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EFFECTS OF VERMICAST APPLICATION TO THE GROWTH AND SURVIVAL OF BITANGHOL (*Calophyllum blancoi* Pl. and Tr.) IN GRASSLAND

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Abstract

The study was conducted to determine the percentage survival and early growth performance of Bitanghol (*Calophyllum blancoi*) applied with varying levels of vermicast in an open grassland. The experiment was laid out using randomized complete block design (RCBD) consisting of three (3) replications with three (3) different levels of vermicast treatment, 0 gram, 250 grams and 500 grams respectively. Descriptive statistics and analysis of variance (ANOVA) were used in data analysis. Results showed that survival of Bitanghol in grassland had no significant difference in terms of vermicast application when analyzed statistically, average survival after 4 months are as follows 0 gram vermicast application 82%, 250 g vermicast application 84%, and 500 g vermicast application of 83%. Survival is mainly influenced by climatic site factor, long dry periods greatly affects the survival and growth of the outplanted seedlings as well as poor soil nutrient availability in the area. Height growth increment of outplanted seedlings as affected by different levels of vermicast showed insignificant difference when tested using ANOVA. 250 g vermicast application showed the highest height increment of 2.17 cm. followed by 500 g vermicast application and 0 g vermicast application of 1.98 cm and 0.94 cm respectively. Diameter growth increment and number of leaves of seedlings were not significantly affected with the different levels of vermicast. It was found out that bitanghol seedlings applied with 250 grams of vermicast showed relatively the same results compared to 500 grams of vermicast application. Average diameter increment of seedlings as affected by different levels of vermicast 0 g, 250, g , and 500 g is as follows 0.17 mm, 0.42 mm, 0.37 mm respectively.

Key words: Vermicast, *Calophyllum blancoi*, growth, survival, reforestation

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INTRODUCTION

In the Philippines, continued forest degradation of second-growth forests led to the expansion of grassland areas. A grassland area in the Philippines is estimated to cover 5.2 million hectares (Lamanilao, 1991). The extent of grassland vegetation cover tends to increase at an alarming rate if not immediately solved and controlled. As emphasized by Kartawinata (1994), the need for the rehabilitation of these deforested and grassland requires urgent and serious attention. This could potentially help in restoring biological diversity, increase productivity, provide socio-economic benefits and supply raw material in the wood industry. In the Philippines, the president had passed an executive order for a large scale reforestation activity under E.O. 26 or the National Greening Program (NGP). One of the provisions of this code is the planting of indigenous tree species on the project consisting of about 83% or 47.2 million and promoting the use of organic fertilizer (DENR, 2011).

Vermicompost is an organic fertilizer which is commonly used nowadays. Vermicompost are derived from the organic wastes of earthworms and other microorganisms, through biological activities. The microbial activity of vermicompost as compared to soil is said to be 10 to 20 times higher (Chaoui, 2010). Chemical nutrient analysis of vermicompost is estimated to contain, 2.3% N, 3.0% P, 0.6% K, 0.1% S, 0.65% Mg, and 8.6% Ca (Atiyeh et al., 1999).

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With the promising availability of macro and micro nutrients from vermicast, several studies had been conducted to evaluate the effects of vermicast application to the growth and productivity of a variety of crops. Vasanthi and Kumaraswamy (1999), reported that there is significantly higher rice paddy grain yields in plots applied with a combination of vermicompost and NPK, compared with the treatment that received NPK alone. Another study by Manivannan et al. (2009) on the effect of vermicompost on soil fertility and crop productivity of beans (*Phaseolus vulgaris*) showed that at 5 tonnes ha^{-1} vermicompost application significantly enhanced the pore space, water holding capacity, and cation exchange capacity of soil. Additionally it enhanced the growth and yield of beans. Govindapillai et al. (2018) showed that there is significant improvement of 50% vermicompost application with plant growth enhancers (GA and IAA) on the exo-morphological features of *Capsicum annum* (Linn.) Hepper, which was observed at the end of 3rd, 4th and 5th weeks of treatment.

Aside from growth and yield application of vermicompost, a study also reported on the effect of application of vermicasts as layering media for an ornamental, (*Codiaeum variegatum* (L.) Bl.) showed that vermicast application either alone or in combination with Peat Moss (PM) were able to initiate earlier rooting and development of roots better than in the layering experiments conducted only with PM (Karmegam & Daniel, 2009). Another study reported that Chemical composition of kale as influenced by dry vermicast, potassium humate and volcanic minerals differentially influenced the compositions of mineral nutrients, lipids, total phenolic content and antioxidant activities in kale plants. Growing medium mixed with dry vermicast yields high amounts of macronutrients, phospholipids, and polyunsaturated and monosaturated fatty acids (Abbey et al., 2018).

Undoubtedly, vermicompost application had significantly improved growth and yield parameters of agricultural crops. With this positive result, possibilities of vermicompost application to forest trees in reforestation and rehabilitation projects has been deemed viable. Establishment of reforestation projects especially on grassland areas had been very challenging in the past. Grasses out-competes planted tree seedlings in terms of essential nutrients uptake (N,P,K), exposure to sunlight, and water availability in soil. In a study that was conducted by Riginos (2009), reported that grass can strongly suppress the growth of trees. In a savanna of Laikipia, Kenya; three size classes of *Acacia drepanolobium* was liberated from grasses around its stem. With the removal of grasses, it led to a doubling in growth and a doubling in the probability of transitioning to the next size class over two years of the said trees. Competition is evident in grassland areas, especially with early establishment of tree seedlings. This competition results to higher mortality rates in reforestation and rehabilitation projects. Application of vermicompost is expected to improve soil properties as well as growth and survival of outplanted seedlings in grassland areas, thus ensuring higher survival rate in rehabilitation and reforestation projects.

Rehabilitation of grassland areas using native trees applied with organic fertilizer is now gaining attention. There are already studies conducted on the application of vermicast as organic fertilizer to influence the growth of trees (Morarka, 2008 & Sungthongwises, 2015) but such studies incorporates inorganic fertilizer application and the use of commercial tree species. No studies had been conducted involving the planting of indigenous trees applied with vermicast in grassland. This study is undertaken, with the end view that its results will be an input in drawing up a cheaper and eco-friendly approach to grassland areas reforestation/rehabilitation activities. Results of the study are considerably a valuable output to future studies that will be conducted in the area and to the implementation of the National Greening Program (NGP) of the Philippine government. This will provide rehabilitation implementing agency or individuals the most basic and simple protocol in plantation establishment comprising indigenous trees.

Hence, the study generally was conducted to evaluate the survival and growth performance of bitanghol (*Calophyllum blancoi* PL. and Tr.) seedlings applied with different levels of vermicast in open grassland area in Brgy. Sap-ang, Silago, Southern Leyte, Philippines. Specifically, the study aimed to a.) Determine the percent survival of bitanghol outplanted in a grassland area; and b.) Determine the growth performance of bitanghol applied with different levels of vermicast.

MATERIALS AND METHODS

The Study Site

The study was conducted in Brgy. Sap-ang, Silago, Southern Leyte, Philippines from April to August 2013. The site is located at (10.4884 N, 125.1546 E). The site is classified under climatic type II of the modified Corona climatic classification. This climatic type does not have a distinct dry season and experiences maximum rainfall in the period between November to February.

The most abundant and frequently occurring grass species in the site is Agsam (*Dicranopteris linearis*). The species of cogon (*Imperata cylindrica*), associates with the dominant species. This community type usually occurs in sloping areas having shallow bedrock and common in colluvial soils deposited by landslides. The soil is therefore well-drained, containing high amount of gravel. These sites were rarely cultivated apparently due to terrain and instability of the soil. Colonization by *Dicranopteris linearis* helped in stabilizing what was otherwise a very shaky soil. The close canopy of *Dicranopteris*, the thick litter it produced and the occurrence of fire in this vegetation may explain the near absence of woody species (Cular, 1999).

Experimental Design and Field Layout

The study was laid-out in a Randomized Complete Block Design (RCBD) replicated three (3) times. The site covered a total land area of about 400 square meters. Each experimental plot had a dimension of 6 m x 6 m with a plot distance of 2 meters within each block and 2 meters in between blocks. Bitanghol seedlings including fertilizer treatments were arranged according to a randomization technique. The planting distance adopted within plots was 2m X 2m.

The treatment combinations used were as follows;

BT_0 = Bitanghol + grassland soil + 0 g vermicast (control)

BT_{250} = Bitanghol+ grassland soil +250 g vermicast

BT_{500} = Bitanghol + grassland soil + 500 g vermicast

The field experiments comprised about 3 treatment combinations randomly and equally distributed in each plot in every block. A total of 16 sample plants (4 experimental plants and 12 border plants) were planted in each plot in every block. Only four (4) plants were monitored and measured for every treatment combinations of each block. In total, about 144 seedlings (36 experimental plants and 108 border plants) were planted in the area.

Plantation Establishment, Maintenance and Protection of Outplanted Seedlings

The entire experimental area was clear brushed three days before planting. By the use of a field measuring tape, field lay out was done and distances between blocks, plots, and planting spacing were determined. After field lay outing, staking was done using bamboo stakes. Holes with a dimension of 20 cm diameter by 20 cm depth were dug into the ground with the use of a planting bar.

Vermicast was placed and added into the hole with the use of a measuring plastic bottle. The seedlings were planted into the hole with the vermicast at the base of the seedlings, then covered with the surface soil. Decomposing plant materials were placed around the base of the newly-outplanted seedlings as mulch to reduce evaporation of soil moisture.

Firelines of about 5 meters wide located at the research site border were established to secure the plantation from grass fires. Watering was done right after planting and twice each month during the first and second months when extreme heat occurred at the research area. Moreso, ring weeding activities were done during the 3rd month in order to free the outplanted seedlings from grass competition.

Data Collection

Climatic Data

Climatic data on the average rainfall and temperature of the site for the whole duration of the study was gathered at DOST-PAGASA station in Maasin, Southern Leyte.

Soil Collection and Analysis

Soil samples were taken from the site after land preparation. Composite samples from the surface soil from the depth of zero to fifteen centimeters (0-15 cm) and fifteen to thirty centimeters (15-30 cm) were collected at the lower, middle, and upper slope level for the determination of pH, organic matter, total nitrogen, available P, and exchangeable K. Chemical analyses were done at the Soils Research, Testing and Plant Analysis Laboratory (SRTPAL), ViSCA, Baybay, Leyte and Central Analytical Services Laboratory, PhilRootcrops Complex, ViSCA, Baybay, Leyte.

Seedling Parameters

Initial measurement on the growth variables; height, diameter and number of leaves of the seedlings were first conducted to have baseline information for the comparison on the effect of the different levels of vermicast on seedlings growth. Initial parameters includes: number of leaves, height (cm), and root collar diameter (mm) of the seedlings. The initial average height, diameter, and number of leaves of the seedlings were 19.31 cm, 2.80 mm, and 13 respectively. Measurements were done on a monthly basis starting from March 2013. After the measurements had been done the experimental plants were tagged using plastic strips.

Measurement on Height, Diameter and Number of Leaves

A calibrated meter stick was used in measuring the height of the planted seedlings. The height of the seedlings was measured from the base of the seedling up to the highest leaf of the plant. For diameter measurement, the stem base of the plants was examined first in order to locate the point from which the diameter could be measured. The identified point was permanently marked with a marker. A vernier caliper was used in measuring the root collar diameter (mm) of the experimental plants on designated points within the stem base. The leaves of the seedlings were counted and tabulated. Newly-formed shoots were not subjected to counting; only those who were already matured enough. The last point on the stem of the seedlings where the last leaf was counted was marked with a permanent marker. The next data collection was based on the marked point and newly-matured leaves were counted and added to the previous measurements.

Percent Survival

The survival of the seedlings was obtained by counting the number of out planted seedlings that survived in each of the experimental plot from the start until the end period of this experiment. The percent rates of survival of the plants were computed as follows:

$$\text{Percent survival} = \frac{\text{Total number of seedling survived/plot}}{\text{Total no. of plants planted or grown/plot}} \times 100$$

Data Analysis and Interpretation

Data collected were collated, tabulated and analyzed in accordance with the objectives of the study. Descriptive statistical tools that include averages, totals and percentage were used in analyzing the data. Analysis of variance (ANOVA) using SPSS program was used to determine the significance of the studied variables. The level of significance was placed at 5%.

RESULTS AND DISCUSSION

Climatic Condition of the Site

The average monthly rainfall and temperature of the site for the whole duration of the study is shown in figures 1 and 2. The lowest rainfall and highest temperature was registered during the month of April and May. The area experienced a long dry period which started on April 1, 2013 and ended on June 4, 2013. The soil in the said area was already cracking indicating that it had no more moisture left on the surface. This long dry period during the plantation establishment in the site, greatly affects the survival of the out planted seedlings. This is evident by several studies conducted on tree establishment in grassland or abandoned pasture areas. Studies emphasized that drought effects greatly influences the survival of tree seedlings. In grassland areas, high temperature and water stress results to high mortality of tree seedlings (Engelbrecht et al., 2005; Nepstad et al., 1990; Nepstad et al., 1996; & Holl et al., 2000).

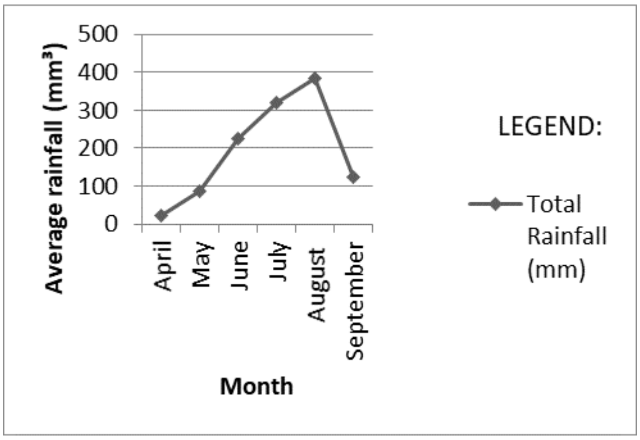

Figure 1. Average monthly rainfall (mm) in the site

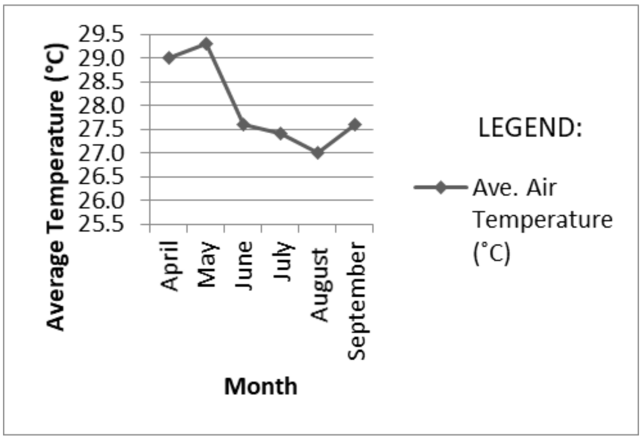

Figure 2. Average monthly air temperature (˚C) in the site

Edaphic Condition of the Site

The soil chemical and physical properties of the site is shown in Table 1. The soil pH level in the site is low which indicates that the soil was acidic. This can be explained by the presence of grasses as the dominant vegetation of the study area. A study by Buschbacher et al. (1988) on the abandoned pastures in eastern Amazonia showed that in these grassland areas, surface soils have higher cation concentration and pH than those of undisturbed mature forest within the area. The soil in the research area showed moderately higher amount of OM brought about by the accumulation of dead plant parts mostly from grasses. In terms of macro nutrients, nitrogen, phosphorous and potassium is considerably low in concentration. According to (Coomes & Grubb, 1998; Lewis et al., 2000), below ground competition on available nutrients in poor soils has an impact on the growth rate of developing tree seedlings. Where in most degraded grassland areas, soil nutrients are scarce. Although macro-nutrient availability is one of the constraints in the growth and development of seedlings in grassland areas (Aide & Cavelier, 1994 ; Holl, 1999), poor soil physical properties in these areas proved to be of significant influence to the growth and survival of seedlings (Snelder, 2001 ; Ohta, 1990).

Table 1. Soil Chemical and Physical Properties of the site

Soil Depth (cm)	SOIL CHEMICAL PROPERTIES				
	Exchangeable K (mg/kg)	Total OM (%)	Soil Ph	Total N (%)	Extractable P (mg/kg)
0-15	82.25	13.216	4.3	0.22	4.06
15-30	33.55	4.256	4.12	0.09	0.92

Soil Depth (cm)	SOIL PHYSICAL PROPERTIES		
	Moisture Content (%)	Bulk Density (g/m^3)	Soil Texture
0-15	34.4	1.1	sandy loam
15-30	33		

Survival of out planted Seedlings

The survival of seedlings four months after planting is shown in figure 3. Seedlings applied with vermicast revealed varying effects. Seedlings applied with 250 g vermicast showed the highest percent survival of 84 %. This was followed by seedlings applied with 500 g vermicast with 83 % and the control seedlings without vermicast application got the lowest rate of survival 82 %. Although there are slight differences in the survival rate of bitanghol, however, when tested using ANOVA it showed no significant difference among treatments.

Mortality of the seedlings during the 4th month had been greatly affected by the long dry period experienced in the research area during the months of April and May. Most of the experimental plants were already dying during the month of May as they had been experiencing a long dry season starting from the time it was planted; water availability in the area was relatively scarce which caused the high mortality of the seedlings. This is the main constraint in grassland rehabilitation. Hau and Corlett (2003) reported, seasonal drought, belowground competition, and low soil nutrients-can significantly impair seedlings growth on a degraded hillside.

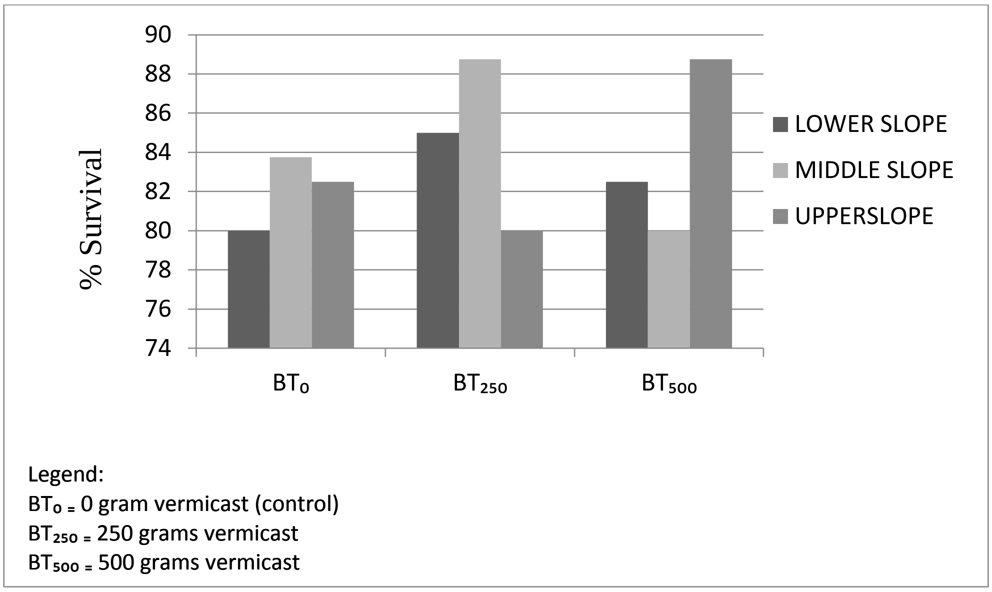

Figure 3. Percentage survival of bitanghol seedlings as affected by different levels of vermicast at different slope categories

Height, Diameter and Number of Leaves of out planted Seedlings

The average growth increment in height, diameter, and number of leaves is shown in figure 4. Bitanghol applied with 250 grams of vermicast showed the highest average growth increment in terms of height of about 2.17 cm. The higher amount of vermicast, about 500 g showed little effect in terms of average height increment 1.98 cm, compared to the 250 grams, followed by the control which has an average height increment of 0.94 cm. Trend in height growth follows from lower, middle, and upper slopes. This confirmed the depletion of soil fertility in growth areas that resulted in stunted growth and poor development in height of planted seedlings (Angeles & Tamolang, 1984).

Results show that the application of higher level of vermicast would not mean much higher height growth. In this case, bitanghol applied with 250 g of vermicast in 4 months showed better results in terms of height growth compared to 500 g vermicast application. This can be validated by the study conducted by Sinha et al, (2009) that the growth of corn applied with 200 g of vermicast plus worms showed higher results in terms of height growth compared with soluble chemical fertilizers (NPK), earthworms without feeds, and control in 19 weeks. In addition, a study that was conducted by Sabijon and Sudaria (2019) reported that the addition of vermicompost had increased the chemical properties of acid soils. This could facilitate in the improvement of acidic soil in grassland areas which would favor better growth, development, and survival of planted seedlings. More so, as the result was subjected to analysis of variance it was found out that there is no significant difference in the application of different levels of vermicast on the height growth increment of outplanted bitanghol seedlings.

Diameter of outplanted bitanghol seedlings was also monitored. Figure 4. shows the variability in diameter growth of bitanghol seedlings with the vermicast application, bitanghol seedlings applied with 250 grams of vermicast had the highest average diameter growth increment of 0.42 mm, followed by 500 grams of vermicast application of 0.37 mm, and control of 0.17 mm (Figure 9).The seedling which had a 250 g vermicast application increased more in terms of diameter growth. This coincides with the result in height growth wherein seedlings applied with 250 g vermicast showed promising increment. This was confirmed by the generalization of Bumatay (1984) that adequate amount of essential fertilizer stimulates diameter growth. But when result was subjected to analysis of variance it showed that there is no significant difference in terms of vermicast application to the growth increment in diameter of the outplanted bitanghol seedlings.

Effects of vermicast on the number of leaves of bitanghol showed that bitanghol applied with 250 g of vermicast had the highest average increment in number of leaves at 1.90. This was followed by bitanghol applied with 500 g vermicast 1.56 and 0 g vermicast of 0.90. This follows the trend in the survival, height, and diameter of seedlings wherein seedlings applied with 250 g of vermicast showed good results. This implies that 250 g vermicast application would promote better growth increment in terms of leaf production on outplanted bitanghol seedlings.
However, when result was tested using ANOVA, it showed insignificant difference.

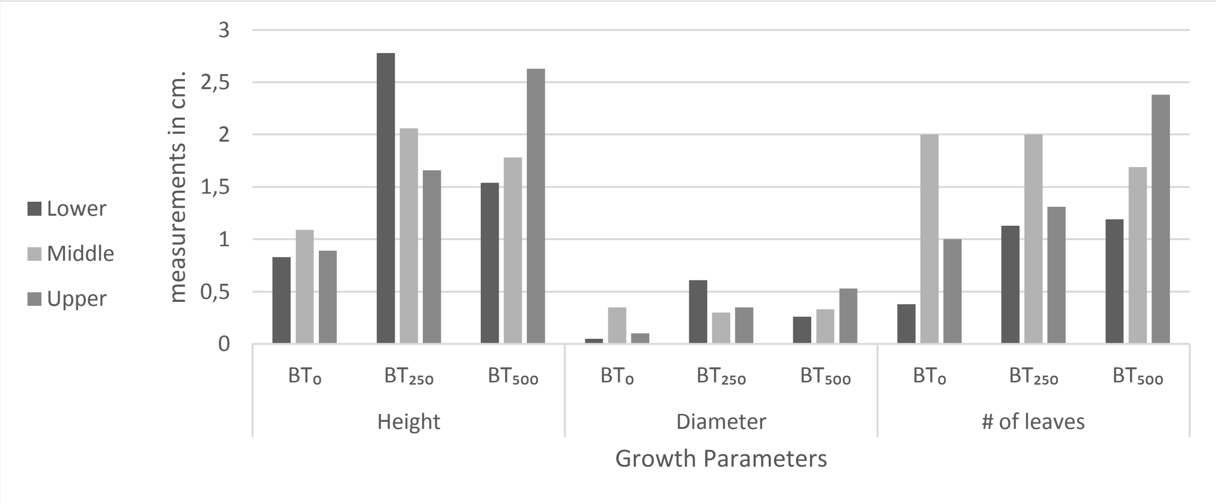

Figure 4. Growth parameters of Bitanghol seedlings as affected by different levels of vermicast at different slope categories

CONCLUSION

Percentage survival of bitanghol (*Calophyllum blancoi* Pl. and Tr.) seedlings planted in an open grassland in Silago was insignificantly affected by the different level of vermicast after 4 months of observation.

Results shows, that the effect of vermicast application to the growth in height, diameter, and number of leaves of bitanghol seedlings 4 months after planting had no significant effect, although a slight variation in height, diameter, and number of leaves was observed. Seedlings applied with 250 grams of vermicast showed the highest results in terms of height, diameter, and number of leaves, compared to seedlings that were applied with 500 grams and 0 gram of vermicast, respectively.

RECOMMENDATION

(1) It is recommended that longer observation period and timing should be done and considered in order to determine the significant effect of vermicast application; (2) Higher levels of vermicast is recommended in order to know the variability of its effects once applied to bitanghol seedlings or any other type of indigenous seedlings planted in an open grassland; (3) Comparative study on survival and early growth performance of shade-tolerant and light demanding tree species should be conducted in an open grassland.

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