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RESEARCH ARTICLE

RAPID PRODUCTION OF MULBERRY (*MORUS ALBA* L.) SAPLINGS THROUGH THE INCORPORATION OF CLONAL AND ROOT TRAINER METHODS

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ABSTRACT

Efficient propagation is the prime act of any farming and plays vital role in its existence, survival and continuity in future course of action. Mulberry (*Morus alba* L.) being perennial in nature cultivated as seasonal crop for its foliage to feed silkworm (*Bombyx mori* L.) is mainly propagated through vegetatively and plays major role on the upliftment and socio economic conditions of the sericulturists. Therefore, proficient method of propagation not only saves farmers economy but also plays pivotal role on the future of sericulture. Keeping the above aspects a pilot study was undertaken at Regional Sericultural Research Station, Central Silk Board, Kodathi, Bangalore during 2016-17 to evaluate the influence of clonal mulberry saplings and their prospects and problems on the future of mulberry cultivation. Field trails undertaken with V1 mulberry variety raising clonal and traditional (bed) saplings resulted that 93.5% sprouting of clonal saplings was recorded compared to 87.0% in the traditional method. Survival of clonal mulberry saplings were more (88.2%) over traditional practice (76.2%) recording 13.32% increase. Similar trend of improvement in case of aerial plant growth, no. of tillers, shoot biomass, root length, no. of rootlets and root biomass among clonal mulberry saplings indicating their superiority over the saplings raised through traditional method. The above results not only open new avenues of its utilization for the benefit of the farming community but also with multifaceted benefits viz. consumes less time to generate healthy and fully established with profusely rooted saplings with minimized drudgery of manpower use, assured establishment, easy to transport and transplant with assured survival after plantation and efficient technology for popularization of improved mulberry verities in large scale generating a ray of hope for brighter future of sericulture farming.

INTRODUCTION

Mulberry (*Morus alba* L.) a perennial plant cultivated for its foliage training as seasonal crop for feeding to silkworm (*Bombyx mori* L.). Being perennial in habit once mulberry plantation taken up after establishment it consistently yields quality mulberry leaf for a period of more than 15-20yrs. For propagation of mulberry several methods are followed such as seedling propagation (sexual) as well as vegetative propagation (asexual) like bud grafting, stem grafting and through the planting of cuttings in soil. Seedling propagation was not popular for regular multiplication of mulberry because of its poor viability and difficult to produce pure variety due to high heterozygosity, hence seedling production was restricted for breeding experiments only.

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Propagation of mulberry: Among the vegetative propagation methods budding and grafting were practiced where the planting material is limited and temperate climate prevails limiting the rooting ability. Mulberry is predominantly propagated through stem cuttings since time immemorial. Stem cuttings used for the propagation material depending upon the nature of wood have been termed as hard wood, semi-hardwood and soft wood. Besides, the edaphic and climatic conditions, factors such as type of wood, stage of stock plant growth and time of plantation plays important role in rooting and subsequent survival of cuttings (Fred T. Davies, Jr., *et al.,* 2018). In general most popularly and traditionally hard wood cuttings of 6-8 months old shoots after pruning are recommended for planting (Fig.1) (Krishnaswami, 1986, Dandin *et al*., 2003). However, evolution and contribution of superior mulberry varieties is the most satisfying and inexpensive of all the efforts to improve stable productivity and quality of mulberry. In the recent years, due to the development and evalution of superior mulberry varieties under improved

cultivation technologies, the leaf productivity of 60-70MT/ha/yr has been achieved and contributed significantly for the benefit of farming community and economy of India. However, rate of popularizing such superior evolved mulberry varieties and their timely availability among the farming community has remained slow and unachievable due to non-availability of seed cuttings and sapling materials for transplantation.

- Hence, it has become imperative to spare part of their productive garden for seed purpose to raise new plantation.
- In the popular traditional hard wood multiplication system, seed cuttings are obtained from a seed garden at the most twice in a year, leading to time lapse between evolution of an improved mulberry variety and its exploitation in the farmer's fields.

Fig. 1. Constraints involved in production of mulberry saplings in traditional method

Constraints involved in mulberry propagation

The major reason for slow rate of popularization and spread of new mulberry varieties are:

- Due to inadequate availability of seed material in time and use of only hard wood (>6 months old) cuttings for planting.
- Further, High degree of adoption of shoot rearing technology involving cutting the whole shoots for feeding silkworms, a practice i.e. beneficial in terms of higher returns through low cost of production and better hygiene but lead to non-availability of seed cutting material of required maturity (hard wood) from commercial gardens.
- Further, waiting for mature cutting material (hard wood) leaving a part of productive garden to obtain 6-8 months old shoots, raising saplings and achieving suitable mature saplings (after 5-6 months) and transplanting the same to main garden and struggling for its establishment (> 6months) is almost incurring 16-18 months period.
- Which is very valuable and at times farmers are not ready to waste their time for such long period to involve in mulberry cultivation is not only delaying the popularization programme of 'High Yielding Evolved Mulberry Varieties' (HYEMV) among the farming community but also generating a lot of hesitation to venture in to sericulture (Fig. 1).

- Moreover, if at all a farmer wants to purchase the required quantity of readily available mulberry saplings, not easily available, if available involves drudgery & expenditure in uprooting, transportation and establishment.
- Even after transportation & transplantation causing loss of sapling mortality lacking post transplantation care, at times due to unavoidable circumstances if farmers want to post pone the plantation cannot because of fearing desiccation of saplings.

Soft shoot propagation

In traditional hard wood propagation systems, seed cuttings are obtained from seed gardens at the most twice in a year, leading to time lapse between evolution of an improved mulberry variety and its exploitation in the farmers fields. However, plant types through softwood cutting is practiced in a variety of crops like Eucalyptus, forest nurseries using seedling propagation through root trainer methods (Ercisli and Read, 2001; Radwan *et al*., 1989, Pijut and Moore, 2002) including

Raising of clonal Eucalyptus saplings on commercial scale at ITC, Bhadrachalam, Telangana State

Forest nurseries raised on commercial at Central Forest Research Station (CFRS), Chetticulum, Kerala

Fig. 2. Rising of saplings and seedlings on commercial scale through the use of clonal & root trainer methods.

temperate mulberry varieties as in China and Japan (Mogili, 2000). Mogili *et al.* (2011) attempted in generating mulberry saplings by using soft or green wood cuttings from the seed wood gardens between 45-60th day after pruning. The cuttings were treated with root promoting hormone (NAA) and planted in soil covering with bamboo framed polythene sheets and produced rooted saplings in 45 days of time. In this process they have achieved 75-85% survival but incurred the same drudgery as involved in the traditional cutting plantation. Keeping the problems involved in raising of traditional (bed) saplings, through the use of 'Clonal production of saplings with root trainer methods' has become imperative for large scale production of established clonal saplings in shorter span of time (100 days) with less drudgery, economic and easily transferable & transplantable by the farming community. Vegetative propagated saplings developed from a single superior tree with most desirable qualities along with the ortet constitute a clone. Therefore, clonal saplings of each clone are uniform and true to type with all the genetic qualities of the mother tree. Each clone represents a particular genotype and the genetic traits differ from clone to clone (Lal, 2008). Hence, the study initiated to impart the same technology in mulberry.

MATERIALS AND METHODS

Keepings the above problems involved in sericulture propagation, to generate large scale production of clonal mulberry saplings through the use of rapid method with the existing infrastructural facilities *in vivo* farm trials were undertaken at Regional Sericultural Research Station, Central Silk Board, Kodathi, Bangalore.

Clonal production of saplings using root trainer methods: These methods are very popular in the production of Forest nurseries at Central Forest Nursery Station, Chalakkudi, Kerala and *Eucalyptus* multiplication center at ITC, Bhadrachalam, Telangana State. In these processes *Eucalyptus* clones (coppice) were collected from 30 days after wood cut gardens and processed for the production of saplings as depicted in the Fig. 2. Similar procedures were imparted in the production of mulberry clonal saplings (Fig. 3). A healthy and well maintained clonal mulberry garden of 25-30 days old after pruning was selected for the selection and collection of mulberry clone (coppice) material for using in clonal mulberry saplings generation and processed in the following manner:

Fig. 3. Processes involved in the rapid production of mulberry clonal saplings

Fig. 4. Clonal mulberry saplings of fully established 100 days old and ready for supply to the sericulturists

Mulberry shoots of 25-30 days old were collected from each coppice shoot 5-8 clonal segments were cut keeping 2-3 leaflets by trimming each leaf let in ¼ size keeping intact with petiole (Fig. 4). The clonal cuts were dipped in a thoroughly mixed IBA/IAA composition of 5000ppm concentration (in combination of 5g IAA or IBA+ 40g Bavistin or Capstan (fungicide)+40g Boric acid+ 915g Talcum powder). Each clonal cuts were dipped in the above plant growth promoting composition and planted in the root trainer plastic blocks filled with manure+coir pith+soil+sand in the ratio of 50:30:15:5%, respectively. Under any circumstances if the clonal cuts process is required to be postponed coppice material can be stored in water drums for 2-3 days in shade.

After plantation plastic cones were incubated in the poly-house under high humidity (>90% RH) & high temperature (>45 ºC) using mist form of sprinklers in 15-20mts interval for 2mts. Thirty (30) days after the poly-house treatment saplings were shifted to the shade net house (of 75% shade) for 7-10 days to acclimatize the open environment. Followed by the shade net incubation the sapling cones were shifted to the tree shade areas for 60 days making ready for supply to the buyers (Fig. 3 & 4). The production of traditional mulberry saplings using mature (6-8months old) cuttings were raised following the standard procedures (Dandin *et al*., 2003).

RESULTS AND DISCUSSION

The perusal of the results presented in Table 1 and Fig 1 & 2 indicated that the averages of the five trials of raising the mulberry saplings through the use of clonal and traditional methods revealed that percent of saplings sprouted was higher in clonal saplings (93.4%) compared to the traditional method (87.0%). Survival percentage of the clonal saplings were also recorded higher (88.2%) followed by the traditional method of saplings rising (76.4%). The study revealed that 13.32% increase of survival of clonal mulberry saplings was noticed compared to traditional method indicating its superiority over traditional practice (Table 1).

In case of aerial growth and biomass of shoots and root growth and biomass studies presented in the Fig. 5 & 6 revealed that, significantly improved levels of sapling growth, no. of tillers shoot biomass was noticed. The shoot height was noticed with 48.78% improvement, no. of shoots with 37.14% and shoot biomass was recorded with 41.89% increases was noticed over the traditional sapling production. In case of root proliferation 41.55% increase of root length, 268.24% increase of root lets and 71.36% increase of root biomass was noticed in the clonal mulberry saplings compared to the traditional production of mulberry saplings (Table 2, Fig 5 & 6).

Table 1. Sprouting & survival performance of clonal mulberry saplings compared to traditional

Trials	No. of saplings (planted)	% of saplings sprouted		% of saplings survived		% of Improvement over traditional (%)
		Traditional	Clonal	Traditional	Clonal	
1	300	85	92	72	81	11.1
2	300	91	95	80	92	13.0
3	300	80	90	71	89	20.2
4	300	89	96	78	90	13.3
5	300	90	94	81	89	9.0
Average	300	87.0	93.4	76.4	88.2	13.32

Table 2. Establishment and growth behavior of Clonal and traditional (bed) mulberry saplings.

Sl No	Growth parameters	Type of saplings	Growth behavior of saplings
A.	Aerial growth of the saplings:		
1	Plant height	Traditional (cm)	11.50
		Clonal (cm)	22.45
		% of increase	48.78
2	No. of branches	Traditional (cm)	3.50
		Clonal (cm)	4.80
		% of increase	37.14
3	Shoot biomass (g)	Traditional (cm)	18.50
		Clonal (cm)	26.25
		% of increase	41.89
B.	Root growth of the saplings:		
4	Root length (cm)	Traditional (cm)	10.35
		Clonal (cm)	14.65
		% of increase	41.55
5	No. of root lets	Traditional (cm)	6.8
		Clonal (cm)	25.04
		% of increase	268.24
6	Root biomass (g)	Traditional (cm)	10.65
		Clonal (cm)	18.25
		% of increase	71.36

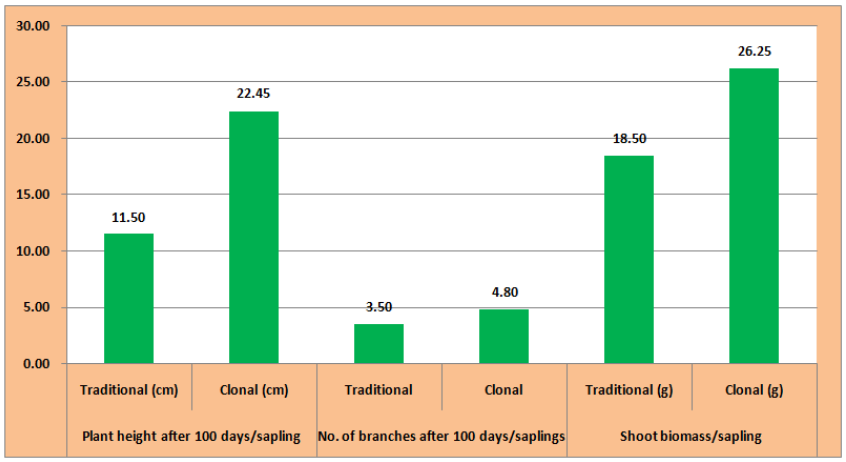

Fig. 5. Aerial biomass variation of clonal mulberry saplings compared to traditional saplings

The advantages of using intensively managed container-grown stock plants are becoming more and more obvious for many other perennial habit of plants (Wendling and Xavier, 2003; Titon, 2006). It is indeed much cheaper and easier to monitor and manage than the hydroponics or sub-irrigation systems which are currently more and more adopted for mass producing eucalyptus and other forest tree species by rooted cuttings in many parts of the world (Alpoin *et al*., 2004; Jimenez, 2005). The rationale for promoting mass clonal propagation by rooted cuttings of selected tree genotypes by intensive stock plant management has been argued and demonstrated for a long time on different arborescent species (Franclet, 1977). Use of root trainer polythene blocks in forest nurseries have been extensively used at Kerala Central Forest Nurseries during 1997-98 Kerala. (Anonymous, 1996; Chandra, 1998).

When assessed the cost economics between clonal and traditional (bed) mulberry saplings production it was noticed that there was a huge margin of profit among the both practices. Through traditional (bed) mulberry saplings production hardly 5 lakhs/ha/yr of saplings were produced with a sale value of Rs. 3/- per saplings. Whereas in case of clonal mulberry saplings production on an average 25 lakhs mulberry saplings can be possible to generate per year with a sale value of Rs. 5/- per sapling. Basing on the above facts the sericulturists can obtain huge margin of financial benefits if adopted clonal mulberry saplings production (Fig. 7). Maintaining by frequent pruning or pinching operations, the production of shoots to be used as cuttings close to the root system has been proven to promote their ability for adventitious rooting and true-to-typeness development once

rooted (Franclet, 1977; Monteuuis, 1993). Such practices shorten indeed the distance between the roots and the shoot apical meristems, whose role for true-to-type cloning is determining, in other words, between the "sources "and the "sinks" from a metabolic viewpoint.

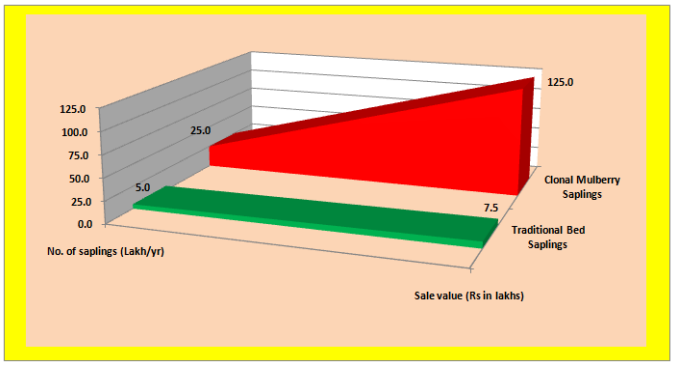

Fig. 6. Root growth and proliferation of clonal mulberry saplings compared to traditional saplings

The architecture of the stock plant becomes simplified and the within-plant variability responsible for physiological gradients minimized for a more uneven physiological condition of the shoots, and assumedly a better morphologic uniformity of the resulting rooted cuttings (Saya *et al*., 2008). This is consistent with other findings on different species, especially when starting from mature original ortets (Monteuuis, 1993; Aimers-Halliday *et al*., 2003). In India during 1992-1999, 5.64 million saplings of genetically superior fast growing clones covering 3217 ha area among 1914 farmers was undertaken with Eucalyptus and Casuarina successfully under the ITC, Bhadrachalam (Lal, 2001; Kulkarni, 2013).

Conclusion

Pre rooted mulberry saplings of any variety has been proved to be good to use in mulberry cultivation for proper establishment and to economize the cost of cultivation of the sericultural farming community. However, traditional method of vegetative mulberry sapling production has got certain limitations such as its laborious, labour intensive, time consuming and economically not viable because of incurring expenditure on uprooting, transportation and plantation by the farming community. Further, un-scientific method of uprooting, transportation and transplantation is also incurring huge loss due to poor survivability. Therefore under the circumstances production 'Certified improved mulberry varietal saplings' of healthy grown with profuse rooting, easily transportable and assured survivability after transplantation in the field has become priority for the benefit of farming community. Therefore, rapid production and spread of superior crop plant varieties within the shortest possible time is as essential as developing them to justify the need for investment of resources in breeding programmes. In sericulture, it is often felt the superior varieties of food plants and silkworms reach the end users taking a long time leading to under utilization of the existing potential. The clonal production of mulberry saplings generated in 100 days of duration opens avenues to produce large quantities of required variety against the demand of the farming community for the popularization of evolved variety for the vertical and horizontal development of the sericulture industry.

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