



MULBERRY CULTIVATION PRACTICES AND DISEASES: AN OVERVIEW

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Abstract

Mulberry plant belonging to the family Moraceae and genus *Morus*. It is the main food for silkworm *Bombyx mori*.L. Mulberry plant is perennial, various pathogens like fungi, bacteria, viruses and nematodes cause diseases in mulberry. To manage or control these diseases and pests a number of management strategies are followed which include physical, chemical and biological methods. So there is a need to think of ecofriendly safe methods for managing pests and diseases. In this review paper an attempt has been made to discuss in brief about cultivation practices, various disease and pests of mulberry and their management techniques and highlighting the importance of eco-friendly management strategies, their advantages and demerits. This review article will describes the research conducted on cultivation techniques, disease and pests and their management strategies in mulberry for better leaf quality production.

Key words: Mulberry, Cultivation, diseases, pests

INTRODUCTION

Mulberry is derived from Latin word *Morus* and the cultivation of mulberry leaves of rearing of silk worms is called as *Moriculture*. Mulberry is grown as shrub in tropical countries and trees in temperate countries like Japan. It belongs to order *Urticales*, the family *Moraceae* and genus *Morus*. There is an estimated about 68 species of the genus *Morus* with the majority of them occurring in Asia and in China there are over 1000 varieties under cultivation. The most

common species are *M.alba*, the white mulberry, *M.nigra*, the black mulberry and *M.rubra*, the red mulberry.

Mulberry cultivation is the agriculture part of sericulture which constitutes not only the rearing of silk worms but also silk reeling. Cultivation of mulberry plays a significant role in determine the production cost of cocoons and silk as it is estimated that 60-70% of the cost of cocoons goes to mulberry. It is the chief food for *Bombyx mori*. Mulberry leaves protein is the source for silk worm to biosynthesize the silk, which is made up of two proteins i.e., fibroin and sericin and its leaf and cell wall together contains with structural carbohydrates and which is highly digestible. So mulberry is the main food source for silk worms.

One hectare of fertile land can produce about 15-40 tones of mulberry leaves over a 12 month period. This increase in the production of mulberry and reducing the cost of production. Attention has been paid to intensive cultural operations including application of economic dosage of fertilizer and adoption of suitable irrigation schedules furthermore, research conducted on breeding of mulberry as resulted in evolving over 200 varieties of mulberry. Distribution of mulberry cultivation on a global survey of sericulture industries reveals that there are at least 29 countries cultivation of mulberry plant is not only for silk rearing, but so many applications are used. Mulberry are widely distributed because of berries, some of the berries are very sweet tasting as honey, these syrupy sweet mulberries are used in ice cream, jams, jellies and beverages.

This mulberries are rich in anthocyanins which are colourful pigments with beneficial health effects that may include the prevention of cancer and these mulberries having many medicinal value, due to its pigmentation it is used in preparation of stains, used in preparation of fabrics, the leaves of mulberry contain 6 times more calcium than green tea and 25 times more than spinach, mulberry leaves are also high in general content antioxidants and effective in regulating fat while boosting metabolism etc..

Mulberry is the main food source for silk worm and the sericulture is mainly based on the mulberry for the production of silk. The

superiority of the silk as a textile fiber has been recognized from the time immemorial; the luxurious look, sleek feel and luster of silk fabric are unquestionably inimitable. The industries have had an adventurous course of evolution, becoming established from time to time in other part of the world.

LEAF CHEMICAL COMPOSITION

This differs according to variety and maturity. However, on the basis of the analysis carried out by CSRTI (Mysore), the chemical composition of the leaf (Datta, 2000) is as follows:

Component	Range
Moisture	65 - 78 %t
Protein	19 - 25 %
Minerals	10 - 15 %
Reducing sugars	1.2 - 1.9 %
Sugars	10 - 15 %

MULBERRY CULTIVATION PRACTICES

Soil and Climate in Mulberry Cultivation

Mulberry cultivation can be done in a wide range of soils, but best growth is obtained in loamy to clayey loam soils. The mulberry plant can tolerate slightly acidic conditions in the soil. In the case too acidic soils with pH below 5, necessary corrective measures through application of dolomite or lime should be adopted. In case of alkaline soils, application of gypsum should be resorted to for correction of the soil alkalinity.

Since mulberry is a deep rooted plant the soil should be sufficiently deep upto about 2 feet in depth. In respect of elevation mulberry thrives well upto about 4000 feet, above this level growth will be retarded because of the cooler temperature.

Land preparation for mulberry cultivation

Mulberry falls under the category of perennial crops and once it is properly raised during the first year, it can come to full yielding capacity during the second year and lasts for over 15 years in the field without any significant deterioration in the yield of leaf. Usually flat lands are suitable for irrigated mulberry cultivation. If the slope is more than 15%, suitable land development measures such as contour bunding, bench terracing should be adopted.

In mulberry cultivation, field should be prepared by deep ploughing upto a depth of 30-45 cm in order to loosen the soil and thereafter with the country plough or tractor to bring the soil to a fine tilt. Weeds and stones should be removed during the preparatory stage. Basal dose of farm yard manure at 20 tonnes per hectare is recommended, which as to thoroughly incorporate into the soil. Farm lands along the highways, in the vicinity of factories, area irrigated by raw sewage and untreated effluents plots affecting other gardens with intensive pesticide usage, water logged areas and tobacco grown land are not suitable locations for mulberry cultivation.

Selection of variety in Mulberry cultivation

The criteria for selection of variety include fertility of the land, water availability region specificity, extent of garden and problematic soils. Wherever the size of operation is bigger, it is advisable to have a separate garden for chawki rearing for which a variety like S-36 can be chosen in addition to a high yielding variety for rearing late age worms (M-5, S-36 and v-1). In alkaline soils a variety AR-12 is suitable. An improved selection namely K2, also referred to as M5 is a superior variety evolved by the institute, which is a vigorous strain responding well to manure, and capable of giving about 25% more leaf yield. This variety thrives well both

under dry as well as irrigated conditions. Quality wise also, it is superior to the local variety of mulberry and therefore could be used with great advantage in mulberry cultivation

Preparation of cuttings in Mulberry cultivation

Cuttings should be prepared from well-matured 6-8 months old shoots of about 1.5 cm diameters. Cuttings of 15-20 cm length with 3-4 healthy buds are selected from plantation.

Raising of saplings in Mulberry cultivation

Nursery beds with the dimension of 5m×1.5m are prepared. The land is dug to a depth of 30-40 cm and the soil should be pulverized well. FYM is applied @ 15 kg per bed and mixed well with the soil. Some quantity of sand is also added to heavy (clayey) soils to make the soil loose and friable, while some quantity of tank silt or other well decomposed organic matter has to be applied to sandy soils to increase the water

holding capacity. Cuttings should be planted in nursery beds with a spacing of 15 cm ×10cm. The full length of cutting is pushed into soil keeping only one bud exposed above the ground. It should be irrigated twice a week. Fertilized is applied at 25:25:25 (N:P:K) kg per hectare after 5-6 weeks when plants sprout well and the root system is established. In mulberry cultivation, saplings of about 80-90 days old can be used for planting. While uprooting the saplings, maximum care should be taken to avoid damage to the root system.

Spacing

In cultivation, spacing depends upon the soil conditions, slope, variety and convenience for inter-cultural operations has detailed below in the case of rain fed mulberry gardens, the aim should be to raise mulberry plant with a sturdier frame so that it is able to withstand prevailing drought conditions.

Spacing(cm.)	Suitability	No. of plants/ ha.
90×90	Heavy soils, black soils, heavy rainfall areas	12345
120×60	Sloppy land (hilly areas)	13888
(90+150)×60	Suitable for mechanized farming	13888

Planting methods

Pit system is ideal in 90×90cm spacing. Pits of 3cm cube are dug and left for one month, which are later filled with FYM and soil at 1:2 ration. Trenchers of 35cm×35cm are also convenient to take up plantation in mulberry cultivation. It is preferable to start the plantation during the rainy season.

In highly areas , three cuttings of 20-22cm length are planted in each pit at a spacing of 15cm. cutting not sprouting in 4-5 weeks need to be replaced by saplings to ensure the required plant density.

Weeding and inter-cultivation

During the initial stage of mulberry plant established in the field, weed growth should be kept to the minimum, so that the growing young plants are not smothered by the weeds. At least 2 weeding should be carried out during the first 6 months after planting of cuttings, once after 2 months of planting and again after an interval of 2-3 months. The weeding operations should be thorough and the soil should be dug deep to eliminate the weeds with roots. This deep digging is carried out as part of the weeding

operation and results in necessary loosening of the soil and stimulation to the plants to grow vigorously. Thus special care should be taken to reduce the weed growth as much as possible in the first year of planting. Thereafter, the shade effect of the fully grown in mulberry will tend to keep the weeds down. Similarly, periodical inter-cultivation helps in catching the rain water and its deep penetration for better retention of soil moisture.

Training and pruning

In order to get good leaf yield for 15-20 years, it is necessary to give a good and study frame to the plant. After the planting, the saplings need to be cut at 10-15 cm above the ground level within a week. After the growing period of 6 months, the plants are to be cut a height of 25 cm above the ground level keeping 3-4 strong branches. In leaf picking method, the first bottom pruning has to be taken up at a height of 20-25 cm from ground level and second bottom pruning is done again at 30 cm height cm has to be followed once in a year during Jan to Feb and it in short harvesting method, each shoot harvest done at 25cm height which itself acts as pruning.

Manures and fertilizers

Application of a basal dose of organic manure like compost or cattle manure is necessary for successful establishment of the garden. Thereafter, the young growing plants should be assisted to put forth vigorous and maximum growth through periodical fertilizer applications.

FYM has to be applied at 20t/ha/year in two doses following the first bottom pruning and third pruning. Fertilizers has to be applied has per the recommended schedule and secondary and micronutrients have to be applied wherever necessary. Foliar sprays such as Boron (1%) urea (0.5%), zinc sulphate (0.1%) will improve the leaf quality. The recommended fertilizer dose (kg/ha) is indicated below:

Table showing fertilizer application

		N	P	K
Rainfed mulberry	1st year	50	25	25
	2ndyear onwards	100	50	50
Irrigated mulberry	Shoot harvest			
	1st year	100	50	50
	2ndyear onwards	300	120	120
Leaf harvest	1st year	100	50	50
	2ndyear onwards	300	120	120

Irrigation/ water supply

Regular irrigation at an interval of 8-10 days is ideal. It may be noted that there is only one irrigation channels for every two rows of mulberry plants. This helps in both saving and more effective use of the irrigation water. In case of water scarcity, drip irrigation can also be adopted for better production.

Harvesting of mulberry leaves

Picking of leaves should be carried out in time in mulberry cultivation, that is to say, when the leaves are the correct stage of maturity for harvest. Otherwise, part of the leaves become over mature coarse and suffer in quality from the point of view of the nutritive value for the silk worms. Also the part of the leaves may turn

yellow, shed and be lost. Therefore, timely harvest, as the leaves reach the required stage of maturity, will lead to fuller harvest of the available leaves without wastage, and realization of maximum yield.

Yield in mulberry cultivation

Normally the expected annual yield is 40-50 tone of leaves per acre. In shoot harvest method, harvesting can be done at an interval of 70 days (5 harvests). In case of leave method, first harvest is taken 70 days after pruning and second and third harvest (coinciding with second bottom pruning) at an interval of 55days. The fourth harvest is taken 70 days after the third harvest and 5th and 6th at an interval of 55days.



Diseases and pests of mulberry plants

Different kinds of disease of mulberry which are caused by fungi, bacteria, viruses and also mineral deficiencies are physiological disorders.

Of these, 10 or 12 diseases cause much damage to mulberry plants. They are widespread in all the mulberry growing countries of the world. The diseases affect different parts of the plant. The

mulberry being a perennial crop the pathogens seem to readily perpetuate and quickly spread to cover extensive areas. Certain alternate and collateral host (mainly weeds) places some role in perpetuation of some of the pathogens.

FOLIAR DISEASES

Leaf spot

This disease is caused by *Cercospora moricola*. The diseased leaves have a number of circular or irregular brownish black spots of varying sizes. Usually the incidence is more during rainy seasons the infected leaves are not suitable for feeding the silk worms. Leaves become yellow and wither off as disease becomes severe. About 10-12% of the crops are lost by this disease.

Factors responsible for spreading of the disease.

- ❖ The disease is air borne spreading by conidia primarily through rain droplets.
- ❖ Temperature of 24-26°C and 70-80% relative humidity are most congenial for the disease development.

Control measures

- Spraying suitable fungicides on the young leaves.
- Weeding out the alternate hosts, removing the affected leaves, and fungicidal sprays can effectively control the leaf spots.

Powdery mildew

This disease is caused by *Phyllactinia corylea*. The disease is prevalent during winter and rainy seasons and progresses 40th DAP/ leaf harvesting become severe on 70th DAPS. It is more common during winter and following rainy seasons in the tropical regions. Usually in the hilly areas, it is commonly found by the end of the monsoon seasons. The lesions first appear as whitish patches on the lower surface of the leaf. Gradually they turn yellow brown to black colored patches and quickly cover the entire leaf surface. Crop loss by this disease is about 5-10%.

Factors responsible for spreading of the disease

- The disease is air borne spreading by conidia primarily through wind current, the whitish powdery material seen on the leaves consists of the fungal hyphae and conidia.
- Low temperature and high relative humidity are responsible for infection and disease development.

Control measures

- Follow wider spacing of plantation (90cm×90cm) or paired row planting system [(90+150)×60cm].
- Spray sulfex 0.2%, safe period 15 days.

Leaf rust

Leaf rust is caused by *Serotelium fici*. The disease is more prevalent during winter and rainy seasons. It starts progressing 45-50 DAP becoming severe on 70th DAP. The mature leaves are more prone to the disease.

The pathogen infects the leaves and green woody portions of the plant. The affected green portions swell up and get deformed, with dark brown lesions and finally break down. The affected leaves have whitish brown pustules on both the sides and are deformed and not nutritive. Therefore, they are not to be fed to the silkworms.

Factors responsible for spreading of the disease

- ❖ The disease is airborne dispersing by uredospores through water droplets and wind current.
- ❖ Temperature of 22-26°C and high relative humidity above 70% are favorable for the disease development.

Control measures

- ❖ Follow wider spacing plantation (90cm×90cm) or paired row planting system[(90+150)×60cm]
- ❖ Avoid delayed leaf harvest.
- ❖ Safe period: 5 days

ROOT DISEASES: 1.Root knot.

Meloidogyne incognita (nematode) is the causative agent. The disease is out break throughout the year and more common in sandy soils under irrigated conditions. Severely affected mulberry plants show stunted growth with low water moisture in leaves, later yellowing of leaf margins. Formation of knots/galls on roots is the main indicator of the disease symptom. About 20% of the crop are lost by this disease.

Factors for spreading the disease

- ❖ Spreads primarily through contaminated soil farm implements and run off irrigation.
- ❖ Planting of infected saplings along with other susceptible crops increases the disease intensity, some susceptible weeds in and around the mulberry gardens act as the secondary sources of infection.

- ❖ Temperature between 27-30°C, soil moisture of less than 40% and pH of 5-7 are favorable for the development of the root knot disease.

Eco-friendly Control measures

- ❖ Apply Neem oil cake @ 800kg per acre/year in 4 split doses during inter cultural operation or after pruning the plant or after leaf harvest by making the trenches of 10-15 cm deep near the root zone of plant and cover with soil and irrigate.

Root rot

Root rot is caused by *Rhizoctonia bataticola* (*Macrophomina Phaseolina*) and associated secondary microbes: *Fusarium solani*/F. *oxysporum*/*Botryodiplodia theobromae*.

The disease appears sudden withering of plants and leaf fall off from the bottom of the branches and progressing upwards. The below ground system includes decaying of root cortex or skin, turn black due to fungal spores/mycelium below the bark.

The severely affected plants loose the hold in the soil and can be easily uprooted. Affected plants after pruning, either fail to sprout or plants sprouted bears small and pale yellow leaves with rough surface.

15% of the crops loss and above depending on the soil health and climate.

Factors for spreading the disease

- ❖ The disease occurs in soils of high temperature (28-34°C), low moisture (below 40%) and low organic matter.

- ❖ The disease spreads primarily through contaminated soil, farm implements and irrigation.

Control measures: A target specific new formulation “Navinya” (herbal 80% and chemicals 20%) is used for the control of root rot a disease of mulberry.

Pests

1. Pink Mealy bug

Pink mealy bug, *Maconellicoccus hirsutus* (green) causes deformity symptoms in mulberry which is popularly called as Tukra. Leaves become dark green, wrinkled and thickened with shortened intermodal distance resulting in bunchy top appearance/ resetting of leaves. It occurs throughout the year, but severe during summer months. Mulberry leaf yield is reduced by 4500kg / ha / yr due this pest.

Mechanical control:

Clip off the infested portion and collect in a polythene bag and destroy by burning. This will help in reducing the chances of recurrence of pest. This practice may be followed when the silk worms attain 4th age.

Chemical control

Spray 0.2% DDVP 76% EC (@2.63 ml/liter water) 15-20 days after pruning. safety period : 15 days

Ecofriendly approaches

Release predatory lady bird, beetles, *Cryptolaemus montrouzieri* @ 250 adult beetles or *Scymnus coccivora* @ 500 adult beetles in 2 equal splits at an interval of 6 months.



Medicinal value of mulberry leaves

Mulberries are delicious and nutritious and are a product of the *Morus alba* tree. Leaves contain nutrients and are even used as food for silkworms. The dominant taste of the ripe fruit is

sweet but usually somewhat land, due to the high water content and low level of other flavouring ingredients. Mulberry fruit juice has been commercially produced as a health beverage.

Mulberry twigs are used as raw material for paper production.

As a result of working with the fresh fruits to yield a juice product, the constituents have been

analyzed. The main nutrient content of fresh, ripe, mulberry fruit is given below

Water: 85-88%

Carbohydrates: (sugars, mainly glucose and fructose, producing the sweet taste) 7.8-9.2%

Protein: 0.4-1.5% fat (mainly fatty acids such as linoleic, stearic and oleic acids in the seeds.

Free acids: (Mainly mallic acid, producing the sour taste) 1.1-1.9%

Fibre: 0.9-1.4%

Minerals: 0.7-0.9%

Nutritional value of mulberries

Iron, Riboflavin, Vit C, Vit K, potassium, Phosphorous, calcium, dietary fiber, phytonutrients, anthocyanins

Health benefits of mulberry

- ❖ Mulberries contain dietary fibre, can help to improve digestive health by bulking up the stool, also reducing occurrences of constipation, bloating and cramping. Also helps to regulate cholesterol levels and can boost heart health when regularly added to the diet.
- ❖ Mulberries contain carbohydrates that convert sugar into glucose. There by providing energy to the cells.
- ❖ Mulberries increases iron intake and ensures sample supply of oxygen to the tissues.
- ❖ Mulberries are rich in vitamin-K and vitamin-C, Increases tissue strength and boosts collagen synthesis. Vitamin-K helps in bone tissue development and is an essential component for blood clotting.
- ❖ They also contain riboflavin(vitamin-B2) which protects tissues from free radicals and helps in transferring oxygen throughout the body
- ❖ Mulberry are source of antioxidants, help lesser the damage caused by free radicals
- ❖ Mulberries contain alkaloids that activate macrophages, which stimulate the immune system.
- ❖ Mulberry has a remedy for swelling and redness.
- ❖ Mulberry can nourish and promote production of body fluid.
- ❖ Mulberries are rich in antioxidants and phyto nutrients that help in stopping the growth and spread of tumor cell they also contain resveratrol, which has anticancer properties, which fight against colon cancer, skin cancer, prostate cancer and thyroid.

- ❖ Mulberries control blood pressure and cleans the blood, antioxidants helps in improving the function of the blood vessels by keeping them supply and dilated.

CONCLUSION

From our review work we could understand that cultivation practices of mulberry under land preparation, harvesting, pruning, manures and fertilizers followed during the plantation time and we recorded three species of mulberry, also have able to know about diseases and control measures, nutritional value, medicinal importance and economic importance of mulberry. In Karnataka, Mysore is famous for mulberry cultivation. But now a day's cultivation of mulberry plant is progressively declining due to lack of knowledge, awareness and lack of rainfall and also production cost is very expensive. Finally we conclude that people need to know the value of Mulberry.

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