The American Journal of Agricultural Science, Engineering and Technology (AJASET) is blind peer reviewed international journal publishing articles that emphasize research, development and application within the fields of agricultural science, engineering and technology. The AJASET covers all areas of Agricultural Science, Engineering and Technology, publishing original research articles. The AJASET reviews article within approximately two weeks of submission and publishes accepted articles online immediately upon receiving the final versions.

**Published Media:** ISSN: 2158-8104 (Online), 2164-0920 (Print).

**Frequency:** 2 issues per year (January, July)

**Area of publication:** Agricultural Science, Any Engineering and Technology related original and innovative works.

**EDITORIAL BOARD**

**Chief Editor**

Dr Mamun-Or-Rashid  
Professor, Dhaka University, Bangladesh

**Board Members**

Dr. Sumit Garg, IL, USA  
Professor Dr. James J. Riley, The University of Arizona, USA  
Dr. Ekkehard KÜRSCHNER, Agriculture Development Consultant, Germany  
Professor Dr. Rodriguez Hilda, USA  
Professor Dr. Michael D. Whitt, USA  
Professor Dr. Wael Al-aghibari, Yemen  
Professor Dr. Muhammad Farhad Howladar, Bangladesh  
Dr. Clement Kiprotich Kiptum, University of Eldoret, Kenya  
Professor Dr M Shamim Kaiser, Professor, Jahangirnagar University, Bangladesh  
Professor Dr Mohammad Shahadat Hossain, Chittagong University, Bangladesh  
Professor Dr. Nirmal Chandra Roy, Sylhet Agricultural University, Bangladesh

**Managing Editor**

Md. Roshidul Hasan  
Professor, Department of Computer Science and Information Technology,  
Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh
GROWTH EFFECT OF THE DIFFERENT RATIOS OF WOOD VINEGAR ON 

Brassica juncea

Aljon Victor G. Nibalvos1*, Cristina H. Tan-Nibalvos1

DOI: https://doi.org/10.54536/ajaset.v5i2.111

ABSTRACT

Four (4) different ratios of wood vinegar namely; 1:5; 1:10; 1:20 and 1:30 mL WV to water ratio extracted from coconut shell was tested to determine their growth effect on Brassica juncea or mustard plant or locally known as mustasa. Parameters measured were leaf number, plant height, plant leaf width. Using randomized complete block design, experimental tests were conducted using Brassica juncea as test plants. The samples of 10 days old were allowed to flourish in a potted plant with day to day application of the wood vinegar solutions together with the negative control for a total of 30 days. Results revealed that the wood vinegar ratios applied have no significant effect on the growth of the mustard plant in terms of its leaf number, plant height and leaf width. This indicates that coconut shell wood vinegar at 1:5, 1:10, 1:20 and 1:30 are not applicable ratios for plant production, as that an increased wood vinegar application increases plant production and growth.

Keywords: Wood Vinegar, Brassica juncea, Organic Fertilizer, Wood Vinegar Ratio

1 Natural Science Department, College of Arts and Sciences, Eastern Samar State University, Borongan City, Eastern Samar, Philippines
* Corresponding author: aljonvictor.online@gmail.com
INTRODUCTION

As commonly known, chemical fertilizers which are usually utilized in the agricultural industry can cause the soil being sprayed to be too acidic and leads to another problem in the environment; water pollution. Wood vinegar is the substance produced through the condensation of smoke emitted during the pyrolysis of wood and its residues from processing. It is an essential substance that promotes healthy method for propagating plants, and also, it can be used as fertilizer or soil conditioner. Several researches have already evidenced the great impact of using wood vinegar for elevating the nutrient level of soil. According to Payamara, J. (2011), the major component of wood vinegar products are acetic acid, methanol, propanoic acid, phenolic and carbonyl compounds. The wood vinegar improves soil quantity eliminates pests, accelerating plant growth, plant growth regulator or growth inhabiting. The bio–test of wood vinegar inhibits the growth of Xanthomonas comprestris pv. The wood vinegar was applied on maize with spraying on leaf compare with spraying on soils every 6 days after planting. The acidity range 1.95 to 2.14 the major component in wood vinegar was observed to be acetic acid. According to Thailand’s Department of Agriculture (2010), wood vinegar can improvement of soil quality, eliminates of plant and soil pests, controls plant growth, is able to accelerate the development of roots, stems, tubers, leaves, flowers, and fruits, and, increases amounts of fruit produced in orchards. According to Brunette, R. (2010), wood vinegar is produced when smoke from charcoal production is cooled by outside air while passing through a chimney or flue pipe. The cooling effect causes condensation of pyroligneous liquor, particularly when the temperature of smoke produced by carbonization ranges between 80 and 180ºC/176 and 356ºF (Nikhom, 2010). This temperature is reached at the carbonization stage of exothermic decomposition (see previous article about charcoal production) and is indicated by the production of yellowish, acrid smoke. Moreover, Tancho, A. reported that wood vinegar can be applied to the soil surface to help increase the population of beneficial microbes and to promote plant root growth. Additionally, the product can help boost crop defenses against disease. A strong solution of wood vinegar with a 1:30 ratio application to the garden soil surface at a rate of 6 liters of solution per 1m² will enrich the soil prior to planting crops. Also, it can be used to control soil-based plant pathogens with an even stronger rate of 1:5 to 1:10 ratio. This prompted the researchers to further add literature and studies to the growing interest of the scientific community in utilizing the many uses of wood vinegar in the agricultural sector, to further prove the best exploit of wood vinegar in backyard soil to further determine if the application of wood vinegar for agriculture is reasonable. This study
anchors on determining the effects of different ratio proportion of wood vinegar sourced out from coconut shell on the physical aspects of Brassica juncea (Mustard plant). More specifically, this study aims to determine the growth effect of the different coconut shell ratio on the growth of Mustard plant in terms of (1) number of leaves, (2) plant height, (3) plant leaf width. Further to determine which ratio of wood vinegar (Wood Vinegar to Water) is more suitable for growing mustard plants in the following ratio levels; 1:5, 1:10, 1:20, and 1:30. Lastly, to determine if there is a significant difference on the growth effect of the different wood vinegar ratio on mustard plant.

METHODOLOGY

Research Design
This study will employ the Experimental Research Design in which Randomized Complete Block Design (RCBD) will be used for determining the growth effect of the different ratios of wood vinegar extracted from coconut shell.

Instrumentation and Data Gathering procedure
Dry distillation of coconut shell will be done using procedures from Phywe (2017). The dry distillation (as seen on Figure 1) was assembled by the researchers for a faster rate of extracting wood vinegar. Experimental procedures were done under laboratory conditions, all in triplication to minimize errors. Extra care was also utilized in this experiment for explosive and toxic fumes are emitted during distillation.

Instruments of the Study
In the following figure (Figure 2 and 3) the instruments and reagents that were used in the study are specified:

Figure 1. Kiln for Extracting Wood Vinegar

Figure 2. Equipment used in Dry distillation
Wood Vinegar Ratio

The wood vinegar produced from the dry distillation of coconut shell will be diluted in the manner of ratio (Table 1):

| Ratio | Amount of WV | Amount of H₂O | Total volume |
|-------|--------------|---------------|-------------|
| 1:5   | 10 mL        | 50 mL         | 60 mL       |
| 1:10  | 10 mL        | 100 mL        | 110 mL      |
| 1:20  | 10 mL        | 200 mL        | 210 mL      |
| 1:30  | 10 mL        | 300 mL        | 310 mL      |

Table 1. Wood Vinegar to Water Ratio

The following ratio are adopted following the suggestions made by Tancho, A. (n.d.) wherein a strong solution of wood vinegar with a 1:30 ratio application to the garden soil surface at a rate of 6 liters of solution per 1m² will enrich the soil prior to planting crops. Also, it can be used to control soil-based plant pathogens with an even stronger rate of 1:5 to 1:10 ratio.

Growth Effect of Wood Vinegar to *Brassica juncea*

Planting and Propagating Mustard Samples

Ten (10) days old mustard plants will be utilized in this study. The mustard plants will be potted and divided into 5 groups. The ratio groups consisted of 1:5, 1:10, 1:20 and 1:30 ratios and the control group which is the negative control (no wood vinegar added).

The division of groups will follow the randomized complete block design (RCBD) which is as follows which will have three trials and three replications (Table 2):

| 1:5 ratio | 1:10 ratio | 1:20 ratio | 1:30 ratio | N. control |
|-----------|------------|------------|------------|------------|
| T₁        | T₂         | T₃         | T₁         | T₂         | T₃         | T₁         | T₂         | T₃         | T₁         |
| T₂        | T₃         | T₁         | T₂         | T₃         | T₁         | T₂         | T₃         | T₁         | T₂         |
| T₃        | T₁         | T₂         | T₃         | T₁         | T₂         | T₃         | T₁         | T₂         | T₃         |

Table 2. Randomized Complete Block Design

The potted plant samples will be put in open area and will be watered everyday twice daily using tap water. The plant samples will be allowed to flourish to its maturity for 30 to 35 days while continuous adding of 0.5 mL wood vinegar ratio is done once daily. After the maturity date, the plants will be harvested in the morning and will be subjected to the following parameters; a) Number of leaves, b) plant height, and c) Plant leaf width.

Number of Leaves

The number of leaves of the samples will be counted manually and will be recorded. Average number per trial will be computed based.

Plant Height

Plant height will be determined manually using a tape measure and then recorded. Average height per trial will also be computed. The computation will be from the base at which the plant and the soil is touching and up to the topmost part of the plant.
Plant Leaf Width

Plant leaf width will be determined manually using a tape measure and then recorded. The widest plant leaf in the sample will be used as representative of the plant for this kind of test. Average width per trial will also be computed.

Statistical Analysis of Data

One-way Analysis of Variance (ANOVA) was used in this study to determine if there is a significant difference on the growth effect of the different wood vinegar ratio on mustard plants using IBM SPSS version 28.

RESULTS AND DISCUSSION

The following data were gathered after thorough experimentation and analysis:

Growth Effects

A number of plant parameters were measured to determine the growth effect of varying wood vinegar ratios on *Brassica juncea*. The following plant factors were taken into consideration:

Number of leaves

Leaf number was counted before application and 30 days after the propagation of the plant to determine if the application of wood vinegar would increase or decrease the total number of leaves that can be propagated by the plant species. The following results were obtained (Table 3):

Table 3. Results on leaf number before and after administering different wood vinegar ratios

| WV Ratio | Replicates | Day 1 | | Day 30 | | |
| --- | --- | --- | --- | --- | --- | --- |
| | | T1 | T2 | T3 | T1 | T2 | T3 |
| 1:5 | 1 | 5 | 5 | 7 | 9 | 5 | 6 |
| | 2 | 6 | 6 | 5 | 7 | 8 | 7 |
| | 3 | 5 | 5 | 6 | 7 | 8 | 6 |
| Average | 5.33 | 5.33 | 6 | 7.67 | 7 | 6.33 |
| 1:10 | 1 | 5 | 6 | 6 | 6 | 7 | 6 |
| | 2 | 6 | 7 | 6 | 5 | 9 | 7 |
| | 3 | 7 | 6 | 7 | 8 | 8 | 7 |
| Average | 6 | 6.33 | 6.33 | 6.33 | 8 | 6.67 |
| 1:20 | 1 | 5 | 5 | 6 | 5 | 6 | 6 |
| | 2 | 5 | 5 | 6 | 5 | 7 | 6 |
| | 3 | 6 | 7 | 6 | 7 | 7 | 5 |
| Average | 5.33 | 5.67 | 6 | 5.67 | 6.67 | 5.67 |
| 1:30 | 1 | 7 | 6 | 6 | 8 | 8 | 5 |
| | 2 | 6 | 6 | 7 | 6 | 6 | 6 |
| | 3 | 5 | 6 | 7 | 6 | 6 | 4 |
| Average | 6 | 6 | 6.67 | 6.67 | 6.67 | 5 |
| Untreated | 1 | 8 | 7 | 5 | 6 | 6 | 6 |
The results above were gathered during day 0 and day 30 of the entire study after administering 0.5 mL of different ratios of wood vinegar and water together with the negative control. It can be observed that a slight change in the number of leaves was observed on all ratios while almost no change was observed on the untreated group.

**Plant Height**

Leaf height was measured to determine if plants samples administered to different levels of wood vinegar would grow taller or not. These were the results obtained at the millimeter (mm) unit (Table 4):

| WV Ratio | Replicates | Day 1 (mm) | Day 30 (mm) |
|-----------|------------|------------|-------------|
|           |            | T₁         | T₂         | T₃         |
|           |            | T₁         | T₂         | T₃         |
| 1:5       | 1          | 70         | 42         | 44         | 225        | 163        | 113         |
|           | 2          | 50         | 61         | 49         | 201        | 215        | 208         |
|           | 3          | 61         | 46         | 55         | 171        | 210        | 132         |
|           | **Average**| **60.33**  | **49.67**  | **49.33**  | **199.0**  | **196.0**  | **151.0**   |
| 1:10      | 1          | 67         | 70         | 70         | 135        | 144        | 134         |
|           | 2          | 65         | 60         | 75         | 150        | 223        | 141         |
|           | 3          | 49         | 74         | 68         | 173        | 211        | 213         |
|           | **Average**| **60.33**  | **68.0**   | **71.0**   | **152.67** | **192.67** | **162.67**  |
| 1:20      | 1          | 72         | 49         | 51         | 162        | 138        | 139         |
|           | 2          | 52         | 64         | 74         | 131        | 162        | 181         |
|           | 3          | 102        | 100        | 81         | 216        | 232        | 140         |
|           | **Average**| **75.33**  | **71.0**   | **68.67**  | **169.67** | **177.33** | **153.33**  |
| 1:30      | 1          | 76         | 59         | 68         | 222        | 171        | 159         |
|           | 2          | 55         | 41         | 74         | 128        | 133        | 151         |
|           | 3          | 78         | 54         | 62         | 164        | 190        | 121         |
|           | **Average**| **69.67**  | **51.33**  | **68.0**   | **171.33** | **164.67** | **143.67**  |
| Untreated (Negative Control) | 1 | 64         | 50         | 68         | 147        | 156        | 162         |
|           | 2          | 74         | 52         | 89         | 160        | 155        | 162         |
|           | 3          | 39         | 78         | 76         | 168        | 161        | 181         |
|           | **Average**| **59.0**   | **60.0**   | **77.67**  | **158.33** | **157.33** | **168.33**  |

The results above were gathered during day 0 and day 30 of the entire study after administering 0.5 mL of different ratios of wood vinegar and water together with the negative control. It can be observed that a great change in plant height was observed on all ratios as well as on the untreated group.

**Plant Leaf Width**

Leaf width was measured to determine if plants samples administered to different levels of wood vinegar will have green broader leaves which indicates healthy and well-rounded
growth of the plant samples. These were the results obtained at the millimeter (mm) unit (Table 5):

**Table 5. Results on leaf width before and after administering different wood vinegar ratios**

| WV Ratio | Replicates | Day 1 (mm)       | Day 30 (mm)     |
|----------|------------|------------------|-----------------|
|          |            | T₁ | T₂ | T₃ | T₁ | T₂ | T₃ |
| 1:5      | 1          | 32 | 18 | 31 | 96 | 67 | 48 |
|          | 2          | 26 | 36 | 27 | 71 | 82 | 75 |
|          | 3          | 27 | 22 | 26 | 69 | 75 | 54 |
|          | Average    | 28.33 | 25.33 | 28.0 | 78.67 | 74.67 | 59.0 |
| 1:10     | 1          | 42 | 34 | 38 | 51 | 55 | 56 |
|          | 2          | 34 | 27 | 29 | 46 | 92 | 55 |
|          | 3          | 26 | 35 | 31 | 57 | 56 | 80 |
|          | Average    | 34.0 | 32.0 | 32.67 | 51.33 | 67.67 | 63.67 |
| 1:20     | 1          | 30 | 41 | 30 | 59 | 65 | 54 |
|          | 2          | 22 | 34 | 32 | 57 | 61 | 57 |
|          | 3          | 38 | 33 | 34 | 79 | 68 | 54 |
|          | Average    | 30.0 | 30.0 | 32.0 | 65.0 | 64.67 | 55.0 |
| 1:30     | 1          | 31 | 22 | 32 | 71 | 80 | 55 |
|          | 2          | 32 | 18 | 38 | 50 | 55 | 66 |
|          | 3          | 33 | 25 | 34 | 55 | 70 | 30 |
|          | Average    | 32.0 | 21.67 | 34.67 | 58.67 | 68.33 | 50.33 |
| Untreated (Negative Control) | 1 | 28 | 33 | 25 | 66 | 55 | 49 |
|          | 2          | 31 | 21 | 48 | 74 | 55 | 56 |
|          | 3          | 24 | 36 | 34 | 60 | 65 | 67 |
|          | Average    | 27.67 | 30.0 | 35.67 | 66.67 | 58.33 | 57.33 |

From day 0 to day 30, the results gathered during the entire study after administering 0.5 mL of different ratios of wood vinegar and water together with the negative control showed a change in the plant leaf width which was observed on all ratios as well as on the untreated group.

**Statistical Analysis**

The ANOVA table 6 was generated using IBM SPSS version 28 (free trial) indicating that there are no significant differences between the wood vinegar ratios with that of the negative control (factor control). This indicates result eliminates the bias on the start of the conduct of research (Aerd Statistics, 2018; EZ SPSS Tutorials, 2021). Also, the table above showed no significant difference between individual wood vinegar ratios and the untreated group or control group since F computed values are all below the T-computed values indicated by the table above.

**Table 6. ANOVA Table for Pre-treatment (Leaf Number)**

|         | Sum of Squares | df | Mean Square | F    | Sig. |
|---------|----------------|----|-------------|------|------|
| 1:5 ratio (Leaf) Between Groups | .075 | 1 | .075 | .333 | .667 |
However, after 30 days of application of the different wood vinegar ratios together with the negative control showed minimal difference indicated by the table 7 below:

**Table 7. Warnings on ANOVA Post-treatment (Leaf Number)**

| Ratio          | Between Groups | Within Groups | Total   |
|----------------|----------------|---------------|---------|
| 1:5 ratio      | .018           | .054          | .073    |
| 1:10 ratio     | .018           | .054          | .073    |
| 1:20 ratio     | .000           | .224          | .224    |
| 1:30 ratio     | .075           | .224          | .299    |

| Ratio          | Between Groups | Within Groups | Total   |
|----------------|----------------|---------------|---------|
| 1:5 ratio      | .333           | .667          | .667    |
| 1:10 ratio     | .000           | .000          | .000    |
| 1:20 ratio     | .000           | .000          | .000    |
| 1:30 ratio     | .333           | .667          | .667    |

Now since the data has fewer groups, the researchers run MVA or Missing Value Analysis to determine where the data sets are missing, the results are shown in the table 8 below:

**Table 8. Univariate Statistics (Leaf Number)**

| Day          | N  | Mean    | Std. Deviation | Missing | No. of Extremes* |
|--------------|----|---------|----------------|---------|------------------|
| day1.1.5     | 3  | 5.5533  | .38682         | 11.78.6 | 0 0              |
| day1.1.10    | 3  | 6.2200  | .19053         | 11.78.6 | 0 0              |
| day1.1.20    | 3  | 5.6667  | .3501          | 11.78.6 | 0 0              |
| day1.1.30    | 3  | 6.2233  | .38682         | 11.78.6 | 0 0              |
| day1.NC      | 3  | 6.2233  | .38682         | 11.78.6 | 0 0              |

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

As seen from the table above, since the number of extremes in both high and low is zero (0) this indicates that in all the ratios together with the negative control indicate no difference between them since univariate statistics show 78.6% missing values and an almost similar standard deviation between samples. It means that all individual samples from different groups have almost the same leaf number count or result thus there is no variability in that leaf number parameter. This result indicates that there are no significant differences between individual ratios versus the negative control and that, after 30 days of administering wood
vinaigres, in terms of leaf number, the wood vinegar ratios and the untreated groups have similar result (Aerd Statistics, 2018; EZ SPSS Tutorials, 2021).

This result varies with the result conducted by Zhu et al. (2021) wherein they stated that different treatments of wood vinegar tended to increase the total leaf number and green leaf number of their samples which are rapeseed in the pod stage. However, their result also suggested that the combination of wood vinegar and melatonin most effectively increased the total leaf number. It was found out based on ANOVA that the difference was insignificant in all treatments over the control plots.

**Table 9. ANOVA Pre-treatment (Plant Height)**

| Ratio   | Sum of Squares | df   | Mean Square | F    | Sig. |
|---------|----------------|------|-------------|------|------|
| 1:5     | Between Groups | 78.250 | 2 | 39.125 | .   | .   |
|         | Within Groups  | .000  | 0 | .     | .   | .   |
|         | Total          | 78.250 | 2 |       |     |     |
| 1:10    | Between Groups | 60.559 | 2 | 30.280 | .   | .   |
|         | Within Groups  | .000  | 0 | .     | .   | .   |
|         | Total          | 60.559 | 2 |       |     |     |
| 1:20    | Between Groups | 22.844 | 2 | 11.422 | .   | .   |
|         | Within Groups  | .000  | 0 | .     | .   | .   |
|         | Total          | 22.844 | 2 |       |     |     |
| 1:30    | Between Groups | 205.678 | 2 | 102.839 | .   | .   |
|         | Within Groups  | .000  | 0 | .     | .   | .   |
|         | Total          | 205.678 | 2 |       |     |     |

The ANOVA table 9 above was generated using IBM SPSS version 28 (free trial) indicating that there are sum of squares within groups between the wood vinegar ratios with that of the negative control (factor control). This indicates result eliminates the bias on the start of the conduct of research. Also, the table above showed no difference between individual wood vinegar ratios and the untreated group or control group since F computed and T-computed values are not available due to 0 WSS (within sum f squares). This result also indicates that the data is a good model since value of zero in the sum of squares means the model used in the research is a perfect fit (Aerd Statistics, 2018; EZ SPSS Tutorials, 2021).

ANOVA test in the post-treatment (Table 10) also revealed no significant difference between individual ratios and the negative control. As postulated above, the F and T values are not computed due to 0 results in the sum of squares. It was found out based on ANOVA above that the difference was insignificant in all treatments over the control plots.
Table 10. ANOVA Post-treatment (Plant Height)

| Ratio (Plant Height) Day | Sum of Squares | df | Mean Square | F  | Sig. |
|--------------------------|----------------|----|-------------|----|------|
| 1:5                      | 1446.000       | 2  | 723.000     |    | .    |
| Between Groups           | .000           | 0  | .           |    | .    |
| Total                    | 1446.000       | 2  |             |    |      |
| 1:10                     | 866.667        | 2  | 433.333     |    | .    |
| Between Groups           | .000           | 0  | .           |    | .    |
| Total                    | 866.667        | 2  |             |    |      |
| 1:20                     | 300.557        | 2  | 150.279     |    | .    |
| Between Groups           | .000           | 0  | .           |    | .    |
| Total                    | 300.557        | 2  |             |    |      |
| 1:30                     | 416.810        | 2  | 208.405     |    | .    |
| Between Groups           | .000           | 0  | .           |    | .    |
| Total                    | 416.810        | 2  |             |    |      |

Univariate statistics (Table 11) of the plant height result also revealed a 0 number on the low and high number of extremes which indicates that all individual samples from different groups have almost the same means or average, in terms of plant height or result thus there is no variability in that plant height parameter (Aerd Statistics, 2018; EZ SPSS Tutorials, 2021).

Table 11. Univariate Statistics

| Day     | N    | Mean | Std. Deviation | Missing | No. of Extremes | Count | Percent | Low | High |
|---------|------|------|----------------|---------|-----------------|-------|---------|-----|------|
| day1.1.5 | 3    | 5.553 | .38682         |         |                 | 11    | 78.6   | 0   | 0    |
| day1.1.10 | 3    | 6.2200 | .19053        |         |                 | 11    | 78.6   | 0   | 0    |
| day1.1.20 | 3    | 5.6667 | .33501        |         |                 | 11    | 78.6   | 0   | 0    |
| day1.1.30 | 3    | 6.2233 | .38682        |         |                 | 11    | 78.6   | 0   | 0    |
| day1.NC | 3    |       |                |         |                 | 11    | 78.6   |     |      |

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

This result is in contrast to the result conducted by Xin et al. (2017) wherein they stated that the wood vinegar alone addition significantly increased the plant height, root length, root volume and root tips of cucumber by 20.2%, 45.2%, 7.8% and 30.9%, respectively, compared to that of the CK treatment. However, based on the analysis of variance conducted by Travero & Mihara (2016) on their soybean research, it was found that the difference was insignificant in all treatments over the control plots in terms of their samples plant height which is in support to this study. The ANOVA table 12 was generated using IBM SPSS version 28 indicating that there are sum of squares within groups between the wood vinegar ratios with that of the negative control (factor control) in terms of plant leaf width also generated the same result as with the leaf height eliminating the bias on the start of the conduct of research. Also, the table above showed no difference between individual wood vinegar ratios and the untreated group or control group since F computed and T-computed values are not available due to 0 WSS (within sum of squares). This result also indicates that
the data is a good model since value of zero in the sum of squares means the model used in the research is a perfect fit (Aerđ Statistics, 2018; EZ SPSS Tutorials, 2021).

**Table 12. ANOVA Pre-treatment (Leaf Width)**

| Ratio         | Sum of Squares | df | Mean Square | F     | Sig. |
|---------------|----------------|----|-------------|-------|------|
| 1:5 ratio (Leaf Width) Day 1 | Between Groups | 5.413 | 2 | 2.706 | . | . |
|               | Within Groups  |   | 0 | . | . | . |
|               | Total          | 5.413 | 2 | . | . | . |
| 1:10 ratio (Leaf Width) Day 1 | Between Groups | 2.073 | 2 | 1.036 | . | . |
|               | Within Groups  |   | 0 | . | . | . |
|               | Total          | 2.073 | 2 | . | . | . |
| 1:20 ratio (Leaf Width) Day 1 | Between Groups | 18.667 | 2 | 9.333 | . | . |
|               | Within Groups  |   | 0 | . | . | . |
|               | Total          | 18.667 | 2 | . | . | . |
| 1:30 ratio (Leaf Width) Day 1 | Between Groups | 94.279 | 2 | 47.140 | . | . |
|               | Within Groups  |   | 0 | . | . | . |
|               | Total          | 94.279 | 2 | . | . | . |

Similar results were also obtained during ANOVA test run in the post-treatment also revealed no significant difference between individual ratios and the negative control in terms of the plant height of the samples. As postulated above, the F and T values are not computed due to 0 results in the sum of squares (Aerđ Statistics, 2018; EZ SPSS Tutorials, 2021).

All data sets and results here were computed using IBM SPSS version 28 with emphasis on On-way Analysis of Variance (ANOVA), Missing Value Analysis (MVA), Post-hoc’s were done using Tukey’s and descriptive analysis in relation to mean plots (Aerđ Statistics, 2018; EZ SPSS Tutorials, 2021). It was also found out based on ANOVA that the difference was insignificant in all treatments over the control plots. And that, this data is supported by the study of Travero & Mihara (2016), that application of wood vinegar has no influence on the growth of plants based on weekly recorded height of plants. Moreover, plants treated with 10% and 20% wood vinegar showed no significant difference as to its effect on yield.

**CONCLUSIONS**

The wood vinegar extracted from coconut shell at 1:5, 1:10, 1:20 and 1:30 are not suitable ratios for plant growth use. The wood vinegar extracted from coconut shell at 1:5, 1:10, 1:20 and 1:30 does not affect the growth of *Brassica juncea* in terms of the plant samples leaf number, plant height and leaf width. There are no significant differences between the leaf number, plant height and width of leaves based on the results on the statistical data analysis using 1-way Analysis of Variance (ANOVA). This study provides several recommendations such as; use an increased concentration of wood vinegar on the application to further
determine its effect, utilize other types of plant samples in determining efficacy of using wood vinegar in plant growth and as fertilizer, conduct a similar research to further oppose or affirm the results of this study, and conduct wood vinegar extraction on other wood materials.

REFERENCES

Aerd Statistics, 2018. One-way ANOVA in SPSS Statistics. Retrieved at: https://statistics.laerd.com/spss-tutorials/one-way-anova-using-spss-statistics-2.php

Bess R, 2016. How to Test the Specific Gravity of Liquids. Retrieved at: https://www.wikihow.com/Test-the-Specific-Gravity-of-Liquids

ECHO, 2012. An Introduction to Wood Vinegar. Technical Note 77.

EZ SPSS Tutorials, 2021. One Way ANOVA in SPSS Including Interpretation. Retrieved at: https://ezspss.com/one-way-anova-in-spss-including-interpretation/

Food and Fertilizer Technology Center 2010. Wood Vinegar. Retrieved at: http://www.fftc.agnet.org/library.php?func=view&id=20110720153306

Modified from S.J. Thien. 1979. A flow diagram for teaching texture by feel analysis. Journal of Agronomic Education. 8:54-55.

Office of Her Royal Highness,, n.d. Benefits of Wood Vinegar. Princess Maha Chakri, Sirindhorn’s Projects, Thailand

Payamara, J. Usage of Wood Vinegar as New Organic Substance. International Journal of ChemTech Research. Vol. 3 (3), pp1658-1662, 2011.

Phywe 2017. The Characterization of Acetic acid “Wood Vinegar”. Teacher’s/ Lecturer’s Sheet. Tess Advanced.

Tancho, A. n.d. An Introduction to Wood Vinegar. Retrieved from: https://c.ymcdn.com/sites/echocommunity.sitemym.com/resource/collection/F6FFA3BF-02EF-4FE3-B180-F391C063E31A/Wood_Vinegar.pdf

Theapparat, et al. 2014. Physicochemical Characteristics of Wood Vinegars from Carbonization of Leucaena leucocephala, Azadirachta indica, Eucalyptus camaldulensis, Hevea brasiliensis and Dendrocalamus asper. Kasetsart Journal - Natural Science. 48. 916-928.

Traverio, J.T. & Miha, M. 2016. Effects of Pyroligneous Acid to Growth and Yield of Soybeans (Glycine max). International Journal of Environmental and Rural Development (2016) 7-1.

US Department of Agriculture. n.d. Chapter 6: Methods of Soil Characterization. Agriculture Handbook. 83 – 126.

Wada, T. 1997. Charcoal Handbook. Forest management section, agriculture, forestry and fisheries division, Bureau of labour and economic affairs, Tokyo Metropolitan Government. Tokyo, Japan: 92 pp.

Xin et al. 2017. Effect of adding biochar with wood vinegar on the growth of Cucumber. IOP Conf. Series: Earth and Environmental Science 1234567890 61 012149.

Yokomori, M., 2011. Farmers in Benguet Practice Savers Technology. Safe Vegetable Promotion Project in Benguet

Zhu et al. 2021. Wood Vinegar as a Complex Growth Regulator Promotes the Growth, Yield, and Quality of Rapeseed. Agronomy 2021, 11, 510. https://doi.org/10.3390/agronomy11030510.