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Research Article

Effects of Eggshells and Wood Ashes as Organic Fertilizers on the Growth Performance of Scallions (*Allium fistulosum* L.)

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ABSTRACT

Growing scallion plants using organic farming is one of the healthy ways that reduce agrochemicals. One of the interesting problems in organic farming is the right amount of fertilizer that maximizes the growth and yield of plants. This study intended to evaluate the growth of scallions (*Allium fistulosum* L.) using eggshells and wood ashes as organic fertilizer. It aims to assess and determine the optimal fertilizer material combination that is compatible with the growth performance of scallions using eggshells and wood ashes. Four different treatment combinations were considered in this study as follows: T1 (consisting of 100% garden soil), T2 (consisting of 75% garden soil, 25% wood ash), T3 (consisting of 75% garden soil and 25% eggshells) and T4 (consisting of 70% garden soil, 15% wood ash, and 15% eggshells). The height and number of leaves per experimental unit were gathered as the variables of interest. A Complete Randomized Design (CRD) was employed in this study as an experimental design under a one-way ANOVA. The finding of the study shows that T2 (consisting of 75% garden soil and 25% wood ash) has a small effect ($p=0.15$) on the growth performance of scallions concerning the number of leaves. Moreover, the results showed that organic fertilizer T4 significantly ($p<0.01$) affected the plant height of scallions at the last of the month. In particular, scallion plants treated with wood ash mixed with eggshells as fertilizer were higher in terms of plant height. Hence, the study recommends that egg shells and wood ash are suitable fertilizers to enhance the growth performance of scallions.

Keywords: Eggshells, garden soil, organic fertilizer, scallion plants, wood ash

1. INTRODUCTION

The problem of growing scallions is not easy to find a remedy for since this plant is suitable for the neutral to slightly acidic (pH value ranges from 5.5-7.0) form of soil, and perhaps it fails to thrive if the soil is very alkaline (Hung, 2022). Hence, there are new technologies for growing scallions that were developed to produce the desired healthy production (Ma et al., 2021). Organic farming is part of the picture. Organic farming is a kind of biological farming that does not apply synthetic chemical fertilizers (Abelenda et al., 2022). Organic gardening is a healthy way of growing consumable plants or vegetables. Organic gardening is a kind of farming without the use of synthetic fertilizers, herbicides, and pesticides that is considered the fastest growing area of agriculture (Seufert et al., 2017). It's a method

that can sustain in improving the soil and cultivate vegetative plants without the need for chemical products. It is known to many that organic farming is healthier and more nutritious because of the absence of harmful chemicals (Seufert et al., 2017). In that case, by applying organic gardening, vegetable plants can experience a well-balanced and well-nourished ecosystem that enhances them as the nature intended to work. On the face of it, it is considered that a good source of soil nutrients is an organic fertilizer that contains a natural and healthy composition. According to Esmaeilzadeh and Ahangar (2014), and Jen et al. (2023), organic fertilizer has improved the soil's physical, chemical, and biological aspects as well as its nutrients. Moreover, organic fertilizers are environmentally friendly to the soil content and neutralize their acidity, and they also give natural benefits to any kind of plant (Hazra, 2016; Mercl et al., 2020). Likewise, the study of Shaji et al. (2021), stated that organic fertilizer contains naturally available mineral sources that serve a moderate amount of plant essential nutrients that are capable of mitigating plant health problems.

Enriching the soil content with organic supplementary fertilizer and progressing the growth of natural beneficial organisms, gives the plants the instrument they need to access nutrients and the ability to defend themselves from harmful infectious agents and pests (Sharma & Chetani, 2017). Wood ashes and eggshells are some of the sources of organic fertilizer that exist. Wood ash is an excellent source of lime hydrate and potassium for the soil garden (Paulsson et al., 2023). In addition, using wood ashes in the garden provides many of the trace nutrients and elements that a plant needs to prosper (Shawver et al., 2021). Through the years, several studies have discovered that the utilization of wood ashes in farming and forestry serves as an alternative approach for disposal. Because of their good properties (suitable minerals) and their influence on soil content, the usage of wood ash is suited for the fertility administration of acid soils and vegetation soils (Mercl et al., 2020). Moreover, cast-off eggshells are used as a plant organic fertilizer and are impressive lime sources because of their high calcium content that neutralizes the pH level of acidic soil (King'Ori, 2011; Wang et al., 2023). Egg shells are known to be one of the thrown-away food that excessively piles up over the years and is considered to have high potential nutrient content that can be utilized in progressing soil gardens to have cultivable vegetable production (Karne et al., 2023). Hence, with the idea of organic farming, the costs of growing vegetables will be lessened and it also promotes healthy foods.

In the Philippines, there have been many reports that vegetable plants are becoming highly overpriced due to various reasons that include overshooting of gas prices, high demand during peak seasons, drought, floods, pests, and infestation with plague, among others (Ordonez et al., 2018; Ebert, 2020; Montefrio, 2020). One of those vegetables is scallion (*Allium fistulosum*) plants, known as spring onions. This is particularly well-loved in a place like Latin American and Asian cuisine, and these green onions can be found in many recipes from different countries and are commonly used in many Asian dishes as well (Johnston et al., 2020). However, as the prices of scallion plants rise yearly, farmers are now looking at alternative ways to improve the growth performance of scallions as a source of garnish and are a great provider of many essential nutrients to the human body (Newman et al., 2021). Additionally, scallion plants are also known to have an antioxidant that is helpful in health issues (Johnston et al., 2020).

Nowadays, agricultural input prices are increasing, especially synthetic (inorganic) fertilizers depending on their brand and mineral content (Casinillo, 2020; Casinillo & Serino, 2022). In that case, agricultural researchers are finding an alternative way to have a cheaper, more affordable fertilizer through the use of organic fertilizer. Several studies in the literature found the type of organic fertilizer materials that are suitable for progressive plant growth (Mercl et al., 2020; Karne et al., 2023; Wang et al., 2023). This is vital nowadays since year by year, the kinds of vegetable fertilizers are constantly increasing their prices. Additionally, with vegetables also at their highest prices in the market, an alternate solution to save money is to

have organic gardening and use potential excesses within the household. Hence, this study tends to determine if wood ash and eggshells as an organic fertilizer material combination can improve the growth performance of scallions, which also have hit their highest price in the market as of today.

Generally, this study aimed to evaluate the growth of scallion plants with the combination of wood ash and eggshells as organic fertilizer. Specifically, this study aimed to (1) investigate the effect of wood ash and eggshell as an organic fertilizer combination on the growth performance of scallions; and (2) determine the best possible fertilizer material combination compatible with the growth performance of scallions. The purpose of this study is to recommend to the farmers a new fertilizer combination that is effective in progressing the growth of scallions. Moreover, this study may serve as a benchmark for agricultural scientists and may contribute to the body of knowledge in the area of organic farming.

2. MATERIALS AND METHODS

2.1. Research design

This study employed an experimental research design to capture the desired objectives that determine the suitable organic fertilizer that progresses the growth performance of scallion plants. An experimental research design was used to obtain the desired precision which maximizes the specific conclusions that can be obtained concerning the hypothesis.

2.2. Preparation of materials and equipment

One sack (20 kg) of garden soil (loam) was collected in the Palhi Elementary Garden, Palhi, Baybay, City Leyte. The sack of soil was taken from Barangay Pangasugan, Elementary Garden. The wood ash was obtained after lighting up wood furnaces and the eggshells were collected from waste from various kitchens. Finally, the scallion stalks were obtained from the local wet market. Four sets of pots with two pots in each set were prepared. Soil, wood ash, and eggshells were placed inside each pot depending on the material combination. In each set, there were two pots containing its material combination. The soil was used as garden soil. After that, the scallion was planted into their respective pots.

2.3. Experimental set-up

The researcher compared each pot depending on its height and number of leaves every three to four days for thirty days. The researchers analyzed the effectiveness of the combination of wood ash and eggshells and compared it with no fertilizer and wood ash as fertilizer on the growth performance of scallions. The researchers compared four sets of pots and each set of pots had garden soil with different types such as no fertilizer, wood ash as fertilizer, and wood ash and egg shells as combined fertilizer. Table 1 shows the different kinds of treatments with different organic fertilizer material combinations.

Table 1. Different kinds of treatments with different organic fertilizer material combinations

Treatment combinations	Garden Soil	Wood Ash	Eggshell
T1 - Garden soil	100%	0%	0%
T2 - Garden soil + wood ash	75%	25%	0%
T3 - Garden soil + eggshells	75%	0%	25%
T4 - Garden soil + wood ash + eggshells	70%	15%	15%

The first set of pots had treatment (T1) control which purely had 100% soil and 0% wood ash and eggshells. Treatment (T2) had 75% soil and 25% wood ash. Treatment (T3) had 75% soil and 25% eggshells. Lastly, (T4) had 70% soil, 15% wood ash, and 15% eggshells. The pots were placed in a vegetable garden where the environmental factors were being controlled. Since all pots were of the same type and treated equally in the growth maintenance (amount of water and sunlight), hence, there exists no bias in the different growth levels of the scallions. Thus, in each set of pots, it was observed which pots had well-grown scallion(s) relative to time (weekly) after being planted. Due to the limited resources of the researchers, a minimum requirement (two replicates for each treatment) in the experiment design, which is sufficient to compute the parameters (mean, standard deviation, and ANOVA) was employed. Hence, Figure 1 shows the experimental setup.

Figure 1. Experimental Setup

2.4. Transferring the Scallion Stalks to their respective soil

The scallion was first bought, then the roots and the grown leaves were trimmed. We also prepared the pot that contained its fertilizer. A day later, the trimmed scallion stalk was transferred to every pot, depending on which set they were assigned. The scallions were then evenly distributed on each of the pots at an equal height. Each scallion was watered equally, no matter what kind of organic fertilizer material combination the scallion was planted with. Moreover, each pot was equally exposed to the same sunlight.

2.5. Data gathering

Height of scallion stalk: The height in centimeters (cm) of the scallion stalk was measured every week for about 30 days, starting from the first week after it is being planted. It was done by measuring the sample plants from the ground level to the top of the highest plant part with the aid of a measuring tape.

Number of leaves per scallion: The number of leaves of the scallion stalk was counted every week for about 30 days, starting from the first week after it is being planted. It was done by counting all new visible leaves sprouting from the scallion plant.

2.6. Statistical analysis

The gathered data were analyzed using mean, standard deviation, and one-way Analysis of Variance (ANOVA) in the form of a Complete Randomized Design (CRD). CRD was used for this study not only because is it relevant to experimental agriculture but also because the pot was grouped into four sets of treatments that are unique to one another. A mean comparison was also done using Honestly Significant Difference (HSD) known as Turkey's test at a 1% level of significance to find significantly different means between treatments. In that case,

significant treatment means were assigned different letters. Furthermore, all calculations were obtained using a statistical software called STATA version 14.

3. RESULTS AND DISCUSSION

Table 2 presents the number of leaves of scallion plants planted in the different organic fertilizer combinations mixed in the garden soil. With the aid of ANOVA in the form of CRD, it is revealed that the four treatments are not significant to each other (Week 1: F=1.33, p=0.38; Week 2: F=0.69, p=0.60; Week 3: F=01.51, p=0.34; Week 4: F=0.90, p=0.51) at 5% level in four consecutive weeks. This goes to infer that the treatments (T2, T3, and T4) do not show an advantage as opposed to pure garden soil.

Table 2. The number of leaves of different organic fertilizer material combinations of garden soil

Treatment	Descriptive statistics	Week 1^{ns}	Week 2^{ns}	Week 3^{ns}	Week 4^{ns}
T1 - Garden soil	Mean	1.00^{a}	3.00^{a}	3.50^{a}	5.00^{a}
	SD	0.00	1.41	0.71	1.41
T2 - Garden soil + wood ash	Mean	0.50^{a}	4.50^{a}	6.00^{a}	7.00^{a}
	SD	0.71	0.71	1.41	2.83
T3 - Garden soil + eggshells	Mean	1.50^{a}	4.00^{a}	4.00^{a}	4.00^{a}
	SD	0.71	1.41	1.41	1.41
T4 - Garden soil + wood ash + eggshells	Mean	1.00^{a}	3.00^{a}	4.00^{a}	5.00^{a}
	SD	0.00	1.41	1.41	1.41

*ns - not significant; same assigned letters imply not significantly different

However, Figure 2 shows that in weeks 3 and 4, treatment 2 (T2) (garden soil mixed with wood ashes) has a slight advantage in the number of leaves as opposed to other treatments (T1, T3, and T4). This implies that wood ashes as a fertilizer have a small effect (p=0.15) in increasing the number of leaves of scallion plants.

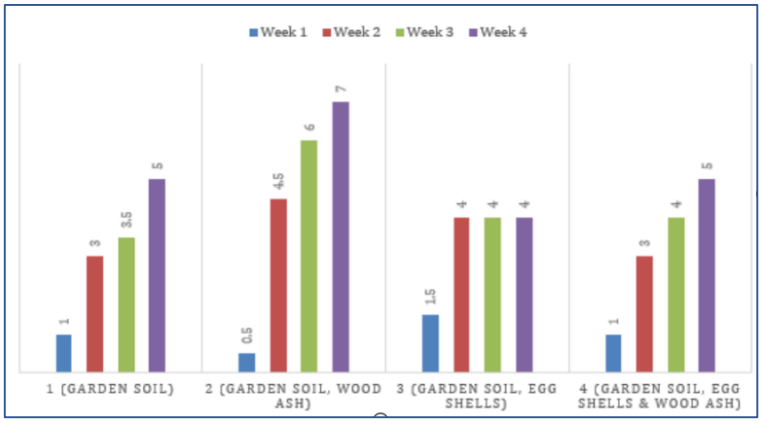

Figure 2. The weekly mean number of leaves of scallion plants

The recorded height of the scallion plants in the garden soil with varying organic fertilizer material combinations is presented in Table 3. By ANOVA in the form of CRD, it is shown that the treatment means of the height of scallions are not significantly different for the first three weeks (Week 1: F=0.53, p=0.68; Week 2: F=0.79, p=0.56; Week 3: F=4.91, p=0.08; Week 4: F=62.94, p<0.001) at 5% level. This implies that the scallion plant heights are approximately the same for the first three weeks. However, in the fourth week of recording, it is shown by ANOVA that the different treatment combinations are highly significant (F=62.94, p<0.001) at a 1% level.

Table 3. Height of the scallion using different organic fertilizer materials combined with garden soil

Treatment	Descriptive statistics	Week 1^{ns}	Week 2^{ns}	Week 3^{ns}	Week 4**
T1 - Garden soil	Mean	30.00^{a}	105.50^{a}	155.50^{a}	185.00^{c}
	SD	9.89	2.12	20.51	11.31
T2 - Garden soil + wood ash	Mean	18.00^{a}	88.50^{a}	155.00^{a}	208.50^{c}
	SD	25.46	36.06	11.31	3.54
T3 - Garden soil + eggshells	Mean	38.00^{a}	113.00^{a}	184.50^{a}	237.50^{b}
	SD	15.56	11.31	6.37	3.54
T4 - Garden soil + wood ash + eggshells	Mean	21.00^{a}	87.50^{a}	192.00^{a}	271.50^{a}
	SD	15.56	13.44	4.24	4.95

*ns - not significant; same assigned letters imply not significantly different; ** - significant at 1% level

The results of the height of the scallions are also shown in Figure 3. It is revealed that there was a significant difference among the treatments as the weeks (from 1st week to 4th week) have progressed. Week 1 has not shown any significance on its growth in each of the treatments. Similar to week 1, week 2 also did not show any sign of significant growth. Contrary to the first and second weeks, the 3rd week has shown slightly significant growth among the treatments. It is revealed in the 3rd week that T3 and T4 have the higher height among the four (4) treatments, with T4 slightly leading. By the time the fourth week had been conducted, the treatments had now shown a highly significant difference from each other. It is revealed that the highest height developed is T4, which had 70% soil, 15% wood ash, and 15% eggshells, followed by T3, T2, and T1.

Moreover, the finding implies that T4 was more likely to be effective on the growth performance of the height of scallion plants at the later stage of its growth. The steady growth of the scallion's height starts showing in its 3rd week as shown in Figure 3. In its 4th week, it is shown that T4 with its fertilizer combination of 70% garden soil, 15% wood ash, and 15% eggshell has the most growth potential of the four treatments, with it having a large difference between T1 of 100% garden soil.

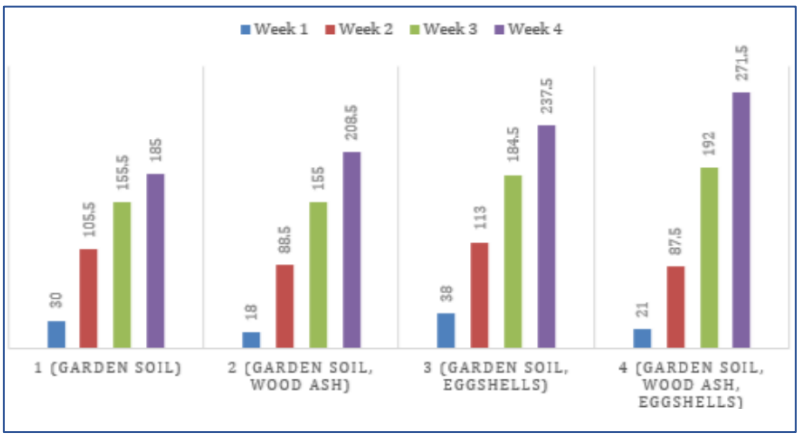

Figure 3. The weekly mean height of scallion plants

The different organic fertilizer material has a low varying effect on the growth performance of the number of leaves of scallion plants, as it resulted in no significant difference among the four treatments. Additionally, the results imply that the different organic fertilizer materials, namely, Treatment 2, 3, and 4, were not suitable for supporting the growth of the number of leaves, since it does not compete with the control group or Treatment 1 (100% garden soil). This result is inconsistent with the findings of Afa (2016), Apriansi et al. (2022), and Asare et al. (2022) that the growth and yield of scallions can be significantly improved using

organic fertilizer such as egg shells and wood ashes. The slight advantage of its effect on the number of leaves of scallion plants is not obvious in the early stage but can be seen in the 2nd half of the month after being it planted. Some studies in the literature prove that organic fertilizer can somehow progress the number of leaves of scallion plants (Kandil et al., 2013; Abelenda et al., 2022; Nault et al., 2022). According to Mercl et al. (2020) and Wang et al. (2020), organic fertilizers such as egg shells and wood ashes can improve the nutrient elements of soil, which give improvement to the leaves of scallion plants.

The different treatment combinations (T2, T3, T4) including the control (T1) do not vary their effect on the performance growth of scallion plants in the early stage. According to Levine and Paré (2009), the growth of the scallion plant is slow in the early stage where the variation is not significantly different. Likewise, the study by Zhou et al. (2018) found that scallion plants will grow faster in their vigorous growth stage (maturity) in which the plants flourish and are considered the essential stage of scallion plants. Additionally, it implies that the growth performance is not improved by egg shells and wood ashes relative to pure garden soil in the early stage of its maturity. The different organic fertilizer material has a significant impact on the height of the scallions, as it resulted in a highly significant difference among the treatments in the latter days (4th week) after it were planted. According to Karo et al. (2020), scallions can be productive with the right type and dosage of fertilizer. Likewise, the study by Podong and Junta (2020) found that the right amount of macronutrients (including calcium, magnesium, and sulfur) in the agricultural soil through organic fertilizer can positively impact the growth of scallions.

It is stated by Zhou et al. (2018), that scallions normally begin their seedling stage 7-14 days before their planting. During this period, plant growth in all combinations is nearly equal as seedlings do not need much fertilizer to help them grow. The organic fertilizer material combination used for treatment 4 was suitable for supporting the growth height of scallions. In other words, wood ash as a fertilizer is an effective nutrient supplement for growing scallion plants. This means that wood ashes as an organic fertilizer have a slight advantage in increasing the number of leaves of scallion, particularly in the 2nd half of the month after it is planted. Several studies have discovered that wood ash helps lime soil acidity and provides appropriate minerals and nutrients for plants, specifically, a source of phosphorus and potassium (Abelenda et al., 2022; Asare et al., 2022). Moreover, egg shells are an effective nutrient provider for the growth of scallions since it is a good source of calcium (Apriansi et al., 2022). Furthermore, Photiou et al. (2023) stated that with the aid of eggshells, soil can immediately recover from phosphate and calcium deficiency.

4. CONCLUSION

The result shows that the application of garden soil mixed with wood ashes has a slight effect on the growth performance of the number of leaves of scallion plants. Likewise, wood ashes as a fertilizer have a small advantage in increasing the number of leaves of scallion plants beginning in the 2nd half of the month after it is planted. Additionally, the results of the study concluded that out of all varying levels of organic material combinations, wood ash mixed with eggshell has the most impact on the growth performance of scallion plants since T_4 (consisting of 70% garden soil, 15% wood ash, and 15% eggshells) gave the best results in plant height of all treatments and different combinations. Hence, it is the most suitable organic fertilizer material combination for scallion plant growth since it provides the appropriate nutrients needed by the plants. A possible limitation of this study is the few number of replicates in each treatment, which draws a lack of confidence in the conclusion. Hence, to further assess the said fertilizers, a similar study should be conducted with a large number of replicates. Furthermore, for future studies, the pH level of the soil and its mineral content is also recommended to be

measured and investigated for different soil compositions as a potential weakness of the current study.

Declaration of Interest
The authors declare that there is no conflict of interest.

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