearing tray over which the rearing bed of silkworm is formed.**

**A second sheet of paraffin paper is placed loosely over the silkworm bed.**

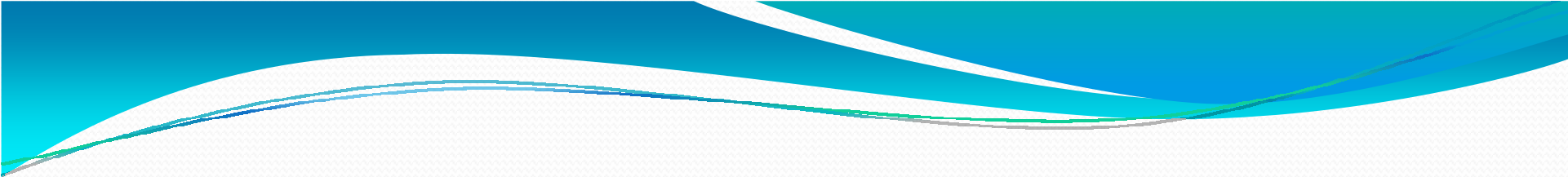
**In between the two sheets, on all four sides of the rearing bed, strips of wet foam rubber pads or ordinary newspaper folded into strips are placed to maintain the required humidity.**



Fig. Covered rearing with paraffin paper



**Care should be taken to see that the cover sheet is removed at least 30 minutes before each feed so that supply of fresh air to the silkworms is received and simultaneously the expulsion of the accumulated toxic gases on the rearing beds is also achieved.**

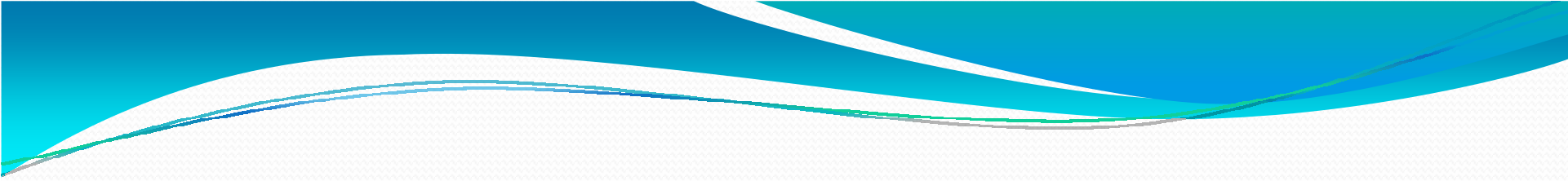


**In humid places, there is fear of incidence of muscardine disease. To prevent this, a thin layer of Ceresan Lime or Dithane M<sub>45</sub> or Capton-Kkoalin mixture is spread over the bed as a prophylactic measure at the time of hatching, at each moult and in the middle of each age**

# Environmental Conditions for Rearing

The ecological factors, chiefly temperature, humidity, light and air during rearing, have a significant influence on the growth of larvae and ultimate cocoon crop quality.

The influence is not the same throughout the rearing period, but varies in different stages of growth.



**The conditions ideal for the young age rearing and the principles of how they affect the health and growth of silkworms are discussed below.**

# Temperature

- Silkworm being a poikilotherm, the body temperature is changeable according to the environmental temperature. The physiology of silkworm viz., metabolic rate, activity of enzymes, nutrients conversion, assimilation *etc.*, is influenced by environmental temperature.
- **Optimum rearing temperature during early instars (I to III) as obvious from many reports, range from 25°C-27°C. The standard rearing temperature recommended for first, second and third instars are 27°C, 27°C and 26°C, respectively (Table).**



# Maintenance of optimum temperature

If the rearing room temperature is below the optimum, Electric room heaters or charcoal stove can be used for this purpose.

The temperature, more often, is above the optimum. Proper designing of rearing building, use of thick walls and roof, free circulation of air, Sprinkling of water on the ground, hanging of wet gunny cloth *etc.*, are required.

# Humidity

- Humidity plays a vital role in silkworm rearing. For example, the amount of ingestion, digestion and metabolism increased with the rise in relative humidity.
- It is clearly understood that early instar larvae are more resistant to high humidity and it supports better survival rate and maximum growth. Considering the overall effect, humidity ranges of 85 to 90 % in first and second instar and 80% in third instar, are recommended (Table).

Particulars	Instars		
	1	2	3
Temperature	27°C	27°C	26°C
Humidity	85-90%	85-90%	80%

- The humidity requirement during feeding and moulting stage in silkworm is different. Comparatively high humidity is maintained during feeding. Low humidity (10% RH) is preferable during moulting.



## Humidity Maintenance during Young Age Silkworm Rearing

Regulation of humidity for young age silkworms is achieved through the use of paraffin paper as cover for the rearing bed and the wet foam or paper pads. It should be understood that rearing humidity above 90% is not at all desirable. In rainy seasons, when the room humidity is high, it is not necessary to use the wet foam pads. Even piling of trays can be avoided, when room humidity is extremely high. Paraffin paper seat or cover also can be dispensed with judiciously when humidity is very high.

# Light

Silkworms are fond of dim light of 15 to 30 lux and avoid very strong light and darkness. Light has little influence on the health and survival ability of silkworms, but it influences distribution of larvae in rearing bed. It is more crowded and distributed in several layers in dark condition compared to thin and even distribution in light condition. There is a profound influence of photoperiod on the early instars on the type of eggs produced (hibernating/non- hibernating) by the resulting moth. But, this is of no importance in commercial rearing.

**A photoperiod of 16 hours dark and 8 hours light is considered ideal for young age rearing.**

# Air

In the rearing room, the air is polluted by CO<sub>2</sub> from silkworm rearers, mulberry leaves, formaldehyde gas, ammonia and sulphur dioxide.

The safe limit for silkworm rearing is 1 to 2% of CO<sub>2</sub>, formaldehyde gas up to 1 %, 0.02% of sulphur dioxide and 0.1 % ammonia, in the air in rearing room.

Though it is less important to ventilate the room during younger stages, care should be taken to remove paraffin cover and keep the rearing bed open, before each feed, for adequate period.

# Feeding

The purpose and key points of feeding of silkworms are as follows:

- (i) To satisfy the appetite of larvae.
- (ii) To promote eating and digestion of leaves by larvae.
- (iii) To keep the quality of leaves good during eating.
- (iv) To keep rearing beds clean.
- (v) To avoid wastage of leaves and labour.

Generally the early age silkworms eat leaves from the surface while late age worms from the edges. At the beginning of each age the worms have a great appetite. This appetite falls off very rapidly in the early part of the age and then goes on gradually increasing till close to the end of the age, when it again declines as the worms reach the moulting time.

## Selection of Mulberry Leaves for Young Age Silkworms

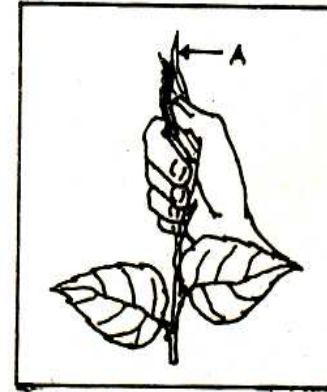
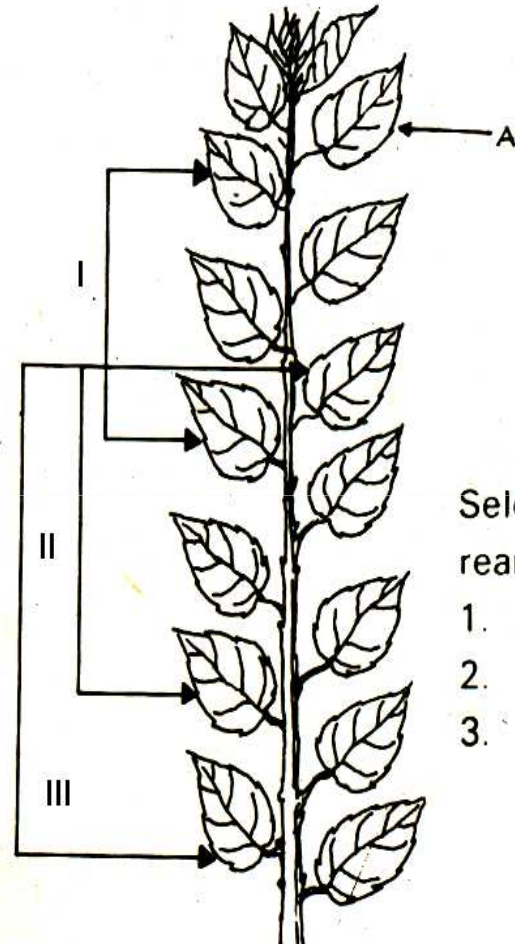
Mulberry leaves for young silkworms must be soft and rich in water content, protein, carbohydrates, *etc.*,.

For plucking the correct leaves for young age rearing, the largest glossy leaf method is adopted. The largest glossy leaf is the one light green and glossy, being the largest among the first few leaves on the top of the shoot. This can be identified in a fully grown shoot, by scooping the top leaves and marking the largest leaf by its tip (Fig.).

From the one below the largest glossy leaf, 5 or 6 leaves for I instar, 6-7 leaves for II instar and 7-8 leaves for III instar are used in young age silkworm rearing.



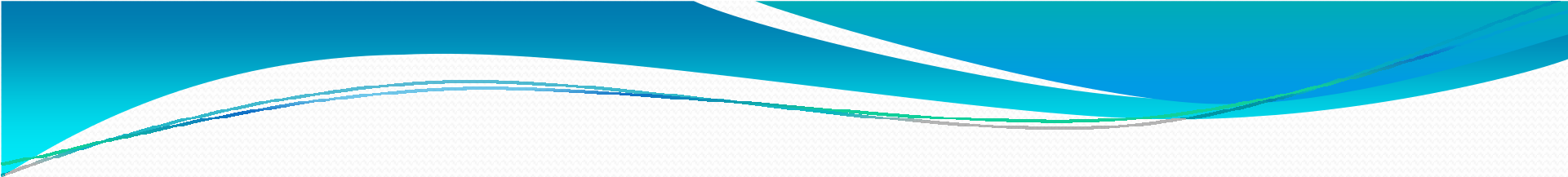
## A- FIRST Glossy Leaf



Selection of leaf for young age rearing

1. For first instar
2. For second instar
3. For third instar





**Mulberry leaves for early age silkworms are to be harvested in the cool time of the day *i.e.*, early morning or in the late evening and should be preserved in the cool and wet condition in order to prevent them withering. Immediately after leaf harvesting, leaves are preserved in suitable containers like leaf bins (Fig.), where the humidity must be maintained close to 100 % RH by repeated sprinkling or spraying of water over the gunny or cloth surface of the container. If containers are not available they should be at least covered with wet cotton cloth or gunny cloth. The cloth used to cover leaves should be clean as far as possible.**

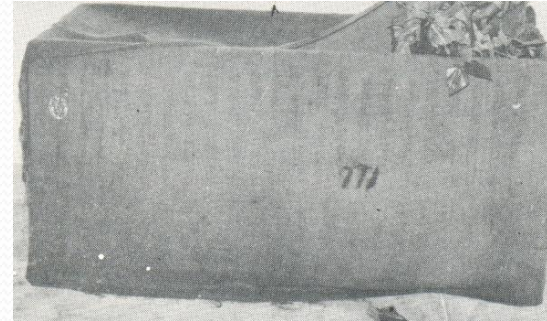
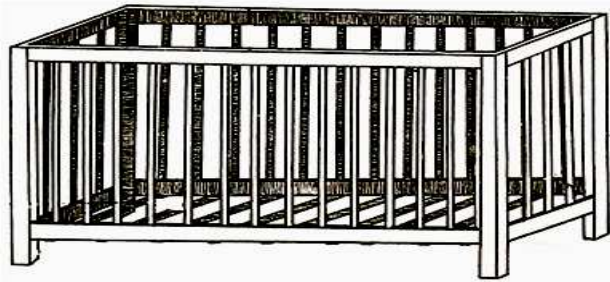


Generally there are two methods are used for leaf harvesting

- **Individual leaf harvesting**
- **Shoot lets harvesting**

In both the methods same type of leaves are selected for feeding the Chawki worms.

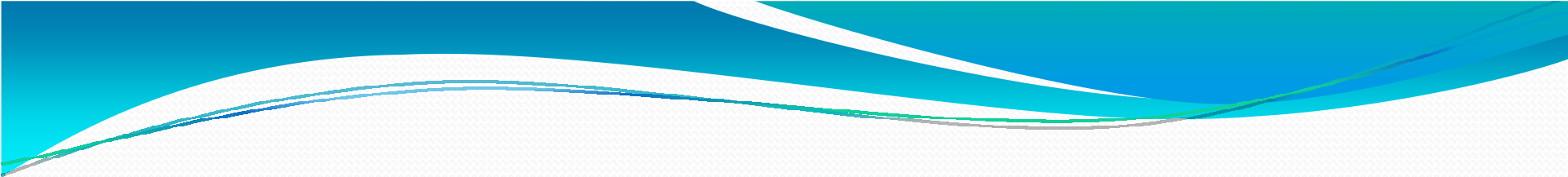
## Mulberry Leaf Storage Bins

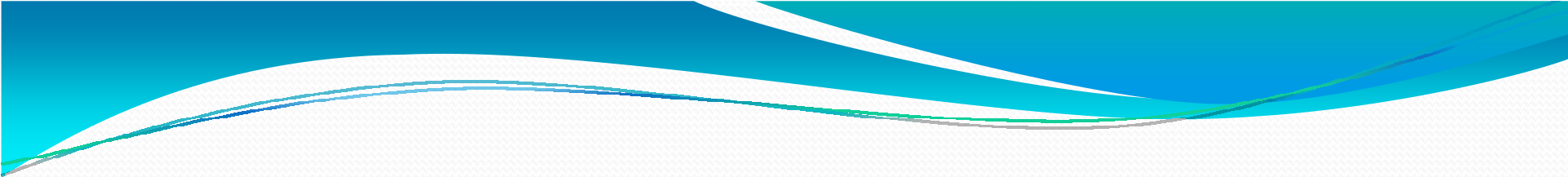


**Mulberry leaves should be chopped in order that they are supplied to silkworms evenly. The size of chopped leaves is variable according to the form of leaves, that is entire leaves or shoot lets.**

**The following size is an example of leaves supplied to chawki worms.**

	Chopped leaves (mm square)	Chopped shoot lets (mm square)
For first instar	6-12	12-18
For second instar	12-18	18-24
For third instar	18-30	24-entire shoot lets

- 
- **Generally the size of chopped leaves and chopped shoot lets is smaller at the earlier age and premoulting stage of each instar, and large at the voracious age of each stadium.**
  - **For example, 0.5 – 1 cm square can be gradually raised to 1.5 to 2 cm squares by the end of first instar. Also, the leaf size started with 2 cm squares and increases to 3-4 cm squares by the end of second instar.**

- 
- Regarding the amount of mulberry leaf to be supplied to silkworms and the times of feeding, they are variable according to the rearing temperature and RH, ventilation of the rearing room, area of rearing bed, form of mulberry leaves (chopped, entire leaves, chopped shoot lets, entire shoot lets).
  - In general, in case of paraffin paper rearing or box rearing, the amount of mulberry leaves supplied to silkworms and the times of feeding are as follows (For one egg box *i.e.*, 20,000 eggs).

As mentioned, silkworms are supplied with mulberry leaves 3-4 times per day, but in this case the rearing temperature, humidity and the area of the bed (spacing) must be regulated in the range of standards.

However, in Karnataka state, during wet weather, only 3 feeds need be given at 6am, 1pm and 8pm.

During other seasons including summer months, however 4 feeds may be found necessary, which may be given at 6am, 11am, 3pm and 8 pm.

The leaf requirement for 100 layings (Average 400 eggs per laying)

	Amount of mulberry leaves (g)	Feeding Times per day	Temperature °C	RH %
First Instar	1125-1350	3	27	90
Second Instar	2813-3375	3	27	90
Third Instar	13023-14000	4	26	80

## **BED CLEANING**

Normally a much larger quantity of mulberry leaves has to be fed than is eaten by the worms. It is obvious, therefore, that a sizeable quantity of unconsumed leaves, more or less in a state unfit for food, remains over in the tray at the end of each feed.

In addition to this, there are excreta which the worms are passing, and the whole forms a thick and often damp bed which ought not to be allowed to remain.

The piling of litter makes beds moist and releases processes of fermentation, thus generating injurious gases and favouring multiplication of pathogenic micro-organisms. This imperils the health of the worms.

In order to keep the silkworms healthy, the litter piled on rearing beds together with waste mulberry leaves, *etc.*, should be periodically removed. This process is called "Bed cleaning".



# Frequency of Cleaning

Following schedule of cleaning could be adopted profitably:

**I age - Once**

I age - Twice *i.e.*, once just after the I moult and again before settling for I moult.

III age - Thrice *i.e.*, once after moult, once in the middle of the III age and once just before settling for IV moult.



# Methods of Cleaning

There are three methods of cleaning; *viz.*,

- (i) **Cleaning with husk**
- (ii) **Cleaning with net**
- (iii) **Cleaning with husk and net**

## Cleaning with Husk

A thin layer of paddy husk is sprinkled evenly over the bed so as to cover the same completely. This is done generally just prior to first feeding in the morning. The worms crawl through the layer of husk to get at the feed of leaves. After a few hours when the second feeding is given the bed is ready for cleaning. The worms are swept together by a brush and transferred to another tray. This method is advantageous in that immediately the husk is applied, the worms begin to crawl through and thus get separated from the old bed.



**For these ages, the Husk should be pounded and broken into small pieces before use with the young worms.**

**Of late, charred paddy husk is being used in place of ordinary husk. When the worms are in the 3<sup>rd</sup> age, there is no need to pound the husk; when they have passed the 4<sup>th</sup> age, chopped straw may be used instead of husk with advantage.**

- Formalinised charred husk when used for cleaning helps avoid attacks of muscardine disease.**

## Cleaning with Net

In this a net with mesh suited to the size of the silkworms is spread over the bed just prior to the first feeding in the morning. As in the case of husk method, cleaning is done after the second feeding is given. This method is simple besides requiring very little labour and is quite popular in West Bengal. However, it is not so convenient for purposes of spacing as the size of the bed remains restricted to the size of the net as the worms cannot be easily separated from the net (Fig.).

Generally, the mesh sizes used:

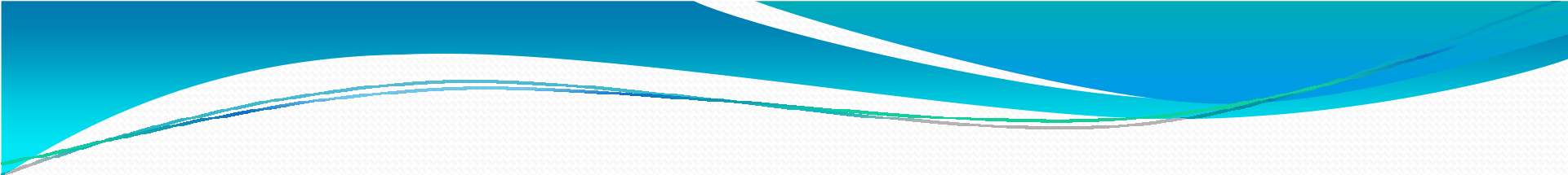
- **First and Second instars -- 0.5 cm<sup>2</sup>**
- **Third instar --1 cm<sup>2</sup>**





## **Combined Husk and Net method**

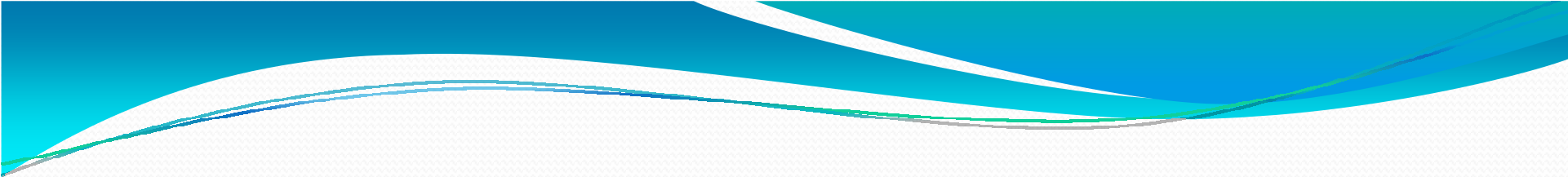
**A thin layer of paddy husk is first sprinkled over the bed and a net of suitable mesh is superposed on it. Two successive feedings follow where after the net with the worms on it is transferred to another tray. This method combines the cleanness of the husk method, with the ease of transference of the net method and requires less of skill and care in manipulation than the former; but it is more expensive than either and has some inconvenience in regard to spacing as in the case of net method.**

- 
- It is however to be mentioned that the general practice even now is to resort to the old method of cleaning. In this no husk or net is used. The worms, if in earlier stages, up to III moult, are simply swept together with a feather and transferred to another tray. The worms are then spread out using chopsticks or feather, to form a fresh bed. This method is likely to cause injury to the worms and is perhaps one of the main causes for the "missing larvae" in our rearings which depress our cocoon yields.
  - It is remembered that, under the traditional system of bed cleaning about 25-30% of worms will loses. Under the improved method of bed cleaning, the loss of worms during chawki rearing is minimum i.e., less than 10%. Again these worms being more robust, the mortality at the later stage is also considerably less and consequently, the total loss of worms is also minimum, which may be of the order of 15-20% only. Thus the ERR (effective rate of rearing) will be 80-85%.

# SPACING

## Purpose of Spacing

Silkworm is a very fast growing animal and records a 10,000 fold increase in weight and about 7,000 fold increase in size during the short span of 20 to 30 days. The above figures clearly establish the need to extend the rearing beds from time to time in order to avoid overcrowding of the worms and thus to provide for their orderly growth. The purpose of spacing is to achieve this objective.

- 
- **Sparse spacing leads to wastage of mulberry leaves.**
  - **Over Crowding leads to unhealthy conditions.**

**Optimum spacing therefore to be accomplished through experience. Normally it would be sufficient if rearing space is doubled or trebled from first instar to third instar.**



# METHOD OF SPACING

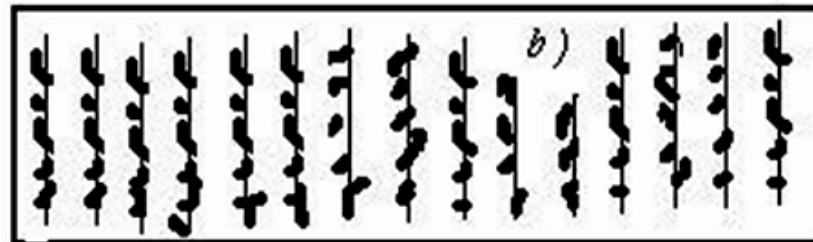
before



a) high density

each mulberry branch and silkworm move to right

After



b) enough density

The spacing to be provided for silkworms of 50 layings or a box of 20.000 eggs is given below.

Age	At the beginning of each age (Sq.mt)	At the end of each age (Sq.mt)
<b>For Uni and Bivoltines</b>		
First age	0.2	1.0
Second age	1.0	2.0
Third age	2.0	5.0
<b>For MVxBV hybrids</b>		
First age	0.2	0.5
Second age	0.5	1.5
Third age	1.5	3.0

## **Time and frequency of spacing**

**As the development of silkworms is most rapid in the first age and therefore, the spacing has to be frequent. The first spacing should be given on the day after the worms are brushed and hence forward spacing should be done every day, till the day when the worms show signs of going into moult. It would of course be advantageous to combine spacing with cleaning as it would help save labour and also ensure more even expansion of rearing space.**

**In the 2<sup>nd</sup> to the 5<sup>th</sup> age, generally spacing is combined with cleaning. It may be found necessary to provide more spacing when the humidity and temperature are higher than optimum. The rearing trays are also kept in alternate shelves of the rearing stand. This enables free circulation of air in the rearing bed and there by ensures reduction in temperature and humidity in the bed.**

## Methods of spacing

There are two methods of spacing *i.e.* either

- Conducting it independently
- In combination with cleaning.

In the former case, where the object is just to spread out the worms over a more extended bed, a convenient way is to mark out on the tray the limits of the space desired, and to distribute worms on it by picking out worms from the parts of the bed where they are thickest, so that in the end, they are evenly distributed over the whole of the increased space.

Where spacing is combined with cleaning by husk and net, the worms are taken as a whole from the old bed, and distributed evenly over a new bed of the required space. This is most convenient and satisfactory. When cleaning by net alone is done, the process becomes slightly more complicated, as it will be similar to independent spacing.

# **MOULTING AND CARE AT MOULTING**

**The silkworm casts off its skin four times during its life of 20 to 30 days to provide for its growth. This is called moulting. This is a very sensitive period in the life of the silkworm, when it does not feed but just tries to wriggle out of the old skin. Unless care is taken to stop the feeds and also to resume the same after the moults in proper time, uniformity in growth of the silkworms cannot be secured.**

## **MOULTING AND CARE AT MOULTING continued ....**

- **At the approach of moulting, the silkworms attain their maximum body growth for the particular instar and as a result the body of the silkworm becomes stout, shiny and amber coloured. In relation to the size of the body, the head of the worm about to moult appears quite small and also somewhat dark. It is desirable that a bed cleaning is given just at this time and the worms are spaced out. Leaves also could be cut to a smaller size for feeds just prior to moulting. As soon as all the worms have settled down for moult, the feeding is stopped. It is also advantageous to sprinkle lime powder after the last feed. This prevents the worms which have come out of moult early from commencing eating of leaves and thus causing uniformity in growth. Further, application of lime helps to keep the bed dry during moulting.**

### MOULTING AND CARE AT MOULTING continued ....

- The larvae normally take 15 to 30 hours to complete moulting during the different instars. Worms out of moult have a rusty colour and the head also appears bigger compared to its size at the time of going for moult. From these, it becomes easy to identify the moulting as also out of moult worms easily.
- The first feeding of the new instar should start only after all the worms have come out of the moult. In localities where muscardine is prevalent, it is desirable to take anti-muscardine precautionary measures by dusting ceresin lime on to the newly moulted worms prior to the first feeding.



## CARE AT MOULTING AND MOULTING continued .....

If any irregularity in settling for moult is observed, the late larvae may be segregated through net feeding and reared as a second batch. It is however of very great importance that the rearing bed should be as dry as possible when the worms are in moult. This enables the silkworm to crawl out of the skin easily thus securing uniformity of moulting. Since the newly formed skin is thin and delicate, under more humid conditions the worms become susceptible to fungal attacks. Therefore, it is very essential that the silkworm beds are kept dry during the moult.





**Acknowledgements/References  
to**

- 1. Internet**
- 2. Sericulture Manual II, FAO, Rome.**