Introduction

Native trees are very important in the web of life. They are the foundation of our natural ecosystems (1). They provide food and shelter to wildlife much better than introduced tree species. Native trees also adapt naturally to their local surrounding, thus more resilient than introduced species (2). They also retain their natural capacity to form devastation caused by raging weather and from pests and diseases (1).

In recent decades, there was a sharp decline in the population of native trees because of destructive and extractive human activities. Deforestation, replacement by invasive alien species, mono-crop plantations that propagate only commercially popular varieties (3) and the rapid proliferation of exotic plant species (4) are some of the reasons why native trees have been disappearing at a very fast rate. Moreover, local people also continuously replacing economically important tree species with “money trees” like Gmelina and Mahogany for profit. As a result, a significant number of native tree species were moved to “endangered” status because of the dwindling population and continuous threat.

The diminishing population and the threat of extinction of native trees justify the need to exert more effort to protect the fast desertion of native fruit and forest tree species in the country. The Ecosystems Research and Development Bureau (ERDB) in the country have already conducted researches in the macro propagation of native tree species to restore their status but concentrated on the Dipterocarp tree and well known native tree species but not on lesser known fruit and forest tree species. Hence, the researchers proposed the research project, “Development of Clonal Propagation Protocols for Native Forest and Fruit-Bearing Tree Species of Quirino and Nearby Provinces” funded by the The Department of Science and Technology- Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (DOST-PCAARRD). One of the fifteen identified fruit tree species included in the study is ‘Bignay’.

Antidesma bunius (Linn.) Spreng (‘Bignay’) is an endemic tree species of Euphorbiaceae family. It is a dioecious tree, usually reaches a height of about 10 meters. The tree grows well in the primary or secondary montane rain forest reaching about 1800
meters altitude. They grow well in alluvial flats, clayey soils, peaty soils, volcanic soils, podzols and limestone type of soils (5). The edible fruit develops in clusters like grapes and its size reaches 8 mm long containing one seed per fruit. ‘Bignay’ fruit juice contains health-stimulating chemical compounds such as phenolic, anthocyanin, ascorbic acid and flavonoid that can be a natural source of antioxidants (6). Also, the entire plant is used as an antisyneretic, antioxidative, anticancer, anti diabetic and gives sudorific effects that increase its medicinal significance. Likewise, the leaves are sudorific and employed in treating snakebite in Asia (7).

‘Bignay’ seeds can be sown one month after ripening under the shade without pre-treatment (5). Its seeds germination rate ranges from 3% to 30% which will take 30 to 60 days after sowing. The low viability rate of ‘bignay’ seed makes the supply of quality seeds inadequate which posed a major problem for massive planting and restoration. The present status of bignay needs immediate action to conserve, multiply and prevent the species from being endangered.

In the absence of quality seeds, the use of other plant parts such as stem as planting propague is a possible alternative. Vegetative propagation through stem cutting has been acknowledged as an effective technique of rapid propagation of exact replica, true-to-type of the needed tree species for commercial plantation with fast reproductive gains (8) and germplasm preservation of vital tree species (9). As affirmed in a study (10), due to the reduced time needed for cuttings of excellent quality trees to produce roots and survive, this method of propagation is a rapid and very essential nursery management technique that accelerates planting stock production.

With the rigorous management of forest areas and the proliferation of fast growing exotics, including the genetic improvement of forest tree species, it is vital to develop quick and cost effective methods of producing top quality planting stock. Vegetative propagation technique through stem cutting of forest trees is very promising for the reproduction of clones and for fast increase of planting stocks. Clones provide the advantages of genetic uniformity and the rapid multiplication of superior trees for seed orchards and plantations.

Successful vegetative propagation through stem cuttings was successfully undertaken through the application of plant bio-regulators. As a result, ERDB reported to have successfully propagated seven species of dipterocarp by cuttings through a non-mist propagation system using different plant bio-regulators with high rooting performances (11). Bio-regulators affect the fundamental processes of plant growth and development. Indole-3-butyric acid (IBA), Indole-3-acetic acid (IAA) and Naphthalene acetic acid (NAA) are plant bio-regulators belonging to the auxin group that play an important role in root initiation (12). The most relevant role of auxins in plant propagation is that they stimulate root initiation on stem and leaf cuttings and the development of branch roots (13). This function of auxin is essential for the propagation of cuttings in many plant species used in horticultural and in forestry industries. Usually, Indole-3-butyric acid (IBA) is found to be the most effective root promoting auxin (14) and least toxic for plant tissues (15). IBA has important functions in several phases of root development that include adventitious root formation (16). IBA also enhances rooting since it translocates poorly and is retained near the site of application (17).

BioGro, on the other hand, is made up of solid-based microbial plant growth promotor comprising of Plant Growth-Promoting Bacteria (PGPB). PGPB are associated with bacteria that affect root growth. These bacteria synthesize plant hormones provide nutrients in insoluble form. PGPB also shield plant surface against pathogenic microbes that attack through direct competitive effects and creation of antimicrobial compounds. As pointed out in a study (18), plant hormone produced by soil microorganisms are tangle in plant growth promotion and development. This is due to the creation of plant growth regulators like gibberellins, auxins and cytokinins. BioGro trials were successfully conducted to different crops with an increased yield of 8% to 88% and resulted to a higher income for the farmer. For ornamentals and other cut plants, the cuttings effectively survived at a ratio of 1:10 ratio of BioGro to water suspension (19). There is no study conducted yet on trees using BioGro as a root enhancer hence, the result of this test was first-hand information contributing to BioGro technology.

Thus, the study determined the effect of cutting origins, IBA and BioGro treatments on the growth and survival of A. bunius. It aimed to generate information of the macro-clonal propagation protocol for A. bunius that serves as a guide for proper propagation of the species to improve its germplasm, for ex-situ conservation, and for mass propagation for the establishment of a future plantation to adequately supply the raw materials needed by wine producers in the upland communities. Specifically, to find the best cutting origin that will significantly increase the survival and rooting of cuttings and to determine the most effective root promoting hormone and economical dosage best for the propagation through cuttings.

Materials and Methods

Collection and Maintenance of wildlings along Hedgerows

Two hundred and sixteen (216) wildlings of ‘bignay’ about 0.1 to 0.2 m were earth-balled from the mountainous ranges of Quirino province. These were initially placed in a mist chamber, acclimatized in nursery condition (i.e. Increasing the amount of outdoor exposure one hour each day to gradually acclimate the seedlings to increasing amounts of dappled sun and wind). The seedlings were finally grown in a 200 m² hedgerows established beside the clonal nursery of the university. These were maintained until they have reached approximately 6-10 nodes and are at least 0.9 m in height (Fig. 1).

Preparation of Cuttings

Two hundred and sixteen (216) healthy stem cuttings
containing 9 nodes each were obtained from the seedlings grown along the hedgerows were used in the study. Cuttings were collected early in the morning and leaves were reduced to half their size to minimize transpiration. The cuttings were placed in a basin filled with water to wash off dust and to avoid drying. These were soaked in 5% Benlate solution, a fungicide for 30 min to eliminate fungal contamination. The cuttings were divided into three parts: top (1st-3rd nodes), middle (4th-6th nodes) and bottom (7th-9th nodes). These were bundled into 24 cuttings with the basal part at the same end trimmed and soaked in their specific dosage of rooting hormone treatments (Fig. 2).

**Preparation of Rooting Chamber**

The propagation chambers inside the clonal propagation facility are structures provided with elevated rooting beds (rooting chambers) equipped with a programmable mist system. The whole rooting bed had an area of 6 sq m and was divided into three chambers having dimensions of 1 m x 2 m each. Each rooting chamber is sealed tightly with polyethylene plastic no. 8. The chambers were cleaned and washed by a fungicide (i.e. 200 ppm Benlate) solution to minimize possible fungi contamination. The rooting bed was filled with layers of sterilized gravel and sand. The gravel layer as the first layer has a thickness of 5 cm and the sand layer as the surface layer has a thickness of 20 cm. A net is placed between them to avoid the mixing of the gravel and sand. The planted cuttings were watered using the automatic mist system. This was programmed so that the cuttings were watered in an interval to keep the cuttings moist always.

**Preparation of Rooting Media**

Pure river sand collected from Bagabag, Nueva Vizcaya was used as a rooting media for the experiment. The rooting media was sterilized in an improvised autoclave through steam cooking for up to 80°C to eliminate all possible microorganisms that could contaminate the cuttings. This was sprayed first with a fungicide solution to eliminate some available fungi in the media. The rooting medium was divided into compartments based on the experimental layout and labels were established for easier planting of the cuttings (Fig. 3).

**Preparation of Rooting Hormone**

The rooting hormone IBA was prepared in powder form. Using a digital weighing scale (Merc-2 gms capacity), 1 gm of powdered/solid form of IBA was diluted with enough distilled water and exposed to a water bath at 45 °C. After which, this was vortexed or titrated using the titrator machine. When properly diluted, the rooting hormone was volumed to 1000 ml
by adding 1 l of distilled water using a volumetric flask producing a stock solution of 1000 ppm concentration (20). Varying concentration of 500 ppm, 1500 ppm and 2000 ppm was prepared from that stock solution of 1000 ppm by serial dilution. The same procedure was used in preparing the different levels of BioGroe treatments.

Parameters Measured
Assessment of treatment effects was done after 3 months. The following parameters were obtained:

- Mean number of adventitious roots, average shoot length, percent survival and percent rooting.
- The mean number of adventitious roots was calculated by counting the total number of roots emanated from the base of all cuttings per treatment divided by the total cuttings used per treatment.
- The average shoot length was determined by dividing the total length of shoots over the total number of sample cuttings with shoots. Shoot length was measured using a foot rule from the point of origin of the shoots up to the tip of the elongated shoots.

Percent survival was computed by dividing the number of surviving cuttings that produced roots and shoots at the end of the experiment with the total number of stem cuttings planted and then multiplied by 100. Percent rooting was determined by dividing the actual number of cuttings that rooted with the total number of cuttings planted and then multiplied by 100. Photos of survived cuttings that produced roots and shoots are shown (Fig. 4).

Experimental Design, Treatments and Statistical Analysis
The study utilized a 3 x 9 factorial experiment laid out in a factorial Complete Randomized Design (CRD) replicated three times. A two-way Analysis of Variance (ANOVA) was used to determine the significance of the data collected. A comparison of treatment means was done for parameters showing significant differences using the Duncan's Multiple Range Test (DMRT). A statistical package (Statistix 10) was used for the data analysis.

There were two factors used in the study. Factor A composed of three cutting origins. C₁ were cuttings collected from the topmost part of the seedlings having the 1st three nodes with a pair of healthy leaves. C₂ were cuttings collected from the middle portion of the donor plant containing the 4th to 6th nodes with a pair of healthy leaves and C₃ were cuttings derived from the bottom part of the donor plant containing the 7th to 9th nodes.

Factor B was the hormonal treatments applied to the cuttings. There were 27 treatment combinations used per replication in the study (Table 1).

Results and Discussion
Percent Survival
The percent survival of the cuttings as affected by its origin showed no significant difference among each other (Table 2). The highest survival rate was observed in the bottom cuttings (82.41%) followed by the top cuttings (81.48%) and the lowest was recorded by the middle cuttings (72.22%), however, they do not vary statistically (Table 3). The high rate of survival was due to the juvenile state and presence of endogenous auxins in all cutting. As explained in a study (21), juvenile stem cuttings ensured higher photosynthetic activity due to an increase of stomatal conductance which leads to more supply of carbohydrates for root development and subsequent survival of the cuttings.

Among the levels of IBA and BioGroe treatments, the highest percent survival was exhibited by cuttings with 500 ppm IBA (86.11%) followed by cuttings treated with 500 ppm BioGroe (83.33%), and the least (70.83%) was yielded by the control (Table 4). However, the data showed that the application of IBA and BioGroe have no significant effect on the percent survival of the cuttings. This means that the cuttings can still survive even without the application of IBA or BioGroe.
The Analysis of Variance (ANOVA) on the percent survival of A. bunius cuttings as affected by various levels of IBA and BioGroe revealed no significant difference. This conforms with a research finding conducted in propagating Dillenia suffruticosa (Griff.) Martelli (22). However, the interaction effect of cutting origins and rooting hormone levels showed a significant difference at a 5% level of confidence. This means that the percent survival was different for every treatment combination. DMRT results showed that top cuttings treated with 500 ppm IBA was significantly different from untreated top cuttings, cuttings treated with 1000 ppm IBA, untreated middle cuttings, middle cuttings with 500 ppm IBA treatment, top cuttings applied with 500 ppm BioGroe and middle cuttings with 2000 ppm BioGroe (Table 5).

### Percent Rooting

Percent rooting of cuttings was not influenced by cutting origins in Bignay. As shown in the Analysis of Variance (ANOVA), it was observed that there is no significant difference among the percent rooting of each cutting origin (Table 2). This implies that the percent rooting of 'bignay' is not dependent on the origin cuttings. The highest rooting percentage (82.41%) was obtained by the bottom cuttings followed by the top cuttings (81.48%) and the least was noted in the middle cuttings (72.22%). This coincides with the findings of a study (23) where hardwood cuttings taken from the basal part of the stem recorded the highest rooting percentage (82.57%).

Table 3 indicates that using any of the 3 set of cutting will yield a high rooting percentage. It is possible that the age of the ortet where the 3 stem cutting origins were derived contributed to the high rooting of the cuttings. This could be connected to the report that juvenile seedlings as a source of cuttings produce lower rooting inhibitors as compared to older plants (24). This report coincides with the findings that, propagating juvenile leafy stem cuttings of Litsea monopetala (Roxb. ex Baker) Pers. can be a helpful method to increase the rooting percentage (25).

The different concentrations of IBA and BioGroe applied to cuttings revealed that there is no effect on the percent rooting of bignay cuttings (Table 4). The highest rooting percentage was exhibited by cuttings treated with 500 ppm IBA (86.11%) followed by cuttings applied with 500 ppm BioGroe while the lowest was in cuttings treated with control (70.83%). This implies that bignay is an easy to root species. Easy to root plants respond better to the exogenous

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**Table 1. Treatment Combinations for the experiment**

| Top Cuttings (C1) | Middle Cuttings (C2) | Bottom Cuttings (C3) |
|-------------------|---------------------|---------------------|
| C1 T1             | C2 T1               | C3 T1               |
| Control (distilled H2O) | Control (distilled H2O) | Control (distilled H2O) |
| C1 T2             | C2 T2               | C3 T2               |
| 500 ppm IBA       | 500 ppm IBA         | 500 ppm IBA         |
| C1 T3             | C2 T3               | C3 T3               |
| 1000 ppm IBA      | 1000 ppm IBA        | 1000 ppm IBA        |
| C1 T4             | C2 T4               | C3 T4               |
| 1500 ppm IBA      | 1500 ppm IBA        | 1500 ppm IBA        |
| C1 T5             | C2 T5               | C3 T5               |
| 2000 ppm BioGroe  | 2000 ppm BioGroe    | 2000 ppm BioGroe    |
| C1 T6             | C2 T6               | C3 T6               |
| 500 ppm BioGroe   | 500 ppm BioGroe     | 500 ppm BioGroe     |
| C1 T7             | C2 T7               | C3 T7               |
| 1000 ppm BioGroe  | 1000 ppm BioGroe    | 1000 ppm BioGroe    |
| C1 T8             | C2 T8               | C3 T8               |
| 1500 ppm BioGroe  | 1500 ppm BioGroe    | 1500 ppm BioGroe    |
| C1 T9             | C2 T9               | C3 T9               |
| 2000 ppm BioGroe  | 2000 ppm BioGroe    | 2000 ppm BioGroe    |

**Table 2. Summary of the Analysis of Variance on percent survival, percent rooting, number of adventitious roots and length of shoots of Bignay (Antidesma bunius)**

| Source of Variation | Percent (%) survival | Percent (%) rooting | Number of adventitious roots | Length of shoots (mm) |
|---------------------|---------------------|---------------------|-----------------------------|-----------------------|
| FACTOR A            | 3.07ns              | 3.07ns              | 0.65ns                      | 28.59                 |
| FACTOR B            | 0.65ns              | 0.65ns              | 1.88ns                      | 2.03%                 |
| FACTOR A x B        | 2.00*               | 2.00*               | 1.51ns                      | 1.54%                 |
| CV (%)              | 21.22               | 21.22               | 28.29                      | 29.21                 |

* significant at 5% level; ** significant at 1% level; ns = not significant

**Table 3. Summary of the parameters evaluated as affected by the different cutting origins of Bignay (Antidesma bunius)**

| Cutting Origins | Percent (%) survival | Percent (%) rooting | Mean Number of adventitious roots | Mean Length of shoots (mm) |
|-----------------|---------------------|---------------------|----------------------------------|---------------------------|
| Top Cuttings    | 81.48               | 81.48               | 1.67                            | 2.03                       |
| Middle Cuttings | 72.22               | 72.22               | 1.74                            | 10.96*                     |
| Bottom Cuttings | 82.41               | 82.41               | 1.85                            | 12.48*                     |
| F Computed      | 3.07**              | 3.07**              | 0.47**                         | 3.50*                     |
| CV (%)          | 21.22               | 21.22               | 28.29                          | 29.21                     |

**Table 4. Summary of the parameters evaluated as affected by the different rooting hormone treatments of Bignay (Antidesma bunius)**

| Different levels of rooting hormone treatment | % Survival | % Rooting | Mean number of adventitious roots | Mean length of shoots (mm) |
|---------------------------------------------|------------|-----------|----------------------------------|---------------------------|
| T1  - Distilled H2O                          | 70.83      | 70.83     | 1.44                            | 10.42                     |
| T2  - 500 ppm IBA                           | 86.11      | 86.11     | 1.89                            | 8.81                      |
| T3  - 1000 ppm IBA                          | 75.00      | 75.00     | 2.09                            | 12.52                     |
| T4  - 1500 ppm IBA                          | 80.36      | 80.36     | 1.99                            | 11.02                     |
| T5  - 2000 ppm IBA                          | 76.39      | 76.39     | 2.36                            | 13.26                     |
| T6  - 500 ppm BioGroe                        | 83.33      | 83.33     | 1.89                            | 11.44                     |
| T7  - 1000 ppm BioGroe                       | 79.17      | 79.17     | 1.36                            | 9.66                      |
| T8  - 1500 ppm BioGroe                       | 77.78      | 77.78     | 1.67                            | 9.35                      |
| T9  - 2000 ppm BioGroe                       | 72.37      | 72.37     | 1.97                            | 8.49                      |
| F Computed                                  | 0.65**     | 0.65**    | 1.88**                         | 2.03*                     |
| CV (%)                                      | 21.22      | 21.22     | 28.29                          | 29.21                     |

ns = not significant
implies that the origin of cuttings does not influence the number of adventitious roots produced by the respective cuttings. The result was opposite to the findings of (29) where softwood cuttings significantly increase the number and length of adventitious roots of Tindalo cuttings.

Table 4 revealed that the greatest number of adventitious roots produced was exhibited by cuttings treated with 2000 ppm IBA (2.28) followed by cuttings applied with 1000 ppm IBA (2.06) and the least was noted in control (1.44). This contradicts with a research finding (30) where root production of Holarrhena pubescens Wall. ex G. Don is a little more receptive to lower levels of IBA concentrations. Analysis of Variance revealed no significant difference among the different rooting hormone treatments (Table 2). It implies that the mean number of adventitious roots was statistically the same even when applied with different levels of IBA and BioGro. This means that with or without the application of hormones such as IBA and BioGro, the number of adventitious roots produced by the cuttings will still be the same. Bignay stem cuttings can produce roots even without the application of the rooting hormone. This conforms with the findings on rooting of Drimys brasiliensis Miers, Ficus elastica Roxb. ex Hornem and Albizia zygia (DC.) J. F. Macbr. respectively (31, 32, 33). Their findings showed that the rooting hormone treatment tested by them did not influence the number of roots per cutting, percentage of rooted cuttings, percentage of cuttings with callus and length of the longest roots per cuttings.

### Length of Shoots

The longest shoot (12.48 mm) was obtained by the bottom cuttings while the lowest (8.71 mm) was obtained by top cuttings (Table 3). Analysis of variance revealed that there is a significant difference among cutting origin means. This means that the length of shoots differs from each other. Further analysis using LSD in comparing the means of cutting origin showed that the longest shoot (12.48 mm) was obtained by the bottom cuttings that were statistically the same with middle cuttings (10.96 mm). Meanwhile, the shortest shoot obtained on top cuttings with a mean length of 8.71 mm was found to be statistically different from bottom cuttings (12.48 mm).

Furthermore, in terms of the effect of the various concentrations of IBA and BioGro to the length of shoots produced by the cuttings, data showed that there is no significant difference among the treatment means. The same findings were recorded on the stem cuttings of A. bunius as with that of the length of adventitious shoots of Swietenia macrophylla King, of which they were not significantly affected by the IBA treatments (34) but they differ on the significant effect of different doses of indole-3-butyric acid (IBA) on the shoot length and other vegetative growth performance of hardwood cuttings of Flordaguard peach (35).

The longest shoot was noted in cuttings applied with 2000 ppm IBA (14.75 mm) followed by cuttings applied with 1000 ppm IBA (12.52 mm) while the shortest was achieved by cuttings applied with 500 ppm IBA (8.81 mm). This implies that even if the

### Table 5. Comparison of means for the interaction effect of cutting origin and rooting hormone levels on percent survival and percent rooting of ‘Bignay’ (Antidesma bunius)

| Interaction of Factor A X B | Percent Survival (%) | Percent Rooting (%) |
|----------------------------|----------------------|---------------------|
| C1T1                       | 54.17*               | 54.17*              |
| C1T2                       | 100.00*              | 100.00*             |
| C1T3                       | 58.33*               | 58.33*              |
| C1T4                       | 87.50*               | 87.50*              |
| C1T5                       | 95.83*               | 95.83*              |
| C1T6                       | 83.33**              | 83.33**             |
| C1T7                       | 70.83**              | 70.83**             |
| C1T8                       | 91.67**              | 91.67**             |
| C1T9                       | 91.67**              | 91.67**             |
| C2T1                       | 66.67*               | 66.67*              |
| C2T2                       | 66.67*               | 66.67*              |
| C2T3                       | 79.17**              | 79.17**             |
| C2T4                       | 79.17**              | 79.17**             |
| C2T5                       | 66.67*               | 66.67*              |
| C2T6                       | 87.50*               | 87.50*              |
| C2T7                       | 75.00**              | 75.00**             |
| C2T8                       | 58.33*               | 58.33*              |
| C2T9                       | 70.83**              | 70.83**             |
| C3T1                       | 91.67**              | 91.67**             |
| C3T2                       | 91.67**              | 91.67**             |
| C3T3                       | 87.50*               | 87.50*              |
| C3T4                       | 75.00**              | 75.00**             |
| C3T5                       | 66.67*               | 66.67*              |
| C3T6                       | 79.17**              | 79.17**             |
| C3T7                       | 91.67**              | 91.67**             |
| C3T8                       | 83.33**              | 83.33**             |
| C3T9                       | 75.00**              | 75.00**             |
| F Computed                 | 2.00*                | 2.00*               |
| CV (%)                     | 21.22                | 21.22               |

*Significant at 5% level
mean length was numerically different from each other, they are still statistically the same as revealed by the Analysis of Variance.

Likewise, the interaction of Factor A and Factor B as revealed by the Analysis of Variance shows no significant difference between each other. This implies that the different treatment combinations, when used in ‘bignay’, have a comparable result.

Conclusion

The study revealed that ‘Bignay’ stem cuttings are effectively rooted and survived using the three cutting origins. Further, rooting of A. bunius (‘Bignay’) cuttings does not necessarily need the application of growth hormones such as IBA and Biogro since the cuttings produced roots and survived easily without the aid of these treatments. For the mass production of Bignay cloned seedlings, it is best to use any cutting origins severed from the test plants without exogenous auxin application. Findings of this study may be used as macro-clonal propagation protocol for ‘bignay’ to economically propagate and adequately supply the planting materials needed by wine producers in the upland communities in Quirino province.

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Authors’ contributions

EV Benabise, JJ Quinan, JG Carig had contributed equally in this work.

Conflict of interests

Authors do not have any conflict of interest to declare.

References

1. Philippines. Department of Sciences and Technology. Philippine native trees-what to plant in different provinces [Internet]. Laguna: PCAARD; 2015 [cited 2019 Sept 9]. Available from: http://www.pcaard.dost.gov.ph
2. Tarriela FG. Why native trees. Manila Bulletin [Internet]. 2018 Feb 7 [cited 2019 Oct 15]. Available from: https://mb.com.ph/2018/02/07/why-native-trees/
3. Oliva, MTM. Philippine Native Trees. Green Convergence [Internet]. 2019 Oct. 23 [cited 2019 Nov 29]. Available from: http://greenconvergencephil.com/philippine-native-trees/
4. Cabansag MG. Species composition, diversity and richness in understanding threats on biodiversity conservation of Philippine native and indigenous species of trees. Int J Appl Environ Sci [Internet]. 2016 [cited 2019 March 15]11(3):759-72. Available from: https://www.ripublication.com/ijaes16/ijaesv11n3_05_pdf
5. Philippines. Department of Environment and Natural Resources-Ecosystem Research and Development Bureau. Natural dyes [Internet]. RISE: DENR-ERDB; 1999 [cited 2019 Nov 29]11(1):6-8. Available from: http://erdb.denr.gov.ph/wp-content/uploads/2015/06/r_v11n1.pdf
6. Hardinasinta G, Mursalim M, Muhidon J, Salendgse K. Determination of some chemical compounds of bignay (Antidesma bunius) fruit juice. Int J Fruit Sci. [Internet]. 2020 [cited 2020 Jan 15](8(2):15-34. Available from: https://doi.org/10.1590/Fs27720
7. Belmi RM, Giron J, Tansengco ML. Antidesma bunius (Bignay) extract as an organic pesticide against Epilachna spp. J Asian Sci Res. [Internet]. 2014 [cited 2020 April 11](4):320-27. Available from: http://www.asejournals.org/journals/5002
8. Shekhawat MS, Manokari M. Impact of auxins on vegetative propagation through stem cuttings of Couroupita guianensis Aulb.: A conservation approach [Internet]. 2016 [cited 2019 Oct 15]. Available from: https://doi.org/10.1155/2016/685751
9. Bhuyan L, Singh CL, Kharg G, Sharma MB. Vegetative propagation of two important Garcinia sp. of Assam, NE India. J Med Plants Stud. [Internet]. 2017 [cited 2019 Aug 25; 5(3): 273-77. Available from: https://www.plantsjournal.org/archives/2017/07/vol5issue3/pdf
10. USA. University of Auburn. Overview of cutting propagation [Internet]. Alabama: Department of Forestry; 1997 [cited 2019 Oct 1]. Available from: http://www rooting-hormone.com/hudson.html
11. Philippines. Clonal propagation of selected high-premium tree species [Internet]. Laguna: PCAARRD; 2007 [cited 2019 Nov 29]. Available from: http://www.pcaard.dost.gov.ph
12. Beyl CA, Trigiano RN. Introduction to plant propagation: plant propagation concepts and laboratory exercises [e-book], 2nd Edition. Boca Raton, Florida: CRC Press; 2015. [cited 2019 Sept 27]. Available from: https://doi.org/10.1201/b17340
13. Beyl CA, Burger DW, Cheng ZM. Plant growth substances used in propagation plant propagation concepts and laboratory exercises [e-book], 2nd Edition. Boca Raton, Florida: CRC Press; 2015. [cited 2019 Nov 19]. Available from: https://www.roundle.com/Beyl-Trigiano/book
14. Leakey RRB. Physiology of vegetative reproduction. encyclopedia of forest sciences [e-book]. San Diego: Academic Press; 2004 [cited 2019 Nov 07]. Available from: https://doi.org/10.1016-B0-12-145160-7/00108-3
15. Mazzini-guedes RB, Nogueira MR, Ferraz MV, Bezerra AK, Pereira TS, Piveta CGL. Rooting of Azalea cuttings (Rhododendron x simissim Planch.) under indolebutyric acid and boron concentrations. Int. J. New Technol. and Res. 2017:3158-62.
16. Frick EM, Strader LC. Roles for IBA-derived auxin in plant development. J Exp Bot. [Internet]. 2018 [cited 2020 Feb 25; 69(2):169-77. Available from: https://doi.org/10.1093/jxb/erx298
17. Pollisco MT. Rooting hormone and their practical application to macro-vegetative propagation by cuttings. Paper presented at National Plant Propagation Congress; Philippines; 2002 Sept. 3-5.
18. Philippines. Department of Science and Technology -Invention Development Division. Nano-encapsulated plant growth regulators [Internet]. DOST-IDD; 2019 [cited 2019 Nov 29]. Available from: https://techtrans.gov.ph/trademark/plant-growth-regulator
19. Philippines. BIOGRO Technology: Paving the way for efficient fertilizer use and increased farmer’s income. [Internet]. Laguna: PCAARRD Monitor; 2013 [cited 2020 Jan 29]. Available from: https://biotech.uplb.edu.ph/images/stories/BioGRO%20article.pdf
20. George EF. Plant propagation by tissue culture. 2nd Edition. Exigats Limited Publication, UK. 2003.
21. Tombesi S, Palliotti A, Poni S, Farinelli D. Influence of light and carbohydrate status during the adventitious root formation in Corylus avellana L. Front Plant Sci. [Internet]. 2015 [cited 2020 Jan. 15];6:1-13. Available from: https://doi.org/10.3389/fpls.2015.00097
22. Abidin N, Metali F. Effects of different types and concentrations of auxins on juvenile stem cuttings for propagation of potential medicinal Diilenia suffruticosia Martelli shrub. Res J Bot. [Internet]. 2015 [cited 2020 Mar. 17];10(3);73-87. Available from: https://doi.org/10.3923/rjb.2015.73-87
23. Patel HR, Patel MJ. Role of auxins on rooting of different types of cuttings in Fig. Int J Microbiol App Scie. [Internet]. 2018 [cited 2020 April 27];7:1317–22. Available from: https://doi.org/10.20546/jmasc.2018.703.137
24. Castro C, Bonfil CC. Propagation of three Bursera species from cuttings. Bot Sci. [Internet]. 2013 [cited 2020 June 21]9(2): 217–24. Available from: https://doi.org/10.17172/botsci.416
25. Baul TK, Hossain MM, Mezhahbuddin M, Mohiuddin M. Vegetative propagation of Litsea monopetala, a wild tropical
