Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.2, No.5, 2012

Screening of Selected Mulberry (*Morus*) Germplasm Varieties Through Propagation Parameters.

V. N. Yogananda Murthy[1*] H. L.Ramesh[2] Munirajappa[3] B. R. Dayakar Yadav[4]
[1]Department of Life Sciences, Ganga Kaveri Institute of Science and Management, Dr. Rajkumar Road, Rajajinagar, Bangalore – 560 021, Karnataka, INDIA.
[2]Department of Sericulture, V.V.Pura College of Science, K. R. Road, Bangalore – 560 004, Karnataka, INDIA.
[3]Department of Sericulture/Life Sciences, Jnana Bharathi Campus, Bangalore University, Bangalore – 560 056, Karnataka, INDIA.
[4]Central Sericultural Research and Training Institute, Central Silk Board, Mysore - 570 008, Karnataka, INDIA.
[*]E-mail of the Corresponding Author: yoga16@rediffmail.com

Abstract

Nine mulberry varieties along with one check variety M_5 were field tested at Bethamangala village of Kolar district, Karnataka. These mulberry varieties were evaluated for the propagation parameters, like sprouting, survival, shoot growth and rooting behaviour. Results showed that, sprouting percentage was above 95% inTR_8, TR_{12} and S_{1708} mulberry varieties, while survival rate was as high as 93% in S_{1708}. Mulberry variety S_{1708} recorded highest shoot length of 62.63cm and shorter shoot length was recorded in C_6(35.55cm). Mulberry varieties studied exhibited considerable variations in fresh shoot and dry shoot weight. Among the mulberry varieties studied, *Matigara black* showed the longest root length (25.99cm) followed by TR_{12} (23.57cm) and TR_8 (21.98cm). Numbers of roots / sapling were recorded more in *Matigara black* (42) and less in TR_8 (14). Root volume was significantly high in *Matigara black* (16.27ml) and Tr_{20} (14.21ml) when compared to other varieties. Overall the mulberry variety S_{1708} showed better results in many propagation characters followed by TR_8 and TR_{20} mulberry varieties.

Key Words: Growth, mulberry germplasm; sprouting; survival; rooting; root length, root volume.

1. Introduction.

It is a well-established fact that, in commercial sericulture, more than 60% of the total cost of cocoon production goes towards mulberry production alone. Hence, in recent years maximum attention has been given for the improvement of mulberry both in terms of quality and quantity. The major objective of mulberry crop improvement is to evolve new elite mulberry varieties for high leaf yield, resistance to pests, drought and their adoptability to different agroclimatic conditions. The genus *Morus* L. is highly heterozygous with a lot of variations in the off springs. Propagation of mulberry is done through vegetative means such as planting of cuttings or by grafting so as to preserve the phenotypical characters. Most of the mulberry species in the tropical conditions display tremendous rooting ability because of this mulberry propagation is invariably carried out through planting of cuttings (Doss, 2000). Survival rate is considered as one of the important criteria as mulberry varieties are propagated through vegetative means (Tikader and Kamble, 2009). Kolar district is the traditional sericulture belt in Karnataka. It enjoys a moderate climatic condition with an annual rainfall of 600mm-700mm, mean temperature of 32^{o}C and low humidity of 40%. Sericulture is one of the main occupations covering all 11

taluks in Kolar. Many farmers are depending upon sericulture for their livelihood. The total area under mulberry is around 29,136 ha. and the industry provides employment to about 68,700 persons. Two popular mulberry varieties namely M_5 and Mysore local are used for cultivation both under irrigated and rainfed condition. With the development of sericulture industry and the recent increase in the technical know-how, it has become very essential to evolve better performing mulberry varieties to fulfill the demand of Sericulturists. Hence, it becomes obligatory to examine the agrobotanical parameters while evaluating mulberry germplasm. Therefore, the present investigation was initiated to identify and record suitable mulberry variety for the Kolar agroclimatic region.

2. Materials and Methods.

2.1. Study Area

The experiment was conducted at Bethamangala village of Bangarpet taluk in Kolar district, Karnataka during 2007-2011. This village is located at 12º37^{I} north of the equator and 78º28^{I} east longitudes and 793m altitude above MSL, with an annual rainfall of 650mm. Soil of the experimental plot was red loamy with slightly acidic condition.

2.2. Collection and Preparation of Sampling

Mulberry varieties TR_8, TR_{12}, TR_{20}, S_{1708}, MS_5, *Matigara black*, *Morus nigra*, C_6 and C_{10} were selected from the germplasm bank maintained at CSGRC, CSB, Hosur, Tamil Nadu based on the morpho-anatomical parameters were used in the investigation. The variety M_5 is used as a check variety for the purpose of comparison. The hard wood stem cuttings of all the taxa were prepared choosing the middle part of the Juvenile twigs in order to maintain the optimum moisture and desired level of carbon-nitrogen ratio (Starting, 1923). Each cutting measured about ½" in diameter and 12" in length possessing 3-4 active vegetative buds. Cuttings free from pathogen and pests were chosen for multiplication. Due care was taken to avoid damages to the buds and cut ends while preparing the cuttings (Hartman and Kester, 1978; Bindroo *et al*., 1988).

2.3. Experimental Analysis

Cuttings were planted in the freshly prepared nursery containing well-dried pulverized garden soil, sand and well-decomposed farmyard manure in the proportion 1:1:1 and maintained with consistent care (Jolly and Dandin, 1986; Krishnaswami, 1986a). The experiment was carried out in RBD method with 5replications / variety. During the course of investigation, growing saplings were used to score the various propagation parameters viz., sprouting percentage, survivability, shoot length, fresh shoot weight, dry shoot weight, number of roots/sapling, root length, fresh root weight, root volume were recorded (Dandin and Jolly, 1986; Das *et al*., 1987; Shamachry and Jolly, 1988; Dandin and Kumar, 1989; Bhat and Shilaja Hittalamani, 1992) from time to time in the different season's viz., summer, rainy and winter.

2.4. Statistical Analysis

The data collected on various parameters subjected to statistical analysis by adopting "Method of Analysis of Variance" appropriate to the design of the experiment (Sundarraj *et.al*., 1972; Singh and Choudhary, 1979).

3. Results

The data on the propagation parameters of the selected nine mulberry varieties were compared with the check variety M_5. The values are presented in table. Significant variations were observed in respect of sprouting, survivability and root proliferation characters among the varieties.

3.1. Sprouting

The capacity and quickness of sprouting determine the subsequent growth and yield in fodder crops like mulberry (Hartman and Kester, 1978). Success of the establishment of a new mulberry garden mainly depends on sprouting ability of the mulberry variety. It is an established fact that, sprouting is an inherent capacity of the varieties to unfold buds and produce new shoots. However, the role of moisture and other agro climatic features cannot be ruled out in favouring sprouting of mulberry genotypes (Dandin and Kumar, 1989). In the present investigation, the taxa studied showed variation in sprouting. Mulberry varieties Tr_8 (97%), S_{1708} (96%) and Tr_{12} (95.5%) exhibited good sprouting ability followed by TR_{20} (91%), *Matigara black* (87%), C_{10} (83%), MS_5 (83%), Morus *nigra* (80%). Lowest sprouting was recorded in C_6 (79.5%). However, the check variety M_5 revealed higher sprouting percentage (98%) over other varieties is attributable to the fact that, the variety being a local cultivar that can easily acclimatized to the existing climate (Table-1).

3.2. Survivability

Survivability is the capacity of a plant to with stand and survives under varied agro climatic conditions. Survivability rate depends on genetic constitution as well as the influence of ambient environmental conditions (Honda, 1970). Higher the survival percentage better will be the performance of the mulberry variety. In the present findings, mulberry varieties studied revealed significant variations in survivability ranging from 93.25% to 67.75%. Mulberry variety S_{1708} showed highest survival percentage (93.25%) followed by M_5 (90.75%) and TR_8 (82.00%). On the other hand varieties C_{10} (75%) C_6 (71.5%), TR_{12} (70%), *Morus nigra* (69%), *Matigara black* (68.75%), MS_5 (68.5%) and TR_{20} (67.75%) recorded significant decrease in survivability when compared to S_{1708} mulberry variety (Table-1).

3.3. Root proliferation parameters

The important criterias considered in vegetatively propagated crop plants are the rooting ability and root initiation, since a well-developed root system determines the maximum utilization of nutrients from the soil for growth and development (Hartman and Kester, 1978). Studies on rootability are extremely important for characterisizing different plant genotypes and their general growth pattern in response to various edaphic and agro climatic conditions as well as their efficiencies in nutrient and water uptake. Root proliferation parameters like shoot length, fresh shoot weight, dry shoot weight, number of roots/sapling, root length, fresh root weight and root volume are variable according to mulberry varieties and also influenced by existing agro climatic factors (Fotadar *et al*., 1989). Present results revealed that, shoot length was longer in S_{1708} (62.63cm) followed by TR_8 (57.50cm), TR_{20} (55.87cm), *Matigara black* (54.43cm), M_5 (54.12cm), TR_{12} (51.48cm), MS_5 (48.56cm), C_{10} (45.50cm), *Morus nigra* (40.15cm) and C_6 (35.55cm). Fresh shoot weight in the varieties studied also varied significantly. Highest fresh shoot weight was found in the variety S_{1708} (78.89 gm) and lowest was found in *Morus nigra* (24.00 gm). The varieties TR_{20}, TR_8, *Matigara black*, M_5, C_{10}, TR_{12}, MS_5 and C_6 showed the fresh

shoot weight of 57.25gm, 40.52gm, 32.39gm, 32.11gm, 30.16gm, 27.02gm, 26.63gm and 26.14gm respectively. A considerable variation among the varieties screened with respect to dry shoot weight was also observed. Highest dry shoot weight was recorded in S_{1708} (26.75gm) followed by TR_{20} (13.98gm), TR_8 (10.92gm) and *Matigara Black* (8.92gm). Lowest dry shoot weight was found in variety *Morus nigra* (6.86gm). The varieties M_5, C_{10}, TR_{12}, C_6 and MS_5 showed 8.78gm, 8.63gm, 8.28gm, 7.54gm and 7.15gm of dry shoot weight respectively. With respect to number of roots / sapling, the mulberry varieties studied showed considerable variations. Roots were more in *Matigara black* (42), TR_{12} (31), *Morus nigra* (27), MS_5 (26) and C_{10} (24) varieties. All other varieties viz., S_{1708} (18), M_5 (18), TR_{20} (16), C_6 (16) and TR_8 (14) recorded less number of roots. Root Length was longer in *Matigara black* (25.99cm), TR_{12} (23.57cm), TR_8 (21.98cm) and *Morus nigra* (21.83cm) compared to other varieties. M_5 variety revealed shorter root length (16.06cm). Fresh root weight was highest in *Matigara black* (16.67gm) followed by TR_{20} (13.86gm) and lowest fresh root weight was recorded in M_5 (2.57gm). Mulberry varieties TR_8, S_{1708}, *Morus nigra*, TR_{12}, MS_5, C_{10} and C_6 recorded (7.51gm), (5.39gm), (5.18gm), (4.81gm), (4.51gm), (3.95gm) and (2.57gm) fresh root weight respectively. The root weight has a relation to root volume of the plant. The root volume also significantly varied among the varieties. *Matigara black* recorded highest root volume (16.27ml) followed by TR_{20} (14.21ml). Overall, the variety M_5 recorded least root volume (4.17ml) in the field trial (Table-1).

4. Discussion

4.1. Sprouting

A few workers carried out similar work in the earlier years. Jolly and Dandin (1986) in the mulberry varieties Kaliakutahi, *China white*, Assambola, $Sujanpur_1$, local male, S_{41}, ACC_{112}, AB x $Phil.P_9$, Miz x BCP_{12} and AB x $Phil.P_6$ with 92% sprouting and reported that tropical mulberry varieties are good in sprouting. They are also of the opinion that, though sprouting is a genetic feature of the strain, soil moisture and temperature also contribute equally for the cause. Susheelamma *et al*., (1990) enlisted Sujanpur-1 is the best sprouting one among the varieties studied. Susheelamma *et al*., (1992) observed highest sprouting in mulberry variety S_1 (89.4%) followed by Local (87%). Agastian *et al*., (1995) reported that, mulberry varieties S_{36}, S_{30} and BC_{259} registered good sprouting ability when compared to other varieties studied. Hardhan Sahu *et al*., (1995) studied 36 mulberry accessions for their sprouting ability. They enlisted the variety Himachal local is best in sprouting (95.1%) followed by ACC_{165}, MS_5, MR_2, MS_6, Surat, ACC_{121} and S_{13} varieties screened. Sujathamma and Dandin (1998a) observed highest sprouting (97.17%) in $Sujanpur_5$ mulberry variety followed by Tr_4 (88.42%) and OPH_3 (41.04%). Baksh *et al*., (2000) reported that, mulberry genotype ACC_{48} registered highest sprouting (97.92%) followed by C_4 (97.22%), S_{1301} (95.83%) and Tr_8 (95.14%). Doss *et al*., (2000); Eswar Rao *et al*., (2000); Vijayan *et al*., (1998) have studied the propagation characteristic features of diploid, triploid and tetraploid mulberry genotypes in nursery conditions. They found that, triploids saplings possess larger leaves and grow more quickly than those of diploid and tetraploid genotypes. Eswar Rao *et al*., (2000) were opined that, highest sprouting percentage of mulberry cuttings was recorded in diploid varieties (93.33%) followed by triploids (91.35%) and tetraploids (80.98%). Similar observations were also confirmed from the present findings. Chandrashekar *et al*., (2001) noticed good sprouting in mulberry varieties V_1, M_5, DD and S_{30}. Santosha Gowda V. Patil (2002) reported that, mulberry variety S_{1635} cultivated under 60cm x 60cm recorded 98% of sprouting.

4.2. Survivability

Sujathamma and Dandin (1998a) recorded highest survival rate in $Sujanpur_5$ (96.17%) followed by Tr_{10} (93.75%) and MS_8 (30.08%). Vijayan *et al*., (1998) stated that, triploid mulberry varieties usually reveal 96.67% of survivability rate. Sharma (1993) observed 79%-90% survival rate in Mandalay, K_2, TR_{10} and S_{146} mulberry varieties when cultivated in Uttar Pradesh. Similar observations were made by Hardhan Sau *et al*., (1995) in the mulberry variety Surat which showed highest survival rate (97.1%) followed by K_2, ACC_{115}, ACC_{121}, MR_1, ACC_{120}, ACC_{153}, Punjab local, $Sujanpur_5$ and $Shrim_8$. Chandrashekar *et al*., (2001) reported that, mulberry genotypes V_1, M_5, DD and S_{30} were best in survivability rate compared to other genotypes studied. Darshan Singh *et al*., (2001) were of the opinion that, triploid mulberry varieties are good in survivability when compared to temperate varieties.

4.3. Root proliferation parameters

Since mulberry is chiefly propagated through cuttings, rooting behaviour assumes paramount importance in choosing a promising mulberry variety for cultivation. Rooting behaviour of a variety is purely genetic character and plays a prominent role in the cultivation of vegetatively propagated crops (Honda, 1970; Susheelamma and Jolly, 1986; Goel *et al*., 1998). Lin (1981) opined that lower rooting mulberry varieties have 2-3 layers of overlapping sclerenchyma tissues whereas in high rooting varieties they were scattered over the primary cortex. Profusely rooting varieties showed higher activity of growth substances. There are positive correlations between carbohydrate, total sugar and rootability. High C/N ratio and more aspartic acid and cystine were found in good rooting mulberry varieties. The development of root system in terms of spread, depth and density control the utilization of soil resources for plant nutrient supply and also rooting in mulberry varied greatly between genotypes and various edaphic conditions (Bhatt and Hittalamani, 1992). The present observations are more or less similar to the findings of Susheelamma and Jolly (1986). They suggested the existence of high variability among the mulberry varieties in root growth characters and better scope for the selection. Regeneration capacity, growth and root induction varies greatly among the genotypes. Jolly and Dandin (1986) enlisted ACC_{117}, ACC_{165}, Miz x BCP_9, *English black*, RFS_{135}, ACC_{121}, Kaliakutahi, $Kokuso_{21}$, Local male and $Sujanpur_5$ are the best ten in rooting ability (90%-100%) among the mulberry varieties studied. Fotadar *et al*., (1989) studied some temperate mulberry varieties and they reported that, among the varieties observed, china white showed the best rooting (62.7%). Susheelamma *et al*., (1990) enlisted LS_1 and *English black* are best in rooting ability among the varieties examined. Further, they have also reported that tropical mulberry varieties are good in rooting. Mala *et al*., (1992) reported that, mulberry varieties $Kokuso_{21}$ a hybrid of *Morus multicaulis* and $Kokuso_{13}$ and a hybrid of *Morus bombycis* and *Morus latifolia* produce highest rooting percentages (76.67%-90.00%). Susheelamma *et al*., (1992) observed highest rooting in local mulberry variety (95.5 %) followed by ACC_{203} (94.2%). Hardhan Sau *et al*., (1995) observed the best rooting performance in the mulberry varieties ACC_{165}, ACC_{118}, S_{36} and Punjab local. Agastian and Vivekanandan (1997) reported highest rooting potential in BC_{259}, S_{30}, S_{36} and ACC_{235} mulberry genotypes. Sujathamma and Dandin (1998a) reported that, mulberry variety $Sujanpur_5$ was superior among all the genotypes tested with 96.17% rooting ability. Eswar Rao *et al*., (2000) observed that cutting from 1-3 year old plants had 82.6% to 94.66% rooting. Triploid forms rooted better than diploids and tetraploids. Similar results were also observed in the present findings. Masilamani *et al*., (2000)

studied 18mulberry genotypes for their growth parameters and related traits. They reported that, high phenotypic and genotypic coefficient of variation were recorded for shoot to root ratio by dry weight per plant (38.42% and 37.09%) and volume of roots per plant (37.91% and 34.62%), indicating wide range of variability (93.24% and 83.29%) coupled with high genetic advance over mean (73.55% and 65.13%) recorded by these traits. Shoot length and number of roots per plant had moderate values of heritability (72.67% and 68.05%) and genetic advance over percentage of the mean (46.51% and 50.70%). Baksh *et al*., (2001) screened twenty-seven mulberry genotypes comprising 18 tropical and 9 sub-tropical cultivars for their rooting and leaf yield. They reported that S_{36} and Mandalay exhibited more stable in rooting and they opined that there is no correlation between rooting ability and leaf yield. Sinha *et al*., (2001) evaluated four elite mulberry varieties viz. S_1, K_2, C_{763} and C_{776} under partially irrigated conditions on the basis of growth parameters like extension growth, branching, no. of leaves, leaf area, 100 leaf weight, weight of 100 sq cm laminar area, total photosynthetic area, fresh leaf yield and moisture content of leaf and reported that, mulberry variety S_1 was found to be the best from sericulture point of view and NPK @ 150:50:50 kg/ha/yr. in combination of FYM @ 10 MT/ha/yr. was found to be the most cost· effective fertilizer level under partially irrigated conditions. Santosha Gowda V. Patil (2002) noticed that, mulberry genotype S_{1635} grown under 60cm x 60 cm plants spacing revealed good rooting (87%) compared to M_5 (81%). Adolkar *et al*., (2007) evaluated six mulberry varieties K_2,Thailand, Thika, S_1, S_2 and S_{36} for growth and yield parameters and reported that, all the varieties differ significantly in results and mulberry variety S_{36} exhibited superiority in characters over other cultivars tested. Paul and Quiyyum (2010) reported that, irrigation has significant effect on leaf yield and some of its components. Twice irrigation in a month with mulberry variety BM_4 gives higher leaf yield. Gnanaraj *et al*., (2011) reported that, among the four saline tolerant mulberry genotypes S_{1635}, S_{36}, S_{13} and MR_2 studied, S_{1635} gives good results in growth and yield parameters compared to other 3 genotypes.

Conclusion.

Nine indigenous mulberry varieties were evaluated in the field condition for growth and propagation parameters. Clonal population is popular in mulberry cultivation since mulberry is a cross pollinated and heterozygous plant. In the present investigation observations revealed that, two mulberry varieties namely S_{1708} and Tr_8 performed notably well when compared to other varieties selected for investigation. Further, these two mulberry varieties require detailed bio-chemical, bio-assay studies and multilocational tests to qualify to become authorised cultivars for commercial exploitation. Experiments are underway to confirm the superiority of these varieties.

Acknowledgements

Authors thank the authorities of CSGRC, Central Silk Board, Govt. Of India, Hosur, Tamil Nadu for providing the germplasm mulberry varieties. Special thanks to Mr. B. R. Vasudev, Rtd. Deputy Director, Department of Fisheries, Govt. of Karnataka and family, Bethamangala, Kolar district, Karnataka for providing necessary requirements for carrying out the present research work.

References.

Adolkar, V.V., Raina, S.K. & Kimbu D.M. (2007), "Evaluation of various mulberry *Morus spp*. (Moraceae) cultivars for the rearing of the bivoltine hybrid race Shaanshi BV-333 of the silkworm *Bombyx mori* (Lepidoptera: Bombycidae)", *Int. J. Tropical Insect Science*, **27**: 6-14. doi:10.1017/S174275840774537X.

Agastian Sim Yan Theoder, P., Dorcus, D. & Vivekanandan, M. (1995), "Screening of mulberry varieties for saline tolerance", *Sericologia*, **35(2)**: 487-492.

Agastian, P. & Vivekanandan, M. (1997), "Evaluation of mulberry genotypes for saline tolerance by chemo and bio-assay", *Indian J. Seric*., **36(2)**:142-146.

Baksh, S., Mir, M.R., Darzi, G.M. & Khan, M.A. (2000), "Performance of hardwood stem cuttings of mulberry genotypes under temperate climatic conditions of Kashmir", *Indian J. Seric*., **39(1)**:30-32.

Baksh, S., Mir, M.R., Darzi, G.M., Khan, M.A. & Ahsan, M.M. (2001), "Performance of some mulberry varieties under temperate climatic condition of Kashmir". *Proceedings of Natl. Semi. Mulb. Seri. Res*., November, 26 – 28, KSSR&DI, Bangalore, India: 97.

Bhat, G.G. & Hittalamani, S. (1992), "Clonal differences in mulberry (*Morus* spp.) for root growth parameters", *Indian J. Seric*., **31(1)**: 5-8.

Bindroo, B.B., Tiku, A.K. & Pandit, R.K. (1988), "Response of Japanese mulberry varieties propagated through cuttings under Kashmir eco-climate", *Geobios*, **7(1):** 26-39.

Chandrashekar, S., Prakash, B.G. & Shaila, H.M. (2001), "Evaluation of different mulberry varieties with respect to establishment and yield", *Proceedings of Natl. Semi. Mulb. Seri. Res*., November, 26 – 28, KSSR&DI, Bangalore, India: 99.

Dandin, S.B. & Jolly, M.S. (1986), "Mulberry descriptor", *Sericologia*, **26(4)**: 465-475.

Dandin, S.B. & Kumar, R. (1989), "Evaluation of mulberry genotypes for different growth and yield parameters", In: *Genetic resources of mulberry and utilisation*. Ed. by Sengupta, K. and Dandin, S.B., CSR&TI, Mysore: 143-151.

Darshan Singh, Ajay Koul, Bali, R.K. & Ramesh Pandit. (2001), "Propagation of mulberry by cutting in subtropics", *Proceedings of Natl. Semi. Mulb. Seri. Res*., November, 26 – 28, KSSR&DI, Bangalore, India:123-124.

Das, B.C., Bindroo, B.B., Tiku, A.K. & Pandit, R.K. (1987), "Propagation of mulberry through cuttings", *Indian Silk*, **26(1)**: 12-13.

Doss, S.G., Vijayan, K., Rahman, M.S., Das, K.K., Chakraborti, S.P. & Roy, B.N. (2000), "Effect of plant density on growth, yield and leaf quality in triploid mulberry", *Sericologia*, **40(1)**: 175-180.

Eswar Rao, M.S., Mallikarjunappa, R.S. & Dandin, S.B. (2000), "Evaluation of tetraploid and triploid mulberry genotypes for propagation, growth and leaf yield parameters", *Proceedings of Natl. Conf. Stra. Seri. Res. Devpt*., November, 16 – 18, CSR&TI, Mysore, India: 2.

Fotadar, R.K., Ahsan, M.M., Dhar, K.L. & Bhakuni, B.S. (1989), "Evaluation and utilization of genetic variability in mulberry", *Indian J. Seric*., **28(2)**: 150-158.

Gnanaraj, M., Sivakumar, O. & Nobel Surya Pandidurai, R. (2011), "Genotypic variations for saline tolerance in morus species based on their overall attributes", *Int. J. Pharma and Bio Sciences,* **2(1):** 392-401.

Goel, A.K., Ravindran, S., Ananda Rao, A., Girish Naik, V., Tikader, A., Mukherjee, P. & Sekar, S. (1998), "Variability in rooting parameters at Juvenile stage in mulberry (*Morus* spp.) Germplasm", *Indian J. Seric.,* **37(2):** 109-112.

Hardhansau, Pradip Kumar Sahu, Dayakar Yadav, B.R. & Saratchandra, B. (1995), "Evaluation of mulberry (*Morus* spp.) genetic resources-I sprouting, survival and rooting ability", *J. Environ. Res*., **3(1)**: 11-13.

Hartman, H.T. & Kester, D.E. (1978), "Plant propagation – Principles and practices", Prentice Hall of India Pvt. Ltd., New Delhi.662.

Honda, T. (1970), "Studies on the propagation of mulberry trees by cuttings", *Bull. Seric. Expt. Sta*, Tokyo, Japan, **24(1)**: 133-145.

Jolly,M.S. & Dandin, S.B. (1986), "Collection, Conservation and Evaluation of Mulberry (*Morus* spp.) Germplasm", C.S.R & T.I., Mysore, India: 43.

Krishnaswami, S. (1986a), "Mulberry cultivation in South India", *Bulletin No.* 1, Central Silk Board, Bangalore, India: 1-19.

Lin, S.H. (1981), "Histological and biological studies on the rooting of hardwood cutting in mulberry (*Morus* spp.)", *Seric. J. Korea*, **23(1)**: 1-31.

Mala, V.R., Dandin, S.B. & Ramesh, S.R. (1992), "*Morus multicaulis*, a potential exotic introduction for mulberry improvement programme in India", *Sericologia*, **32(1)**: 85- 90.

Masilamani, S., Reddy, A. R., Sarkar, A. & Jayaswal, K. P. (2000), "Selection of quantitative traits in mulberry (*Morus* spp.) for root growth parameters", *Madras Agricultural Journal*, **87(10/12)**: 689-690.

Paul, N.K. & Quiyyum, M.A. (2010), "Effect of soil moisture regimes on growth and yield of mulberry", *Bangladesh J. Sci. Ind. Res*., **45(4)**:331-336.

Santosha Gowda V. Patil. (2002), "Evaluation of promising genotype S_{1635} under irrigated conditions", *Indian Silk*, **41(2)**: 7-9.

Sharma, P.C. Boruvah, P. & Bordoloi, D.N. (1993), "Vegetative propagation of mulberry (*Morus alba,* L.)", *Indian Silk*, May: 37-39.

Shamachary & Jolly, M.S. (1988), "A simple device for quick determination of mulberry leaf area in the field", *Indian J. Seric.,* **27(1)**: 51-54.

Singh, R.K. and Choudhury, B.D. (1979), "*Bio-metrical methods in quantitative genetic analysis*". Kalyani Publishers, New Delhi.

Sinha P.S., Gangwar, S.K., Singh, B.D., Jaiswal, J. & Griyaghey, U.P. (2001), "Evaluation of some elite mulberry *(morus alba* l.) varieties and NPK levels under partially irrigated conditions from sericulture view point", *Indian J Agric. Res*., **35(2)**: 71-78.

Starring, C.C. (1923), "Influence of the carbohydrate-nitrate content of cuttings upon the production of roots", *Proceedings of Amer. Soc. Hort. Sci*., **20**: 288-292.

Sujathamma, P. & Dandin, S.B. (1998a), "Evaluation of mulberry (*Morus* spp.) genotypes of propagation parameters". *Indian J. Seric*., **37(2)**: 133-136.

Sundararaj, G.L., Nagaraju, M.N., Venkataramu & Jaganath. (1972), "*Design and Analysis of field experiments*", U.A.S., Misc., Series No. 22, Bangalore, India: 424-440.

Susheelamma, B.N. & Jolly, M.S. (1986), "Evaluation of morpho-physiological parameters associated with drought resistance in mulberry", *Indian J. Seric*., **25(1)**: 6-14.

Susheelamma, B.N., Jolly, M.S., Giridhar, K. & Sengupta, K. (1990), "Evaluation of germplasm genotypes for drought resistance in mulberry", *Sericologia*, **30(3)**: 327-341.

Susheelamma, B.N., Kumar, J.S., Sikdar, A.K., Dandin, S.B., Jolly, M.S. & Sengupta, K. (1992), "Exploitation of promising mulberry germplasm genotypes for yield component", *Sericologia*, **32(2)**: 295-300.

Tikader, A. & Kamble, C.K. (2009), "Studies on sprouting and survival of different exotic mulberry (*Morus spp*.) accessions", *Indian J. Forestry*, **32(1)**: 81-84.

Vijayan, K., Chakraborti, S.P., Doss, S.G., Tikader, A. & Roy, B.N. (1998), "Evaluation of triploid mulberry genotypes I. Morphological and anatomical studies", *Indian J. Seric*., **37(1)**: 64-67.

First Author: Dr. V. N. Yogananda Murthy born on 22.06.1967 at Gubbi in Tumkur district, Karnataka, INDIA. He completed his Masters in Sericulture (M.Sc.) with First class in 1993 and Master of Philosophy (M.Phil.) in Sericulture with Distinction in 1996 from Dept. of Sericulture, Bangalore University, Karnataka, INDIA. He further pursued his Doctoral degree in Sericulture from Dept. of Sericulture, Bangalore University, and awarded Doctor of Philosophy (Ph.D.) in 2003. His major areas of research interest are Plant Breeding & Genetics, Evaluation, Biochemistry & Plant and Agricultural Biotechnology. Author is a LIFE MEMBER [L 16335] for the Indian Science Congress Association, KOLKATA, West Bengal, India and LIFE MEMBER [L 1005] for the Applied and Natural Science Foundation (ANSF), Journal of Applied and Natural Science, Gurukula Kangri University, Haridwar, Uttarakhand, India. Author has presented 13 research papers at National Conferences and 8 at International Conferences. He has to his credit 8 Research Papers published in National and International peer reviewed journals. Author is a Resource Person for preparing Course Curricula (E-Content) in Sericulture for Ministry of Human Resources Development, Government of India, NEW DELHI. In 2009, he was a Board Member for framing syllabus to Sericulture Sector for Modular Employable Skills (MES) under Directorate General of Employment and Training, Ministry of Labor and Employment, Government of India, NEW DELHI. He Chaired a technical session in the International Conference on Bioremediation & Environmental Management and Polar Science & Technology (24th Annual Conference on National Environmental Science Academy, NEW DELHI) held at Bangalore in 2011, Karnataka, INDIA. Author is recognised as a Research Guide for M.Phil. Research programme from Periyar University, Tamil Nadu, INDIA and guided for 4 M.Phil. students. He has completed one UGC sponsored Research project in Sericulture as a co-investigator. Author has organized One Day Seminar on Recent Trends in Biotechnology, Three Days National Conference on Medicinal and Aromatic Plants, Workshop on PCR, Workshop on Agro Bacterium Mediated Transformation. He is a B.O.E Member for Under Graduate and Post Graduate in Biotechnology in Bangalore University. Author worked as LECTURER in the Dept. of Sericulture, K.G.F First Grade College, Oorgaum, K. G. F.- 20 from 1994 – 2000 and presently working as Principal and Professor in the Department of Life Sciences, Ganga Kaveri Institute of Science and Management, Bangalore, Karnataka, INDIA.

Second Author: Dr. H. L. Ramesh born on 05.01.1964 at Bangalore, Karnataka, INDIA. He completed his Masters in Sericulture (M.Sc.) with First class in 1987 and Doctoral degree (Ph.D.) in Sericulture from Dept. of Sericulture, Bangalore University, Karnataka, INDIA in 1997. His major areas of research interest are Plant Breeding & Genetics. He published 10 Research Papers in National and International peer reviewed journals. He served as Research Advisory Committee (RAC) member in Karnataka State Sericulture Research and Development Institute (KSSR&DI), Govt. of Karnataka, Bangalore, India. He is a resource person for preparing E-Content in sericulture, MHRD, Govt. of India. In 2009, he was a board member for framing syllabus for Modular Employable Skills (MES), Govt. of India. He has completed 2 projects sponsored by VISION Group on Science and Technology, Govt. of Karnataka, Bangalore. He worked as organizing secretary and has organized 3 National and 1 International Conferences. He is a B.O.E and B.O.S Member in Bangalore University, University of Mysore and Kuvempu University in Karnataka and Yuvarajas College in Mysore.

Third Author: Dr. Munirajappa born on 11.11.1950 in Bangalore, Karnataka, INDIA. He completed his Masters in Botany (M.Sc.) in 1975 and Doctoral degree (Ph.D.) in Botany from Dept. of Botany, Bangalore University, Karnataka, INDIA in 1980. His major areas of research interest are Plant Breeding & Cytogenetics. He has presented 20 research papers at National and International Conferences and Published 3**0** Research Papers in National and International peer reviewed journals. In 2009, he was a Vice-chairman for Modular Employable Skills (MES), Govt. of India for framing syllabus in Sericulture Sector. He has organized several National Conferences. He is a Member, Board of Appointment, Board of Studies and Board of Examination for Under Graduate and Post Graduate courses in various Universities in INDIA. He has guided 6 M.Phil and 10 Ph.D students. Presently working as Senior Professor in Department of Sericulture and Coordinator, Department of Applied Genetics, Bangalore University, Bangalore, Karnataka, INDIA.

Fourth Author: Dr. B. R. Dayakar Yadav born on 26.12.1952 in Bangalore, Karnataka, INDIA. He completed his Masters in Botany (M.Sc.) in 1975 from Dept. of Botany, Bangalore University, Karnataka, INDIA. He pursued his doctoral degree in Botany from Agarkar Research Institute (MACS) Pune, University of Poona, INDIA and awarded Doctor of Philosophy (Ph.D.) in 1980. His major areas of research interest are Mycology and Plant Pathology, Evaluation, Plant Breeding & Genetics. He has Overseas Advance Training in Sericulture (Mulberry Protection) at JAPAN from Aug – Dec. 1986, Short-term Overseas Training in Mulberry Disease & Pests at Sericulture Research Institute, Chinese Academy of Agricultural Sciences, ZHENJIANG, P. R. OF CHINA from Sept - Nov. 1993. Author has presented around 8 research articles at and National Conferences and 5 at International Conferences. He has to his credit 57 Research Papers published at National and International peer reviewed journals. Presently author is having 2 projects. 1. “Disease Forecasting and Forewarning system” funded by Central Sponsored Scheme and 2. “Use of bio-control agents - *Burkholderia cepacia* and *Bacillus subtilis* against root rot soil borne fungal pathogens” funded by Central Silk Board, Bangalore. Presently he is working as Scientist – D in Mulberry Pathology Division at Central Sericultural Research & Training Institute, Srirampura, Mysore – 570 008, Karnataka, India.

Mulberry varieties	Sprouting (%)	Survival (%)	Shoot length (cm)	Fresh shoot wt. (gm)	Dry shoot wt.(gm)	No. of roots/ sapling	Root length (cm)	Fresh root wt.(gm)	Root volume (ml)
Tr_8	97.00	82.00	57.50	40.52	10.92	14	21.98	07.51	07.02
Tr_{12}	95.50	70.00	51.48	27.02	08.28	31	23.57	04.81	05.01
Tr_{20}	91.00	67.75	55.87	57.25	13.98	16	18.97	13.86	14.21
S_{1708}	96.00	93.25	62.63	78.89	26.75	18	17.95	05.39	06.07
MS_5	83.00	68.50	48.56	26.63	07.15	26	18.15	04.51	06.02
Matigara black	87.00	68.75	54.43	32.39	08.92	42	25.99	16.67	6.27
Morus nigra	80.00	69.00	40.15	24.00	06.86	27	21.83	05.18	09.56
C_6	79.50	71.50	35.55	26.14	07.54	16	16.59	03.58	05.80
C_{10}	83.00	75.00	45.50	30.16	08.63	24	20.72	03.95	08.64
M_5	98.00	90.75	54.12	32.11	08.78	18	16.06	02.57	04.17
CD@5%	5.20	5.43	2.02	0.15	0.56	1.07	0.24	0.07	0.17

Table - 1: Propagation parameters of selected mulberry germplasm varieties