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Comparing the Growth Rates of *Ipomoea aquatica* Using Washed Rice Water From Different Rice Varieties

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Numerous agricultural sectors rely on chemical fertiliser to accelerate crop development, as demand continues to expand each year. Synthetic fertilisers may leak into groundwater, increasing its toxicity and resulting in water contamination. Alternatives such as washed rice water may be utilised to mitigate the environmental impact of chemicals. This research aims to assess the effects of washed rice water on the growth rate of *Ipomoea aquatica*. Three types of rice water were used in this study: washed white rice water, washed brown rice water, and washed sticky rice water. Two of the rice water served as the control and each was treated with distilled water and NPK fertiliser. Significant values were determined using Analysis of Variance (ANOVA) and post-hoc tests for multiple comparisons. Resultantly, washed white rice water demonstrated the most significant effect in increasing the growth of the plant height, length of root, number of leaves, circumference of the stem and suitability of soil pH. Alternative methods such as washed white rice water could be employed to reduce the cost of agricultural operations to protect the environment from further degradation.

Keywords: fertiliser; *Ipomoea aquatica*; plant; washed rice water; WRW

I. INTRODUCTION

The global population is rapidly increasing, putting a strain on biological resources to provide an adequate quantity of food while also sustaining the environment and ecosystem. Malaysia's current population is 32,106,130 as of 2019, according to a world-metres elaboration of the most recent United Nations data. This current population represents a significant rise above the 29,791,949 estimated in 2013 (Dadax, 2019). Food consumption is expected to rise from 59% to 98% by 2050 (Elferink & Schierhorn, 2016). The agricultural sector needs to enhance food output in order to meet the increased demand. Farmers must also boost agricultural production through the use of fertiliser. Nevertheless, environmental challenges will be induced when chemical fertilisers are used without suitable regulation and understanding (Fageria, 2007). Without appropriate implementation, the use of chemical fertilisers in plants will create environmental problems in agricultural fields. Excessive fertiliser usage could result in eutrophication (Hodgkin & Hamilton, 1993). Excessive fertilisation also depletes the soil of organic matter and nutrients, resulting from soil acidity and mineral depletion (Wallace, 1994). Hence, this experiment was designed to evaluate if washed rice water could be used as a fertiliser to enhance plant growth.

Rice (*Oryza sativa*) is a basic meal for over half of the world's population, including almost all of the daily calories consumed, mainly in Asia. One of the most important wastes is the water used to wash rice (washed rice water = WRW). It is the term used to describe the water used to wash rice before cooking. Rice water waste and vast volumes of rice washing results are often discarded, despite containing nutrients that may be used as fertiliser (Santosa & Soekendarsi, 2018). Additionally, microorganisms that promote plant

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development, such as *Bacillus* and *Lactobacillus* spp., were detected in rice washing water (Abba *et al*., 2021). WRW has the capacity to extract a significant amount of water-soluble nutrients in rice. Washing rice often leads to a loss of up to 7% protein, 30% raw fibre, 15% free amino acids, 25% calcium (Ca), 47% total phosphorus (P), 47% iron (Fe), 11% zinc (Zn), 41% potassium (K), 59% thiamine, 26% riboflavin, and 60% niacin (Teh, 2017). As a result, some studies indicate that WRW might be used as an organic fertiliser. However, such assertions are very subjective since there is no genuine scientific data to support them (Abba *et al*., 2021).

Reusing rice washing water should be promoted since it helps with water management. Additionally, the United Nations advocates for more effective water management due to the adverse effects of climate change and the growing global population (Abba *et al*., 2021). Inorganic fertiliser is one of the synthetic fertilisers that might have a direct or indirect effect on biodiversity. The most commonly encountered components in commercial fertilisers are nitrogen, phosphorous, and potassium. While commercial fertilisers have assisted farmers in increasing agricultural output since the 1930s, they have the most negative environmental consequences, most notably water pollution. To prevent these environmental concerns, this study investigates the effects of washes of various rice on the growth rate of the plant, *Ipomoea aquatica* (often known as water spinach or "kangkung"). This experiment examined three variations of washing rice water, including white rice water, brown rice water, and sticky rice water.

II. MATERIALS AND METHOD

The experiment was conducted by growing five *Ipomoea aquatica* plants in separate polybags (repeated three times). The seeds of the plants were allowed to germinate and develop to a specific length before being tested for their growth with different kinds of rice water. A 1:1:1 mix of mature compost, topsoil, and sand was used to prepare the soils. All the plants were allocated to the same environment, which is shady and away from direct sunlight and moist in nature.

A. Treatment for plant

Two polybags were used as controlled plants and labelled A and B. The polybag labelled A contained the plants that were watered with distilled water while polybag B contained NPK fertiliser. For the B plants, NPK fertiliser was added to the soil of the plant every week. Another three polybags were used for the experimental plants labelled C, D and E, which were employed for watering the white rice, brown rice and sticky rice, respectively. For the controlled plants, both plants were treated with the same amount of water every day. All experiments were repeated thrice to obtain the average measurement.

B. Washed Rice Water Preparation

The white rice water, brown rice water and sticky rice water were prepared for watering the plants. For every rice, the ratio of 1:3 was used which entailed the mixture of 200 mL of water with 66.6 g of rice. The bottle was shaken until the water was cloudy. The prepared washed rice was then used for the plant treatment, by directly pouring the water on the soil. The step was repeated for brown rice and sticky rice for plants D and E, respectively. These mixtures were prepared daily to water the plants for the whole month.

C. Data collection and analysis

The plants were harvested four weeks after planting. The number of leaves, the circumference of the stem (cm), the height of the plant (cm), length of the root (cm) and pH value of the soil were measured. Marketable weight yield was recorded and expressed in kg/ha. All the data gathered were analysed using Analysis of Variance (ANOVA) to determine any significant differences.

III. RESULT AND DISCUSSION

Measurements were obtained for four weeks and are summarised in Table 1. The treated plants C, D, and E exhibited an increasing number of leaves during the week, ranging from 9 to 10 leaves; nevertheless, the controlled plant B reflected the maximum number of leaves, exceeding 10 leaves (Table 1). Circumference of the stem: C and E plants treated with white rice water and glutinous rice, respectively, recorded the largest circumference of the stem at around

Table 1. The growth of *Ipomoea aquatica* plant for each rice water treatment compared to the control (cm units)

Sample	Treatment	Growth Parameter				
		Number of Leaves	Circumstance of Stem	Height of Plant	Length of Root	pH of Soil
A	Tap water (-ve control)	9.00±1.73[a]	0.4333±0.058[a]	29.10±0.755[c]	8.90±0.10[d]	6.146±0.005[a]
B	NPK fertiliser (+ve control)	10.667±1.16[a]	0.500±0.00[a]	46.93±2.25[a]	12.067±0.208[a]	5.503±0.005[e]
C	White rice	9.66±0.57[a]	0.5667±0.058[a]	35.90±0.693[b]	11.067±0.153[b]	5.707±0.005[d]
D	Brown rice	9.677±1.15[a]	0.4667±0.058[a]	34.400±1.277[bc]	10.267±0.208[c]	5.893±0.005[c]
E	Glutinous rice	9.00±2.65[a]	0.5667±0.116[a]	39.47±4.78[b]	9.8667±0.1528[c]	5.97±0.0608[b]

All the growth parameter values are indicated as mean with standard deviation values (n=3).

[a, b, c, d, e] Means with different letter are significantly different from each other. ($P<0.05$)

0.567 cm, but D1 plants had a circumference of only 0.467 cm (Table 1). B1 and A1 plants obtained approximately 0.5 cm and 0.433 cm, respectively, for the controlled plant (Table 1). For the height of the plant, E recorded a height of 39.47 cm, while C and D recorded 35.9 cm and 34.4 cm, respectively. However, controlled plant B achieved the highest height of 46.93 cm (Table 1). Finally, C demonstrated the most developed root system of all treated plants at 11.067 cm, followed by D and E at around 10.267 and 9.867 cm, respectively. For the controlled plant, B measured the root length at 12.06 cm, whereas A was approximately 8.9 cm (Table 1). In comparison to other plants, A had the highest pH soil reading of 5.97 while control had the lowest pH soil reading.

The statistical analysis revealed that different types of rice water used did not yield any significant effect on the number of plant leaves and the circumference of the stem (Table 1). This might be due to the low concentration of rice water or the amount of rice water being insufficient to deliver nutrients to the plants. According to Istiqomah (2012), the amount and concentration of rice water influence plant development. The low nutritional content of waste rice water results in an inadequate complement for plant development. Nutrients, particularly nitrogen, have a strong influence on the development of leaves and stems. According to Khtiyanto (2010), nitrogen plays an active role in vegetative development, namely shoot formation, leaf creation, and stem growth. Thus, the leaves of the plant will grow large and extend the surface area accessible for photosynthesis if adequate nitrogen is available. Higher nutrient in soil enhances the growth of plant leaves and facilitate the production of food (Verma & Shukla, 2011).

For the circumference of the stem, white rice treatment and glutinous rice treatment displayed the same results, which was 0.5667 cm and the highest among other treatments. NPK fertiliser treatment was the second-highest at 0.5 cm. Brown rice recorded the third-highest result, which is 0.4667 cm while tap water treatment displayed the lowest result (0.4333 cm) as the negative control. Nitrogen and potassium are two factors that might impact the circumference of the stem. The nutrients nitrogen and potassium are found in rice and rice water. Consistent with previous reports, brown rice and glutinous rice has been shown to contain the most nutrients (Ghosh & Bhat, 1998).

For the height of the plants, most of the treatment plants yielded significant results, especially when compared to the

NPK control plant. NPK fertiliser enriches the soil with more nutrients for the plant growth, however, the present result depicted that rice water also contributed significant nutrients as much as NPK fertiliser did. Sitinjak *et al.* (2018) reported that rice water may also include components such as N, P, and K, depending on the concentration of rice water. The element N contributes to the fast development of plants, particularly on their stems and leaves. While element K is responsible for activating various enzymes that promote the transport of carbohydrates from leaves to other organs. Meanwhile, element P is necessary for cell development. According to Sari *et al.* (2017), cell division will occur rapidly in the presence of adequate nitrogen given that the nutrient has a critical function in the stimulation of height growth. Nutrient contents such as nitrogen and phosphorus are vital for plant development since their availability must match the plant's requirements, and a shortage of these components might lead plants to become stunted (Fathini *et al.*, 2014). From seed germination through seed production, plants need a variety of macronutrients and micronutrients. Nitrogen is required to increase seedling height and root collar diameter (Andivia *et al.*, 2011) and phosphorus is needed to increase plant height and root collar diameter (Razaq *et al.*, 2017), and potassium is necessary for plant growth and development (Razaq *et al.*, 2017; Hasanuzzaman *et al.*, 2018). Root collar diameter is diameter at the base tree trunk and always used to predict the performance (growth and development) some plant species (Bayala *et al.*, 2009).

The pH of the soil is a measure of the amount of hydrogen ions (H^+) in the soil. In other words, the pH value of soil is a representation of the concentration of ions bound to soil particles and organic matter. The pH of the soil is important since it affects a variety of soil characteristics that impact plant development, including soil bacteria, nutrient leaching, nutrient availability, toxic compounds, and soil structure (Pawar, 2015). Although the pH does not indicate fertility, it affects the solubility and availability of fertiliser nutrients in the soil (McCauley *et al.,* 2009). While it is well established that the majority of plant nutrients are best accessible to plants in intermediate/sub-acid pH ranges and are compatible with root development (Jensen, 2010), the ideal pH soil for *Ipomoea aquatic* is between 5.3 and 6.0. NPK fertiliser treatment is the most optimal for *Ipomoea aquatica* soil pH because it produces the greatest results for the plant's development in all aspects, and the pH soil of NPK fertiliser treatment is 5.51. According to prior research and in contrast to the present findings, soil pH 7 is ideal for total soil microbial activity, crop tolerance, and nutrient availability (McCauley *et al.*, 2009). In tap water treatment, the soil pH value should be between 6.15 and 8.5. This value is unsuitable to *Ipomoea aquatica* due to its high alkalinity. The pH of the soil is 5.7 in white rice and 5.9 in brown rice treatments, respectively. Both treatments recorded the highest soil pH values when compared to other treatments, nearly attaining the optimal rate of soil pH development for *Ipomoea aquatica*.

Plants are anchored by their roots, which protect them from wind and, in certain situations, trampling. They absorb the water and nutrients required by plants, similar to the activities leaves do for carbon and energy absorption (Jackson *et al.*, 1999). According to the results, plant B has the longest root development, followed by plants C, D, and E. Additional N nutrients obtained from washed rice water have the same impact as fertiliser in that the growth-promoting action of N enhances cytokinin synthesis, which in turn influences cell wall flexibility (Bloom *et al.*, 2005). While the distilled water for plant A recorded the shortest length of the root compared to others. This is attributed to the fact that distilled water lacks nutrients, which are the primary source of plant growth (Kozisek, 2005). The root growth of *I. aquatica* was not as fast as the remaining treatments as the soil do not contain additional nutrients. The *I. aquatica* has a high requirement for nitrogen and potassium (Teh, 2017). However, nitrogen is the primary nutrient needed by plants to maintain root development. They specifically stimulate plants to establish a dense network of new roots and reinforce existing roots as they grow, ensuring optimal plant yield and quality (Zapata & Zaharah, 2002). Another study by Nabayi *et al.* (2021) stated that, washed rice water can increase beneficial plant bacterial population by process fermentation. The treatment used to washed rice water showed presence of beneficial bacteria that can increase N, S, P, K, Mg, and NH_4^+ and NO_3^- and at the same time decrease soil pH that potentially increase plant growth and enhance soil health (Nabayi *et al.*, 2021)

IV. CONCLUSION

Overall, washed white rice water was the most helpful rice water (other than control treatments) since it recorded the highest nutrient leached to increase the growth of *Ipomoea aquatica* and could be used in place of artificial fertiliser based on this study. The washed glutinous rice water, on the other hand, has the least nutrient leached. To preserve the quality and prevent pollution, the most effective method is to educate the public about the critical role of soil quality in plant growth. Furthermore, the public should be encouraged to lessen their reliance on chemical fertilisers, which will assist in reducing the world's environmental issues.

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VI. REFERENCES

Abba, N, Sung, CTB, Paing, TN & Zuan, ATK 2021, 'Wastewater from Washed Rice Water as Plant Nutrient Source: Current Understanding and Knowledge Gaps', *Pertanika Journal of Science and Technology*, vol. 29, no. 3, pp. 1347–1369.

Andivia, E, Fernández, M & Vázquez-Piqué, J 2011, 'Autumn Fertilization of *Quercus Ilex ssp. Ballota (Desf.) Samp.* Nursery Seedlings: Effects on Morpho-Physiology and Field Performance', *Annals of Forest Science*, vol. 68, no. 3, pp. 543.

Bayala, J, Wilson, J, Dianda, M & Ouedraogo, SJ 2009, 'Predicting field performance of five irrigated tree species using seedling quality assessment in Burkina Faso, West Africa', *New Forest*, vol. 38, no. 3, pp 309-322.

Bloom, AJ, Frensch, J & Taylor, AR 2005, 'Influence of Inorganic Nitrogen and pH on The Elongation of Maize Seminal Roots', *Annals of Botany*, vol. 97, no. 5, pp. 867-873.

Dadax 2019, Malaysia Population, viewed 20 April 2022, <https://www.Worldometers.Info/World-Population/Malaysia-Population/>.

Elferink, M & Schierhorn, F 2016, 'Global Demand for Food Is Rising. Can We Meet It?' *Harvard Business Review*, vol. 7, no. 4.

Fageria, N 2007, 'Yield Physiology of Rice', *Journal Of Plant Nutrition*, vol. 30, no. 6, pp. 843- 879.

Fathini DN, Sriyanto, W & Suci, H 2014, 'Pengaruh Masa Inkubasi Vinasse Dan Takaran Pupuk Kalium Terhadap Pertumbuhan Dan Hasil Cabai Merah (*Capsicum Annum* L.', *Vegetalika*, vol. 3, no. 2, pp. 13 – 24.

Ghosh, B & Bhat, R 1998, 'Environmental Hazards of Nitrogen Loading in Wetland Rice Fields', *Environmental Pollution*, vol. 102, no. 1, pp. 123-126.

Hasanuzzaman, M, Bhuyan, M, Nahar, K, Hossain, M, Mahmud, JA, Hossen, M & Fujita, M 2018, 'Potassium: A Vital Regulator of Plant Responses and Tolerance to Abiotic Stresses', *Agronomy*, vol. 8, no. 3, pp. 31.

Hodgkin, E & Hamilton, B 1993, 'Fertilizers and Eutrophication in Southwestern Australia: Setting the Scene', *Fertilizer Research*, vol. 36, no. 2, pp. 95-103.

Istiqomah, N 2012, 'Effectiveness of Applying Washed Brown Rice Water on The Productivity of Green Bean (*Phaseolus Radiatus* L.) On Lowland Swamps', *Ziraa'ah*, vol. 33, no. 1, pp. 99-108.

Jackson, RB, Pockman, WT & Hoffmann, WA 1999, *The Structure and Function of Root Systems*, Handbook of Functional Plant Ecology, pp. 195-220.

Jensen, LDT 2010, *Soil pH and The Availability of Plant Nutrients*, Plant Nutrition Today, article no. 2, International Plant Nutrition Institute (IPNI), Georgia, USA.

Khtiyanto, RE 2010, 'Pengaruh Pupuk Nitrogen Dan Fosfor Terhadap Pertumbuhan Dan Produksi Tebu (*Sacharum Officinarum* L.)', *Skripsi, Departemen Agronomi Dan Hortikultura Fakultas Pertanian Institut Pertanian Bogor*.

Kozisek, F, 2005, 'Health Risks from Drinking Demineralised Water', *Nutrients in Drinking Water*, vol. 1, no. 1, pp. 148-163.

Mccauley, A, Jones, C & Jacobsen, J 2009, 'Soil Ph and Organic Matter', *Nutrient Management Module*, vol. 8, no. 2, pp. 1-12.

Nabayi, A, Sung, CTB, Zuan, ATK & Paing, TN 2021, 'Fermentation of Washed Rice Water Increase Beneficial Plant bacteria Population and Nutrient Concentration', *Sustainability*, vol. 13, no. 23, pp. 13437.

Pawar, RM 2015, 'The Effect of Soil Ph on Bioremediation of Polycyclic Aromatic Hydrocarbons (PAHS)', *Journal of Bioremediation & Biodegradation*, vol. 6, no. 3, pp. 291-304.

Razaq, M, Zhang, P & Shen, HL 2017, 'Influence of Nitrogen and Phosphorous on The Growth and Root Morphology of *Acer Mono*', *PLOS ONE*, vol. 12, no. 2.

Santosa, S & Soekendarsi, E 2018, 'Utilization of Rice and Coconut Water Waste to Accelerate the Growth Of *Syzygium Myrtifolium* (Roxb) Walp Seedlings On Sediment Media', *Academic Research International*, vol. 9, no. 4, pp. 1-5.

Sari, Nawang, V, Same M & Yonathan P, 2017, 'Pengaruh Konsentrasi Dan Lama Fermentasi Urin Sapi Sebagai Pupuk Cair Pada Pertumbuhan Bibit Karet (*Hevea Brasiliensis Muell. Arg.*)', *Jurnal Agro Industri Perkebunan*, vol. 5, no. 1. pp. 57-71.

Sitinjak, RR, Purba, MP & Nababan, BD 2018, 'Pengaruh Pemberian Air Cucian Beras Dan Air Kelapa Terhadap Pertumbuhan Bibit Kelapa Sawit (*Elaeis Guineensis Jacq.*) di Pre-Nursery', *Agroprimatech*, vol. 2, no. 1, pp. 16-24.

Teh, C 2017, 'Is Watering Our Houseplants with Washed Rice Water Really That Effective. Here's The Scientific Evidence?'

Verma, D & Shukla, K 2011, 'Nutritional Value of Rice and Their Importance', *Journal of Indian Farmers Digest*, vol. 44, no. 1, pp. 21-35.

Wallace, A 1994, 'Soil Acidification from Use of Too Much Fertilizer', *Communications in Soil Science and Plant Analysis*, vol. 25, no. 1-2, pp. 87-92.

Zapata, F & Zaharah, A 2002, 'Phosphorus Availability from Phosphate Rock and Sewage Sludge as Influenced by The Addition of Water-Soluble Phosphate Fertilizer', *Nutrient Cycling in Agroecosystems*, vol. 63, no. 1, pp. 43-48.