European Journal of Agricultural and Rural Education (EJARE)
Available Online at: https://www.scholarzest.com
Vol. 2 No. 4, April 2021,
ISSN: 2660-5643

GROWTH OF FIRST THREE SEEDLINGS FROM POLY-EMBRYONIC MANGO SEED APPLIED WITH WOOD VINEGAR

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Article history:

Received March 22th 2021
Accepted: April 3th 2021
Published: April 20th 2021

Abstract:

The study was laid out in Factorial in Randomized Complete Block Design (RCBD) with two (2) treatments, three (3) sub-treatments, and three (3) replications with five (5) samples per replication. The treatments used in the study were Treatment 1 (0 ml of wood vinegar) and Treatment 2 (20 ml of wood vinegar).

The result showed that mango applied with Treatment 2 in sub-treatment 1 (with application, 1st seedling) was the fastest in terms of plant growth and it also produced to be the tallest seedling. There was a highly significant difference in Treatment and in the Interaction between Treatment 1 and Treatment 2 in terms of plant growth. There was no significant difference in number of new leaves as the analysis of variance of the said parameters revealed.

Based on the study, the application of wood vinegar has a greater effect on plant growth that enables to accelerate the development of roots and leaves.

Furthermore, studies on the application of wood vinegar and lengthening the span of the study can be used for future researches.

Keywords: Mango, Wood Vinegar, Poly-embryonic

INTRODUCTION

Rationale

Mango, (*Mangifera indica*), member of the cashew family (Anacardiaceae) and one of the most important and widely cultivated fruits of the tropical world. The mango tree is considered indigenous to Eastern Asia, Myanmar (Burma), and Assam state of India. It is a rich source of vitamins A, C, and D.

According to Philippine Statistics Authority (PSA, 2019) during the period April to June 2019, mango production was recorded at 556.88 thousand metric tons. It was 5.4 percent higher than the 2018 level of 528.49 thousand metric tons. The highest producer of mango during the period was Ilocos Region, contributing 22.6 percent to the total national production. Zamboanga Peninsula and Central Visayas followed with 10.5 percent and 9.7 percent, respectively. Carabao mango has been recorded as the highest output of 445.78 thousand metric tons, representing 80.1 percent of the total mango production this period.

In 2015, Central Luzon posted the largest area planted at 33.54 thousand hectares representing 17.8 percent of the total area planted to mango. Ilocos Region came next with 11.8 percent; Davao Region, 9.7 percent; SOCCSKSARGEN, 9.2 percent; and Zamboanga Peninsula, 9.0 percent. In 2015, the major variety of mango produced was Carabao at 740.24 thousand metric tons representing 82.0 percent of the total mango production. Piko and other varieties of mango shared 4.3 percent and 13.7 percent, respectively. The 2011-2015 production of carabao mango increased at an average annual rate of 3.8 percent, area planted by 0.3 percent, and number of bearing trees by 4.6 percent. In 2015, production of carabao mango was estimated at 740.24 thousand metric tons, 1.4 percent higher than the 2014 level of 730.14 thousand metric tons. Similarly, area planted increased by 0.4 percent and number of bearing trees by 9.9 percent.

Wood vinegar is also called as a Pyroligneous Acid, Liquid Smoke or Mokusako. It is a dark liquid produced through the natural act of carbonization which occurs when a biomass is heated in an airless container during charcoal/biochar production. The exhaust smoke from this charcoal production is condensed (cooled) into a liquid. After the condensation, it further separates into Tar, Vinegar and Bio-Oil.

Wood vinegar has a long history of successful use throughout Asia for the replacement of expensive fossil derived agriculture chemicals. There is an evidence of the successful use dating back to thousands of years in the Amazon and even in the 1900s when substantial factories commercially produced wood vinegar with creosote as a source of acetic acid.

Moreover, it improves soil quality, eliminates pests and controls plant growth, but is slightly toxic to fish and very toxic to plants if too much is applied. It accelerates the growth of roots, stems, tubers, leaves, flowers, and fruit. In certain cases, it may hold back plant growth if it is applied at different volumes. Also, it is safe to living matters in the food chain, especially, insects that help pollinate plant.

Furthermore, it is the product obtained by distilling the smoke arising from burning wood and it is a complex mixture of 80-90% water, and 10-20% organic compounds. In addition, it contains several phenolic compounds such as guaiacol and cresol, and organic acids like acetic, formic and propionic acids. It can be refined by fractional distillation to produce a food-grade product (Sakaguchi and Uyama, 2007).

The synonyms for WV include pyrolysis oil, pyrolysis liquid, wood liquid, liquid smoke, liquid wood, bio-oil, bio-crude oil and wood distillate (Zulkarami, Ashrafuzzaman, Husni and Ismail, 2011). Major groups of compounds in WV includes: hydroxy aldehydes, hydroxy ketones, sugars, carboxylic acid and phenolic acid (Guillen and Manzanos, 2002).

According to Thailand's Department of Agriculture, wood vinegar has the following broad benefits such as improvement of soil quality, elimination of pests, plant growth control being able to accelerate the development of roots, stems, tubers, leaves, flowers and fruit and used to increase amounts of fruit produced in orchards (Burnette, 2013).

Mokusaku is liquid obtained from oil, juices, sap and other liquid contents of organic materials such a wood, coconut shell, bamboo, grass, and other plants after being heated in a chamber. The chamber is heated by burning firewood placed at the base of the chamber. When these organic materials are heated, their liquid contents evaporate as steam (gas, smoke). The steam passes through a tube (cooling chamber) where it will be allowed to cool. When the steam is cooled, the vapor will turn into liquid (condensation processed). The liquid product is what is known as Mokusaku. From the tube, the liquid is collected in a container (Yokomori, 2011).

OBJECTIVES OF THE STUDY

Generally, the study aimed to evaluate the growth of first three seedlings from poly-embryonic mango seed applied with wood vinegar.

Specifically, it aims to:

1. Evaluate the effects of wood vinegar in poly-embryonic mango seed in terms of plant height; and
2. Determine the effects of wood vinegar in poly-embryonic mango seed in terms of development of leaves.

Time and Place of Study

The study was conducted from the month of June to October 2019 at President Ramon Magsaysay State University (San Marcelino Campus- San Marcelino Zambales). This study focused in the growth of first three seedlings from poly-embryonic mango seed applied with wood vinegar.

Scope and Limitation

The study aimed to evaluate the growth of first three seedlings from poly-embryonic mango seed applied with wood vinegar. With this study, the mango producer was aided and guided with the used of wood vinegar.

In this study, the researcher had limited herself in evaluating the growth of first three seedlings from poly-embryonic mango seed applied with wood vinegar. This evaluated the average rate of growth, average of final height, average total number of leaves and average of leaf area index.

DEFINITION OF TERMS

The following terms are defined to indicate in the sense which they were used in the discussion of the study.

Apogamy - it is the asexual development of a sporophyte from a cell or cells of the gametophyte other than the egg.

Apomictic - any of several types of asexual reproduction, as apogamy or parthenogenesis.

Asexual Reproduction - it is the reproduction without sex. In the form of reproduction, a single organism or cell makes a copy of itself. The genes of the original and its copy will be the same, except for rare mutations. They are clones. The main process of asexual reproduction is mitosis.

Parthenogenesis – it is reproduction by development of an unfertilized usually female gamete that occurs especially among lower plants and invertebrate animals.

Pyrolysis - it refers to the chemical change brought about by the action of heat.

Sexual reproduction - it is the production of new living organisms by combining genetic information from two individuals of different types (sexes). In higher organisms, one sex (male) produces a small motile gamete which travel to fuse with a larger stationary gamete produced by the other (female).

Wood vinegar - it refers to an acid, reddish-brown aqueous liquid containing chiefly acetic acid, methanol, wood oils, and tars that obtained by destructive distillation of wood.

REVIEW OF RELATED LITERATURE

Mango

Mangifera indica is commonly used herb in ayurvedic medicine. Although review articles on this plant are already published, but this review article is presented to compile all the updated information on its phytochemical and pharmacological activities, which were performed widely by different methods. Studies indicated mango possesses antidiabetic, anti-oxidant, anti-viral, cardiotonic, hypotensive, anti-inflammatory properties. Various effects like antibacterial, anti-fungal, anthelmintic, anti-parasitic, anti-tumor, anti HIV, antibone resorption, antispasmodic, antipyretic, antidiarrhoeal, antiallergic, immunomodulation, hypolipidemic, anti-microbial, hepatoprotective, gastroprotective have also been studied. These studies are very encouraging and indicate this herb should be studied more extensively to confirm these results and reveal other potential therapeutic effects. Clinical trials using mango for a variety of conditions should also be conducted (Shah, Patel and Parmar, 2010).

Wood Vinegar

Villa (2003) stated that the production of wood vinegar is cost-effective. It only takes a day and offers a versatile range of beneficial applications that are gentle on the environment. Charcoal products are used for cooking. Charcoal Wood Vinegar made from wood vinegar produces cleaner, safer smoke. For the following applications, dilute raw wood vinegar with water in the indicated ratio. It kill pests, kill weeds, prevent stem and roots, prevent pests and mold while accelerating plant growth, prevent plant lice, enhance fruit growth.

According to Ichikawa and Ota (1982), the use of wood vinegars in agricultural production is also becoming popular in Asian countries. Wood vinegar are by- products of making charred-materials ("bio char") containing numerous amounts of carboxylic/organic acids and other organic components. It has been reported to have a promoting effect on growth and nutrient absorption of rice roots.

Ohira (2000) stated that the product contains approximately 200 components. These include: Alcohol (Methanol, Butanol, Amylalcohol), Acid (Acetic, Formic, Propioinic, Valeric), Neutral substances such as formaldehyde, acetone, furfural, valerolactone, Phenols (Syringol, Cresol, Phenol), Basic substances such as ammonia, methyl amine, pyridine, Acetic acid, the principal component if acid liquid, is generated through the decomposition of the acetyl group of hemicellulose and the carboxyl group of ironic acid in wood.

Moreover, wood vinegar is also known as fungicide, repellant, insecticide, herbicide and plant growth enhancer (Tiilikkala, Fagernäs and Tiilikkala, 2010)

Furthermore, the study of Lemke (2005) stated that there were several included literatures of the use of wood vinegar for controlling weeds the study of that herbicides were applied according to label rates. Concentrated vinegar and formulated acetic acid were packaged ready to use (RTU). The formulated product and concentrated vinegar have concentrations of 25% (v/v) and 30% (v/v) acetic acid, respectively.

Wood vinegar significantly increase efficacy of HRH in bensulfuron-menthyl + butachlor while high efficacy was already obtained in HRH treatment of imazosulfuron – ethyl + thiobencarb. Wood vinegar did not improve the efficacy of imazosulfuron – ethyl + thiobencarb but improved rice yield. Significantly, similar rice yields were obtained in the HRH + 1000 Wood Vinegar and RH treatment of both herbicides (Rico, Souvandouane, Mintah, Son and Lee, 2007).

According to Yoshimoto (1994), it is reported that there were positive influence of wood vinegar on crop growth and germination.

Wood vinegar has been used for a species of purposes such as industrial, livestock, household and agricultural products. It improves soil quality, eliminates pest, and serves as plant growth regulator or plant growth inhibitor. Since the 1930's, wood vinegar has also been used in agriculture as fertilizer and growth promoting agent. The wood vinegar showed potential to control weeds (Kanlaya, 2014).

Apai and Thongdeethae (2001) stated that wood vinegar reportedly improves soil quality, eliminates pests, accelerates plant growth, and acts as plant growth regulator or growth inhibitor.

METHODOLOGY

Research Materials and Equipment

The materials were use in this study are the following:

- Indian Mango Seed
- Wood Vinegar
- Polythene Bags
- Pruning shear
- Record notebook
- Ruler
- Placard
- Pail
- Deeper

Experimental Design

The study used the Factorial in Randomized Complete Block Design (RCBD) with two (2) treatments, three (3) sub-treatments, and three (3) replications with 5 samples per replication.

Treatments

The different treatments will follow:

Main Treatment 1- Without Wood Vinegar (0 ml)
Main Treatment 2- With Wood Vinegar (20 ml)
Sub-treatment 1- 1st seedling
Sub-treatment 2- 2nd seedling
Sub-treatment 3- 3rd seedling

LAYOUT OF THE EXPERIMENTAL AREA

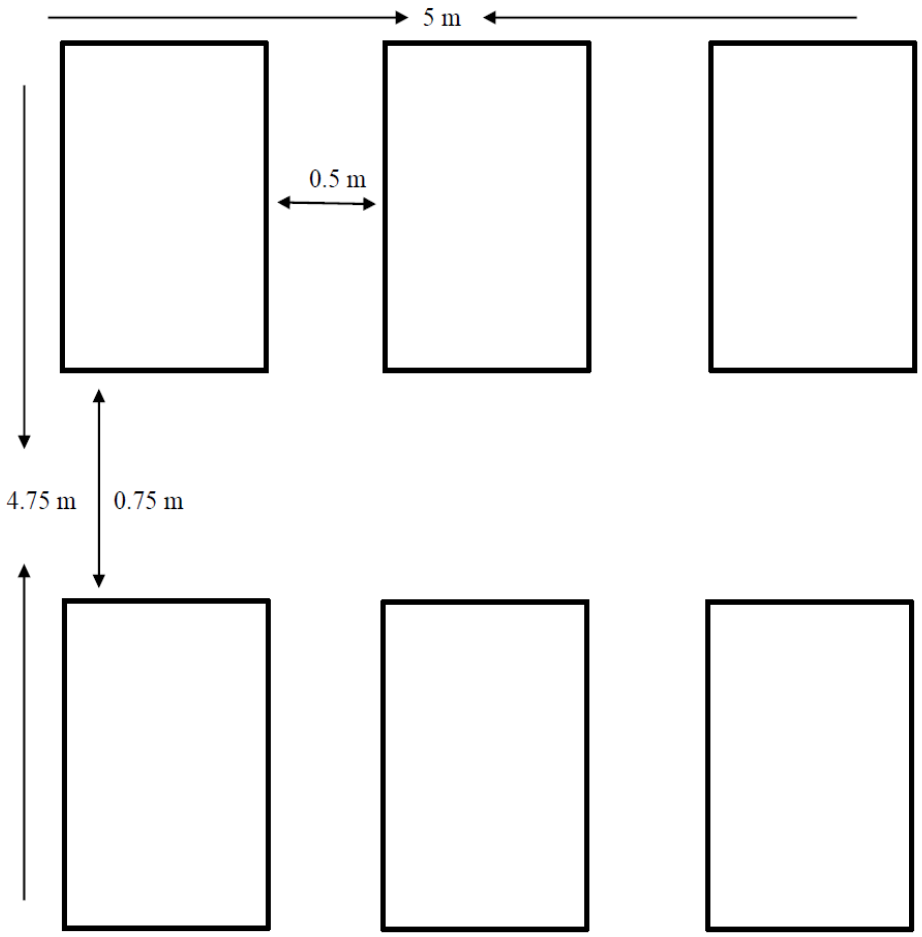

Figure 1. Experimental Layout

Legend:

Distance between block	0.5 meter
Distance between plots	0.75 meter
Width of area	5 meter
Length of area	4.75 meter
Total Area	23.75 square meter

PLOT LAYOUT

There were 3 rows on a plot with 5 pots each row. The distance between rows and hills was 25 cm x 25 cm, respectively.

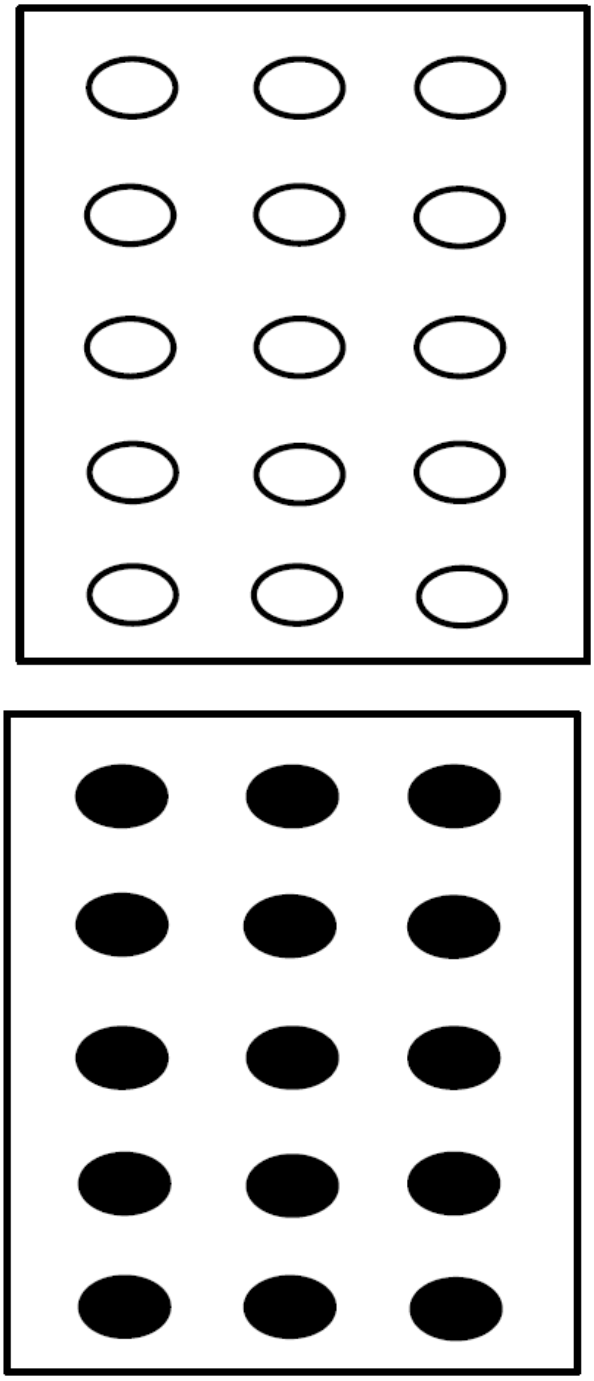

Figure 2. Plot Layout

Legend:

Sample Plant

Distance between pots	25 cm
Distance between rows	25 cm
Length of plot	1 m
Width of plot	1.5 m

EXPERIMENTAL PROCEDURE

Soil Analysis

The soil sample that was collected was submitted to the Integrated Agricultural Laboratories Division Regional Soil Laboratory, City of San Fernando Pampanga.

Gathering of Materials

The materials were gathered by harvesting of Indian mango seeds, a riped fruits were taken at Barangay Maligaya, San Antonio, Zambales. Meanwhile, wood vinegar was obtained in Zambali Beach Farm, Botolan, Zambales.

Purchased of Polythene Bags (5x5x7)

The polyethylene bag was purchased in Agricultural Supply in Palauig, Zambales.

Soil Preparation

Make a plot where the selected seeds were sown.

Seed Sowing

The selected seeds were sown in a plot at 1-2 cm deep or at the subsurface of the soil. Light irrigation was provided just after sowing.

Labelling

The yarns were put. The violet yarn was for 1st seedling, the yellow yarn was for the 2nd seedling while the pink yarn was for the 3rd seedling.

Transplanting

Two months after seed sowing, 1st, 2nd and 3rd seedlings were transplanted.

Watering

When planting is done, during low rainfall season, the young plants were watered every other day to avoid drying and wilting.

Treatment Application

One week after transplanting, treatment was applied (20 ml: 1 L). It was applied once a week in 6 weeks.

DATA GATHERED

The date were observed and recorded every week.

The data gathered were as follows:

A. *Weekly Height*

Height of plant was measured weekly starting from the second week of application. The weekly length of plant was computed by subtracting the 1st data on length of plants from the second data to third and so on.

B. *Final Height*

Height of plant was measured on the last week of application.

C. *Total Number of Leaves*

Number of leaves was counted when the leaves are matured.

D. *Leaf Area Index*

The leaf area index was computed with the used of grids.

STATISTICAL ANALYSIS

The gathered data was analyzed by using Analysis of Variance (ANOVA) in Factorial in Randomized Complete Block Design (RCBD). The significance differences were calculated by using Least Significance Differences (LSD) at 5% and 1% of significance level of gathered data.

RESULT AND DISCUSSION

In this study, growth of first three seedlings from poly-embryonic mango seed applied with wood vinegar was evaluated.

As shown in Table 1.a, the Treatment 2 Sub-treatment 1 (With application, 1st seedling) produced the fastest plant growth with an average of 0.61 cm, followed by Treatment 1 Sub-treatment 1 (No application, 1st seedling), then Treatment 2 Sub-treatment 2 (With application, 2nd seedling), Treatment 1 Sub-treatment 3 (No application, 3rd seedling), Treatment 2 Sub-treatment 3 (With application, 3rd seedling) and Treatment 1 Sub-treatment 2 (No application, 2nd seedling) with an averages of 0.57 cm, 0.54 cm, 0.52 cm, 0.41 cm and 0.36 cm respectively.

Table 1.b, revealed that there is no significant difference in applications of wood vinegar because the computed F value was lower than tabular F value at 5% and 1% level of significance.

Table 1.a Mean of Weekly Rate of Growth (cm)

Treatment	R1	R2	R3	Treatment Total	Mean
T1S1	0.38	0.58	0.75	1.72	0.57
T1S2	0.35	0.42	0.30	1.07	0.36
T1S3	0.65	0.48	0.42	1.55	0.52
T2S1	0.63	0.57	0.63	1.83	0.61
T2S2	0.60	0.5	0.52	1.62	0.54
T2S3	0.50	0.35	0.38	1.23	0.41
Grand Total (G)				9.02	
Grand Mean					0.50

Table 1.b Analysis of Variance of Weekly Rate of Growth

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	Computed F	Tabular F 5%	1%
Replication	2	0.00	0.00	0.16	4.10	7.58
Treatment	5	0.14	0.03	2.40^{ns}	3.33	5.64
Control (A)	2	0.04	0.02	1.50^{ns}	4.10	7.58
WV (B)	1	0.03	0.03	2.60^{ns}	4.96	10.04
AXB	2	0.08	0.04	3.20^{ns}	4.10	7.58
Error	10	0.12	0.01			
Total	17	0.27				

^{ns}= Not Significant

CV = 21.90%

As shown in Table 2.a, the Treatment 2 Sub-treatment 1 (With application, 1st seedling) produced the tallest plant with an average of 21.24 cm, followed by Treatment 1 Sub-treatment 1 (No application, 1st seedling), then Treatment 2 Sub-treatment 2 (With application, 2nd seedling), Treatment 1 Sub-treatment 2 (No application, 2nd seedling), Treatment 2 Sub-treatment 3 (With application, 3rd seedling), and Treatment 1 Sub-treatment 3 (No application, 3rd seedling) with an averages of 19.33 cm, 17.64 cm, 14.99 cm, 13.60 cm and 11.08 cm, respectively.

Table 2.b revealed that there is a highly significant difference among Treatments and Interaction between Treatment 1 and Treatment 2 because the computed F value was higher than tabular F value at 5% and 1% level of significance. Also LSD showed that there are a significant different between the interaction of Treatment 1 and Treatment 2.

The result of this study confirmed the statement of Apai and Thongdeethae (2001) wherein they stated that wood vinegar reportedly improves soil quality, eliminates pests, accelerates plant growth, and acts as plant growth regulator or growth inhibitor.

Table 2.a Mean of Final Height (cm)

Treatment	R1	R2	R3	Treatment Total	Mean
T1S1	17.44	19.40	21.14	57.99	19.33
T1S2	16.51	15.74	12.70	44.96	14.99
T1S3	10.73	12.40	10.10	33.23	11.08
T2S1	20.71	22.96	20.06	63.73	21.24
T2S2	19.36	15.96	17.61	52.93	17.64
T2S3	11.51	15.67	13.63	40.81	13.60
Grand Total (G)				293.64	
Grand Mean					16.31

Table 2.b Analysis of Variance of Final Height

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	Computed F	Tabular F 5%	1%
Replication	2	4.60	2.30	0.71	4.10	7.58
Treatment	5	215.06	43.01	13.33**	3.33	5.64
Control (A)	2	7.27	3.63	1.13^{ns}	4.10	7.58
WV (B)	1	1.59	1.59	0.49^{ns}	4.96	10.04
AXB	2	206.20	103.10	31.96**	4.10	7.58
Error	10	32.26	3.23			
Total	17	251.92				

^{ns}= Not Significant
**= Highly Significant
CV = 11.01%
LSD_{axb} (5%) = 2.31%
LSD_{axb} (1%) = 3.29%

As shown in Table 3.a, the evaluation of average number of leaves showed that Treatment 2 Sub-treatment 1 (With application, 1st seedling) has the highest number of new leaves with an average of 2.43 leaves, followed by Treatment 1 Sub-treatment 1 (No application, 1st seedling), Treatment 2 Sub-treatment 3 (With application, 3rd seedling), Treatment 2 Sub-treatment 2 (With application, 2nd seedling), Treatment 1 Sub-treatment 3 (No application, 3rd seedling) and Treatment 1 Sub-treatment 2 (No application, 2nd seedling) with an average of 2.13 leaves, 2.12 leaves, 1.85 leaves, 1.71 leaves and 1.64 leaves respectively.

Table 3.b, revealed that there is no significant difference in applications of wood vinegar because the computed F value was lower than tabular F value at 5% and 1% level of significance.

Table 3.a Mean of Total Number of Leaves

Treatment	R1	R2	R3	Treatment Total	Mean
T1S1	1.80	2.60	2.00	6.40	2.13
T1S2	1.67	1.75	1.50	4.92	1.64
T1S3	1.67	1.14	2.33	5.14	1.71
T2S1	2.33	2.83	2.11	7.28	2.43
T2S2	2.33	1.71	1.50	5.55	1.85
T2S3	2.75	1.86	1.75	6.36	2.12
Grand Total (G)				35.6	
Grand Mean					1.98

Table 3.b Analysis of Variance of Total Number of Leaves

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	Computed F	Tabular F 5%	1%
Replication	2	0.15	0.08	0.35	4.10	7.58
Treatment	5	1.34	0.27	1.22^{ns}	3.33	5.64
Control (A)	2	0.10	0.05	0.23^{ns}	4.10	7.58
WV (B)	1	0.12	0.12	0.54^{ns}	4.96	10.04
AXB	2	1.12	0.56	2.55^{ns}	4.10	7.58
Error	10	2.19	0.22			
Total	17	3.68				

^{ns}= Not Significant
CV = 23.63%

As shown in Table 4.a, Treatment 2 Sub-treatment 1 (With application, 1st seedling) produced the biggest size of leaves with an average of 32.20 cm, followed by Treatment 1 Sub-treatment 2 (No application, 2nd seedling), Treatment 2 Sub-treatment 2 (With application, 2nd seedling), Treatment 2 Sub-treatment 3 (With application, 3rd seedling), Treatment 1 Sub-treatment 1 (No application, 1st seedling), and Treatment 1 Sub-treatment 3 (No application, 3rd seedling) with an average of 29.27 cm, 28.80 cm, 28.50 cm, 25.85 cm and 22.40 cm, respectively.

Table 4.b revealed that there is a significant difference on treatment 2 because the computed F value was higher than tabular F value at 5% but not higher than tabular F value at 1% level of significance. Also LSD showed that there are highly significant differences on treatment 2.

The result of this study confirmed the statement of Burnette (2013) that wood vinegar has the following broad benefits such as improvement of soil quality, elimination of pests, plant growth control being able to accelerate the development of roots, stems, tubers, leaves, flowers and fruit and used to increase amounts of fruit produced in orchards.

Table 4.a Mean of Leaf Area Index (cm)

Treatment	R1	R2	R3	Treatment Total	Mean
T1S1	26.75	33.00	17.8	77.55	25.85
T1S2	29	33.8	25.00	87.80	29.27
T1S3	25.2	20.25	21.75	67.2	22.40
T2S1	31.00	31.20	34.40	96.60	32.20
T2S2	30.40	26.2	29.80	86.40	28.80
T2S3	27.50	30.60	27.40	85.50	28.50
Grand Total (G)				501.05	
Grand Mean					27.84

Table 4.b Analysis of Variance of Leaf Area Index

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	Computed F	Tabular F 5%	1%
Replication	2	31.77	15.89	0.99	4.10	7.58
Treatment	5	167.87	33.57	2.09^{ns}	3.33	5.64
Control (A)	2	6.16	3.08	0.19^{ns}	4.10	7.58
WV (B)	1	83.42	83.42	5.18*	4.96	10.04
AXB	2	78.29	39.14	2.43^{ns}	4.10	7.58
Error	10	160.89	16.09			
Total	17	360.53				

*= Significant
ns= Not Significant
CV = 14.41%
LSDb (5%) = 7.30 %
LSDb (1%) = 10.38 %

CONCLUSION AND RECOMMENDATION

The result showed that Treatment 2 Sub-treatment 1 (With application, 1st seedling) was the fastest in terms of plant growth and it also produced the tallest seedling. Treatment 2 Sub-treatment 1 (With application, 1st seedling) also produced the highest number of leaves. Based on the study, the Treatment 2 can be recommended to accelerate plant growth, and can act as plant growth regulator or growth inhibitor in a short period of time.

Furthermore, studies on the application of wood vinegar and lengthening the span of the study can be considered for future researches.

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APPENDICES

APPENDIX A

Tables

Appendix Table 1. Mean of Weekly Rate of Growth (cm)

Treatment	R1	R2	R3	Treatment Total	Mean
T1S1	0.38	0.58	0.75	1.72	0.57
T1S2	0.35	0.42	0.30	1.07	0.36
T1S3	0.65	0.48	0.42	1.55	0.52
T2S1	0.63	0.57	0.63	1.83	0.61
T2S2	0.60	0.5	0.52	1.62	0.54
T2S3	0.50	0.35	0.38	1.23	0.41
Grand Total (G)				9.02	
Grand Mean					0.50

Appendix Table 2.a. Mean of Final Height (cm)

Treatment	R1	R2	R3	Treatment Total	Mean
T1S1	17.44	19.40	21.14	57.99	19.33
T1S2	16.51	15.74	12.70	44.96	14.99
T1S3	10.73	12.40	10.10	33.23	11.08
T2S1	20.71	22.96	20.06	63.73	21.24
T2S2	19.36	15.96	17.61	52.93	17.64
T2S3	11.51	15.67	13.63	40.81	13.60
Grand Total (G)				293.64	
Grand Mean					16.31

Appendix Table 2.b. Least Significant Difference of Interaction between Treatment 1 and Treatment 2

	Mean	Difference	5%	1%
T1S1	19.33	5.72	2.228	3.169
T1S2	14.99	1.38		
T1S3	11.08	2.53		
T2S1	21.24	7.64		
T2S2	17.64	4.04		
TSS3	13.60			

LSD_{axb} (5%) = 2.31%
LSD_{axb} (1%) = 3.29%

Appendix Table 3. Mean Number of Total Number of Leaves

Treatment	R1	R2	R3	Treatment Total	Mean
T1S1	1.80	2.60	2.00	6.40	2.13
T1S2	1.67	1.75	1.50	4.92	1.64
T1S3	1.67	1.14	2.33	5.14	1.71
T2S1	2.33	2.83	2.11	7.28	2.43
T2S2	2.33	1.71	1.50	5.55	1.85
T2S3	2.75	1.86	1.75	6.36	2.12
Grand Total (G)				35.6	
Grand Mean					1.98

Appendix Table 4.a Mean Number of Leaf Area Index (cm)

Treatment	R1	R2	R3	Treatment Total	Mean
T1S1	26.75	33.00	17.8	77.55	25.85
T1S2	29	33.8	25.00	87.80	29.27
T1S3	25.2	20.25	21.75	67.2	22.40
T2S1	31.00	31.20	34.40	96.60	32.20
T2S2	30.40	26.2	29.80	86.40	28.80
T2S3	27.50	30.60	27.40	85.50	28.50
Grand Total (G)				501.05	
Grand Mean					27.84

Appendix Table 4.b Least Significant Difference of Treatment 2

	Mean	Difference	5%	1%
S3	28.65	1.09	2.228	3.169
S2	27.30	0.26		
S1	27.56			

LSDb (5%) = 7.30 %
LSDb (1%) = 10.38 %

APPENDIX B

Documentation

Appendix Figure 1. Experimental Layout

Appendix Figure 2. Pruning Shear

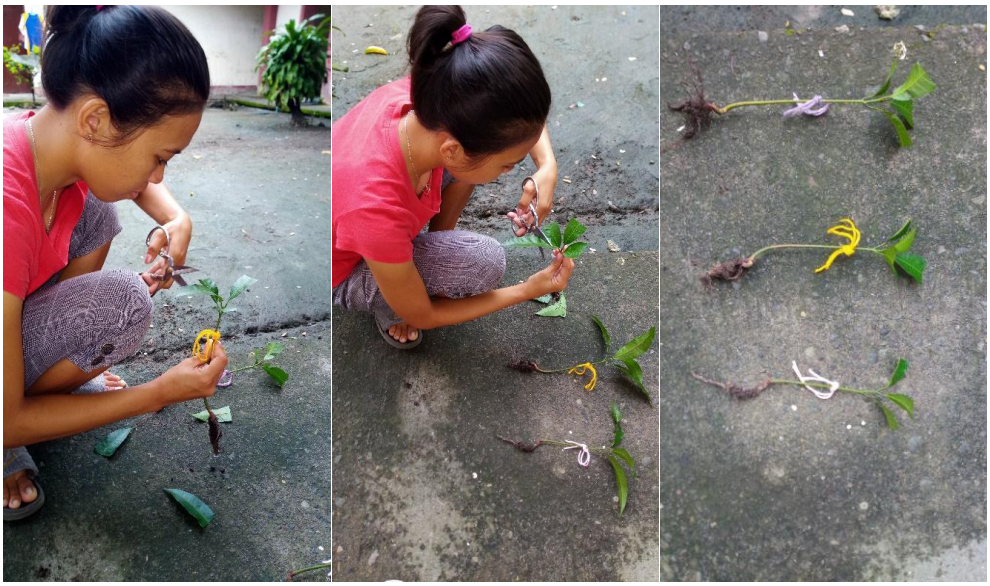
Appendix Figure 3. Dehusking of Seeds

Appendix Figure 4. With and Without Seed Coat

Appendix Figure 5. Seed Sowing

Appendix Figure 6. Labelling

Appendix Figure 7. Separation of Seedlings



Appendix Figure 8. Cutting of Leaves

Appendix Figure 9. Transplanting

Appendix Figure 10. Measuring and Mixing of Wood Vinegar

Appendix Figure 11. Application of Wood Vinegar

Appendix Figure 12. Watering

Appendix Figure 13. Measuring of Height

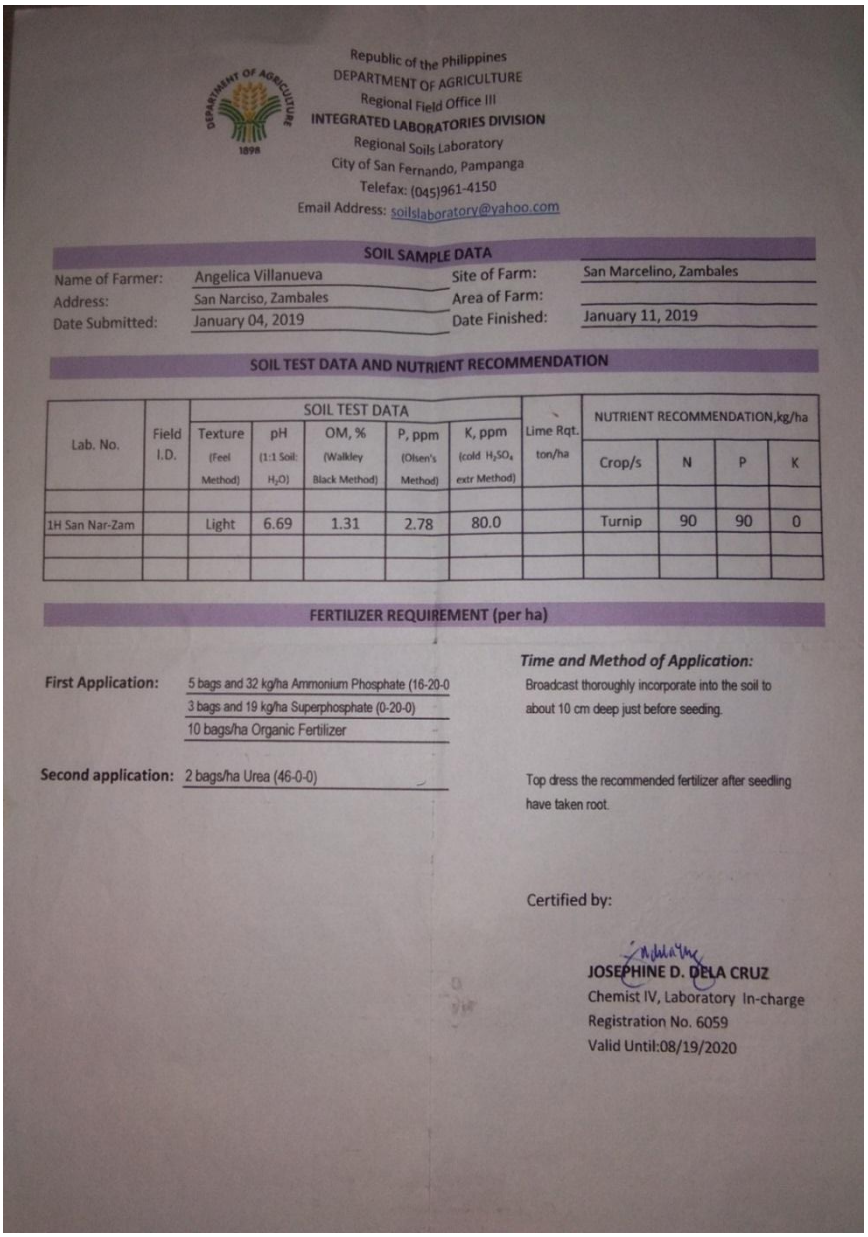
Appendix Figure 14. Placards

Appendix Figure 15. Photograph of New Leaves

Appendix Figure 17. Treatment 1 (0 ml)

Appendix Figure 18. Treatment 2 (20 ml)

SOIL ANALYSIS



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SOIL SAMPLE DATA

Name of Farmer:	Angelica Villanueva	Site of Farm:	San Marcelino, Zambales
Address:	San Narciso, Zambales	Area of Farm:	
Date Submitted:	January 04, 2019	Date Finished:	January 11, 2019

SOIL TEST DATA AND NUTRIENT RECOMMENDATION

Lab. No.	Field I.D.	SOIL TEST DATA					Lime Rqt. ton/ha	NUTRIENT RECOMMENDATION,kg/ha			
		Texture (Feel Method)	pH (1:1 Soil: H_2O)	OM, % (Walkley Black Method)	P, ppm (Olsen's Method)	K, ppm (cold H_2SO_4 extr Method)		Crop/s	N	P	K
1H San Nar-Zam		Light	6.69	1.31	2.78	80.0		Turnip	90	90	0

FERTILIZER REQUIREMENT (per ha)

First Application: 5 bags and 32 kg/ha Ammonium Phosphate (16-20-0
3 bags and 19 kg/ha Superphosphate (0-20-0)
10 bags/ha Organic Fertilizer

Second application: 2 bags/ha Urea (46-0-0)

Time and Method of Application:
Broadcast thoroughly incorporate into the soil to about 10 cm deep just before seeding.

Top dress the recommended fertilizer after seeding have taken root.

Certified by:

JOSEPHINE D. DELA CRUZ
Chemist IV, Laboratory In-charge
Registration No. 6059
Valid Until:08/19/2020