Mysore J. Agric. Sci., 58 (1) : 65-73 (2024)

Evaluation of Fruit Yielding Mulberry Genotypes for Propagation and Growth Parameters

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AUTHORS CONTRIBUTION

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CHIKKALINGAIAH & S. MANJUNATH GOWDA : Planned the research programme and arranged for the mulberry genotypes;
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Received : November 2023
Accepted : December 2023

ABSTRACT

A study was conducted to evaluate the performance of eight elite fruit yielding mulberry genotypes for propagation and growth parameters. The results revealed that, genotype MI-0014 was found to be vigorous as it took less number of days (5.18) for sprouting, higher sprouting percentage (82.22), more leaves per sapling (9.07) at ninety days after planting and a higher survival percentage of 79.02. The genotype ME-0006 recorded longest shoot length (28.74 cm) and root length (13.61 cm) at ninety days after planting. Growth parameters indicated that, at sixty days after pruning, genotype ME-0006 recorded higher shoot length (130.49 cm) and single-leaf area (216.85 cm^2). Whereas, the genotype MI-0014 recorded shorter internodal distance (4.58 cm) and more leaves per plant (181.33). While more branches per plant (13.23) were recorded in ME-0220 genotype. Based on the performance, two elite fruit yielding genotypes *viz*., MI-0014 (M-5) and ME-0006 (*M. multicaulis*) showed superiority in both propagation and growth parameters.

Keywords : *Bombyx mori*, Elite mulberry genotypes, Mulberry fruit, Propagation, Growth parameters

MULBERRY (*Morus* spp) is a woody, deciduous and perennial plant exclusively cultivated as a primary host plant for rearing of the silkworm, *Bombyx mori* L. (Lepidoptera : Bombycidae) to produce mulberry silk. Worldwide silk is known as 'Queen of Textiles' (Vishaka and Narayanaswamy, 2018). The area under mulberry cultivation in India is 2.44 lakh hectares in the year 2021-2022 (Minhas, 2023). In recent years, the emphasis on improving mulberry cultivation has grown significantly, not only for silk production but also for its potential for the production of nutritious fruits. The commercially unexploited minor fruits have a useful role to play if they are properly utilized. Several such fruits having poor commercial value go as waste in India. Mulberry is one of the fruits, which is highly neglected. Despite its easy growing conditions, considerably high nutritive value, attractive colour and delicate flavour. Mulberry fruits are a rich source of vitamins, minerals, antioxidants and other bioactive compounds, making them valuable for human consumption and health (Ibrahim *et al*., 2018).

The success of mulberry cultivation is inherently linked to the choice of appropriate genotypes, as different mulberry cultivars exhibit significant variations in terms of growth characteristics, fruit-bearing capacity and adaptability to different environmental conditions. This variability necessitates the systematic evaluation of mulberry genotypes to identify those that offer superior performance for both propagation and growth parameters. Such evaluations are crucial for optimizing mulberry cultivation practices, increasing fruit yields, leaf yields and enhancing the sustainability of sericulture.

Mulberry can be propagated through various methods *viz.,* seeds, cuttings, layering, grafting, tissue culture, etc. (Harijan *et al*., 2023). Most of the mulberry species in tropical conditions display tremendous rooting ability and because of this mulberry propagation is invariably carried out through the planting of cuttings (Das *et al.,* 1987). Survival rate is considered one of the important criteria as mulberry varieties are propagated through vegetative means (Tikader and Kamble, 2009). The robust vegetative growth of mulberry plants directly influences the quantity and quality of mulberry leaves available as silkworm food and also plays a pivotal role in achieving optimal plant establishment and fruit production.

Keeping the above information in view, the present investigation was carried out to identify suitable mulberry accessions for fruit purposes which was evaluated through propagation and growth parameters that can guide researchers and farmers in the selection and management of mulberry genotypes to ensure sustainable and diversified agro-ecosystems.

Material and Methods

The experimental material for the present study comprised eight elite mulberry genotypes (Table 1) which were selected from the germplasm unit maintained at the Department of Sericulture, UAS, GKVK, Bengaluru. The clones of eight mulberry genotypes were selected for propagation studies, in which the hardwood cuttings of three nodes were taken and planted in polythene bags (Plate 1a) and propagation parameters were recorded at different growth intervals. Saplings of 90th day old were planted in the main field with a spacing of 5 × 3 feet in a randomized complete block design with three replications. Cultivation practices recommended for rainfed mulberry were followed throughout the study to raise genotypes (Dandin and Giridhar, 2014).

On 150th day, plants were pruned at three feet height from the ground level. Each elite genotype's performance was evaluated by randomly selecting five competitive plants in each replication for growth parameters and recorded in two different seasons from February to March, 2023 and July to August, 2023 at different intervals of time. The data was analysed by ANOVA of randomized complete block design (Sundarraj *et al*., 1972). The values of the experiments were compared by using Duncan's Multiple Range Test (DMRT) (Duncan, 1955).

Results and Discussion

Propagation Parameters

Days taken for Sprouting

The evaluation of elite fruit yielding mulberry genotypes in terms of days taken for sprouting

Table 1

List of elite mulberry genotypes and their accession number used in the study

Treatments	Genotypes/scientific name	Accession number	National accession number
T_1	*Morus indica*	MI-0516	IC-314082
T_2	*M. cathayana*	ME-0018	EC-493775
T_3	*M. latifolia*	ME-0067	EC-493765
T_4	*M. macroura*	ME-0220	EC-493947
T_5	*M. alba*	ME-0086	EC-493843
T_6	*M. multicaulis*	ME-0006	EC-493763
T_7	*M. indica* (S-34)	MI-0160	IC-313779
T_8	*M. indica* (M-5) - Standard check	MI-0014	IC-313679

(a) (b)

Plate 1 : (a) Cuttings of elite mulberry genotypes planted in polythene bags,
(b) Sprouting cuttings of elite mulberry genotypes on 20th day after planting

revealed significant differences in all the genotypes (Table 2). The genotype MI-0014 recorded shortest duration for initiation of sprouting (5.18 days) followed by MI-0164 with 5.64 days. While, ME-0018 recorded a longer period of 9.03 days to start sprouting. The time taken to start sprouting holds pivotal insights into the mulberry genotype's growth patterns and vigour. In MI-0014, notable early bud break could be attributed to its genetic makeup, which might include traits that facilitate quick dormancy release and favourable hormone responses. Nevertheless, it's important to acknowledge that factors such as moisture levels and various agro-climatic conditions also play a role in promoting the sprouting of different mulberry genotypes.

Sprouting Percentage

The sprouting percentage among elite fruit yielding mulberry genotypes significantly differed from each other (Fig. 1). The genotype MI-0014 recorded higher

TABLE 2

Performance of elite mulberry genotypes for propagation parameters

Genotypes	Days taken to start sprouting	No. of leaves per sapling			Length of the shoot (cm)			Survival percentage	Length of the longest root at 90 DAP (cm)
		At 30 DAP	At 60 DAP	At 90 DAP	At 30 DaAP	At 60 DAP	At 90 DAP		
MI-0516	6.79^{de}	4.27^{bc}	5.53^{bcd}	8.27^{ab}	10.57^{abc}	18.80^{c}	25.56^{bc}	72.53^{ab}	12.07^{a}
ME-0018	9.03^{a}	4.13^{bc}	5.33^{cd}	8.13^{b}	8.05^{d}	14.82^{e}	22.13^{d}	55.12^{c}	7.65^{bc}
ME-0067	6.29^{e}	5.20^{a}	6.27^{ab}	8.53^{ab}	9.09^{cd}	17.45^{d}	24.42^{c}	62.85^{bc}	8.66^{bc}
ME-0220	8.48^{b}	4.40^{b}	6.07^{bc}	8.87^{ab}	8.44^{d}	16.59^{d}	23.46^{cd}	69.06^{ab}	7.23^{c}
ME-0086	7.73^{c}	3.47^{d}	5.20^{d}	6.67^{c}	11.23^{ab}	20.42^{ab}	27.01^{ab}	61.02^{bc}	12.97^{a}
ME-0006	7.30^{cd}	3.80^{cd}	5.27^{cd}	7.20^{c}	12.06^{a}	21.40^{a}	28.74^{a}	70.18^{ab}	13.61^{a}
MI-0160	5.64^{f}	4.07^{bcd}	5.47^{bcd}	8.33^{ab}	9.42^{cd}	17.24^{d}	25.12^{bc}	64.83^{bc}	9.57^{b}
MI-0014	5.18^{f}	4.53^{b}	6.87^{a}	9.07^{a}	10.41^{bc}	19.60^{bc}	26.82^{ab}	79.02^{a}	11.77^{a}
F test	*	*	*	*	*	*	*	*	*
S.Em±	0.168	0.179	0.246	0.277	0.473	0.347	0.662	3.375	0.626
CD @ 5%	0.512	0.543	0.748	0.840	1.435	1.055	2.008	10.238	1.900
CV (%)	4.146	7.335 7.	431 5.	899 8.	272 3.	294 4.	513 9.	007	10.393

* Significant at 5%; Figures with the same superscript are statistically on par; DAP- Days after planting

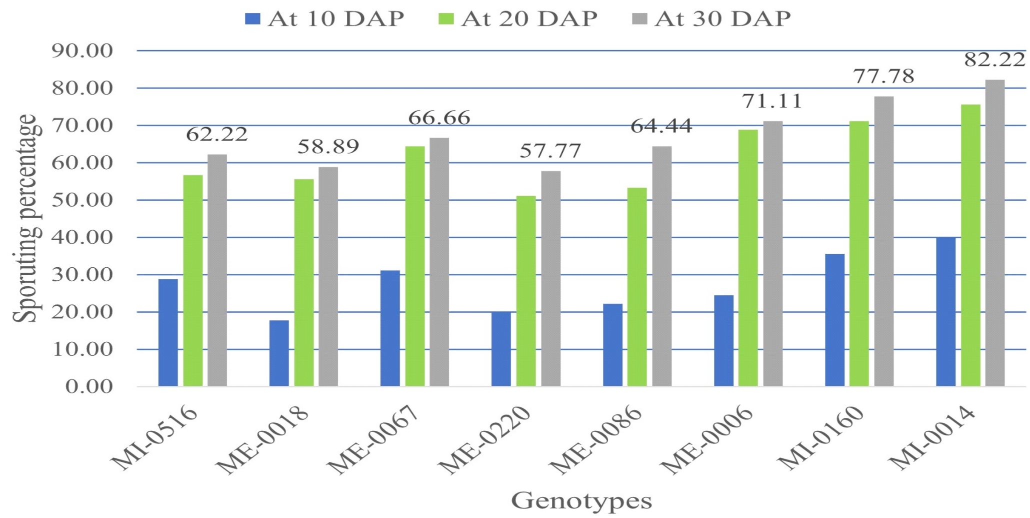

Fig. 1 : Sprouting percentage in cuttings of elite mulberry genotypes on 10th, 20th and 30th day after planting

sprouting percentage of 40.00, 75.55 and 82.22 at 10th, 20th (Plate 1b) and 30th day after planting, respectively followed by MI-0164 with 35.55, 71.11 and 77.78 per cent of sprouting respectively. Conversely, ME-0018 exhibited lowest sprouting percentage of 17.77 on 10th day. Whereas on 20th and 30th day ME-0220 recorded lowest sprouting percentage of 51.11 and 57.77 respectively. The current results were consistent with Tikader and Kamble (2009) who recorded maximum sprouting percentage of 88.44 per cent in *M. rotundiloba* followed by Kenmochi (87.79%). Similarly, Murthy and Yadav (2012) reported that the sprouting percentage was above 95 in TR-8, TR-12 and S-1708 among nine mulberry varieties evaluated along with one check variety M-5. The higher sprouting per cent of MI-0014 across various time intervals might be attributed to its early bud break, which potentially enhances its propensity for rapid sprouting.

Number of Leaves per Sapling

The number of leaves per sapling among elite fruit yielding mulberry genotypes significantly differed from each other (Table 2). On 30th day, ME-0067 recorded the highest leaf count per sapling, with 5.20 leaves, Whereas on 60th and 90th day MI-0014 recorded more leaves per sapling with 6.87 and 9.07 leaves, respectively. While, ME-0086 exhibited a lower leaf count of 3.47, 5.20 and 6.67 leaves on 30th, 60th and 90th day after planting. In a similar study by Aruna *et al*. (2018), who reported highest number of leaves (28.00) in accession MI-0349 and lowest number of leaves (9.00) in MI-0034 among forty mulberry accessions along with check variety V-1. A plant with more leaves will generally produce more photosynthates, which can be used to support faster growth and development.

Length of the Shoot (cm)

Among the evaluated fruit yielding genotypes, ME-0006 recorded highest shoot length of 12.06 cm, 21.40 cm and 28.74 cm on 30th, 60th and 90th day after planting, respectively (Table 2) followed by ME-0086 with 11.23 cm, 20.42 cm and 27.01 cm, respectively. Whereas, ME-0018 recorded lowest shoot length of 8.05 cm, 14.82 cm and 22.13 cm on 30th, 60th and 90th day after planting, respectively. In an earlier study, the mulberry variety S-1708 recorded the highest shoot length of 62.63 cm and a shorter shoot length was recorded in C-6 at 35.55 cm (Murthy and Yadav, 2012) among the nine varieties. Aruna *et al*. (2018) reported that the mulberry accession MI-0718 recorded the highest shoot length of 88.23 cm and the shortest shoot length of 12.66 cm was recorded in MI-0034, which was evaluated by using V-1 as a check variety.

Survival Percentage

All the elite fruit yielding genotypes evaluated for the survival percentage differed significantly (Table 2). The genotype, MI-0014 exhibited highest survival percentage of 79.02 at 90th day of planting followed by MI-0516 (72.53%). In contrast, MI-0018 recorded a lower survival rate of 55.12 per cent. In a similar study by Sujathamma and Dandin (1998), who observed the highest survival rate in Sujanpur-5 (96.17%) followed by Tr-10 (93.75%) and MS-8 (30.08%). Similarly, Prakash *et al*. (2004) reported a good survival percentage of 90.90 in S-1635 and 90 in S-1 as compared to other genotypes including check M-5. The survival percentage followed the same pattern as sprouting with the maximum survival percentage after ninety days. Environmental factors may play a role in the progressive decline in the survival rate of seedlings as their age rises.

Length of the Longest Root (cm)

All the elite fruit yielding genotypes evaluated for length of longest root differed significantly (Table 2). The genotype ME-0006 recorded a significantly longer root length of 13.61 cm followed by ME-0086 with 12.97 cm. While, ME-0018 showed least root length of 8.05 cm on 90th day after planting. The results of the present findings were supported by the earlier study by Murthy and Yadav (2012) who reported that, the variety Matigara black showed the longest root length (25.99cm) followed by TR-12 (23.57 cm) and TR-8 (21.98 cm). The longest root length of 25.60 cm was observed in MI-0678 and the minimum length of the root was recorded by MI-0653 (8.14 cm) (Aruna *et al.,* 2018). The variations in root length among the genotypes signify their root development and capacity for resource absorption. Genotypes with genetic traits that favour robust root development and efficient nutrient absorption tend to exhibit longer root lengths.

Growth Parameters

The growth parameters of elite genotypes were recorded in two different growing periods, from February to March, 2023 and from July to August, 2023 at two growth intervals *i.e.*, 30th (Plate 2) and 60th (Plate 3) days after pruning

Plate 2 : General view of the experimental plot on 30th day after pruning

Plate 3 : General view of the experimental plot on 60th day after pruning

Shoot Length (cm)

All the elite fruit yielding mulberry genotypes evaluated for the shoot height differed significantly from each other (Table 3). The genotype ME-0006 recorded a higher shoot length of 69.93 cm followed by ME-0086 (64.52 cm) and the lower shoot length was recorded by ME-0018 (44.50 cm) for both growing periods at 30 days after pruning. Whereas at 60 days after pruning ME-0006 recorded a higher shoot length of 130.49 cm followed by ME-0086 (125.74 cm) and the lower shoot length was recorded by ME-0220 (88.31 cm) for both growing periods. The results of the present study were confirmed by

TABLE 3

Performance of elite mulberry genotypes for growth parameters

Genotypes	Shoot length (cm)		Internodal distance (cm)		Petiole length (cm)		No. of branches per plant		No. of leaves per plant	
	At 30 DAP	At 60 DAP	At 30 DAP	At 60 DAP	At 30 DAP	At 60 DAP	At 30 DAP	At 60 DAP	At 30 DAP	At 60 DAP
MI-0516	61.46 ^{ab}	98.69 ^{ab}	5.77 ^{bc}	5.88 ^{cd}	4.15 ^{bc}	4.38 ^{c}	7.80 ^{de}	8.73 ^{de}	65.33 ^{cd}	101.33 ^{d}
ME-0018	44.50 ^{c}	89.68 ^{b}	5.13 ^{d}	5.41 ^{d}	5.01 ^{a}	5.29 ^{ab}	7.97 ^{d}	9.08 ^{d}	56.17 ^{d}	105.50 ^{d}
ME-0067	49.58 ^{c}	98.37 ^{ab}	4.29 ^{e}	4.60 ^{e}	3.43 ^{d}	3.76 ^{d}	10.67 ^{ab}	11.83 ^{b}	109.17 ^{a}	176.67 ^{a}
ME-0220	48.24 ^{c}	88.31 ^{b}	5.8 ^{bc}	6.16 ^{bc}	5.38 ^{a}	5.58 ^{a}	11.80 ^{a}	13.23 ^{a}	88.50 ^{b}	150.17 ^{b}
ME-0086	64.52 ^{ab}	125.74 ^{a}	6.64 ^{a}	6.89 ^{a}	4.46 ^{b}	5.56 ^{a}	6.67 ^{e}	7.83 ^{e}	68.50 ^{cd}	124.50 ^{c}
ME-0006	69.93 ^{a}	130.49 ^{a}	6.3 ^{ab}	6.65 ^{ab}	5.16 ^{a}	5.46 ^{a}	7.13 ^{de}	8.43 ^{de}	73.00 ^{c}	136.33 ^{bc}
MI-0160	50.10 ^{c}	113.95 ^{ab}	5.37 ^{cd}	5.48 ^{d}	4.52 ^{b}	4.98 ^{b}	9.33 ^{c}	10.43 ^{c}	93.00 ^{b}	136.17 ^{bc}
MI-0014	60.91 ^{b}	125.08 ^{a}	4.27 ^{e}	4.58 ^{e}	3.99 ^{c}	4.26 ^{c}	10.43 ^{bc}	11.87 ^{b}	108.83 ^{a}	181.33 ^{a}
F test	*	*	*	*	*	*	*	*	*	*
S.Em±	2.675	10.375	0.187	0.165	0.129	0.146	0.380	0.281	4.654	4.527
CD @ 5%	8.114	31.469	0.569	0.501	0.392	0.443	1.153	0.852	14.117	13.731
CV (%)	8.252	16.518	5.968	5.022	4.963	5.156	7.336	4.784	9.734	5.641

* Significant at 5%; Figures with the same superscript are statistically on par; DAP- Days after pruning

Tikader and Kamble (2009) who reported highest shoot length in ME-0174 (206.76cm) followed by ME-0041 (204.64cm) and the lowest shoot length recorded in ME-0165 (123.62cm). Similarly, Peris *et al*. (2014) studied the shoot length, which varied from 97.00cm (S-41) to 123.50cm (M-5). Superior performance of genotype ME-0006 in maintaining higher shoot heights across both growth periods may indicate inherent genetic traits that promote elongation regardless of changing environmental conditions.

Internodal Distance (cm)

All the selected elite fruit yielding mulberry genotypes were differed significantly in internodal distance (Table 3). The genotype MI-0014 recorded a shorter internodal distance of 4.27 cm followed by ME-0067 (4.29 cm) and longer internodal distance was recorded in ME-0086 (6.64 cm) for both growing periods at 30 days after pruning. Whereas at 60 days after pruning, MI-0014 recorded shorter internodal distance of 4.58 cm followed by ME-0067 (4.60 cm) and longer internodal distance was recorded in ME-0086 (6.89 cm) for both growing periods. Influence of the internodal distance on leaf production and overall growth is prominent. Shorter internodal distances contribute to denser leaf arrangement and potentially higher photosynthetic

Similarly, Kumar *et al*. (2016) reported a maximum internodal distance of 7.00 cm in Sujanpur local and the minimum internodal distance by V-1 (5.10 cm).

Petiole Length (cm)

All the fruit yielding mulberry genotypes evaluated for the petiole length differed significantly from each other (Table 3). The genotype ME-0220 recorded higher petiole length of 5.38 cm followed by ME-0006 (5.16 cm) and lower petiole length recorded in ME-0067 (3.43 cm) for both growing periods at 30 days after pruning. Whereas at 60 days after pruning ME-0220 recorded higher petiole length of 5.58 cm followed by ME-0086 (5.56 cm) and the lower petiole length was recorded by ME-0067 (3.76 cm) for both growing periods. The results of the present study were consistent with Peris *et al.* (2014) who reported the length of the petiole varied between 2.82 cm (Thika)

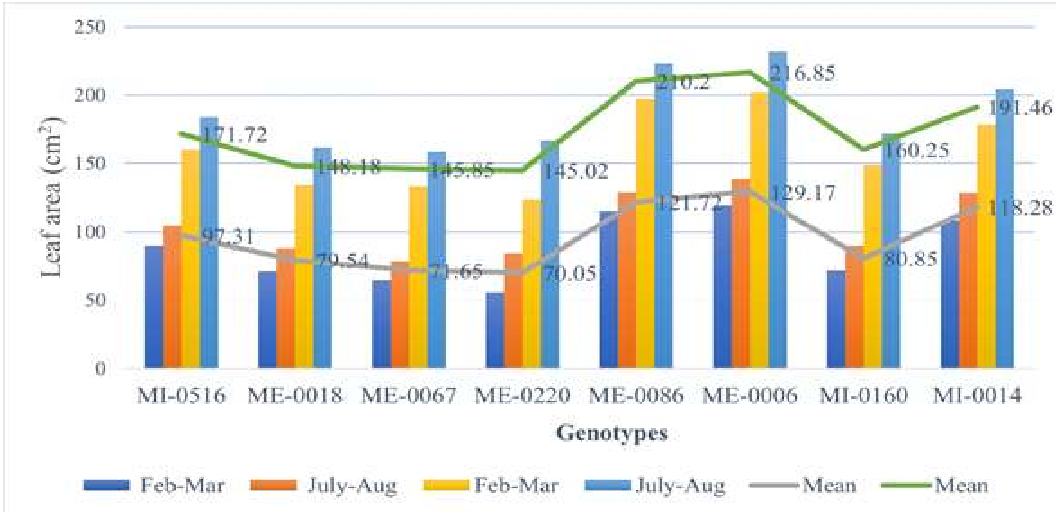

Fig. 2 : Single leaf area of elite mulberry genotypes on 30th &60th day after pruning

to 3.57 cm (Embu) among five mulberry accessions. Petiole length influences the exposure of leaves to sunlight and nutrient transport. Longer petioles may enhance photosynthesis by providing better light access to the leaf blade.

Number of Branches per Plant

All the fruit yielding mulberry genotypes evaluated for number of branches per plant differed from each other (Table 3). The genotype ME-0220 recorded more branches per plant (11.80) followed in MI-0014 (10.43) and less number of branches per plant recorded in ME-0086 (6.67) for both growing periods at 30 days after pruning. Whereas at 60 days after pruning ME-0220 recorded a higher number of branches per plant (13.23) followed by MI-0014 (11.87) and the less branches per plant was recorded by ME-0086 (7.83) for both growing periods. In a similar study, maximum number of branches per plant was 22.42 (M-5) and the fewer branches in Embu (11.29) which was reported by Peris *et al.* (2014). Kumar *et al.* (2016) studied the total number of shoots per plant more in S-1635 (29) followed by V-1 (28) and less number of shoots per plant was found in Tr-10 (20). The number of branches per plant directly influences the overall plant architecture, its ability to support leaves and fruits and ultimately its yield potential.

Number of Leaves per Plant

All the fruit yielding mulberry genotypes evaluated for number of leaves per plant differed from each other (Table 3). The genotype ME-0067 recorded higher number of leaves per plant (109.17) followed by MI-0014 (108.83) and the lower number of leaves per plant was recorded in ME-0018 (56.17) for both growing periods at 30 days after pruning. Whereas at 60 days after pruning MI-0014 recorded higher number of leaves per plant (181.33) followed by ME-0067 (176.67) and the lower number of leaves per plant recorded in ME-0018 (105.50) for both growing periods (Table 3). The number of leaves per plant is influenced by genetic factors, internodal distance and shoot length. Genotypes with higher branching, shorter internodal distances and longer shoots are likely to produce more leaves.

Single Leaf Area (cm^2)

All the fruit yielding mulberry genotypes evaluated for single leaf area differed from each other (Fig. 2). The genotype ME-0006 recorded a higher leaf area of 129.17 cm^2 followed by ME-0086 (121.72 cm^2) and lower leaf area recorded in ME-0220 (70.05 cm^2) for both growing periods at 30 days after pruning. Whereas at 60 days after pruning, ME-0006 recorded higher leaf area of 216.85 cm^2 followed by ME-0086 (210.20 cm^2) and lower leaf area was recorded in ME-0220 (145.02 cm^2) for both growing periods. The results of the current findings supported by the earlier studies by Masilamani *et al.* (2000) who reported leaf area ranged from 74.5 to 201 cm^2 across 18 mulberry varieties. Similarly, Eswar Rao *et al*. (2000) studied seven mulberry genotypes with different leaf areas (168.19 to 255.29 cm^2). The size of a single leaf area is influenced by genetic characteristics, number of leaves per plant and the overall plant architecture. Genotypes with larger leave area and a greater number of leaves per plant are likely to have higher single-leaf area.

The present study highlighted the superior performance of two genotypes, MI-0014 (M-5) and ME-0006 (*M. multicaulis*) in both propagation and growth parameters. MI-0014 recorded exceptional vigor, with a rapid sprouting process, high sprouting percentage and good survival rate. The genotype's ability to produce more leaves per sapling within a short period further underscores its suitability for cultivation. On the other hand, ME-0006 recorded remarkable shoot and root length at ninety days after planting, expressing its robust growth potential. Growth parameters emphasized the strengths of both genotypes. ME-0006 stood out with superior shoot length and single-leaf area. Meanwhile, MI-0014 exhibited favourable characteristics such as shorter internodal distance and a higher leaf count per plant, indicating its potential for dense and lush growth. Notably, ME-0220 displayed a notable feature with a higher number of branches per plant, adding to the diversity of promising traits within the evaluated genotypes. Thus, two genotypes *viz.,* MI-0014 and ME-0006 as elite choices for mulberry cultivation, excelling in both propagation and growth parameters. These genotypes hold promise for enhancing mulberry fruit yield and contributing to the advancement of sericulture practices.

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