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Growth of Four Lesser-used Tree Species in Different Potting Mixtures and Watering Frequencies

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Abstract

This study determined the most suitable potting mixture and watering interval for raising quality seedlings of four lesser-used tree species such as *akleng parang* [*Albizia procera* (Roxb. Benth.], *kariskis* [*Albizia lebbekoidez (*D.C.) Benth.], *sakat* (*Terminalia nitens* Presl.), and *banaba* [*Lagerstroemia speciosa* (Linn.) Pers.]. The experiment was set-up at the MMSU Central Nursery, City of Batac, Ilocos Norte

Results revealed marked effects of potting mixture and watering frequency on the percentage survival of *sakat*. Likewise, potting media and watering frequency affected the height increments of *akleng parang*, while potting mixtures affected the shoot-root ratio of *sakat* seedlings.. In addition, significant interactions of potting mixture and watering frequency were observed on the: a) height and diameter increment and shoot-root ratio of *kariskis*; b) survival and height increment of *akleng parang*; c) height and diameter increments of *sakat*; and d) survival, height, and diameter increments, and shoot-root ratio of *banaba*. Seedlings watered every two days had higher survival rate and increased on height and diameter faster than those watered at longer intervals.

The most promising potting media for producing seedlings of the four species are: a) *kariskis* – ordinary garden soil (OGS) alone, and OGS + river sand (RS, 1:1 ratio); b) *akleng parang* – OGS alone and OGS + RS (1:1 ratio); c) *sakat* – OGS alone and OGS + rice hull (RH at 1:2 ratio); and d) *banaba* – OGS alone and OGS + RS (1:1 ratio). All the tree species should be watered every two days to ensure the production of quality seedlings.

Keywords: *lesser-used tree species, nursery practices, potting media, watering frequency*

Introduction

The Ilocos Region has vast areas of denuded and barren uplands due to illegal logging, fuel wood gathering, kaingin making, and other destructive anthropogenic activities. All of which resulted in wood shortage and numerous environmental problems such as landslide, soil erosion, and flooding of low lying areas during the rainy or wet month and drought or water shortage during the dry months.

Reforestation of these areas is urgently needed to help rehabilitate and restore their protective role and at the same time help meet increasing demands for wood and other forest products. However, reforestation efforts had been constrained by

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inadequate supply of quality seeds and seedlings, planting unsuitable species due to inadequate site characterization, and using exotic species excessively [Carandang and Lasco, (1997), cited in Cruz (1997)].

Thus, the use of indigenous species, especially those with potential uses to the surrounding communities, has been intensified. According to Cruz (1997), maximizing the exploration and exploitation of indigenous species is needed, because they have better resistance to pests and diseases and they play a great role in biodiversity conservation. Since many of these species are not utilized in industries or not traded in commercial scale, they are usually labeled as 'lesser-used tree species'.

Some of the lesser-used tree species found in the region include *akleng parang* [*Albizia procera* (Roxb. Benth.], *kariskis* [*Albizia lebbekoidez (*D.C.) Benth.], *sakat* (*Terminalia nitens* Presl.), and *banaba* [*Lagerstroemia speciosa* (Linn.) Pers.]. Rural folks have been using these species in building houses and farm structures, and in replacing worn-out parts of farm implements. Likewise, three of those species (*akleng parang, sakat,* and *banaba*) are potential sources of tannin and the others (*kariskis* and *akleng parang*) are used as forage for livestock. In addition, they were among the priority species identified by the DENR for reforestation activities in Region I (ERDS-DENR, 1989).

Successful establishment of forest tree plantations depends partly on the quality of planting materials used. Thus, appropriate cultural or rearing techniques must be utilized to enhance the growth and survival of the seedlings, not only in the nursery, but in outplanted areas as well. Two of the nursery practices that affect the growth and development of container-grown seedlings are using suitable potting medium and optimizing watering interval.

A suitable potting medium has high waterholding capacity and excellent drainage to minimize or prevent the occurrence of damping-off disease. Moreover, the medium could supply the nutrient needs of the seedlings and could facilitate hauling when outplanting them. Ordinary soils that have loamy texture are generally considered as ideal potting medium for raising forest tree seedlings in the nursery. However, most soils available in the locality are heavy textured, thus requiring the addition of other materials (*i.e.,* organic materials or sand) to improve drainage and aeration.

Some of the materials added to ordinary garden soil (OGS) in producing forest tree seedlings are rice hull (RH), sawdust (SD), and river sand (RS). However, the effects of these mixtures on the growth and survival of nursery-grown seedlings of lesser-used tree species in Ilocos Norte had not been assessed.

Meanwhile, water, being one of the basic inputs in seedling propagation, must be properly and adequately applied to ensure vigorous growth of the plants. Application of too much or too little water may hinder plant growth. Besides, the activity is one of the most labor-intensive operations in the nursery. Thus, determining the appropriate

watering interval could enhance the quality of seedlings produced and possibly reduce seedling production cost in the nursery without sacrificing quality. Additionally, determining the suitable potting mixture and watering frequency for these species would lead to the production of quality seedlings (sturdy and vigorous) for the reforestation of denuded forestlands in the province.

Generally, the study determined the suitable potting mixture and watering frequency for producing quality seedlings of four lesser-used tree species found in Ilocos Norte. Specifically, it determined the effects of different potting mixtures and watering frequencies and their interaction on the growth of nursery-grown seedlings of four lesser-used tree species; and identified the best potting mixture, watering frequency and their interaction effects on the growth of those species in the nursery.

Methodology

The study was conducted at the Central Nursery of the Mariano Marcos State University located in Batac City, Ilocos Norte. The province has Type I climate with two distinct wet and dry seasons. Rainy season usually starts in May and ends in October with an average annual rainfall ranging from 1500 to 2000mm.

Laboratory analysis showed that the OGS used is medium-textured and slightly alkaline (pH value = 7.55), which is considered favorable for growing most plants (Hoanh and Natividad, 1987). The organic matter (OM), phosphorus (P) and potassium (K) levels were 1.29%, 9.47ppm and 386.28ppm, respectively. The OM and P contents are considered deficient because these are below the adequate levels of 5% and 30ppm, respectively. On the other hand, K level is considered sufficient since it is higher than the adequate or favorable rating of 250ppm (Committee on Soil Fertility Management, 1999).

Separate experiment for each species was established using Completely Randomized Design with a 7 x 4 factorial and three replications. The potting mixtures were assigned as Factor A, while the watering frequencies were Factor B. The potting mixtures were: OGS alone, OGS + rice hull (1:1 ratio), OGS + sawdust (1:1 ratio), OGS + river sand (1:1 ratio), OGS + rice hull (1:2 ratio), OGS + sawdust (1:2 ratio), and OGS + river sand (1:2 ratio). Watering frequencies, on the other hand, were every two days, every four days, every six days, and every eight days.

There were 28 treatment combinations for each experiment. Fifteen sample plants were used per experimental unit or a total of 1,260 seedlings per experiment.

Preparation of experimental plants. The experimental plants were raised from seeds collected from selected mother trees. The mother trees used as sources of seeds were selected based on the following criteria: a) healthy and free of diseases and insects; b) nearly mature; c) one of the biggest if not the biggest trees; and d)

growing in the midst of a healthy stand of the same species. *Akleng parang*, *banaba,* and *sakat* seeds were collected from selected mother trees in Batac City, while *kariskis* seeds were obtained from Banna, Ilocos Norte. The seeds were first sown in boxes and then the germinants were transplanted when a pair of leaves developed. The experimental plants were transplanted into 5" x 7" black polyethylene bags filled with the different potting mixtures.

Collection and preparation of potting materials. OGS was collected near the nursery; rice hull, in Palongpong, City of Batac; and sawdust, at the New Batac Lumber, also in the City of Batac. River sand, on the other hand, was obtained from Badoc, Ilocos Norte. The materials were mixed following the specified ratios in the treatments. The ratio of the potting mixtures was based on the volume of the materials used.

Application of watering treatments. The watering treatments were applied one month after transplanting (MAT) of germinants in order to give enough time for the seedlings to recover from transplanting shock. Watering was done early in the morning, applying 75 ml of water to each pot every watering schedule.

Care and maintenance. The seedlings were shaded with fish net to protect them from excessive exposure to sunlight. Weeding was also done as often as necessary to minimize competition for nutrients, sunlight, soil moisture, and space. Plastic sheets were provided below the pots and roots growing outside the pots were pruned regularly. Complete fertilizer (14-14-14) at a rate of 10g per seedling was applied two MAT. The rate was based on the general recommendation of the Department of Environment and Natural Resources (DENR) for nursery-grown seedlings.

The study assessed the effects of potting mixture and watering frequency and their interaction on the growth and survival of the nursery-grown seedlings of four lesser-used tree species. The assessment was based on percentage survival; height and diameter growth; shoot-root ratio; and production cost.

The effects of the treatments were assessed based on the percent survival, height and diameter growth, and shoot-root ratio of the seedlings. Survival, height, and diameter measurements were done every two months, while the shoot-root ratio of the seedlings was determined at the termination of the experiment.

The data sets were processed using the analysis of variance (ANOVA) for 7 X 4 factorial in CRD. Means of parameters with significant F-test were further compared using the Duncan's Multiple Range Test (DMRT) at 5% level of significance.

Results and Discussion

Kariskis (*Albizia lebbekoidez*) Seedlings

Table 1 summarizes the ANOVA results of the different parameters as affected by potting mixture and watering frequency and their interactions.

It was found that potting mixture and watering frequency have significant main effects on the percent survival of *kariskis* seedlings. However, their interaction was insignificant (Table 1). Seedlings grown in OGS + RS (at 1:1 and 1:2 ratios) had the highest rate survival (92.2%) but were comparable with those grown in the other mixtures, except those grown in OGS + SD (1:1 ratio) having the lowest survival rate (60.0%) (Table 2). The result indicates that OGS alone or the addition of river sand (at 1:1 and 1:2 ratio) or rice hull (at 1:1 ratio) favors better survival of *kariskis* seedlings. Similar result was obtained by Calizo (2003) who found that *panglomboien* seedlings grown in OGS + RS (1:1 ratio) had the highest survival rate (93.3%). Likewise, Domingo (1966) reported that a 1:1 mixture of OGS and sand is the best combination for the survival of Moluccan sau seedlings. Banao (2002) further observed that OGS + RH (at 1:2 and 1:3 ratio) is the most ideal for it recorded the highest survival rate (100%) of *palosapis* seedlings. This result indicates that these mixtures provide enough aeration of the potting media that promoted better root development (Brady, 1990). On the contrary, adding sawdust to the OGS is not suitable as potting medium for growing *kariskis* seedlings. This could be due to the high C:N ratio of sawdust, which when decomposed generated heat, thus resulting to the death of the seedlings.

Meanwhile, seedlings watered every two days had the highest survival rate (92.1%), while those watered every eight days had the lowest (77.0%). The result implies that watering the seedlings every two days is the best frequency to attain high survival of *kariskis*. This concurs with the findings of Aguda (1984) that watering every two days attained high percentage survival of *bitaog* seedlings.

Additionally, significant interaction of potting mixture and watering frequency was observed on the height and diameter increments and shoot-root ratio of the seedlings (Table 1). Seedlings grown in OGS alone (70.1cm), as well as OGS + RS at 1:1 and 1:2 ratios (61.0 and 68.1cm, respectively) and watered every two days had the

Table 1. Results of ANOVA of the different parameters as affected by potting mixture and watering frequency of *kariskis* seedlings 8 MAT.

TREATMENT	PERCENT SURVIVAL	HEIGHT INCREMENT (CM)	DIAMETER INCREMENT	SHOOT-ROOT RATIO
Potting mixture (P)	**	**	**	ns
Watering Frequency (W)	**	**	**	*
P X W	ns	**	**	**

Table 2. Percentage survival of *kariskis* seedlings at 8 MAT as affected by potting mixture and watering frequency.

FACTOR	SURVIVAL (%)
Potting mixture (P)	**
OGS alone	90.6 a
OGS + rice hull (1:1 ratio)	90.0 a
OGS + saw dust (1:1 ratio)	60.0 b
OGS + river sand (1:1 ratio)	92.2 a
OGS + rice hull (1:2 ratio)	85.3 a
OGS + saw dust (1:2 ratio)	86.7 a
OGS + river sand (1:2 ratio)	92.2 a
Watering Frequency (W)	**
Every two days	92.1 a
Every four days	84.8 bc
Every six days	87.3 b
Every eight days	77.0 c
P x W	ns
CV (%)	14.1

MAP - months after transplanting ns - not significant
** - significant at 1% level CV - coefficient of variation
In a column and within the same factor, means followed by a common letter are not significantly different at 5% level of significance using DMRT.

highest height increments, which were at least 10 times higher than the lowest increment (6.3cm) as observed from those grown in OGS + SD (1:2 ratio) and watered every eight days (Table 3). A decreasing trend was also observed as the watering frequency was increased from two to four, six or eight days.

In terms of diameter increment, seedlings grown in OGS + RS (1:1 ratio) and watered every two days also had the biggest increment (0.36cm). They were followed by those grown in OGS alone and OGS + RH (1:2 ratio) with similar increment of 0.32cm (Table 3). These results suggest that in order to obtain optimum height and diameter growth of nursery-grown *kariskis* seedlings, they must be grown in OGS alone or OGS + RS (at 1:1 ratio) and should be watered every two days. Such trend was supported by Calizo (2003) who found that the most favorable potting mixture for the production of *panglomboien* seedlings is OGS + RS (1:1 ratio), because it enhances height and diameter growth. Moreover, Bulao (1982) claimed that pure OGS is the best medium, which promotes fast growth and root development of Benguet pine. Furthermore, Acang (1984) suggested that watering every two days favors better height growth of mahogany. More frequent watering provides the moisture needed by the seedlings to sustain growth. However, delaying the watering later than every two days caused the seedlings to dry-up and repeated wilting occurs, thus hinder the growth of the seedlings.

Table 3. Interaction effects of potting mixture and watering frequency on the height increment (HI), diameter increment (DI), and shoot-root ratio (S-R ratio) of *kariskis* seedlings at 8 MAT.

TREATMENT COMBINATION	HI (cm)	DI (cm)	S-R RATIO
Watering every two days			
OGS alone	**70.1 a**	**0.32 ab**	1.4 bcd
OGS + rice hull (1:1)	40.1 bcd	0.20 def	1.2 cde
OGS + saw dust (1:1)	17.6 h-k	0.09 hi	1.7 ab
OGS + river sand (1:1)	**61.0 a**	**0.36 a**	1.4 bcd
OGS + rice hull (1:2)	46.2 ab	0.32 ab	1.2 cde
OGS + saw dust (1:2)	9.1 jk	0.13 gh	1.8 a
OGS + river sand (1:2)	**68.1 a**	0.29 bc	1.3 cde
Watering every four days			
OGS alone	45.5 ab	0.25 cd	1.4 bcd
OGS + rice hull (1:1)	29.9 d-g	0.22 de	1.2 cde
OGS + saw dust (1:1)	9.2 j-k	0.08 i	1.2 cde
OGS + river sand (1:1)	42.7 bc	0.23 cde	1.4 bcd
OGS + rice hull (1:2)	32.3 de	0.20 def	1.5 abc
OGS + saw dust (1:2)	7.6 jk	0.09 hi	1.3 cde
OGS + river sand (1:2)	41.6 cd	0.29 abc	1.1 de
Watering every six days			
OGS alone	31.8 cde	0.25 cd	1.3 cde
OGS + rice hull (1:1)	24.9 e-h	0.18 efg	1.4 bcd
OGS + saw dust (1:1)	6.4 k	0.08 i	1.2 cde
OGS + river sand (1:1)	31.3 c-f	0.23 cde	1.4 bcd
OGS + rice hull (1:2)	19.4 f-j	0.22 de	1.2 cde
OGS + saw dust (1:2)	9.7 j-k	0.13 gh	1.2 cde
OGS + river sand (1:2)	41.3 bcd	0.26 bcd	1.1 de
Watering every eight days			
OGS alone	22.3 e-i	0.14 fgh	1.5 abc
OGS + rice hull (1:1)	12.5 i-k	0.10 hi	1.2 cde
OGS + saw dust (1:1)	6.3 k	0.08 i	1.4 bcd
OGS + river sand (1:1)	11.4 i-k	0.13 gh	1.4 bcd
OGS + rice hull (1:2)	15.4 h-k	0.14 fgh	1.0 e
OGS + saw dust (1:2)	7.1 k	0.07 i	1.0 e
OGS + river sand (1:2)	18.4 g-k	0.15 fgh	1.4 bcd
CV (%)	21.8	14.50	15.5

MAP - months after transplanting
CV - coefficient of variation
In a column, means followed by a common letter are not significantly different at 5% level of significance using DMRT.

In addition, the highest shoot-root ratio was observed in the seedlings watered every two days and grown in OGS + SD at both ratios (1.7 and 1.8, respectively), while the lowest (1.0) was obtained from the seedlings watered every eight days and grown in the 1:2 mixture of OGS + RH and OGS + SD. Likewise seedlings grown in OGS + RH (1:1 & 1:2), OGS + RS (1:1) and OGS alone, and watered every two days had relatively low shoot-root ratios (1.2 – 1.4). These values are within the ideal shoot-root ratio of 1:1- 2:1 as mentioned by Jaenicke (1999) and Haase (2007). Ratios >2.0 indicate excessively faster shoot growth than root growth and are not desirable because the top becomes heavy and the seedlings may topple down when outplanted in open areas (Liegel and Venator, 1987). Further, seedlings which are top heavy may have lower survival rates when outplanted due to water stress, because they transpire more water than their roots can absorb. This implies that these potting mixtures promote more balanced shoot and root development of the seedlings.

These results suggest that the combination of OGS alone and OGS + RS at 1:2 ratio, and watering every two days had positive effects on the survival and growth of container-grown seedlings of *kariskis*.

Akleng parang (*Albizia procera*) Seedlings

Unlike the case of *kariskis*, potting mixture and watering frequency had no main and interaction effects on the survival rate of *akleng parang* seedlings, but they had marked effects on the height growth of the seedlings (Tables 4 and 5). Seedlings grown in OGS alone had the highest height increment (19.3cm), while those grown in OGS + sawdust had the lowest (8.2cm). On the other hand, seedlings watered every two days had the highest increment (19.9cm) and those watered every eight days had the least (10.7cm). The results imply that the best potting medium and watering frequency that enhance the height growth of *akleng parang* seedlings are OGS alone and every two days, respectively.

The findings further suggest that the physical and chemical characteristics of the OGS used are adequate to support the height growth of the *akleng parang* seedlings. The OGS used is medium-textured, and had a pH value of 7.55 (slightly alkaline), which is favorable for growing most plants (Hoanh and Natividad, 1987). Although the OM and P contents are considered deficient, the K level (386.28ppm) is deemed sufficient since it is higher than the adequate rating of 250ppm (Committee on Soil Fertility Management, 1999). According to Devlin (1977), a plant deficient in K has stunted growth with pronounced shortening of the internodes.

Moreover, significant interaction effects of potting mixture and watering frequency on diameter growth and shoot-root ratio were observed. The highest diameter increment was obtained from the seedlings watered every two days and grown in OGS alone (0.30cm); they were followed by those grown in OGS + RH at 1:1 and 1:2 ratios (0.30 and 0.32cm) [Table 6]. The seedlings watered at longer intervals

Table 4. Results of ANOVA of the different parameters as affected by potting mixture and watering frequency of *akleng parang* seedlings 8 MAT.

TREATMENT	PERCENT SURVIVAL	HEIGHT INCREMENT (cm)	DIAMETER INCREMENT	SHOOT-ROOT RATIO
Potting mixture (P)	ns	**	**	**
Watering Frequency (W)	ns	**	**	*
P X W	ns	ns	**	**

MAP- months after transplanting
CV - coefficient of variation
In a column, means followed by a common letter are not significantly different at 5% level of significance using DMRT.

Table 5. Percentage survival and height increment of *akleng parang* seedlings at 8 MAT as affected by potting mixture and watering frequency.

FACTOR	SURVIVAL (%)	HEIGHT INCREMENT (cm)
Potting mixture	ns	**
OGS alone	73.4	19.3 a
OGS + rice hull (1:1 ratio)	67.8	15.8 b
OGS + saw dust (1:1 ratio)	63.9	8.2 d
OGS + river sand (1:1 ratio)	73.9	15.3 b
OGS + rice hull (1:2 ratio)	71.7	15.4 b
OGS + saw dust (1:2 ratio)	57.2	11.3 c
OGS + river sand (1:2 ratio)	78.9	16.2 b
Watering Frequency	ns	**
Every two days	76.5	19.9 a
Every four days	71.1	15.8 b
Every six days	65.1	11.6 c
Every eight days	65.4	10.7 c
Interaction	ns	ns
CV (%)	2.9	20.1

MAP- months after transplanting ns - not significant
** - significant at 1% level CV - coefficient of variation
In a column and within the same factor, means followed by a common letter are not significantly different at 5% level of significance using DMRT.

had significantly lower diameter increments regardless of the potting mixtures used. The result suggests that using OGS alone and watering every two days enhanced the diameter growth of the *akleng parang* seedlings.

Table 6. Interaction effects of potting mixture and watering frequency on the diameter increment (DI) and shoot-root ratio (S-R ratio) of *akleng parang* seedlings at 8 MAT.

TREATMENT COMBINATION	DI (cm)	S-R RATIO
Watering every two days		
OGS alone	0.32 a	1.5 ab
OGS + rice hull (1:1)	0.26 c	1.4 abc
OGS + saw dust (1:1)	0.17 efg	1.1 de
OGS + river sand (1:1)	0.30 ab	1.6 a
OGS + rice hull (1:2)	0.28 bc	1.3 bcd
OGS + saw dust (1:2)	0.20 de	1.1 de
OGS + river sand (1:2)	0.31 ab	1.5 ab
Watering every four days		
OGS alone	0.22 d	1.2 cde
OGS + rice hull (1:1)	0.19 def	1.0 e
OGS + saw dust (1:1)	0.14 gh	1.0 e
OGS + river sand (1:1)	0.22 d	1.1 de
OGS + rice hull (1:2)	0.22 d	1.0 e
OGS + saw dust (1:2)	0.16 fg	1.1 de
OGS + river sand (1:2)	0.20 de	1.2 cde
Watering every six days		
OGS alone	0.17 efg	1.0 e
OGS + rice hull (1:1)	0.17 efg	1.1 de
OGS + saw dust (1:1)	0.10 ij	1.1 de
OGS + river sand (1:1)	0.15 gh	1.1 de
OGS + rice hull (1:2)	0.15 gh	1.1 de
OGS + saw dust (1:2)	0.12 hi	1.1 de
OGS + river sand (1:2)	0.16 fg	1.0 e
Watering every eight days		
OGS alone	0.12 hi	1.0 e
OGS + rice hull (1:1)	0.11 ij	1.1 de
OGS + saw dust (1:1)	0.08 j	1.0 e
OGS + river sand (1:1)	0.11 ij	1.1 de
OGS + rice hull (1:2)	0.12 hi	1.1 de
OGS + saw dust (1:2)	0.09 i	1.5 ab
OGS + river sand (1:2)	0.11 ij	1.0 e
CV (%)	8.90	10.9

MAT - months after transplanting
CV - coefficient of variation
In a column, means followed by a common letter are not significantly different at 5% level of significance using DMRT.

In terms of shoot-root ratio, seedlings watered every two days and grown in OGS + RS (1:1 ratio) had the highest ratio (1.6), which was followed by those grown in OGS alone (1.5), OGS + RS at 1:2 ratio (1.5) and OGS + RH at 1:1 ratio (1.4) [Table 3]. As reflected earlier, a shoot- root ratio of 1:1 to 2:1 is considered ideal for most seedlings [Liegel and Venator (1987), Jaenicke (1999), and Haase (2007)]; hence the ratios obtained are acceptable. The seedlings grown in the other treatment combinations (e.g., OGS + sawdust and OGS + RH) had significantly lower ratios (1.0 – 1.1) and apparently had more balanced shoot-root development, but these seedlings had poor survival and growth performance.

These results reveal that for the production of *akleng parang* seedlings, OGS alone or a mixture of OGS + RS (1:1) can be used as potting media and the seedlings should be watered every two days.

Sakat (*Terminalia nitens*) Seedlings

Table 7 summarizes the ANOVA results of the different parameters on *sakat* as affected by potting mixture and watering frequency and their interactions. Results showed significant main effects of potting mixture on all parameters - watering frequency on percent survival, height increment and diameter increment, and their interaction effects on height and diameter increments.

As shown in Table 8, *sakat* seedlings grown in OGS alone had the highest survival rate (82.8%) but was comparable with those grown in the 1:1 and 1:2 mixtures of OGS + RH (67.8 and 68.3%, respectively), 1:1 mixture of OGS + RS (67.2%), and 1:2 mixture of OGS + RS (64.5%). The lowest survival rate was exhibited by the seedlings grown in the 1:2 mixture of OGS + RS (41.7%). In terms of shoot-root ratio, seedlings grown in OGS alone had the highest ratio (1.90) but were comparable with the seedlings grown in OGS + RH at both ratios (1.64 and 1.59), and OGS + river sand at both ratios (1.74 and 1.55, respectively). On the other hand, seedlings watered every two days had the highest survival rate of 80.5%.

Table 7. Results of ANOVA of the different parameters as affected by potting mixture and watering frequency of *sakat* seedlings 8 MAT.

TREATMENT	PERCENT SURVIVAL	HEIGHT INCREMENT (cm)	DIAMETER INCREMENT	SHOOT-ROOT RATIO
Potting mixture (P)	**	**	**	**
Watering Frequency (W)	**	**	**	ns
P X W	ns	**	**	ns

Table 8. Percentage survival and shoot-root ratio of *sakat* seedlings at 8 MAT as affected by potting mixture and watering frequency.

FACTOR	SURVIVAL (%)	SHOOT-ROOT RATIO
Potting mixture (P)	**	**
OGS alone	82.8 a	1.90 a
OGS + rice hull (1:1 ratio)	67.8 a	1.59 ab
OGS + saw dust (1:1 ratio)	52.2 bc	1.16 c
OGS + river sand (1:1 ratio)	67.2 a	1.74 a
OGS + rice hull (1:2 ratio)	68.3 a	1.64 a
OGS + saw dust (1:2 ratio)	64.5 ab	1.24 bc
OGS + river sand (1:2 ratio)	41.7 c	1.55 ab
Watering Frequency (W)	**	ns
Every two days	80.5 a	1.67
Every four days	65.7 b	1.50
Every six days	52.4 c	1.50
Every eight days	53.3 bc	1.51
P x W	ns	ns
CV (%)	21.8	10.53

MAT - months after transplanting
CV - coefficient of variation
In a column, means followed by a common letter are not significantly different at 5% level of significance using DMRT.

The results imply that OGS alone is the best medium that could enhance the survival rate of *sakat* seedlings. However, 1:1 and 1:2 mixtures of OGS + RH and 1:1 mixture of OGS + RS are also potential potting media. This supports the previous findings of experiments on *kariskis* seedlings that OGS alone or the addition of river sand or rice hull favors better seedling survival. Similar findings were obtained by Calizo (2003), Banao (2002), and Domingo (1966) on *panglomboien* seedlings (OGS + RS at 1:1 ratio), *palosapis* (OGS + RH at 1:2 & 1:3 ratios), and Moluccan *sau* (OGS + sand 1:1 ratio). Those results indicate that mixtures used provide adequate aeration of the potting media that promoted better root development (Brady, 1990) as well as higher survival rate. Just like in the previous results on *kariskis* and *akleng parang*, watering every two days is the best for the survival of the *sakat* seedlings. On the other hand, all the shoot-root ratios obtained are within the acceptable ratio of 1:1 – 2:1 (Jaenicke, 1999 and Haase, 2007).

Significant interaction of potting mixture and watering frequency was observed on the height and diameter increments of the seedlings (Table 9). The highest height increment was exhibited by the seedlings watered every two days and planted in OGS alone (24.0cm), and 1:2 mixture of OGS + RH (22.2cm), followed by those planted in the 1:1 mixture of OGS + RS (21.2cm). On the other hand, the highest diameter increment was observed from the seedlings watered every two days and grown in OGS alone (0.52cm), and 1:1 and 1:2 mixtures of OGS + RH (0.50 and 0.52cm, respectively) and OGS + RS (0.51 and 0.50cm, respectively). These potting media could have provided optimum drainage and aeration, thus the height and diameter growth of the

Table 9. Interaction effects of potting mixture and watering frequency on the height and diameter increments (cm) of *sakat* seedlings at 8 MAT.

TREATMENT COMBINATION	HEIGHT INCREMENT (cm)	DIAMETER INCREMENT (cm)
Watering every two days		
OGS alone	24.0 a	0.52 a
OGS + rice hull (1:1)	18.2 b	0.50 a
OGS + saw dust (1:1)	10.1 c-f	0.39 b
OGS + river sand (1:1)	21.2 ab	0.51 a
OGS + rice hull (1:2)	22.2 a	0.52 a
OGS + saw dust (1:2)	12.1 cd	0.41 b
OGS + river sand (1:2)	17.5 b	0.50 a
Watering every four days		
OGS alone	12.9 c	0.38 bc
OGS + rice hull (1:1)	11.4 cde	0.31 d
OGS + saw dust (1:1)	7.5 efg	0.28 de
OGS + river sand (1:1)	9.9 c-f	0.31 d
OGS + rice hull (1:2)	11.6 cd	0.33 cd
OGS + saw dust (1:2)	8.0 efg	0.31 d
OGS + river sand (1:2)	11.0 cde	0.28 de
Watering every six days		
OGS alone	8.6 def	0.30 de
OGS + rice hull (1:1)	8.6 def	0.25 ef
OGS + saw dust (1:1)	6.6 fg	0.18 gh
OGS + river sand (1:1)	7.2 fg	0.23 fg
OGS + rice hull (1:2)	8.6 def	0.25 ef
OGS + saw dust (1:2)	7.5 efg	0.22 fg
OGS + river sand (1:2)	6.4 gh	0.20 fgh
Watering every eight days		
OGS alone	7.1 fg	0.19 gh
OGS + rice hull (1:1)	6.5 gh	0.19 gh
OGS + saw dust (1:1)	4.9 h	0.15 h
OGS + river sand (1:1)	6.6 fg	0.19 gh
OGS + rice hull (1:2)	6.6 fg	0.15 h
OGS + saw dust (1:2)	6.3 gh	0.15 h
OGS + river sand (1:2)	5.9 gh	0.15 h
CV (%)	15.7	9.70

MAT - months after transplanting
CV - coefficient of variation
In a column, means followed by a common letter are not significantly different at 5% level of significance using DMRT.

sakat seedlings were enhanced. These results further reinforced earlier findings on survival rate of *sakat* seedlings that OGS alone and OGS + RH are suitable potting media for this species.

It can be inferred from the results that the most promising potting mixtures for raising *sakat* seedlings are OGS alone and OGS + RH (1:2 ratio). Additionally, the seedlings watering every two days is needed to further enhance seedling growth and survival.

Banaba (*Lagerstroemia speciosa*) Seedlings

As highlighted in Table 10, ANOVA results indicate significant main and interaction effects of potting mixture and watering frequency for *banaba* on all the parameters.

Seedlings grown in the combined OGS + RS (1:1 ratio) and two-day watering interval recorded the highest survival rate (86.7%), followed by those grown in OGS alone and watered every two days (77.7%) [Table 11]. Likewise, seedlings watered every two days and grown in OGS + RS (1:1 ratio) had the highest height increment (60.4cm), followed by those grown in OGS alone (58.0cm) and OGS + RS at 1:2 ratio (57.6cm). In addition, seedlings watered every two days and grown in OGS alone, and OGS + RS at 1:1 and 1:2 ratios had the highest diameter increments (0.60, 0.59 and 0.58cm, respectively). These results are consistent with the findings on *akleng parang* and *kariskis* wherein OGS alone and OGS + RS (1:1 ratio) combined with watering every two days promoted the survival and the height and diameter growth of *banaba* seedlings in the nursery. Similarly, Calizo (2003) found that OGS + RS (1:1 ratio) is the most favorable potting mixture in producing p*anglomboien* seedlings. Bulao (1982) adds that pure OGS is the best medium for faster growth and root development of Benguet pine. Furthermore, watering every two days also favors better height growth of mahogany (Acang, 1984) and supa (Mendez, 2002) seedlings.

Table 10. Results of ANOVA of the different parameters as affected by potting mixture and watering frequency of banaba seedlings 8 MAT.

TREATMENT	PERCENT SURVIVAL	HEIGHT INCREMENT (cm)	DIAMETER INCREMENT	SHOOT-ROOT RATIO
Potting mixture (P)	**	**	**	**
Watering Frequency (W)	**	**	**	**
P X W	**	**	**	**

Table 11. Interaction effects of potting mixture and watering frequency on the percentage survival, height and diameter increments and shoot-root ratio of *banaba* seedlings at 8 MAT.

TREATMENT COMBINATION	SURVIVAL (%)	HI (cm)	DI (cm)	S-R RATIO
Watering every two days				
OGS alone	77.7 ab	58.0 b	0.60 a	1.4 a
OGS + rice hull (1:1)	58.9 cd	26.5 de	0.41 bc	1.0 cd
OGS + saw dust (1:1)	60.0 cd	5.5 i-l	0.37 cd	0.9 de
OGS + river sand (1:1)	86.7 a	60.4 a	0.59 a	1.3 ab
OGS + rice hull (1:2)	57.7 cd	21.6 ef	0.36 cd	0.9 de
OGS + saw dust (1:2)	53.3 de	11.4 gh	0.31 de	1.0 cd
OGS + river sand (1:2)	68.9 bc	57.6 ab	0.58 a	1.2 ab
Watering every four days				
OGS alone	77.7 ab	41.3 bc	0.47 b	1.1 bc
OGS + rice hull (1:1)	33.3 e	10.2 ghi	0.34 d	0.8 e
OGS + saw dust (1:1)	46.6 def	4.4 jkl	0.34 d	0.8 e
OGS + river sand (1:1)	68.9 bc	50.7 ab	0.45 b	1.0 cd
OGS + rice hull (1:2)	42.2 efg	13.5 g	0.27 e	1.0 cd
OGS + saw dust (1:2)	37.7 fgh	5.7 h-k	0.24 fg	0.8 e
OGS + river sand (1:2)	56.4 cd	39.7 bc	0.47 b	1.1 bc
Watering every six days				
OGS alone	46.6 def	30.9 d	0.27 e	0.9 de
OGS + rice hull (1:1)	26.6 ijk	6.6 hij	0.25 ef	0.9 de
OGS + saw dust (1:1)	17.7 k	2.6 j-m	0.19 gh	0.8 e
OGS + river sand (1:1)	33.3 e	33.9 cd	0.30 de	0.9 de
OGS + rice hull (1:2)	4.4 l	1.6 lm	0.22 fgh	0.9 de
OGS + saw dust (1:2)	22.2 jk	2.0	0.10 ij	0.8 e
OGS + river sand (1:2)	37.7 fgh	klm	0.34 d	0.9 de
Watering every eight days		30.5 d		
OGS alone	28.9 hij		0.15 hi	1.0 cd
OGS + rice hull (1:1)	0.0 l	16.7 fg	0.00 k	0.8 e
OGS + saw dust (1:1)	0.0 l	0.0 m	0.00 k	0.9 de
OGS + river sand (1:1)	22.2 jk	0.0 m	0.00 k	0.9 de
OGS + rice hull (1:2)	0.0 l	14.0 g	0.02 k	0.9 de
OGS + saw dust (1:2)	0.0 l	0.0 m	0.05 jk	0.9 de
OGS + river sand (1:2)	4.4 l	0.4 cm	0.03 k	0.8 e
		5.4 jkl		
CV (%)	18.9	8.2	2.59	1.5

MAT - months after transplanting

CV - coefficient variation

In a column, means followed by a common letter are not significantly different at 5% level of significance using DMRT.

In terms of shoot-root ratio, *banaba* seedlings watered every two days and grown in OGS alone had the highest ratio (1.4), followed by those grown in OGS + RS at 1:1 and 1:2 ratio (1.3 and 1.2, respectively). The other treatment combinations had lower shoot-root ratios, ranging from 0.8 to 1.0. Although, a shoot-root ratio of 1:1 to 2:1 is considered ideal for most seedlings, a ratio that is lower than one leads to slower growth above ground. This is undesirable because it affects the overall vigor of the seedlings.

As such, the combination of every two-day watering and OGS alone, or OGS + RS at 1:1 ratio promotes the survival and growth of *banaba* seedlings in the nursery.

Conclusions and Recommendations

On the whole, there are significant main effects of potting mixtures and watering frequency on the percentage survival of *kariskis* and *sakat*. Specifically, the potting media and watering frequency used affected the height increments of *panglomboien* and *akleng parang* seedlings. On the other hand, the potting mixtures affected the shoot-root ratio of *sakat* seedlings. In addition, significant interaction effects of potting mixture and watering frequency were observed on the: a) height and diameter increment and shoot-root ratio of *kariskis*; b) survival and height increment of *akleng parang*; c) height and diameter increments of *sakat*; and d) survival, height, and diameter increments and shoot-root ratio of *banaba*. Seedlings watered every two days generally had higher survival rate and faster height and diameter growth than those watered at longer intervals.

Based on the results, the following recommendations are forwarded:

- Seedlings of the four lesser-used tree species can be raised using the following potting media: a) *kariskis* – OGS alone, and OGS + RS (1:1 ratio); b) *akleng parang* – OGS alone, OGS + RS (1:1 ratio); c) *sakat* – OGS alone, OGS + RH (1:2 ratio); and d) *banaba* – OGS + RS (1:1 ratio) and OGS alone.
- The seedlings must be watered every two days starting a month after transplanting until they reach outplanting size.

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