BIBLIOGRAPHY

LANGAWIT, LORNA FAUSTINO. JULY 2008. Evaluation of Different Rooting Media on Cuttings Different Mulberry Varieties (*Morus alba Linn*) for Sapling Production. Benguet State University, La Trinidad, Benguet.

Adviser: Valentino L. Macanes, MSc

ABSTRACT

This study was conducted to find out the effectiveness of the different rooting media in sapling production on different mulberry varieties: Alfonso, Batac, and Kanva-2. It also aimed to determine the average growth increment, number of opened leaves, average weight of leaves and shoots, average length of primary root, average root weight, and survival rate of mulberry saplings using the different rooting media. The different rooting media used were, the mixture of different animal manures: Garden Soil as a Control (T_o), Compost + Chicken Dung + Garden Soil (T_1), Silkworm Rearing Waste + Garden Soil (T_2), Chicken Dung + Cow Manure + Garden Soil (T_3), Sand + Sphagnum Moss + Garden Soil (T_4), and Silkworm Rearing Waste (T_5). All the different manures and silkworm rearing waste were fully decomposed before they were used.

The results of this study found that the Batac mulberry variety cuttings planted in the rooting media mixture of Compost + Chicken Dung + Garden Soil (T_1), Chicken Dung + Cow Manure + Garden Soil (T_3) and Sand + Sphagnum Moss + Garden Soil (T_4) gave the best results among all treatments used on the different mulberry varieties. This

variety grown in the three rooting media gave the longest average length of the primary root, highest average growth increment, highest number of leaves formed, and heaviest weight of leaves.

The study also found that the pH of the different rooting media mixture was within the soil pH range for mulberry production. Likewise, all the mulberry saplings grown in the different rooting media had a survival rate of 100%.

TABLE OF CONTENTS

INTRODUCTION

Mulberry is the basic material of sericulture. Thus, if sericulture is to be promoted in wide scale, there should also be an increased production of mulberry for more leaf production. In the Philippines, the easiest way to increase mulberry tree is done by cuttings for it is simple, least time and no artificial treatment used.

The mulberry tree is the only food for mulberry silkworm (Bombyx mori Linn.) and a potential woody plant consisting of vegetative organs (root, stem, and leaves) and reproductive organs (flowers and fruits). Although the organs are different in form, structure and physiological function, they interact on one another in given conditions and combined harmonious actions for existence. In addition, external conditions such as the application of organic fertilizers, method of cultivation and management can also cause changes in form, which could be an indicator of physiological growth and leaf quality. Propagation of mulberry can be made either by seed or vegetative production. The hardwood cutting, one of the vegetative methods, is the most common in subtropical countries and tropical areas likewise the Philippines. (Alvares and Kim, 1994).

Propagation of mulberry includes sexual and vegetative reproduction. The vegetative reproduction contains grafting, cutting, and layering; Grafting is the most cumbersome, time-consuming and expensive procedure whereas cutting is an easy, cheap, and least time consuming method. In temperate countries, most of the mulberry varieties do not respond to cutting method without pre-treatment. Thus, grafting is the most common practice of propagation. Tropical varieties of mulberry, however, easily respond to cutting method without artificial treatment (Das, 1987).

The rooting capacity of mulberry is one of the most important factors that contribute to a better leaf production because greater roots will tend to supply more food nutrients to the crop for its growth besides anchorage to mulberry is a deep-rooted, perennial, hardy and monoculture crop, hence, it is essential to select suitable soil for mulberry cultivation. In asexual or vegetative propagation like cuttings, the inherited characteristics of the parent stock can be retained. In reality, the new plant is the continuation of the growth and development of the parent stock. This method allows the genetic traits of the mulberry to be used to keep the good characteristics of the good varieties, which allow many good varieties to be, produced (FAO, 1998)

Cabfilan (2000) stated that ever increasing cost of imported fertilizers and sometimes scarcity when needed resulted in the intensive government effort to explore further the utilization of readily available and potential indigenous materials. Eventually the chemical fertilizer crises encourage many local organic fertilizer producers to ease the situation but the raw materials are relatively costly.

Organic fertilizer application constitutes the most effective replacement when problems related to soil fixation, nutrient loss of water excess exist. Organic application is used under a variety of conditions and on different variety crops. It has been successfully established in an economical and convenient as compared to other method (Balsubramanian, et.al...1988).

Generally, this study aimed to evaluate the effects of different rooting media on the cuttings of different mulberry varieties for sapling production.

Specifically, it aimed to:

1) To determine what rooting media gives high growth increment and more leaves formed to the mulberry saplings.
2) To find out what mulberry variety produce the heaviest root and vegetative part as affected by the different rooting media.
3) To find out the survival rate of different mulberry variety cuttings using different rooting media.

This study was conducted at Benguet State University Sericulture Project at Ampasit, Puguis, La Trinidad, Benguet from February to April, 2008.

REVIEW OF LITERATURE

Mulberry

Mulberry is the only food for silkworms (Bombyx mori Linn). Production of quality mulberry leaf controls the survival of silkworms which determines the quality of cocoons they produced and the richness of the silk content of the cocoons. Timely application of inputs such as farm yard manure, labor, and practice of cultural operations like pruning, doffing and leaf harvesting determines the quality of mulberry leaf (Boase and Singhvi, 1989).

Mulberry is a deep rooted plant that requires soil capable of sufficient supply of nutrients, water and air up to where the root system penetrates (Boraiah, 1986). He further stated that the plantation soil should be fertile, deep friable, sandy loamy to loamy in the texture and porous with good water-holding capacity. Slightly acidic soil with pH ranging from 6.2-6.8 is deal for the growth and development of the mulberry plants. On the other hand, Dandin (1994) stated that the suitable range of soil atmospheric temperature of a plantation is from 20%-35C

The different varieties of mulberry plants exhibit different leaf characteristics. These differences could be exploited as basic for comparative studies, selection and breeding purposes. For instance, leaf features for mulberry varietals description can be a take-off point for a study on the nomenclature of existing varieties in the country. However, these physical leaf features are not enough basis for anyone to readily identify a certain variety since some, .if not most, possess the same or similar appearance that are confusing or miss leading (Samay Bulletin, 2002).

The quality of mulberry leaf varieties has a predominating influence on the development of the silkworms and the quality of cocoon produced. If silkworm rearing and cocoon production are to be successful, it is very important that the mulberry leaves are highly nutritive and fresh for feeding silkworm. In La Trinidad, Benguet several foreign and local varieties were introduced and this include S54, Kanva, Batac A and Batac B (Alos, 1996).

Rooting Media

The study by Cabfilan (2002) on the effect of compost and animal manure on mulberry sapling production find out that combination of compost & chicken dung seem to be the best organic fertilizers in mulberry sapling production.

It has been well-recognized that application of manure is important for higher yield and better quality of mulberry leaves (Alvares and Kim, 1994). Moreover, in order to increase the leaf yield, reclamation on physical as well as chemical properties of soil should be ahead of proper operations of fertilizing.

Tan (1975) mentioned that compost is also used to improve the soil condition in various ways. It granulates the soil particles and makes it loose for easy tillage. It also improves soil drainage and lessens leaching aside from being a very good source of plant nutrients. Compost improves water holding capacity and soil aeration where plant root is best adapted.

Compost application replenishes soil organic matter or humus being depleted with continuous cropping application of compost also activates soil micro organisms, consequently increasing the availability of nutrient that plants feed on (Marquez, 1988).

Mulberry Cuttings in Saplings Production

Hartman et al. (1990) stated that after cuttings have been made and placed under environmental conditions favorable for rooting, callus would usually develop at the basal end of the cutting. The callus is irregular mass of parenchyma cells in various stages of lignifications. This callus growth arises from young in the region of the vascular cambium, although cells of cortex and pith may also contribute to its formation in essential for rooting.

In Karmataka and West Bengal, India the normal practice is to plant the cuttings directly in the field; Sometimes when the field is not ready for planting it becomes necessary to preserve the cuttings in sand beds under shade for about a week before planting. This method of storage helps the formation of "callus" and callused cuttings give better performance (Ullal and Narashimhanna, 1987).

Bautista (1994) reported that when cuttings are placed in rooting medium, growth substances like auxins and other products of photosynthesis more from young leaves and concentrate in sites requiring repair or regeneration of tissue such as curing of the cuttings. She further stated that in leafless cuttings, auxins and other photosynthesis are also present and smaller amounts in the stem. These indigenous and inherent auxins interact with inherent factors in the stem cells to activate cell division, which later result in the formation of a mass of identified cells called callus. The callus cells eventually differentiate into root initials growth substances are manufacture from products of photosynthesis, while the energy as well as simple compounds needed for cell division, differentiation and formation of root initials came from respiration.

Descriptions of the Different Mulberry Varieties Used

Alfonso

The leaves are dark green with a rough texture. The base is retuse and the tip is caudate with a margin of belt-serrate. The leaf area has 9cm and the dry matter content is 78.88%. The color of the branches is grayish white with a length of 113.63cm.The color of the shoots is purple, the flower is light green and the roots is brown. The tree growth form is erect, thus, the branches tend to grow upward. (Chopchopen 2006).

Figure 1: Alfonso mulberry leaf

Batac

The study by Chopchopen (2006) stated that the color of the leaves is light green with a rough texture, while the leaf area is 10cm and the base is retuse with a margin of acute-serrate. The dry matter content is 20.04% and the moisture content is 79.96%.The color of the batac branches is grayish brown with a length of 114.67cm.The color of the shoots is purple green, flower is green and the color of roots is brownish. The tree growth form is spreading, thus, the branches grow sideward.

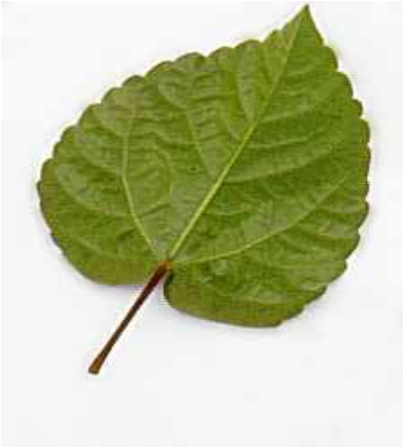

Figure 2: Batac mulberry leaf

Kanva-2

The color of the leaves is light green with a smooth and shiny texture. The shape is ovate and the margin is double-serrate. The base is retuse and the tip is caudate. The leaf area is 9cm while the dry matter content of its leaves is 20.01% and the moisture content is 79.99%.The color of the branch is grayish brown with a length of 107.34cm.The color of the shoots is green, flower is light green, and the roots is brown. (Chopchopen 2006).As with the Batac mulberry, the tree growth form is spreading, thus, the branches grow sideward.

Figure 3: Kanva-2 mulberry leaf

MATERIALS AND METHODS

The following materials used in this study were the cuttings of different mulberry varieties namely: Alfonso, Batac, and Kanva-2. The different rooting media used were: Garden Soil, Compost, Chicken Manure, Cow Manure; Sand, Sphagnum Moss, and Silkworm Rearing Waste. All the different animal manures and silkworm rearing waste were properly decomposed before they were used as a rooting media. In addition; pruning shear, plastic pots, weighing scale and labeling materials were also be utilized.

The different rooting media served as the treatments with garden soil alone as the control check (T_0). The garden soil was taken at Benguet State University Sericulture Project, Puguis, La Trinidad, Benguet. Meanwhile, the study was laid out using the Randomized Complete Block Design (RCBD), factorial method. There were two factors namely: Factor A (Mulberry Variety) and Factor B (Rooting Media Mixtures). The different mulberry varieties (Factor A) were respectively tested on the different rooting media mixtures (Factor B). The different mulberry varieties and rooting media mixtures were as follows:

Factor A (mulberry variety):

Factor	Mulbery Variety
A1	Alfonso
A2	Batac
A3	Kanva-2

Factor B (Rooting Media):

Treatment	Rooting Media
T0	Garden Soil (Control)

T1	Compost + Chicken Dung + Garden Soil (best results obtained by Cabfilan, 2000) using Batac mulberry variety.
T2	Silkworm Rearing Waste + Garden Soil
T3	Chicken Dung + Cow Manure + Garden Soil (best results obtained by Yogyog, 2007) using Batac mulberry variety.
T4	Sand + Sphagnum Moss + Garden Soil (best results obtained by Yogayog, 2007) using Batac mulberry variety.
T5	Silkworm Rearing Waste

Pot Preparation

Ninety (90) plastic pots, each measuring of 15.24 cm x 15.24 cm x 30.48 cm black polyethylene bags were used in this study. Each composition of the media was weighed by a ratio of 1:1:1 and mix thoroughly as used by Cabfilan (2006). After mixing, these were put in the black polyethylene bag and were left in two weeks before planting the mulberry cuttings to give time for the rooting media to settle.

Selection of Mulberry Cuttings

The different mulberry varietal cuttings that was used in the study were; Alfonso, Batac, and Kanva-2. The cuttings were taken from healthy, one year old branches of the mulberry parent stock which is not infected with disease or damage by any pest. The length of cuttings was 15-20 cm long and 1.0 and diameter and it was cut from the lower

to middle part of the mulberry branch. This portion has higher percentage of rooting compared to the upper part which is weaker (Adriance and Brenson, 1975). The base of the cutting was cut horizontally below the leaf scar. While the top was immediately cut above the node after the recommended length that has 3-4 nodes.

Planting Depth of Cuttings

Before planting, the mulberry cuttings were bundled and exposed under natural conditions for one week to enhance the sprouting of buds and to form a callus on the wounds of the mulberry. This method prevents rotting of cuttings when planted. This was done by wrapping the mulberry cuttings with newspaper or just simply let the mulberry stand on a moist area (Hartman et al...1990). Afterwards, the mulberry cuttings were planted in slightly slanting position. Only one bud of the cutting was exposed above the planting media contained in the plastic pots. This method was done, respectively, in all the different mulberry varieties.

Management after Planting

After planting, sanitation was strictly observed to prevent/control diseases and watering of the different treatments were done to avoid dehydration of plants and to keep the soil moist and aerated. Removal of weeds was strictly followed to reduce the competition of nutrients.

Data Gathered

1) Average growth increment (cm). This was gathered one month after planting and it was done weekly thereafter. The growth increment of the sample plants were

measured using a tape measure from the point of the new growth to the tip of the new shoots formed. These were done per treatment replications.

2) Average number of opened leaves formed. This was taken by counting all the opened leaves that was formed by the sample plants. This data was gathered during the termination of the study.

3) Average weight of leaves and shoots (g). The leaves that were taken from every treatment replication were weighed using the weighing balance. This was done after the study.

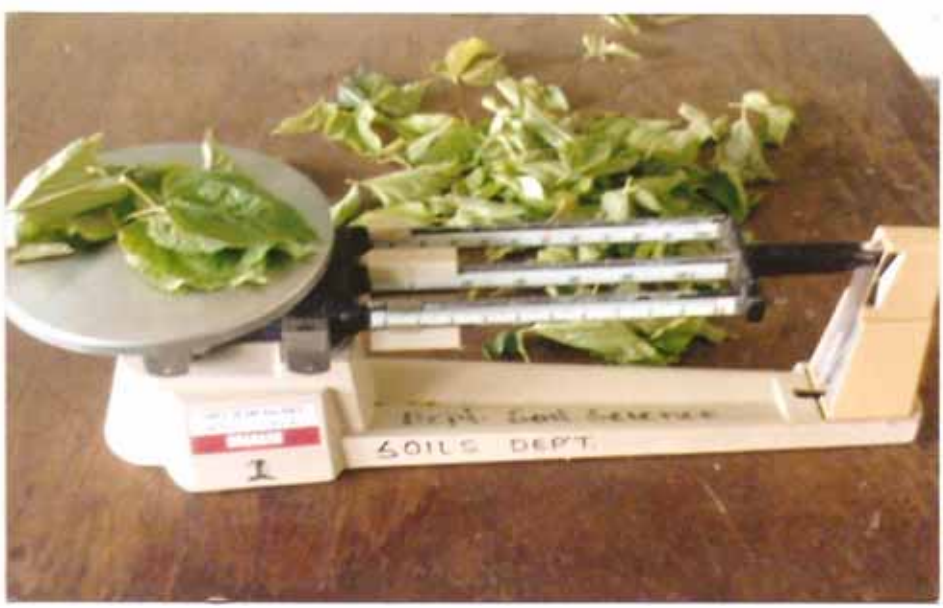

Figure 4: Weighing of collected leaves of each treatment.

4) Average final length of primary root (cm). This was obtained by uprooting sample plants per treatment replications after experiment. The length of the primary root was measured from the base to the tip most part of the root using tape measure.

5) Average root weight (g). Weight of the roots was gathered after the study by weighing all the roots collected per treatment replication.

6) Survival rate (%). The numbers of sapling survived were counted and it was recorded during the termination of study. The percentage survival rate was computed with the used of the following formula:

$$\% \text{ of Survival} = \frac{\text{Number of survived saplings}}{\text{Total number of cuttings planted}} \text{ X100}$$

7) Rooting media pH. Soil samples were brought to Benguet State University Soils Laboratory to determine the pH.

RESULTS AND DISCUSSION

Average Growth Increment of Mulberry Cuttings

Table 1 shows the average final growth increment of mulberry cuttings. Statistical analysis showed highly significant differences among treatment and varieties The Batac mulberry cuttings growth in the mixture of Chicken Dung + Cow Manure + Garden Soil (T_3) gave highest significant growth increment of 13.24 cm among all the varieties and treatments. This was followed by Kanva-2 planted in Compost + Chicken Dung + Garden Soil (T_1) with 11.78 cm. Meanwhile, cuttings of Batac grown in the same rooting media (T_1) had 11.43 cm average growth increment.

The lowest growth increment of 4.66 cm was obtained from Alfonso cuttings planted in the Silkworm Rearing Waste (T_5) and in Compost + Chicken Dung + Garden Soil (T_1) with 4.77 cm. This was followed by Batac mulberry cuttings with 4.89 cm grown in the Silkworm Rearing Wasted (T_5).

Table 1 Average final growth Increment (cm) of the mulberry two months after planting.

Treatment	Alfonso	Batac	Kanva-2
T_0- Garden Soil (Control)	5.56 ^{def}	7.36 ^{cdef}	8.81 ^{cdebf}
T_1 –Compost + Chicken Dung + Garden Soil	4.77 ^{ef}	11.43 ^{cab}	11.78 ^{ab}
T_2 -Silkworm Rearing Waste + Garden Soil	5.41 ^{def}	6.13 ^{def}	9.09 ^{cdeb}
T_3 -Chicken Dung + Cow Manure + Garden Soil	6.81 ^{def}	13.24 ^{a}	9.30 ^{cdb}
T_4 –Sand + Sphagnum Moss + Garden Soil	7.64 ^{cdef}	6.66 ^{def}	6.13 ^{def}
T_5 -Silkworm Rearing Waste	4.66 ^{f}	4.89 ^{ef}	6.46 ^{def}

**Means with the same letter are not significantly different at 5 % level by DMRT.

Average Number of Opened Leaves formed by the Mulberry Saplings

Table 2 shows the number of leaves formed by the mulberry saplings in the different treatments two months after planting. Statistical analysis revealed significant results among the different treatments. The Batac mulberry variety planted in the the rooting media mixture of Chicken Dung + Cow Manure + Garden Soil (T_3) had the highest number of leaves formed with 9.00 as compared to the other mulberry varieties grown in the different rooting media. This result agreed with the findings of Yogyog in 2007 that Batac mulberry cuttings grown in Chicken Dung + Cow Manure + Garden Soil produced high number of leaves. This was followed by the Kanva-2 cuttings planted in Compost + Chicken Dung + Garden Soil (T_1) with 9.00 average number of leaves formed. In addition, the cuttings of this variety grown in Chicken Dung + Cow Manure + Garden Soil had a mean of 8.00 number of leaves formed. These results corresponded with the findings of Yogyog (2007) when he found that Batac mulberry cuttings performed best in this rooting media.

Finally, the lowest number of formed leaves 5.00 was obtained from the cuttings of Alfonso variety planted in Silkworm Rearing Waste + Garden Soil (T_3).

Table 2.Average Number of opened leaves formed by the mulberry saplings two months after planting

Treatment	Alfonso	Batac	Kanva-2
T_{0}- Garden Soil (control)	6.00^{cdb}	6.00^{cadb}	7.00 ^{cadb}
T_1 -Compost + Chicken Dung + Garden Soil	6.00^{cdb}	8.00^{cadb}	9.00 ^{cadb}
T_2-Silkworm Rearing Waste + Garden Soil	5.00^{d}	6.00^{cdb}	7.00 ^{cadb}
T_3- Chicken Dung + Cow Manure+ Garden Soil	6.00^{cdb}	9.00^{a}	8.00 ^{cadb}
T_4 –Sand + Sphagnum Moss + Garden Soil	6.00^{cadb}	6.00^{cdb}	7.00^{cadb}
T_5- Silkworm Rearing Waste	5.00^{cd}	5.00 ^{cd}	5.00 ^{cd}

** With the same letter are not significantly different at 5% level by DMRT.

Average Weight of Leaves and Shoots of Mulberry Saplings

Table 3 reveals the weight of leaves obtained from the different mulberry varieties grown in the different rooting media two months after planting. Statistical analysis gave highly significant differences among rooting media the treatment while the different varieties gave significant differences. The Batac mulberry cuttings grown in the mixture of Chicken Dung + Cow Manure + Garden soil (T_3) gave the highest mean weight of 1.76 grams. This was followed by Compost + Chicken Dung + Garden Soil (T_1) with 1.56 grams. Meanwhile, Kanva- 2, grown in the Compost + Chicken Dung + Garden Soil (T_1) was 1.40 grams.

Finally, the lowest mean weight of leaves of 0.32 grams was obtained from Alfonso mulberry variety planted in Silkworm Rearing Waste (T_5). The same variety grown in Silkworm Rearing Waste + Garden Soil (T_2) had 0.42 grams mean weight of leaves. On the other hand, Batac mulberry cuttings grown in the Silkworm Rearing Waste (T_5) had 0.46 grams.

Table 3. Average weight of leaves and shoots (g) of the mulberry saplings two months after planting

Treatment	Alfonso	Batac	Kanva-2
T_{0}- Garden Soil (control)	0.52 ^{cd}	0.82 ^{cdb}	0.90 ^{cdb}
T_{1}- Compost + Chicken Dung + Garden Soil	0.74 ^{cdb}	1.56 ^{ab}	1.40 ^{cab}
T_{2}- Silkworm Rearing Waste + Garden Soil	0.42 ^{d}	0.82 ^{cdb}	1.10 ^{cadb}
T_{3} -Chicken Dung + Cow Manure + Garden Soil	0.84 ^{cdb}	1.76 ^{a}	1.14 ^{cadb}
T_{4} –Sand + Sphagnum Moss + Garden Soil	0.88 ^{cdb}	0.82 ^{cdb}	0.80 ^{cdb}
T_{5} - Silkworm Rearing Waste	0.32 ^{d}	0.46 ^{d}	0.54 ^{cd}

** Means with the same letter are not significantly different at 5% level by DMRT.

Average Length of Primary Roots of Mulberry Saplings

Table 4 shows the average length of primary roots of mulberry saplings. Statistical analysis revealed highly significant differences among the different mulberry varieties and rooting media treatments. The mulberry Batac variety grown in the mixture of Chicken Dung + Cow Manure + Garden soil (T_3) gave the longest mean with 7.38 cm as compared with the other varieties and treatments. This was followed by Kanva-2 with 6.48 cm planted in Compost + Chicken Dung + Garden Soil (T_1). Also, the Batac variety planted in the Chicken Dung + Cow Manure + Garden soil (T_3) gave a mean of 6.00 cm. Meanwhile, the shortest average length of primary roots of mulberry saplings was 2.80 cm obtained from Kanva-2 planted in the Silkworm Rearing Waste (T_5. Finally, the Alfonso variety cuttings planted in the rooting media of Silkworm Rearing Waste + Garden Soil (T_2) gave 2.82 cm length of primary roots.

Table 4. Average length of primary roots (cm) formed by mulberry saplings two months after planting.

Treatment	Alfonso	Batac	Kanva-2
T_0- Garden Soil (control)	4.20^{cab}	4.48 ^{cab}	5.64 ^{cab}
T_1- Compost + Chicken Dung + Garden Soil	4.38^{cab}	5.46^{ab}	6.48 ^{ab}
T_2-Silkworm Rearing Waste + Garden Soil	2.82^{c}	5.66 ^{cab}	5.14 ^{cab}
T_3 -Chicken Dung + Cow Manure + Garden Soil	5.34 ^{cab}	7.38 ^{a}	6.00 ^{cab}
T_4 –Sand + Sphagnum Moss + Garden Soil	5.74 ^{cab}	4.04 ^{cab}	5.76 ^{cab}
T_5- Silkworm Rearing Waste	2.94^{c}	3.38 ^{cb}	2.80 ^{c}

** Means with the same letter are not significantly different at 5% level by DMRT.

Average Weight of Roots of Mulberry Saplings

Table 5 shows the weight of roots formed by mulberry saplings two months after planting. Significant differences were revealed by statistical analysis among the different mulberry varieties grown in the different treatments. Mulberry cuttings of Kanva-2 variety grown in the mixture of Compost + Chicken Dung + Garden soil (T_1) gave the heaviest mean weight of roots with 1.20 grams. This was followed by Batac mulberry variety with 1.16 grams grown in the Chicken Dung + Cow Manure + Garden soil (T_3). Meanwhile, cuttings of Kanva-2 grown in Chicken Dung + Cow Manure + Garden Soil (T_3) gave 1.02 grams root weight.

Finally, the lowest weight of roots with 0.36 grams was obtained from the cuttings of Kanva-2 variety planted in Silkworm Rearing Waste (T_5). Meanwhile, Batac and Alfonso mulberry cuttings grown in the same rooting media gave low mean root weight of 0.42 grams and 0.50 grams, respectively.

Table 5. Average weight of roots (g) of the mulberry saplings two months after planting

Treatment	Alfonso	Batac	Kanva-2
T_0-Garden Soil (control)	0.48^{c}	0.52^{cb}	0.82^{cab}
T_1- Compost + Chicken Dung + Garden Soil	0.46^{c}	0.76^{ab}	1.20^{a}
T_2- Silkworm Rearing Waste + Garden Soil	0.42^{c}	0.44^{c}	0.64^{cab}
T_3- Chicken Dung + Cow Manure + Garden Soil	0.52^{cb}	1.16^{ab}	1.02^{cab}
T_4- Sand + Sphagnum Moss+ Garden Soil	0.64^{cab}	0.64^{cab}	0.62^{cab}
T_5- Silkworm Rearing Waste	0.50^{c}	0.42^{c}	0.36^{c}

** Means with the same letter are not significantly different at 5% level by DMRT.

Survival Rate of Mulberry Cuttings

Table 6 shows the survival of mulberry cuttings two months after planting. All the different mulberry variety cuttings planted in the different treatments had a survival rate of 100%. This revealed the good characteristics of rooting media mixtures for the mulberry cuttings.

Table 6. Survival rate (%) of the mulberry saplings two months after planting.

Treatment	Alfonso	Batac	Kanva-2
T_0- Garden Soil (control)	100%	100%	100%
T_1- Compost + Chicken Dung + Garden Soil	100%	100%	100%
T_2- Silkworm Rearing Waste + Garden Soil	100%	100%	100%
T_3- Chicken Dung + Cow Manure + Garden Soil	100%	100%	100%
T_4- Sand + Sphagnum Moss + Garden Soil	100%	100%	100%
T_5- Silkworm Rearing Waste	100%	100%	100%

Rooting Media pH

Table 7 shows the pH of the different rooting media mixture before and after the experiment. All the rooting media used were within the soil pH range of 5-9 pH for mulberry production as recommended by Boriah in 1986.

Table 7. Soil pH of each treatment before and after the experiment.

Treatment	Alfonso		Batac		Kanva-2	
	Before	After	Before	After	Before	After
T_{0}- Garden Soil (control)	5.27	5.17	5.27	5.08	5.30	5.09
T_{1}- Compost + Chicken Dung + Garden Soil	6.92	6.32	6.92	6.21	6.92	6.24
T_{2} -Silkworm Rearing Waste + Garden Soil	8.21	8.21	8.21	8.12	8.21	8.14
T_{3} - Chicken Dung + Cow Manure + Garden Soil	6.29	6.19	6.29	6.19	6.29	6.21
T_{4} –Sand + Sphagnum Moss + Garden Soil	6.17	6.11	6.18	6.13	6.77	6.11
T_{5}- Silkworm Rearing Waste	9.16	9.15	9.36	9.27	9.36	9.25

SUMMARY AND CONCLUSION

Summary

This study was conducted to evaluate the effect of the rooting media on the growth of cuttings on different mulberry varieties for sapling production. It is also aimed to find out the growth increment, number of opened leaves, the weight of leaves and shoots, the average length of primary root, average weight of roots and the survival rate of mulberry cuttings. The Randomized Complete Block Design (RCBD) using the factorial method was used in this study. Factor A was the different mulberry varieties and Factor B uses the different rooting media used as treatment. The five rooting media used were: Garden soil (T_0), Compost + Chicken Dung + Garden Soil (T_1), Silkworm Rearing Waste + Garden Soil (T_2), Chicken Dung + Cow Manure+ Garden Soil (T_3), Sand + Sphagnum Moss + Garden Soil (T_4), and Silkworm Rearing Waste (T_5).

All the manures and the silkworm rearing waste used as treatments where properly decomposed before potting. Meanwhile, the different mulberry varieties were: Alfonso (A_1), Batac (A_2), and Kanva-2 (A_3).

This study was conducted at Benguet State University Sericulture Project at Ampasit, Puguis, La Trinidad, Benguet from February to April 2008.

The highest average of growth increment of 13.24 cm of mulberry saplings was obtained from the Batac Variety grown in the mixture of Chicken Dung + Cow Manure+ Garden Soil (T_3). Meanwhile, the lowest increment of 4.66 cm was given by Alfonso cuttings planted in Silkworm Rearing Waste (T_5). On the highest number of opened leaves formed it was taken from the Batac, and Kanva-2 Variety cuttings grown in the rooting media of Chicken Dung + Cow Manure + Garden Soil (T_3) with 9.00.

Meanwhile, the lowest number of opened leaves formed was from the variety, Alfonso, Batac and Kanva-2 varieties planted in Silkworm Rearing Waste (T_5) with 5.00 average number of opened leaves formed.

The highest average weight of leaves and shoots of mulberry variety 1.76 grams obtained from Batac Variety planted in Chicken Dung + Cow Manure + Garden Soil (T_3). While the lowest average weight of leaves and shoots was from the Alfonso Variety planted in Silkworm Rearing Waste (T_5) with 0.32 grams. Meanwhile, the longest length of Primary roots of 7.38 cm was obtained from Batac variety planted in Chicken Dung + Cow Manure + Garden Soil (T_3). The shortest Average length of Primary roots 2.80 cm was from the Kanva-2 variety planted in Silkworm Rearing Waste (T_5). On the other hand, the highest average weight of Roots 1.16 grams was taken from Batac Variety planted in Chicken Dung + Cow Manure+ Garden Soil (T_3) while the lowest average weight of roots 0.36 grams is from the Kanva-2 variety planted in Silkworm Rearing Waste (T_5)

The overall results shown in statistical analysis revealed that the Batac mulberry variety cuttings planted in the mixture of Chicken Dung + Cow Manure + Garden Soil (T_3) gave the highest average growth increment, most number of opened leaves, highest average weight of leaves and shoots, longest length of leaves of primary roots, and heaviest average weight of roots among all treatments and the varieties. Meanwhile, Alfonso and Kanva-2 variety planted in Silkworm Rearing Waste (T_5) gave the lowest of all the parameters used.

Finally, the survival rate of the different mulberry variety cuttings planted in the different rooting media was 100% while the pH of the different rooting media before and

after the experiment was within the Soil pH range of 5-9 as recommended for mulberry production by Boriah in 1986.

LITERATURE CITED

ADRIANCE, G. W. and, F. P. BRISON.1975. Propagation of Horticultural Plants. (2nd ed.)New York: Mc Grawhill Book Co; Inc.P.49

ALOS, M. T.1996.Initial field establishment of three foreign mulberry varieties under La Trinidad, Benguet, Condition. Thesis (Unpub.) BSU La Trinidad, Benguet.P.4.

ALVARES, V. D. and, H. KIM. 1994) Manual on Mulberry Cultivation. (8th ed.) Bicutan Taguig, Metro Manila: PIRI.PP. 1-5

BALASURAMANIAN, I.A.S., S. PRAKASHI and J. SAMPATH. 1988. Mulberry Agronomical R esearch. Indian Journal Sericulture. 26(11):p.26.

BAUTISTA, O. K. 1994. Introduction to Tropical Horticulture. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines, Los Baňos, Laguna. Pp. 188-199.

BOASE, P. C. and H. R. SINGHVI. 1989. Central Research and Training Institute, Mysore. Indian Journal Sericulture. 28(7); Pp.37-39.

BORAIAH, G. 1986. Lectures on Sericulture; Mulberry Cultivation. Department of Sericulture, Bachelor University, P.K. Block. Bangalore. Suramya Publishers, Bangalore. Pp.16-17.

BRANDY, N. C. and H. C. BULKMAN, 1974. The Nature and Properties of Soils. New York: The Mc Millan Book Company.

CABFILAN, J. W. 2000. Effect of compost and animal manure on mulberry sapling production. BS Thesis. Benguet State University. La Trinidad, Benguet. P.23.

CHOPCHOPEN, M. P. 2006. Morphological characteristics of different mulberry varieties in La Trinidad Benguet. BS Thesis.Benguet State University. LaTrinidad Benguet.Pp.12-17.

DANDIN, S. B. 1994. Constant Analysis of High Quality Cocoon and Raw Silk Production in India. Proceeding Report of the International Conference on Sericulture, “Global Silk Scenario 2001” CSR and TI-ICRETS, Mysore, India. Ph.113-119.

DAS, B. C. 1987. Propagation of Mulberry through Cuttings. Indian Silk. 24 (1): P. 12.

FAO. Agricultural Services Bulletin. 1998. Mulberry Cultivation. SIDD-PTRI. Rome. Pp.30-49.

HARTMAN, H. T., D.E.KESTER and F .T. DAVIES JR. 1990. Plant Propagation: Principles and practices. (15th ed.) Prentice Hall Inc. Englewood Cliffs, New Jersey: Pp. 25-241.

MARQUEZ, M. 1988. Utilization of azolla as organic fertilizer for cabbage and white potato. MS Thesis (Unpub.). Benguet State University. La Trinidad, Benguet. P 21-23.

SAMAY BULLETIN. 2002. ISSN 1655-4744. Vol. 2. No.2. P.1.

SANCHEZ, A. P. 1940. Properties of Management of Soil in the Tropics. New Cork: John Willey Inc. P. 178.

TAN, A. S. 1975. Compost Making. The Industrial Life.UPLA.Los Banos, laguna.

ULLAL, S. R. and M. N. NARASHIMHANNA. 1987. Handbook of Practical Sericulture. Bangalore, India: Central Silk board. Pp.210-220.

YOGAYOG, B. G. 2007. Performance of different potting media mixtures on the growth and root development of Batac mulberry (*Morus alba Linn*.) cuttings for sapling production. B.S. Thesis. Benguet State University. La Trinidad, Benguet. Pp.29-30.

YOGYOG, R. B. 2007. Effect of different decomposed manures as potting media on the growth of mulberry (*Morus alba Linn*.) cuttings for sapling media. BS Thesis. Benguet State University. La Trinidad, Benguet. Pp.28-29.

APPENDICES

Appendix Table 1. Average final growth increment of the mulberry saplings two months after planting

REPLICATION

ALFONSO	I	II	III	IV	V	VI	TOTAL	MEAN
T_0	3.46	4.70	5.56	7.11	8.14	10.39	39.36	5.56_{def}
T_1	1.57	2.57	3.99	5.37	6.88	8.20	28.58	4.77_{ef}
T_2	2.79	3.55	4.62	6.10	7.07	8.33	32.46	5.41_{def}
T_3	3.62	4.17	5.24	7.94	9.33	10.59	40.89	6.81_{def}
T_4	4.04	5.21	6.87	8.20	10.03	11.47	45.82	7.64_{cdef}
T_5	1.49	2.41	3.86	5.24	6.65	8.30	27.95	4.66^{f}

REPLICATION

BATAC	I	II	III	IV	V	VI	TOTAL	MEAN
T_0	3.38	4.57	6.06	8.03	10.04	12.08	44.16	7.36^{cdef}
T_1	6.33	8.22	10.10	12.5	14.39	17.01	68.55	11.43^{cab}
T_2	2.98	4.21	5.45	6.86	7.93	9.32	36.75	6.13^{def}
T_3	8.68	10.37	11.86	13.07	17.27	19.17	79.42	13.24^{a}
T_4	3.33	4.71	5.49	7.35	8.25	10.84	39.97	6.66^{def}
T_5	2.45	3.34	4.35	5.52	6.39	7.31	29.36	4.89^{ef}

REPLICATION

KANVA- 2	I	II	III	IV	V	VI	TOTAL	MEAN
T_0	4.14	6.05	7.60	9.20	11.52	14.35	52.86	8.81^{cdebf}
T_1	6.39	8.14	10.47	12.96	15.15	17.30	70.65	11.78^{ab}
T_2	4.51	6.80	7.71	10.12	11.60	13.78	54.52	9.09^{cdeb}
T_3	4.23	6.03	8.34	10.38	12.27	14.52	55.77	9.30^{cdb}
T_4	1.97	3.85	4.99	7.02	8.55	10.42	36.8	6.13^{def}
T_5	2.39	4.00	5.49	7.29	8.77	10.82	38.76	6.46^{def}

ANOVA TABLE

Source of Variance	Degree of freedom	Sum of square	Mean square	F value	Pr >F
Variety	2	147.50680556	73.75340278	7.49**	0.0010
Treatment	5	251.88771944	50.37754389	5.11**	0.0004
Variety * treatment	10	245.37265000	24.53726500	2.49**	0.0110
Error	90	846.68171667	9.85201907		
Total	107	1531.44889167			

**= Highly significant Coefficient of variance 41.20803%

Appendix Table 2. Average number of opened leaves formed by mulberry saplings two months after planting.

REPLICATION

ALFONSO	I	II	III	IV	V	TOTAL	MEAN
T_0	6	7	7	5	4	29	6.00^{cdb}
T_1	6	6	4	5	7	28	6.00^{cdb}
T_2	8	4	4	3	4	23	5.00^{d}
T_3	4	7	7	6	6	30	6.00^{cdb}
T_4	6	5	8	7	6	32	6.00^{cdb}
T_5	6	5	6	5	4	26	5.00^{cd}

REPLICATION

BATAC	I	II	III	IV	V	TOTAL	MEAN
T_0	4	9	5	5	9	32	6.00^{cadb}
T_1	7	8	12	6	5	38	8.00^{cadb}
T_2	7	7	6	7	4	31	6.00^{cdb}
T_3	6	12	11	9	9	47	9.00^{a}
T_4	6	5	4	10	9	34	7.00^{cadb}
T_5	5	6	6	4	4	25	5.00^{cd}

REPLICATION

KANVA-2	I	II	III	IV	V	TOTAL	MEAN
T_0	7	8	7	10	5	37	7.00^{cadb}
T_1	12	8	6	12	5	43	9.00^{ab}
T_2	9	7	6	7	6	35	7.00^{cadb}
T_3	7	10	7	3	13	40	8.00^{cab}
T_4	8	4	10	5	8	35	7.00^{cadb}
T_5	6	4	4	7	5	26	5.00^{cd}

ANOVA TABLE

Source of Variance	Degree of freedom	Sum of square	Mean square	F value	Pr >F
Variety	2	43.40000000	21.70000000	5.18*	0.0079
Treatment	5	67.43333333	13.48666667	3.22*	0.0111
Variety * treatment	10	31.66666667	3.16666667	0.76^{ns}	0.6698^{ns}
Error	72	301.60000000	4.18888889		
Total	89	444.10000000			

**= Highly significant Coefficient of variance 31.16768%

Appendix Table 3. Average weight of leaves and shoots (g) formed by mulberry saplings two months after planting.

REPLICATION

ALFONSO	I	II	III	IV	V	TOTAL	MEAN
T_0	0.60	0.80	0.50	0.40	0.30	2.6	0.52^{cd}
T_1	0.70	0.80	1.20	0.50	0.50	3.7	0.74^{cdb}
T_2	1.20	0.50	0.20	0.10	0.10	2.1	0.42^{d}
T_3	0.60	0.60	1.10	1.20	0.70	4.2	0.84^{cdb}
T_4	0.70	1.20	0.80	0.90	0.80	4.4	0.88^{cdb}
T_5	0.30	0.30	0.60	0.20	0.10	1.6	0.32^{d}

REPLICATION

BATAC	I	II	III	IV	V	TOTAL	MEAN
T_0	0.60	1.10	0.50	0.70	1.20	4.1	0.82^{cdb}
T_1	1.20	1.50	.340	1.20	0.50	7.8	1.56^{ad}
T_2	1.10	0.70	0.90	1.21	0.20	4.11	0.82^{cdb}
T_3	0.30	3.40	2.40	1.30	1.40	8.8	1.76^{a}
T_4	1.20	0.60	0.80	0.60	0.90	4.1	0.82^{cdb}
T_5	0.30	0.60	1.00	0.20	0.20	2.3	0.46^{d}

REPLICATION

KANVA-2	I	II	III	IV	V	TOTAL	MEAN
T_0	1.10	0.90	0.70	1.30	0.50	4.5	0.90^{abc}
T_1	3.10	0.70	0.20	2.50	0.50	7.0	1.40^{abc}
T_2	1.30	2.10	1.10	0.40	0.60	5.5	1.10^{cadb}
T_3	1.20	1.60	0.50	0.30	2.10	5.8	1.14^{abcd}
T_4	0.60	0.60	1.00	0.90	0.90	4.0	0.80^{bcd}
T_5	1.10	0.50	0.30	0.60	0.2	2.7	0.54^{cd}

ANOVA TABLE

Source of Variance	Degree of freedom	Sum of square	Mean square	F value	Pr >F
Variety	2	3.09920222	1.54960111	4.30*	0.0173
Treatment	5	7.24067222	1.44813444	4.2**	0.0029
Variety * treatment	10	2.70294444	0.27029444	0.75^{ns}	0.6759
Error	72	25.96768000	0.36066222		
Total	89	39.01049889			

**= Highly significant Coefficient of variance 68.23588%

Appendix Table 4.Average length of primary root (cm) formed by mulberry saplings two months after planting.

REPLICATION

ALFONSO	I	II	III	IV	V	TOTAL	MEAN
T_0	4.30	6.10	5.10	3.40	2.10	21	4.20^{cab}
T_1	1.10	4.20	5.50	5.60	5.50	21.9	4.38^{cab}
T_2	6.80	3.60	1.50	1.10	1.10	14.1	2.82^{c}
T_3	4.80	4.70	6.10	6.00	5.10	26.7	5.34^{cab}
T_4	4.20	5.10	6.20	6.70	6.50	28.7	5.74^{cab}
T_5	3.10	4.10	5.10	1.20	1.20	14.7	2.94^{c}

REPLICATION

BATAC	I	II	III	IV	V	TOTAL	MEAN
T_0	4.10	9.20	2.10	5.30	1.70	22.4	4.48^{cab}
T_1	6.30	7.80	6.00	8.10	4.10	32.3	5.46^{ab}
T_2	8.30	5.30	7.40	6.10	1.20	28.3	5.66^{cab}
T_3	5.80	5.30	9.20	8.60	8.00	36.9	7.38^{a}
T_4	1.50	3.60	2.10	5.20	7.80	20.2	4.04^{cab}
T_5	4.50	5.10	2.00	2.20	3.10	16.9	3.38^{cb}

REPLICATION

KANVA-2	I	II	III	IV	V	TOTAL	MEAN
T_0	5.10	7.30	6.40	5.10	4.30	28.2	5.64^{cab}
T_1	10.50	5.70	1.00	10.10	5.10	32.4	6.48^{ab}
T_2	7.50	8.90	1.10	2.60	5.60	25.7	5.14^{cab}
T_3	5.60	8.90	5.70	5.20	4.60	30	6.00^{cab}
T_4	7.40	5.60	.90	7.60	7.30	28.8	5.72^{cab}
T_5	2.10	4.30	1.10	5.40	1.10	14	2.80^{c}

ANOVA TABLE

Source of variance	Degree of freedom	Some of square	Mean square	F value	Pr > F
Variety	2	21.36022222	10.68011111^{ns}	2.15	0.1242
Treatment	5	93.57555556	18.71511111**	3.76	0.0044
Variety * treatment	10	43.39444444	4.33944444^{ns}	0.87	0.5624
Error	72	358.05600000	4.97300000		
Total	89	516.38622222			

**= highly significant Coefficient of variance 45.28475%

Appendix Table 5.Average weight of roots formed by mulberry saplings two months after planting

REPLICATION

ALFONSO	I	II	III	IV	V	TOTAL	MEAN
T_0	0.4	0.5	0.6	0.5	0.4	2.4	0.48^{c}
T_1	0.3	0.6	0.5	0.5	0.4	2.3	0.46^{c}
T_2	0.8	0.7	0.2	0.1	0.3	2.1	0.42^{c}
T_3	0.2	0.5	0.6	0.6	0.7	2.8	0.52^{cb}
T_4	0.9	0.5	0.7	0.5	0.6	3.2	0.64^{cab}
T_5	0.5	0.3	0.6	0.9	0.2	2.0	0.50^{c}

REPLICATION

BATAC	I	II	III	IV	V	TOTAL	MEAN
T_0	0.2	0.9	0.4	0.3	0.8	2.6	0.52^{cb}
T_1	0.6	0.7	1.5	0.6	0.4	3.8	0.76^{ab}
T_2	0.6	0.5	0.4	0.5	0.2	2.2	0.44^{c}
T_3	0.4	2.0	1.7	0.9	0.8	5.8	1.16^{ab}
T_4	0.5	0.4	0.2	1.2	0.9	3.2	0.64^{cab}
T_5	0.4	0.5	0.5	0.3	0.4	2.1	0.42^{c}

REPLICATION

KANVA-2	I	II	III	IV	V	TOTAL	MEAN
T_0	1.0	0.7	0.6	1.5	0.3	4.1	0.82^{cab}
T_1	2.1	0.6	0.5	2.5	0.3	6.0	1.20^{a}
T_2	0.8	0.7	0.5	0.7	0.5	3.2	0.64^{cab}
T_3	0.6	1.6	0.6	0.1	2.2	5.1	1.02^{cab}
T_4	0.7	0.2	1.2	0.3	0.7	3.1	0.62^{cab}
T_5	0.5	0.3	0.2	0.5	0.3	1.8	0.36^{c}

ANOVA TABLE

Source of Variance	Degree of freedom	Sum of square	Mean of square	F value	Pr >F
Variety	2	1.12622222	0.56311111	3.03*	0.0545
Treatment	5	2.42188889	0.48437778	2.61*	0.0319
Variety * treatment	10	1.93511111	0.19351111	1.04^{ns}	0.4186
Error	72	13.38000000	0.18583333		
Total	89	18.86322222			

**= Highly significant Coefficient of variance 66.77720%

Appendix Table 6. Survival rate (%) of mulberry saplings two months after planting.

	Mulberry Variety		
Treatment	Alfonso	Batac	Kanva-2
T_0	100%	100%	100%
T_1	100%	100%	100%
T_2	100%	100%	100%
T_3	100%	100%	100%
T_4	100%	100%	100%
T_5	100%	100%	100%

Appendix Table 7. Rooting Media pH of the different treatments on the different mulberry variety before and after the experiment.

	Mulberry Variety					
	ALFONSO		BATAC		KANVA-2	
Treatment	Before	After	Before	After	Before	After
T_0	5.27	5.17	5.27	5.08	5.30	5.09
T_1	6.92	6.32	6.92	6.21	6.92	6.24
T_2	8.21	8.21	8.21	8.12	8.21	8.14
T_3	6.29	6.19	6.29	6.19	6.29	6.21
T_4	6.17	6.11	6.18	6.13	6.77	6.11
T_5	9.16	9.15	9.36	9.27	9.36	9.25