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Research Article

Utilization of Wood Vinegar as Nutrient Availability Enhancer in Eggplant (*Solanum melongena* L.)

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ABSTRACT

The study aims to evaluate the effect of different levels of wood vinegar as a nutrient availability enhancer in eggplant. The treatments used in the study were Treatment 1 (No application of wood vinegar), Treatment 2 (0.5% of wood vinegar), Treatment 3 (0.67% of wood vinegar), and Treatment 4 (1% of wood vinegar).

Based on the study results, the average height of plants showed a significant difference among the treatments. The other parameters, average growth increment, average stem diameter, average number of days to flower initiation, the average length of fruits, and an average weight of fruits, showed high significance among treatments. The result was supported by LSD that showed significant differences in control and among the treatments. Therefore, the application of Treatment 4 is the recommended ratio in eggplant production.

Hence, researchable areas need to be addressed, such as evaluating the continuous use of wood vinegar in eggplant production, and challenge literature stating that wood vinegar should be stopped one week before harvesting. Additional research on time and level of wood vinegar for insect control is recommended.

Keywords: Eggplant, nutrient availability enhancer, wood vinegar

Introduction

Rationale

Eggplant (*Solanum melongena* L.) is widely grown in the Philippines and is one of the most important vegetables. Young fruits can be roasted, stuffed, curried, pickled, or combined with other vegetables in Ilocano dishes such as pinakbet and dinengdeng. This vegetable is high in potassium, iron, protein, and vitamins A and B. It is fat-free and has a naturally low-calorie count. The eggplant's skin is referred to as "nasunin." Nasunin is a potent antioxidant and scavenger of free radicals that have been shown to protect all membranes (Business Diary PH, 2020).

According to (Philippine Statistics Authority, 2021), in the fourth quarter of 2020, eggplant production was 23.13 thousand metric tons, down -5.9% from the 24.57 thousand metric tons produced in the same quarter of

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2019. With 3.42 thousand metric tons, Central Luzon was the top producer, accounting for 14.8 percent of the country's total output this quarter. With 12.9 percent, Calabarzon came in second, followed by Central Visayas with 10.0 percent.

Organic agriculture is increasingly popular in the modern era. Organic agriculture significantly reduces external inputs by avoiding synthetic fertilizers, pesticides, and pharmaceuticals. The Philippine Organic Agriculture Act (RA 10068) encompasses all agricultural systems that promote environmental sustainability.

According to (Apai & Thongdeethae, 2001), raw wood vinegar contains over 200 chemicals, including acetic acid, formaldehyde, ethyl-valerate, methanol, and tar. Wood vinegar has been used in various processes and products, including industrial, livestock, household and farming. Wood vinegar, according to reports, improves soil quality, eliminates pests, accelerates plant growth, and acts as a growth regulator or inhibitor of plants.

Wood vinegar is an acidic aqueous by-product obtained from the distillation of smoke. It comprises water and a mixture of complex organic compounds. Wood vinegar is known for its use in odor removal, smoke flavoring, promoting plant growth (Nakai et al., 2007; Ho et al., 2013).

Guzman (2009) stated that several agricultural applications are also mentioned in which wood vinegar is combined with water in ratios ranging from 1:50 (1 liter wood vinegar to 50 liters water) to 1:800. The solution can be sprayed over plant shoots to increase plant production. As with hormones, wood vinegar is absorbed into twigs, trunks, and leaves, resulting in more vigorous plants and greener, more resistant to pests and diseases leaves.

Additionally, wood vinegar application has a significant effect on plant growth and seed germination. It enables rapid root and leaf development in a short period of time (Garcia-Perez et al., 2007; Guzman and Adalla, 2021; Guzman and Dadural, 2021).

Thus the study was conducted to evaluate the effect of different levels of wood vinegar utilization in eggplant as nutrient availability enhancer.

Materials and Methods

Research Materials and Equipment

The materials used in the study are the following: Fortuner F1 (East-West seed), wood vinegar, seedling tray, caliper, measuring tape, weighing scale, record notebook, sprayer.

Research Design

One hundred twenty (120) eggplant seedlings are used in the study. The study was laid out in Randomized Complete Block Design (RCBD) with four (4) treatments, three (3) replications and ten (10) samples per replication. The treatments were follows:

Treatment 1 = Control (No application of wood vinegar)
Treatment 2 = 1 L wood vinegar:200 L water (0.5%)
Treatment 3 = 1 L wood vinegar:150 L water (0.67%)
Treatment 4 = 1 L wood vinegar:100 L water (1%)

Research Procedure

Selection and Gathering of Planting Source

The seed used in the study was Fortuner F1 (East-West seed) and the wood vinegar was obtained in Zambali Beach Farm, Botolan, Zambales. The farm usually uses rice hull in making wood vinegar.

Seed Sowing and Land Preparation

The seeds were sowed in a seedling tray. Each hole of the seedling tray was sowed with one (1) seed. A tractor was used to plow the area twice. The grasses were removed, and the ground was then leveled with a carabao and a comb. Following the cleaning of the area, plots were created, with 812.8 grams of chicken manure incorporated into each plot, according to (Ruelos, 2016) recommendation.

Transplanting

Seedlings were hardened for thirty (30) days after emergence (DAE) before being transplanted by gradually reducing the amount of water and exposing them to direct sunlight. On the day of transplanting, the seedlings were watered. The seedlings were carefully removed from the trays to ensure that the roots

remained intact, reducing transplant stress and allowing for a faster recovery.

Water and Fertilizer Management

Eggplants were watered every afternoon with six liters of water. According to the treatments, eggplants were sprayed with wood vinegar once a week as a nutrient enhancer, and the application was stopped a week before harvesting.

Harvesting

Harvesting was done late in the afternoon with 3 days interval.

Data gathered

The data were observed and recorded every week. Photographs were also taken in every activity.

The data gathered were as follows:

1. Average height of plant

   One week after transplanting, the height of the plants was measured by placing a marked stick on each plant. The weekly growth was determined by measuring it on a weekly basis.
2. Average growth increment

   The weekly height of plants was computed by subtracting the first data on height from the second and second data to the third and so on.
3. Average Stem Diameter

   Stem diameter was measured weekly using caliper.
4. Average number of days to flower initiation

   Average number of days to flower initiation was counted starting the day after transplanting to the day the flower was first observed.
5. Average weight of fruit

   The average weight of fruit was measured using weighing scale.
6. Average length of fruit

   The average length of fruit was measured using tape measure.

Statistical Analysis of Data

Significant differences were evaluated using Analysis of Variance (ANOVA) using Randomized Completed Blocked Design (RCBD). The differences among treatment means were determined using Least Significant Differences (LSD) at 5% (F_t=5%) or 1% (F_t=1%) level of significance.

Results and Discussion

In this study, the effects of different levels of wood vinegar as a nutrient availability enhancer in eggplant was evaluated.

Table 1 presents the average plant height (cm).

Table 1. Average Plant Height (cm)

Treatment	R1	R2	R3	Total	Mean
Treatment 1(control)	16.48	18.3	21.51	56.29	18.76
Treatment 2 (0.5%)	19.08	25.32	22.81	67.21	22.40
Treatment 3(0.67%)	22.08	22.86	24.17	69.11	23.04
Treatment 4(1%)	24.54	25.47	24.39	74.4	24.80
Grand Total				267.01	
Grand Mean					22.25

As shown in Table 1, the plants applied with Treatment 4 produced the tallest plant among all treatments with an average of 24.8 cm, followed by Treatment 3, Treatment 2, and Treatment 1 with averages of 23.04 cm, 22.4 cm, and 18.76 cm, respectively.

Table 2 presents the analysis of variance of the average plant height (cm).

Table 2. ANOVA of the Average Plant Height (cm)

Source of Variation	DF	SS	MS	Computed F	Tabular F	
					5%	1%
Replication	2	17.57	8.79	2.92	4.76	9.70
Treatment	3	57.91	19.30	9.63*	4.76	9.70
Error	6	18.04	2.00			
Total	11	93.51				

*Significant
CV=6.39%

Table 2 revealed the significant difference in levels of wood vinegar because the computed F value was higher than 5% and 1% level of significance.

The result confirms the study of (Siriwardena et al., 2020), wherein he stated that the application of 1% wood vinegar for eggplant has significantly increased plant height. (Wang et al., 2014) added that wood vinegar has physiological and biochemical responses that reflect the quality growth of plants. The soluble proteins as part of enzymes were contributed to the physiological and biochemical metabolism regulation of fruits and vegetables.

Table 3 presents the average plant increment (cm).

Table 3. Average Plant Increment (cm)

Treatment	R1	R2	R3	Total	Mean
Treatment 1 (control)	5.72	6.72	7.9	20.34	6.78^{a}
Treatment 2 (0.5%)	7.36	9.77	8.9	26.03	8.68^{b}
Treatment 3 (0.67%)	9.81	9.68	9.51	29	9.67^{bc}
Treatment 4 (1%)	10.53	10.42	10.35	31.3	10.43^{bcd}
Grand Total				106.67	
Grand Mean					8.89

Table 3 shows that plants applied with Treatment 4 has the fastest growth with an average 10.43 cm, followed by Treatment 3, Treatment 2 and Treatment 1 with averages of 9.67 cm, 8.68 cm and 6.68 cm respectively.

Table 4 presents the analysis of variance of the average plant height (cm).

Table 4. ANOVA of the Average Plant Increment (cm)

Source of Variation	DF	SS	MS	Computed F	Tabular F	
					5%	1%
Replication	2	1.71	0.86	1.39	4.76	9.70
Treatment	3	22.45	7.48	18.15**	4.76	9.70
Error	6	3.71	0.41			
Total	11	27.87				

**highly significant
CV= 7.22 ; LSD 5%=1.28% ; LSD 1%=1.94%

Table 3 revealed a highly significant difference in wood vinegar levels, as the computed F value was greater than 5% and the 1% level of significance, respectively. There are significant differences between the control group and the other treatments, but none between the other treatments.

This finding was consistent with (Li et al., 2006) observation that the soluble proteins in wood vinegar were closely related to plant growth and development, maturity, and aging.

Table 5 presents the average stem diameter (mm).

Table 5. Average Stem Diameter (mm)

Treatment	R1	R2	R3	Total	Mean
Treatment 1 (control)	5.72	6.2	6.94	18.86	6.29[a]
Treatment 2 (0.5%)	6.7	7.88	7.22	21.8	7.27[b]
Treatment 3 (0.67%)	7.02	7.3	7.6	21.92	7.31[bc]
Treatment 4 (1%)	7.72	7.78	7.58	23.08	7.69[bcd]
Grand Total				85.66	
Grand Mean					7.14

Table 5 shows that Treatment 4 plants have the biggest stem diameter with an average of 7.69 cm, followed by plants applied with Treatment 3, Treatment 2, and Treatment 1 with averages of 7.31 cm, 7.27 cm, and 6.29 cm, respectively.

Table 6 presents the analysis of variance of the average stem diameter (mm).

Table 6. ANOVA of Average Stem Diameter (mm)

Source of Variation	DF	SS	MS	Computed F	Tabular F	
					5%	1%
Replication	2	0.73	0.37	2.41	4.76	9.70
Treatment	3	3.23	1.08	10.64**	4.76	9.70
Error	6	0.91	0.10			
Total	11	4.88				

**highly significant
CV= 4.46 ; LSD 5%=0.64% ; LSD 1%=0.96%

Table 6 revealed that there is a highly significant difference in levels of wood vinegar because the computed F value was higher than 5% and 1% level of significance. There are significant differences between control and other treatments but there is no significant difference among other treatments.

The result corroborated (Siriwardena et al., 2020) study, which found that applying 1% wood vinegar to eggplant significantly increased stem girth. Furthermore, Masaki (2011) asserted that wood vinegar improves the stems of various vegetables. When wood vinegar was used, the stems became stronger and thicker, and he noticed that the stems grew larger and the leaves turned a deep green color.

Table 7 presents the average number of days to flower initiation.

Table 7. Average Number of Days to Flower Initiation

Treatment	R1	R2	R3	Total	Mean
Treatment 1 (control)	26.4	27	27.3	80.7	26.90[a]
Treatment 2 (0.5%)	23.1	22.9	22.9	68.9	22.97[b]
Treatment 3 (0.67%)	23.3	23.2	23.2	69.7	23.23[bc]
Treatment 4 (1%)	22.9	22.9	22.8	68.6	22.87[bcd]
Grand Total				287.9	
Grand Mean					23.99

The evaluation of average number of days to flower initiation showed that Treatment 4 plants were the fastest to flower as shown in Table 5 with an average of 22.87 days, followed by plants applied with Treatment 2, Treatment 3 and Treatment 1 with averages of 22.97 days, 23.23 days and 26.90 days respectively.

Table 8 presents the analysis of variance of the average number of days to flower initiation.

Table 8. ANOVA of Average Number of Days to Flower Initiation

Source of Variation	DF	SS	MS	Computed F	Tabular F	
					5%	1%
Replication	2	0.032	0.01	0.22	4.76	9.70
Treatment	3	34.05	11.35	238.48**	4.76	9.70
Error	6	0.43	0.05			
Total	11	34.51				

** Highly significant
CV= 0.91 ; LSD 5%=0.44% ; LSD 1%=0.66%

Table 8 revealed that there is a highly significant difference in levels of wood vinegar because the computed F value was higher than 5% and 1% level of significance. There are significant differences between control and other treatments, but there is no significant difference among other treatments.

The findings backed up Masaki's (2011) claim that wood vinegar aids in the development of desirable and stronger flowers in plants. He sprayed wood vinegar on the leaves until flower buds appeared.

Table 9 presents the average weight of fruit (g).

Table 9. Average Weight of Fruit (g)

Treatment	R1	R2	R3	Total	Mean
Treatment 1 (control)	118.43	106.33	116.73	341.49	113.83[a]
Treatment 2 (0.5%)	124.1	131.97	128.67	384.74	128.25[b]
Treatment 3 (0.67%)	131.23	134.97	133.63	399.83	133.28[bc]
Treatment 4 (1%)	151.77	168.1	153.93	473.8	157.93[bcd]
Grand Total				1599.86	
Grand Mean					133.32

As shown in Table 9, the plants applied with Treatment 4 plants produced the heaviest fruit with an average of 157.93 grams, followed by plants applied with Treatment 3, Treatment 2, and Treatment 1 with averages of 133.28 grams, 128.25 grams, and 113.83 grams, respectively.

Table 10 presents the analysis of variance of the average weight of fruit (g).

Table 10. ANOVA of Average Weight of Fruit (g)

Source of Variation	DF	SS	MS	Computed F	Tabular F	
					5%	1%
Replication	2	31.40	10.47	0.38	4.76	9.70
Treatment	3	3034.25	1011.42	36.38**	4.76	9.70
Error	6	250.21	27.80			
Total	11	3316.86				

** Highly significant
CV= 3.95 ; LSD 5%=10.53% ; LSD 1%=15.96%

The Analysis of Variance revealed a highly significant difference in levels of wood vinegar because the computed F value was higher than 5% and 1% level of significance. There are significant differences between control and other treatments, but there is no significant difference among other treatments.

Masaki's (2011) claim that he used wood vinegar as a fertilizer and that the potato tubers he grew were of exceptional size is supported by the findings. The weight of the harvest increased as well. Also, according to Zulkarami et al. (2011), wood vinegar increased the weight of rockmelon fruit significantly.

Table 11 presents the average length of fruit (cm).

Table 11. Average Length of Fruit (cm)

Treatment	R1	R2	R3	Total	Mean
Treatment 1 (control)	18.1	15.17	17.17	50.44	16.81[a]
Treatment 2 (0.5%)	20.37	20.72	21.4	62.49	20.83[b]
Treatment 3 (0.67%)	21.82	22.28	22.27	66.37	22.12[bc]
Treatment 4 (1%)	24.07	24.15	24.07	72.29	24.10[cd]
Grand Total				251.59	
Grand Mean					20.97

Table 11 shows that plants applied with Treatment 4 produced the longest fruit with an average of 24.10 cm, followed by plants applied with Treatment 3, Treatment 2, and Treatment 1 with averages of 22.12 cm, 20.83 cm, and 16.81 cm, respectively.

Table 12 presents the analysis of variance of the average length of fruit (cm).

Table 12 ANOVA of Average Length of Fruit (cm)

Source of Variation	DF	SS	MS	Computed F	Tabular F	
					5%	1%
Replication	2	0.93	0.31	0.66	4.76	9.70
Treatment	3	85.21	28.40	60.25**	4.76	9.70
Error	6	4.24	0.47			
Total	11	90.39				

** Highly significant
CV= 3.28 ; LSD 5%=1.37% ; LSD 1%=2.08%

The Analysis of Variance revealed the highly significant difference in levels of wood vinegar because the computed F value was higher than 5% and 1% level of significance. There are significant differences between the control and other treatments. There are also significant differences between Treatment 4 and Treatment 2, but there are no significant differences between Treatment 4 and Treatment 3.

The findings supported Zulkarami et al. (2011)'s claim that wood vinegar significantly increased the size of rockmelon fruit.

Conclusion and Recommendation

This study was an evaluation of wood vinegar utilization as a nutrient availability enhancer in eggplant. With the results, it was concluded that Treatment 4 performed highly significantly with the other treatments. The result of the study in the average height of plants showed a significant difference among treatments. Also, the average height increment, average stem diameter, average number of days to flower initiation, the average weight of fruit, and average length of fruit showed high significance among the treatments.

Therefore, the application of Treatment 4 (1 L wood vinegar:100 L water) is the recommended ratio in eggplant production.

Hence, there are researchable areas to be addressed, such as evaluating the continued utilization of wood vinegar in eggplant production and challenging the literature, saying that the application of wood vinegar should be stopped a week before harvesting. Furthermore, additional research on time to apply and insect control (Fruit and Shoot Borer, 28 Spotted Beetle and Aphids) and chemical residue test is recommended.

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