BILINGUAL PUBLISHING GROUP

Journal of Environmental & Earth Sciences

https://journals.bilpubgroup.com/index.php/jees

ARTICLE

Research on Biomass and Biochar of Reed (Phragmites australis) in U Minh Thuong National Park, Vietnam

Luom Thanh Thai* *, *Ngoc Thi Hong Dang*, *Thien Van Ngo*, *Mo Danh

Department of Natural Resources and Environment, Kien Giang University, Minh Luong 91000 Vietnam

ABSTRACT

Aims: Reed *(Phragmites australis*) is a plant species with a seasonal reproductive cycle; it has a very high biomass in U Minh Thuong National Park, in Vietnam. This study aims to evaluate fresh and dry biomass of the reed and the production of biochar from the plants. The biochar is then used as a bio-organic fertilizer for watermelon cultivation in agriculture. Methods: To achieve these objectives the following experiments were conducted (1) investtigating the fresh and dry biomass of reeds producing biochar using local methods; (2) adsorption with pig urine and chemical fertilizers (nitrogen, phosphorus and potash) to examine the uptake of chemical components into the water environment; (3) mixing biochar with inorganic mineral fertilizers and peat to creat inorganic fertilizer – biochar formulas, followed by an analysis of the chemical compositions of the mixtures; (4) using various biochar-based fertilizers to grow watermelon with local varieties. Results: The results show that reeds produce very high for biomass biochar fertilizer production. Reed biochar can adsorb components of pig urine, such as ammonium, nitrate, nitrogen and phosphorus along with inorganic substances such as nitrogen, phosphorus and potash. Therefore this study proposes the use of this biochar for watermelon cultivation and environment treatment in polluted regions. Conclusions: Biomass and biochar of reed are very high. The biochar can adsorb nitrogen, phosphorus and potash fertilizers. Additionally, biochar can be mixed with peat and inorganic mineral fertilizers for to watermelon cultivation in Mekong Delta. Implications of the research: Forest fires in U Minh Thuong National Park, caused by reed vegetation, occur annually and result in damage to property and human livelihoods. This research not only exploits renewable raw materials but also helps control the risk of forest fires. Originality/Valeu:This

*CORRESPONDING AUTHOR:

Luom Thanh Thai, Department of Natural Resources and Environment, Kien Giang University, Minh Luong 91000 Vietnam; Email: thaithanhluom@gmail.com

ARTICLE INFO

Received: 6 September 2024 | Revised: 20 October 2024 | Accepted: 23 October 2024 | Published Online: 8 May 2025
DOI: https://doi.org/10.30564/jees.v7i5.7211

CITATION

Thai, L.T., Dang, N.T.H., Van Ngo, T., et al., 2025. Research on Biomass and Biochar of Reed (Phragmites australis) in U Minh Thuong National Park, Vietnam. Journal of Environmental & Earth Sciences. 7(5): 274–288. DOI: https://doi.org/10.30564/jees.v7i5.7211

study aims to provide methods for controlling forest fires by producing biochar of from reed (*Phragmites australis*) U Minh Thuong National Park Vietnam. This species thrives and produces a large biomass during the rainy season, supllying dry material that contributes to the intensity of forest fires in the dry season in Vietnam.

Keywords: Biomass and Biochar of Reed; Phragmites autralis; Watermelon; U Minh Thuong; Vietnam

1. Introduction

Reed (*Phragmites australis*) is a fast growing plant in U Minh Thuong Nationnal park Vietnam [1], highest biological productivity among weed species on peatland as U Minh Thuong National Park and growth of reeds in Quang Ninh on mined land has the ability to reduce some polluted metals during the mining process [2], it grows into a very thick vegetation and invades very quickly with the height to 5 meters to the point of covering the ground where it grows, reduces biodiversity of animals and plants. Biomass harvested during winter will have weaker correlations between mineral but constant morphological parameters because nutrient concentrations above ground [3]. Especially when they mature in the dry season, they die with each part of the stem, leaves and flowers, they create amass of flammable material from 5–10 kilograms per square meter, spread evenly from plant top to the ground. As it has a fire, they burn on the plant tops down the leaves and then spread to the ground. Then the fire area lacks oxygen and the wind from surrounding areas spreads to create an increasing winds and fire will burn quickly and strongly. It was finished burning to leave behind red charcoal fires and continue to burn underground in the peat layer and fire underground during many days causing serious damage such as U Minh Thuong National Park.

On the other hand, the reed growth has the highest annual biomass, it is also a very potential renewable resource and research on its biomass serves beneficial purposes not only in reducing the risk of forest fires but also in harvesting a huge amount of biomass every years.

In study biochar producing rice straw and rice husk biochar to improve soil fertility, crop productivity and reduce greenhouse emissions [4]. In this topic, research on reeds on peat soil in U Minh Thuong National Park, a species of plant that produces the largest amount of flammable material, it is a threat to annual forest fires, the topic will focus on research on growth, biomass of stem, leaves, flowers of fresh and dry plants. Its research also made of biochar from reed plant by traditional method to produce into reed biochar.

Studies biochar research on the possibility of using biochar to replace manure and inorganic fertilizers in rice production [5]. This study also analyzed the relationship between peat soil properties and the growth and biomass of reeds on different peat soils in U Minh Thuong National Park. In research The Vietnam Soil and Agrochemical) Institute requires product quality with organic content >30%, humic acid >5%, total NPK > 5% and there are mixed ingredients including: Biochar, nitrogen, phosphorus, potassium fertilizer, intermediate elements, trace elements (TE), organic supplements [6]. Research using biochar to replace manure and ingnorganic fertilizers in rice production [7]. It also study the chemical composition of biochar, on that basis, we will propose directions for use in treating polluted water environments and using it in agriculture by organic and biological fertilizers.

There is a relationship between soil chemical composition and biological density. Therefore, this project also studies the chemical parameters of peat soil on distributed reed base to see the growth and biomass productivity are related to chemical indicators.

Study of ammonium and nitrat adsorption *Phragmites australis* biochar from aqueous solution in Persian give us look at biochar of reeds [8]. Therefore, studying biomass and biochar of reed (*Phragmites australis*) in U Minh Thuong National Park, Vietnam, is extremely necessary and has practical significance in this region.

Mixed inorganic mineral fertilizer as nitrogen, phosphorus, potash with biochar by different formulas and biochar, peat and inorganic mineral fertilizer after five days and ten days to analyze the chemical of them to check the keeping nitrogen, phosphorus and potash to use them for fertilizer.

Using mixed biochar, peat and inorganic to make fertilizer to planting watermlon by experiment with seven formulas and control to check that fertilizer for agriculture in the future.

2. Material and Methods

2.1. Material

The following steps were conducted:

- The reed plants are old plants with dry leaves and flowers during in the dry season. The plants are cut and gathered to a place. Designed traditional manual furnace. Separate the dry part of the trunk, leaves and flowers. Burn until all the smoke is gone, then cut off the oxygen. Collect the biochar to experiment (**Figure 1**).

- Use pig urine from the pig farm to filter through biochar

- Use phosphorus and nitrogen from inorganic fertilizer mixed in water to filter through biochar.

- Made watermelon (Citrillus lanatus) seedlings, planting and apply mixed fertilizer twice at 30 days and 40 days; measure growth indicators at 30 days and 70 days. The indicators include at 30 days measure stem length (Lst), Number of leaves (Lno.), leaf length (Lle.), leaf width (Lwi.), number of flowers (Fno.), number of flower bud (Bno.), leaf color (Lco.); at 70 days as stem length (Lst), leaf color (Lco.), fruit length (Lfr.), fruit width (Wfr.), fruite weigth (Few.), physis in fruit (Pfr.), fruit color (Fco.), sweetness level (Sle.).

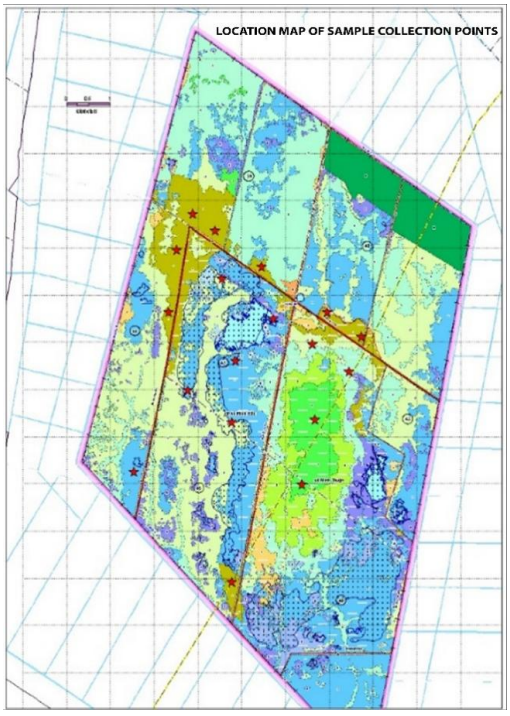

Figure 1. The map of investigating reed plants on different peat thickness (* The points of survey).

2.1.1. Biomass Investigation

- Types of reed vegetation on different peat thicknesses: Peat thickness: (0cm); (>0–30 cm), (>30–60 cm); (>60–90 cm)[9].

- Each thickness selected five sample plots; Total plots are 20, the area of plot is 4 square meters, in each plot selected nine reed plants to mearsure them. The indicators of to measure including: the height of plants (H), the diameter at ground of it (D0.0), number of plants in per one meter (N/m^2).

- In 20 sample plots on four peat thicknesses, in a plot select total nine plants (three shortest plants, three medium plants, 3 highest plants), cut it from the ground, then write number of plant and plot numbers to take them to the laboratory, then take divide the trunk, leaves, flowers and weigh them invidual each other. After take divide at still fresh weigh them before, next step dry them until the weight is not change at that weigh the dry trunk, dry leaves and dry flowers of reed. The third step is burning the trunk, leaves, flowers in the designed biochar burner.

- Determination of fresh plant biomass by weigh total fresh plants (Wft), weigh fresh plant trunks (Wftr), weigh fresh leaves (Wfl), weigh fresh flowers (Wff), unit of weigh is gram (g).

- Determination of dry plant biomass by weigh total dry plant (Wdt), weigh dry plant trunk (Wdtr), weigh dry plant leaves (Wdfl), weigh dry plant flowers (Wff), unit of weigh is gram (g).

- Determination of plant biochar by weigh total plant biochar (Wbt), weigh plant trunk biochar (Wbtr), weigh leave biochar (Wbl), weigh plant flower biochar (Wff), unit of weigh is gram (g). (**Figure 2**).

Figure 2. Reed plants and reed biochars.

Soil investigation

Based on the high distribution map of peat soil, 20 soil investigation plots were established[9, 10]. Using a hand drill to collect samples, a total of 20 plots were set up to survey the growth of the reed at three different peat thickness levels.

There were 5 plots for the thickness 4 level, 0 cm 5 plots, 5–30 cm 5 plots; 30–60 cm 5 plots, 60–90 cm 5 plots (20 plots in total). Each site to collect samples is three[11], and each sample is one kilograms and coded a mumber of the site as UTM1, UTM2, UTM3, UMT4[11], following the same name of the survey plots, then gets them to the laboratory of Southern Institute of Forestry Science for analysis.

The characteristics of the peat soil were evaluated through the indicators: pH (H_2O); Humus (%), Total nitrogen (%), P_2O_5 (%), K_2O (%), Fe^{2+} (mg/100 g), SO_4^+ (mg/100 g), humic acid (%). The analysis method of pH (H_2O) was determined with a pH meter. Humus content and humic acid were evaluated by Walkley Black[11], total nitrogen by the Kjeldhahl method[11]. P_2O_5 was indicated by the colorimetric method. All indications were analyzed at the laboratory of the Southern Forest Sciences Institute and the Laboratory of Kien Giang University.

Reed biochar chemical indicators

Biochar analysis includes indicators: pH, humic acid %, C%, OM%, N% total, P% total, K% total, Ca%, Mg%, Ash %. All of indicators analyzed follow the soil analysis as above.

Mix fertilizer and applicating experiment for watermelon

- Mix fertilizer: With control formulas 1 and 7 experimental formulas labeled

Formula 1: 100g Biochar (Control)

Formula 2: 4g Nitrogen 46% + 3g phosphorus 61 % + 3g Potash 61% (10g NPK+ 90 g Biochar = 100g fertilizer)

Formula 3: 10g (Nitrogen 16% + Phosphorus 16% + 8%) + 90g Biochar = 100g fertilizer

Formula 4: 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%) + 90g Biochar = 100g fertilizer

Formula 5: 50g Biochar + 40g Peatland + 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%)

Formula 6: 60g Biochar + 30g Peatland + 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%)

Formula 7: 70g Biochar + 20g Peatland + 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%)

Formula 8: 80g Biochar + 20g Peatland + 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%)

The dates after mixed during five days and ten days: Analyzed indicators are humic acid %, organic matter OM%, C %, N%, P%, K%, Ca%, Mg%, SiO_2%.

2.1.2. Data Analysis

The analysis involves using t-tests and one-way analysis of variance (ANOVA) to compare the mean differences between peat and reed growth on the different thickness levels of peat[12]. Correlation analysis using the Pearson correlation coefficient described the interdependence between peat quality and the development of reed plants. A correlation is considered significant when the *p*-value is less than 0.05, and the correlation coefficient (r) is more significant than 0.5 in absolute value[12]. The analysis focused on the relationship between the peat environment indicators and the growth of reed plant on different peat thicknesses. Spearman's correlation coefficient was used for analysis, and the significance level will be set at $\alpha = 0.05$[13]. If the correlation coefficient of the variable (peat) levels is significant, hypothesis How will be rejected, indicating a correlation between peat characteristics and reed plant growth.

The characteristics of the biochar on reed plants were evaluated through the indicators: pH(H_2O), humic acid %, organic matter OM%, C%, N%, P%, K%, Ca%, Mg%, SiO_2 %, The analysis methods of pH by measuring the extraction ratio 1: 2.5; K%, Ca%, Mg% measured with an atomic absorption machine; Silic mearsured according to method of AOAC (Association of analytical communities); Nitogen measured according to method Kjeldahl; Phosphorus measured by wavelength colormetric method; Ash calculated by ashing method.

Data processing, including statistical calculations, description, test hypotheses, and graph drawing, was performed using Microsoft Excel 2016, Statgraphic Centurion 19.12, and IBM SPSS Statistic version 20.0[11].

3. Results

3.1. Research Results of Growth and Fresh Biomass

- Comments: The height of reed (**Table 1**) at the thickness 0 centimeter (cm) is 3.39 cm; from 5–30 cm is 4.19 cm; 30–60 cm is 4.48 cm; 60–90 cm is 4.47 cm. The diameter at ground of reed on 0 cm peat thickness is 1.8 cm; at the peat thickness 5–30 cm is 1.9 cm; 30–60 cm is 2.99 cm; 60–90 cm is 3.17 cm. The density of reed on one square meters at peat thickness 0 cm is 87 plants, at 5–30 cm is 62 plants,

at 30–60 cm is 56 plants and 60–90 cm is 49 plants. The volume of the reed trunk 0cm peat thickness on 1 square meters is 0.04 cubic meters, 5–30 cm peat thickness is 0.04 cubic meters, 30–60 cm peat thickness is 0.09 cubic meters, 60–90 cm peat thickness is 0.10 cubic meter. The weight of reed plants at the 0 cm peat thickness is 15.46 kilograms per 1 square meters, 5–30 cm peat thickness is 14.96 kilograms, 30–60 cm peat thickness is 21.90 kilograms; 60–90 cm peat thickness is 20.58 kilograms.

Statistical analysis with ANOVA the investigated indicators were all significantly different at the $\alpha = 0.05$, the p-value of indicators was less than 0.001.

Table 1. The height and diameter of trunk at ground.

No.	Peat Thickness	Height (H)	Diameter ($D_{0.0}$)	Density (N/m^2)	Volume (Ym^3)	Weight (kg)
1	0 cm	3.39	1.8	87	0.04	15.46
2	5–30 cm	4.17	1.9	62	0.04	14.96
3	30–60 cm	4.48	2.99	56	0.09	21.90
4	60–90 cm	4.74	3.17	49	0.10	20.58
	$\alpha = 0.05$	<0.00*	<0.00*	<0.00*	<0.00*	<0.00*

Note: <0.00: Significant different; 0.06N: No significant different*

- In general, growth indicators increase with peat thickness such as height, stem diameter volume and biomass of reed plant. The result (**Table 1**) showed the reed height is highest of grass from 3.39 meters to 4.74 meters; the diameter of plant is very big of grass form 1.8–3.17 centimeters, the density also very high from 49–87 plants per m^2, the volume 0.04 – 0.1 m^3/m^2 equivalent to 400 m^3 per hectare (ha) to 1000 m^3/ha a volume huge biological productivity and weigh from 15.46–20.58 kg/m^2 equivalent to 154,600–205,810 kg/ha, biological.

3.1.1. Fresh Biomass of Reed

- Comments: The fresh plant biomass showed (**Table 2**): The weight of fresh reed plant total (Wft) per plant at the 0 cm peat thickness is 176 grams; 5–30 cm peat thickness is 242 grams, 30–60 cm peat thickness is 391 grams, 60–90 cm peat thickness is 423 grams; the weight of the fresh reed trunk (Wftr) at 0 cm peat thickness is 95 grams per plant, 5–30 cm peat thickness is 138 grams; 30–60 cm peat thickness is 234 grams; 60–90 cm peat thickness is 237 grams; the weight of the fresh reed leaves at the 0 cm peat thickness is 74 grams per plant; 5–30 cm peat thickness is 95 grams; 30–60 cm peat thickness is 152 grams; 60–90 cm peat thickness is 187 grams. The weight of fresh reed flowers (Wff) at the 0 cm peat thickness is 6.8 grams per plant; 5–30 peat thickness is 9.31 grams; 30–60 cm peat thickness is 14.87 grams; 60–90 cm peat thickness is 21.44 grams.

- Statistical analysis with ANOVA the investigated indicators were all significantly diferent at the $\alpha = 0.05$, the p-value of indicators had less than 0.001.

- In general, the weight indicators increase with peat thickness such as weight of fresh reed plant total (Wft), fresh trunk of reed plant (Wftr), fresh leaves of reed plant (Wfl), fresh flowers of reed plant; these indicators increase with peat thickness. The result showed weight of a plant 176–423 grams, a plant stem 95–237 grams, a plant leaves 74–187 grams, a plant flowers 6.8–21.44 grams. This result showed the trunk have weight is highest.

Dry biomass

- Comments: The dry plant biomass showed (**Table 3**): The dry biomass total per plant (Wdt) at 0 cm peat thickness per plant is 127.34 grams, 5–30 cm is 181.01 grams, 30–60 cm is 312.42 grams, 60 -90 cm is 358.58 grams; The dry biomass of plant trunk (Wdtr) at 0 cm peat thickness per plant is 79.55 grams, 5–30 cm is 121.84 grams, 30–60 cm is 196.78 grams, 60–90 cm is 217.78 grams. The dry biomass of plant leaves at the 0 cm peat thickness per plant is 33.78 grams, 5–30 cm is 57.64 grams, 30 – 60 cm is 102.73 gram, 60–90 cm is 122.16 grams. The dry biomass of plant flowers at 0 cm peat thickness per plant is 4.4 grams, 5–30 cm is 7.53 gram, 30–60 cm is 12.91 grams, 60–90 cm is 19.64 grams.

Statistical analysis with ANOVA the investigated indicators were all significantly diferent at the $\alpha = 0.05$, the p-value of indicators had less than 0.001.

- In general, the weight indicators increase with peat thickness such as weight of dry reed plant total (Wdt), dry trunk of reed plant (Wftr), dry leaves of reed plant

Table 2. Fresh reed plant biomass.

No.	Peat Thickness	Wft (g)	Wftr (g)	Wfl (g)	Wff (g)
1	0 cm	176	95	74	6.8
2	5–30 cm	242	138	95	9.31
3	30–60 cm	391	234	152	14.87
4	60–90 cm	423	237	187	21.44
	α = 0.05	<0.00*	<0.00*	<0.00*	<0.00*

Note: <0.00: Significant different; 0.06N: No significant different*
Wft: Weight of total fresh reed plant
Wftr: Weight of fresh reed plant trunk
Wfl: Weight of fresh reed plant leaves
Wff: Weight of fresh reed plant flowers

Table 3. Dry reed plant biomass.

No.	Peat Thickness	Wdt (g)	Wdtr (g)	Wdl (g)	Wdf (g)
1	0 cm	127.34	79.55	33.78	4.4
2	5–30 cm	181.01	121.84	57.64	7.53
3	30–60 cm	312.42	196.78	102.73	12.91
4	60–90 cm	358.58	217.78	122.16	19.64
	α = 0.05	<0.00*	<0.00*	<0.00*	<0.00*

Note: <0.00: Significant different; 0.06N: No significant different*
Wdt: Weight of total dry reed plant
Wdtr: Weight of dry reed plant trunk
Wdl: Weight of dry reed plant leaves
Wdf: Weight of dry reed plant flowers

(Wfl), dry flowers of reed plant; these indicators increase with peat thickness. The results showed a dry plant from 127.34–358.58 grams, a dry plant stem 79.55–217.78 grams, a dry plant leaves 33.78–122.16 grams, a dry plant flowers from 4.4–19.64 grams. This results showed the trunk is highest.

Biochar of reed in U Minh Thuong

- Comments: The reed plant biochar (**Table 4**) showed: The reed biochar total per plant (Wbt) at 0 cm peat thickness per plant is 26.16 grams, 5–30 cm is 36.15 grams, 30–60 cm is 62.37 grams, 60–90 cm is 73.57 grams; The reed biochar of plant trunk (Wbtr) at 0 cm peat thickness per plant is 14.41 grams, 5–30 cm is 20.98 grams, 30–60 cm is 35.64 grams, 60–90 cm is 39.44 grams. The reed biochar of plant leaves at the 0 cm peat thickness per plant is 8.16 grams, 5–30 cm is 10.75 grams, 30–60 cm is 19.16 grams, 60–90 cm is 22.59 grams. The reed biochar of plant flowers at 0 cm peat thickness per plant is 2.59 grams, 5–30 cm is 4.42 grams, 30–60 cm is 7.58 grams, 60–90 cm is 11.54 grams.

Statistical analysis with ANOVA the investigated indicators were all significantly diferent at the α = 0.05, the p-value of indicators had less than 0.001.

In general, the weight indicators increase with peat thickness such as weight of the reed biochar of plant total (Wbt), weight of the reed biochar the reed trunk (Wbtr), the leaf biochar of reed plant (Wbl), the flower biochar of reed plant (Wbf); these indicators increase with peat thickness. The results showed (**Table 4**) a plant biochar 6.16–73.57 grams, a plant trunk biochar 14.41–39.44 grams, a plant leaf biochar 8.16–22.59 grams and a plant flower biochar 2.59–11.54 grams.

This results show (**Table 4**, **Figure 3**) the effectiveness of biochar is as follows: A dry plant/a plant biochar (a dry plant weight give a plant biochar) from 123.34/26.16–358.58/73.57 grams, a dry plant trunk/a trunk biochar from 79.55/14.41–217.78/39.44 grams, a dry plant leaves/a plant leaf biochar 33.78/8.16–122.16/22.59 grams, a dry plant flowers/a plant flower biochar 4.4/2.59–19.64/11.54 grams.

Figure 3. Reed biochar of trunk, leaves and flowers.

Table 4. Reed plant biochar.

No.	Peat Thickness	Wbt (g)	Wbtr (g)	Wbl (g)	Wbf (g)
1	0 cm	26.16	14.41	8.16	2.59
2	5–30 cm	36.15	20.98	10.75	4.42
3	30–60 cm	62.37	35.64	19.16	7.58
4	60–90 cm	73.57	39.44	22.59	11.54
	$\alpha = 0.05$	<0.00*	<0.00*	<0.00*	<0.00*

Note: <0.00: Significant different; 0.06N: No significant different*
Wbt: Weight of total reed plant
Wbtr: Weight of biochar on reed plant trunk
Wbl: Weight of biochar reed plant leaves
Wbf: Weight of biochar reed plant flowers

The results of biochar yield from dry plants are as follows (**Figure 3**): Biochar made a total dry plant 16.62–20.52%, made a dry plant trunk 18–18.11%, made a dry plant leaves 18.49–24.16%, made a dry plant flowers 58.76 – 58.86%, this results, the stem and the leaves is very importance are 18–24%.

Characteristic of peat soil thickness in U Minh Thuong

- Comments: Analysis of biochar chemical indicators in U Minh Thuong (**Table 5**) showed: The indicators such as humic acid increase with peat thickness 0 cm–90 cm is 6.06–18.85%; SO_4^{2-} is 0.082 mg/100g–0.036 mg/100g; P_2O_5 is 0.119%–0.063%; NH_4^+ is 17.4 mg/100g–13.9 mg/100g; pH is 4.1–4.47; nitrogen total from 0.17 to 0.72%; K_2O from 0.12–0.5%; Fe^{2+} from 0.82 mg/100g to 3.58 mg/100g.

Statistical analysis with ANOVA the investigated indicators were all significantly different at the $\alpha = 0.05$, the p-value of indicators had less than 0.001.

Chemical indicators that increase as peat thickness are humic acid, total nitrogen, potassium and Fe^{2+}; and its decrease as peat thickness increase are SO_4^{2-}, P_2O_5, NH_4^+.

Compare the chemical indicators of peat and biochar in U Minh Thuong National Park

- Comments: Analysis of chemical indicators of peat and biochar in U Minh Thuong national park showed (**Table 6**): pH of peat is 4.33 and biochar is 10.10; humic acid of peat is 17.27% and biochar 1.30%; Nitrogen of peat is 0.48% and biochar 0.18%; Phosphorus of peat is 0.08% and biochar is 0.40%; Potassium of peat is 0.34% and biochar is 0.71%, OM% organic matter of peat is 28.12% and biochar 34%.

pH of peat is 4.33 shows high acidity, biochar 10.10 shows high alkalinity; Humic acid of peat 17.27% and biochar 1.30% bigger than many times; Nitrogen of peat is 0.48% and biochar is 0.40% smaller; K_2O% Potassium of peat is 0.34% smaller biochar 0.71%; OM% organic matter of peat is 28.12% smaller biochar 34.82%. These results showed if combining peat and biochar in creating bio-organic fertilizer is effective.

Results in indicators of peatland and biochar (**Table 6**): pH biochar is alkaline; peat is acidic and can be mixed to become neutral; biochar humic acid 1.3% and peat 17.27%; biochar nitrogen 0.42% and peat 0.08%; biochar phosphorus is 0.42 and peat 0.08%; biochar potash is 0.71% and peat 0.34%; biochar organic matter OM% is 34.82% and pesat is 28.12%.

Between biochar and peatland have indicators higher and lower, so when mixed them together, they will promote the effectiveness of fertilizer.

Statistical analysis at a significance level of 0.05 means the above indicators are less than 0.001*.

Chemical indicators of Pig urine after filtering through reed biochar

- Comments: Giving 1000 ml of urine taken directly from pig water to filter through reed biochar with (Pi1 = 30 grams, Pi2 = 50 grams, Pi3 = 70 grams, Pi4 = 90 grams) showed (**Table 7**):

Pig urine no biochar to control pH of water is 8.8, as filter by 30 grams is 9.07, filter by 50 grams is 9.21, filter by 70 grams is 9.41, fliter by 90 grams is 9.53. This increase is due to the high alklinity of biochar (about pH = 10–11). Ammonium of pig urine is 150 milligrams per liter, filter by 30 grams biochar remaining is 140 milligrams, fliter by 50 gram biochar remaining is 135 milligrams, filter by 70 grams remaining is 134 milligrams, filter by 90 grams is remining is 130 milligrams. Nitrate (NO_2^- (mg/L) of pig urine is 1.5 milligrams/liter, filter by 30 grams biochar re-

Table 5. Characteristic of peat soil thickness in U Minh Thuong.

No.	Peat Thickness	Humic Acid (%)	SO_4^{2-} (mg/100g)	P_2O_5 (%)	NH_4^+ (mg/100g)	pH	Nt (%)	K_2O (%)	Fe^{2+} (mg/100g)
1	0 cm	6.06	0.082	0.119	17.40	4.32	0.17	0.12	0.82
2	5–30 cm	15.29	0.073	0.104	16.84	4.47	0.30	0.22	1.41
3	30–60 cm	17.67	0.060	0.080	15.89	4.42	0.42	0.30	2.13
4	60–90 cm	18.85	0.036	0.063	13.90	4.10	0.72	0.50	3.85
	α = 0.05	<0.00*	<0.00*	<0.00*	<0.00*	<0.00*	<0.00*	<0.00*	<0.00*

Note: <0.00: Significant different; 0.06N: No significant different*

Table 6. Compare the chemical indicators of peat and biochar in U Minh Thuong National Park.

No.	Material Type	pH	Humic Acid %	Nitrogen Total %	P_2O_5%	K_2O%	OM%
1	Peat	4.33	17.27	0.48	0.08	0.34	28.12
2	Biochar	10.10	1.30	0.18	0.40	0.71	34.82
	α = 0.05	<0.00*	<0.00*	<0.00*	<0.00*	<0.00*	<0.00*

Note: <0.00: Significant different; 0.06N: No significant different*

maining is 0.5 milligrams, filter 50 grams biochar remaining 0.55 milligrams, filter by 70 grams biochar remaining is 0.45 milligrams. Total nitrogen of pig urine is 984 mg/L, filter by 30 grams biochar is 860 milligram, filter by 50 grams is 838 milligrams, filter by 70 grams biochar is 821 milligrams, filter by 90 grams is 726 milligrams. Phosphoruss of pig urine is 48 milligrams, filter by 30 grams biochar is 17 milligrams, filter by 50 grams is 13 milligrams, filter by 70 grams is 10 milligrams, filter by 90 grams is 4 milligrams per liter. In other study reed biochar can removal of ammonium from water[14]. So it can reduce green house. In study low cost and easy rice husk modification to efficiently enhance ammonium and nitrate adsorption that can help to use reed biochar for agriculture[15].

Statistical analysis at a significance level of 0.05 means the above indicators are less than 0.001.

The results show that if the amount of biochar increases, the ability to retain more chemical indicators of livestock wastewater such as amonium, nitric, nitrogen and phosphorus increases.

- Comments: (**Table 8**, **Figure 4**) showed that filter by 30 grams of reed biochar can retain 10 milligrams of amonium, filter by 50 grams is 15 milligrams, filter by 70 grams is 16 milligrams and filter by 90 gram is 20 milligrams of amonium. Nitrate in filter by 30 grams is 0.9 milligrams, in filter by 50 grams biochar is 0.95 milligrams, in filter by 70 grams is 1 milligrams and infilter by 90 grams biochar is 1.5 milligrams. Total nitrogen, in fiter by 30 grams biochar is 124 milligrams, in filter by 50 grams biochar is 146 milligrams, in filter by70 grams biochar is 163 milligrams, in filter by 90 grams biochar is 258 milligrams.

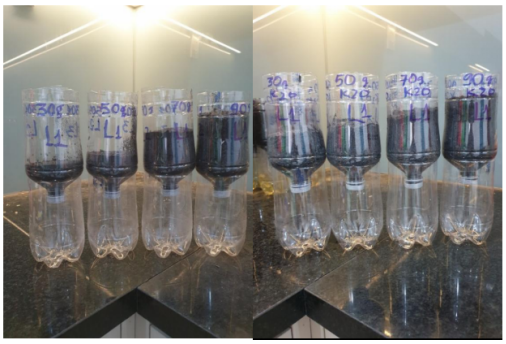

Figure 4. Adsorption filter for pig feed water and inorganic fertilizer.

- Comments: Mix 1000 mililiter water and 10 grams phosphorus 16% (**Table 9**) begin no filter biochar is 448 milligrams, in filter by 30 grams biochar is 443 milligrams, in filter by 50 grams is 441 milligrams, in filter by 70 grams is 438 milligrams and in filter by 90 grams biochar is 432 milligrams. Thus, when phosphorus water passes through biochar more phosphorus be lost and remaining[16].

N0: Mix 1000 mililiters of water with 10 grams of 46% nitrogen

N1: Water mixed with nitrogen filtered through 30 grams of reed biochar

N2: Water mixed with nitrogen filtered through 50 grams of reed biochar

N3: Water mixed with nitrogen filtered through 70

Table 7. Chemical indicators of Pig urine after filtering through reed biochar.

No.	Material Type	pH	NH_4^+ (mg/L)	NO_3^- (mg/L)	Total Nitrogen (mg/L)	Phosphorus (mg/L)
1	Pig urine (Pi0)	8.8	150	1.5	984	48
2	Pig urine (Pi1)	9.07	140	0.6	860	17
3	Pig urine (Pi2)	9.21	135	0.55	838	13
4	Pig urine (Pi3)	9.41	134	0.5	821	10
5	Pig urine (Pi4)	9.53	130	0.45	726	4
	α = 0.05	<0.00*	<0.00*	<0.00*	<0.00*	<0.00*

Note: <0.00: Significant different; 0.06N: No significant different*
Pi0: Pig urine without filtring reed biochar
Pi1: Pig urine when filtered 1000 milliliters with 30 grams biochar
Pi2: Pig urine when filtered 1000 milliliters with 50 grams biochar
Pi3: Pig urine when filtered 1000 milliliters with 70 grams biochar
Pi4: Pig urine when filtered 1000 milliliters with 90 grams biochar

Table 8. Content of chemical indicators of pig urine lost after filtering through reed biochar

No.	Material Type	NH_4^+ (mg/L)	NO_2^- (mg/L)	Total Nitrogen (mg/L)	Phosphorus (mg/L)
1	(Pi0)–(Pi1)	10	0.9	124	31
2	(Pi0)–(Pi2)	15	0.95	146	35
3	(Pi0)–(Pi3)	16	0.1	163	38
4	(Pi0)–(Pi4)	20	0.15	258	44

Pi0–Pi1: Content of pig urine water indicators lost after filtering through 30 grams biochar
Pi0–Pi2: Content of pig urine water indicators lost after filtering through 50 grams biochar
Pi0–Pi3: Content of pig urine water indicators lost after filtering through 70 grams biochar
Pi0–Pi4: Content of pig urine water indicators lost after filtering through 90 grams biochar

grams of reed biochar

N4: Water mixed with nitrogen filtered through 90 grams of reed biochar

- Comments: As above, mixed 1000 milliliters of water

Table 9. Remaining chemical indicators of phosphorus and nitrogen dissolved water after filtering through reed biochar.

No.	Material Type	Phosphorus (mg/L)	No.	Material Type	Nitrogen (mg/L)
1	P0	448	1	N0	556
2	P1	443	2	N1	549
3	P2	441	3	N2	543
4	P3	438	4	N3	424
5	P4	432	5	N4	364
	α = 0.05	<0.00*		α = 0.05	<0.00*

Note: <0.00: Significant different; 0.06N: No significant different*
P0: Mix 1000 mililiters of water with 10 grams of 16 % phosphorus
P1: Water mixed with nitrogen filtered through 30 grams of reed biochar
P2: Water mixed with nitrogen filtered through 50 grams of reed biochar
P3: Water mixed with nitrogen filtered through 70 grams of reed biochar
P4: Water mixed with nitrogen filtered through 90 grams of reed biochar

with 10 grams nitrogen 46% (**Table 9**) begin no biochar is 556 milligrams, in filter by 30 grams biochar is 549 milligrams, in filter by 50 grams is 543 milligrams, in filter by 70 grams is 424 milligrams and in filter by 90 grams biochar is 364 milligrams. Thus, when nitrogen water passes through more nitrogen it be lost and remaining.

- Comments: Phosphorus water as filtered through reed biochar is retained as follows (**Table 10**): In filter by 30 grams is 5 milligrams, in filter by 50 grams biochar is 7 milligrams, in filter 70 grams biochar is 10 milligrams, in filter by 90 grams biochar is 26 milligrams phosphorus remaining. The study effectiveness of reed biochar in mitigating phosphorus dynamics in paddy soil it can use biochar like fertilizer in crops [17, 18].

N0–N1: Content of nitrogen lost after filtering through 30 grams of reed biochar

N0–N2: Content of nitrogen lost after filtering through 50 grams of reed biochar

N0–N3: Content of nitrogen lost after filtering through 70 grams of reed biochar

N0–N4: Content of nitrogen lost after filtering through 90 grams of reed biochar

Table 10. Content of chemical indicators lost of nitrogen dissolved water after filtering through reed biochar.

No.	Material Type	Phosphorus (mg/L)	No.	Material Type	Nitrogen (mg/L)
1	P0–P1	5	1	N0–N1	7
2	P0–P2	7	2	N0–N2	13
3	P0–P3	10	3	N0–N3	32
4	P0–P4	26	4	N0–N4	92

P0–P1:Content of phosphorus lost after filtering through 30 grams of reed biochar
P0–P2: Content of phosphorus lost after filtering through 50 grams of reed biochar
P0–P3: Content of phosphorus lost after filtering through 70 grams of reed biochar
P0–P4: Content of phosphorus lost after filtering through 90 grams of reed biochar

- Comments: Nitrogen water as filtered through reed biochar is retained and remaining as follow (**Table 10**): in filter 30 grams is 7 milligrams, in filter by 50 grams of reed biochar is 13 milligrams, in filter by 70 grams of reed biochar is 32 milligrams, infilter by 90 grams of reed biochar is 92 milligrams nitrogen remaining. Adsorption of ammonium on biochar prepared from gaint reed[19] it can use reed biochar in this experiment for fertilizer rice crops.

Mixed fertilizres

- Comments: Mixed Nitrogen, phosphorus and potash with reed biochar (**Table 11**) showed after 5 days and 10 days. The indicators N%, P% and K% after statistical analysis at a significance level of 0.05 means the above indicators are less than 0.000. The indicators after statistical analysis at a not significance are organic matter OM%, Ca%, Mg%, SiO%. This result shows that biochar of reed that it can stabilize nitrogen in biochar so it can be used to mix fertilizer for agriculture.

Table 11. Mixed Nitrogen, phosphorus and Potash with biochar.

No.	Days	OM%	Humic Acid	N%	P%	K%	Ca%	Mg%	SiO%
1	5 days	34.48	1.36	0.85	1.94	9.03	0.13	0.15	4.40
2	10 days	35.48	1.23	1.26	2.10	7.05	0.17	0.14	4.39
3	Control	36.52	1.29	0.19	0.39	0.69	0.16	0.14	4.25
	α = 0.05	0.21 N	0.24 N	<0.00*	<0.00*	<0.00*	0.1 N	0.91 N	0.58 N

Note: <0.00: Significant different; 0.06N: No significant different*

- Comments: Mixed agricultural mineral fertilizer 16% N, 16% P, 8% K and biochar (**Table 12**): Mixed 10% (16% N 16% p 8% K) and 90% biochar kept after 5 days and 10 days compare control. Organic matter and humic acid are not statistical significantly different. The indicators as N%, P%, K%, Ca%, Mg%, SiO% are different compare control. With nitrogen, phosphorus and potash are main components of fertilizer can exist effectively in biochar after 5–10 days, it can use to add mineral fertilizer to biochar fertilizer.

- Comments: Another type of fertilizer in agriculture mineral fertilizer 20% N 20% P 15% K mixed with biochar (**Table 13**): Results show the indicator SiO% is not different in statistical significant. The other indicators as organic matter, humic acid, N%, P%, K%, Ca%, Mg% are higher compare control. It can use for mixed them in agricultural fertilizer.

- Comments: Mixed biochar, peatland with NPK (**Table 14**): Results show the indicators as humic acid and SiO% are not different statistical significant; The other indicators are OM%, N%, P%, K%, Ca%, Mg% they are different compare with control. The indicators N%, P%, K% that have nutrient requirement, they retained in biochar after 5–10 days.

Table 12. Mixed Nitrogen 16%, phosphorus 16% and Potash 8% with biochar.

No.	Days	OM%	Humic Acid	N%	P%	K%	Ca%	Mg%	SiO%
1	5 days	35.46	1.12	0.79	2.21	11.45	0.18	0.15	4.32
2	10 days	35.58	1.34	1.39	2.20	13.32	0.11	0.11	4.69
3	Control	36.13	1.29	0.19	0.39	0.69	0.12	0.12	4.25
	α = 0.05	0.71 N	0.07 N	<0.00*	<0.00*	<0.00*	0.00*	0.04*	<0.00*

Note: <0.00: Significant different; 0.06N: No significant different*

Table 13. Mixed Nitrogen 20%, phosphorus 20% and Potash 15% with biochar.

No.	Days	OM%	Humic Acid	N%	P%	K%	Ca%	Mg%	SiO%
1	5 days	34.48	1.32	1.06	2.26	15.47	0.18	0.17	4.64
2	10 days	37.25	1.24	2.35	1.96	7.55	0.11	0.10	4.47
3	Control	36.13	0.19	0.39	0.39	0.69	0.16	0.12	4.25
	α = 0.05	<0.00*	<0.00*	<0.00*	<0.00*	<0.00*	<0.00*	0.00*	0.38 N

Note: <0.00: Significant different; 0.06N: No significant different*

Table 14. Mixed Biochar, Peatland with NPK (10g 20% Nitrogen. 20% Phosphorus. 15% Potash).

Days	Biochar Ratio	OM%	Humic Acid	N%	P%	K%	Ca%	Mg%	SiO%
5 days	Formula 1	33.67	1.32	5.48	8.34	15.47	0.18	0.17	4.64
5 days	Formula 2	33.69	1.27	4.52	7.57	9.17	0.14	0.12	4.07
5 days	Formula 3	37.24	1.13	2.17	4.11	8.64	0.10	0.18	4.65
5 days	Formula 4	37.38	1.24	0.61	3.15	6.28	0.18	0.17	4.26
10 days	Formula 5	34.48	1.25	4.32	6.16	15.70	0.10	0.10	4.47
10 days	Formula 6	33.69	1.27	3.62	5.02	10.13	0.15	0.12	4.25
10 days	Formula 7	37.24	1.23	1.81	2.89	7.55	0.12	0.13	3.34
10days	Formula 8	37.38	1.36	0.91	2.19	6.10	0.12	0.11	4.56
Control	Formula C	36.13	1.29	0.19	0.39	0.69	0.15	0.12	4.25
	α =0.05	<0.00*	0.17 N	<0.00*	<0.00*	<0.00*	<0.00*	0.00*	0.62 N

Note: <0.00: Significant different; 0.06N: No significant different*

Planting watermelon by mixed biochar, peat and inorganic mineral fertilizer

- Comments: Watermelon growth after using mixed biochar fertilizer with 10g/plant for each formula after 30 days (**Table 15**, **Figure 5**): Results in 7 formulas from formula 2 to formula 8 is formula 5 (50g Biochar + 40g Peatland + 10g [Nitrogen 20% + Phosphorus 20% + Potash 15%]) reached stem length 248 centimeter, it is the best of them. The growth in dicators in (**Table 16**) also highest. The other formulas are better than compare control in formula 1. Most of indicators statistical analysis at a significance level of 0.05 means the above indicators are less than 0.000* and 0.05*. Only indicators number of flower buds is 0.53 N not different significant.

- Comments: Watermelon growth after using mixed biochar fertilizer after 70 days show (**Table 16**, **Figure 6**): Fertilized as formulas from 1 to 8. For growth status compare formula 1 (control) with all of formulas are higher for stem length, fruit length, fruit width, fruit weight, physis in fruit, fruit color, sweetness level.

Figure 5. Watermelon fertilized mixed biochar fertilizers after 30 days.

Figure 6. Watermelon fertilized mixed biochar fertilizers after 70 days.

Table 15. Watermelon growth using mixed biochar fertilizer after 30 days.

Formula	Stem length (Lst.) (cm)	Number of Leaves (Lno.)	Leaf Length (Lle.) (cm)	Leaf Width (Wfr.)	Number of Flowers (Few.)	Number of Flower Bud (Bno.)	Leaf Color (Lco.)
Formula 1	98.78	22.44	11.81	10.30	3.33	1.18	3
Formula 2	235.96	34.33	14.92	12.63	6.07	1.89	5
Formula 3	232.11	34.81	15.30	13.26	6.07	2.07	5
Formula 4	242.15	36.67	15.56	13.37	6.59	2.22	5
Formula 5	248.04	32.99	15.41	13.04	6.59	2.04	5
Formula 6	236.04	34.93	14.70	12.34	6.37	2.00	5
Formula 7	222.26	32.85	15.26	12.96	5.07	1.85	5
Formula 8	232.93	35.19	15.70	13.41	5.85	2.29	5
α = 0.05	<0.00*	<0.00*	0.017*	0.022*	0.012*	0.53 N	<0.00*

Note: <0.00: Significant different; 0.06N: No significant different*
Formula 1: 100g Biochar (Control)
Formula 2: 4g Nitrogen 46% + 3g phosphorus 61 % + 3g Potash 61% (10g NPK+ 90 g Biochar = 100g fertilizer)
Formula 3: 10g (Nitrogen 16% + Phosphorus 16% + 8%) + 90g Biochar = 100g fertilizer
Formula 4: 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%) + 90g Biochar = 100g fertilizer
Formula 5: 50g Biochar + 40g Peatland + 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%)
Formula 6: 60g Biochar + 30g Peatland + 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%)
Formula 7: 70g Biochar + 20g Peatland + 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%)
Formula 8: 80g Biochar + 20g Peatland + 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%)

Statistical analysis for leaf color in all of formulas is not different significant. In formulas have 4 and 5 is good indicators, but formulas 5 is the best, nearly 3 kilogram/fruit compared Thai Binh province 3.59–4.18 kilogram [18]. We can select formula 5 to develop fertilizer in agriculture for watermelon in Mekong Delta.

Table 16. Watermelon growth using mixed biochar fertilizer after 70 days.

Formula	Stem Length (Lst.) (cm)	Leaf Color (Lco.) (1–5)	Fruit Length (Fle.) (cm)	Fruit Width (Fwi.) (cm)	Fruit Weight (Fwe.) (gr.)	Physis in Fruit (Pfr.) (1–5)	Fruit Color (Fco.) (1–5)	Sweetness Level (Sle.) (1–5)
Formula 1	275	4	19.7	9.58	1910	3.33	3	3
Formula 2	321	4.89	25.59	12.70	2808	4.67	5	5
Formula 3	336	4.67	26.55	13.33	2898	4.67	4.33	4.33
Formula 4	360	4.78	27.78	13.74	2987	4.67	4.67	4.67
Formula 5	372	5	27.41	13.63	2952	5	5	5
Formula 6	360	5	24.44	12.89	2858	5	5	5
Formula 7	341	4.67	26.48	13.30	2908	4.33	4.33	4.33
Formula 8	341	4.67	26.22	13.11	2866	5	5	5
α = 0.05	0.00*	0.11 N	0.02*	<0.00*	0.00*	0.02*	<0.00*	<0.00*

Note: <0.00: Significant different; 0.06N: No significant different*
Formula 1: 100g Biochar (Control)
Formula 2: 4g Nitrogen 46% + 3g phosphorus 61 % + 3g Potash 61% (10g NPK+ 90 g Biochar = 100g fertilizer)
Formula 3: 10g (Nitrogen 16% + Phosphorus 16% + 8%) + 90g Biochar = 100g fertilizer
Formula 4: 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%) + 90g Biochar = 100g fertilizer
Formula 5: 50g Biochar + 40g Peatland + 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%)
Formula 6: 60g Biochar + 30g Peatland + 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%)
Formula 7: 70g Biochar + 20g Peatland + 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%)
Formula 8: 80g Biochar + 20g Peatland + 10g (Nitrogen 20% + Phosphorus 20% + Potash 15%)

4. Discussion

- The reed growth and biomass: The reed grows every year at the beginning of the rainy season and when the reed flowers are ripe at the end of the dry season. The amount of growth and biomass is very high [20, 21], so it is an abundant source of renewable raw materials. In the U Minh Thuong National Park investigated fresh growth indicators are height from 3.39–4.47 meters; the reed diameter measured from 1.8–3.17 centimeters; the density of plants counted from

49–87 plants per square meter; the average volume is from 0.04–0.10 cubic meter per square meter; the average weight is from 15.46–20.54 kilograms per square meter. With such amount of fresh biomass, it will have promising potential for useful biomass usage.

- Harvesting mature reeds (flowers are completely ripe) in March 2024, separate into stems, leaves and flowers; then weigh them into separate of sampling results to different peat thickness. The results showed that the peat thickness from 0–90 cm as follows: Total weight from 127.34–358.58 grams per plant; the reed trunk weight from 79.55–217.78 grams per plant; the leaf weight from 33.78–122.16 grams; the flower weight from 4.4–19.64 grams per plant. The dry biomass composition of reeds by weight as a source of raw materials for future biochar production.

- Investigate biochar on each plant by controlled burning of part at the biochar formation stage and then cutting oxygen to get reed biochar gave the following results: Biochar weight per plant from 26.16–73.57 grams, The trunk biochar of the plant from 14.41–39.44 grams, the weight of leaf biochar per plant from 8.16–22.59 grams, The weigh of flower biochar from 2.59–11.54 grams. Knowing the biochar on each reed plants helps us to evaluate exploitation on the potential for reed biochar, in investigate the density on different peat thickness help us evaluated the amount of biochar available that can be exploited per unit area and also make a basis planning of biochar exploitation for agriculture and environment.

- Researching the chemical properties to peat thickness helps us understand the chemical composition of peat from 0–90 cm the following chemical properties: The indicators decreased are P2O5 from 0.119 decreased 0.063, the sulfuric acid from 0.082 decreased 0.036 mg/100g; Ammonium (NH_4^+) from 17.40 decreased 13.80mg/100g. Indicators increase with peat thickness such as: Humic acid from 6.06%–18.85%, total nitrogen from 0.17%–0.72%, potassium (K_2O) from 0.12%–0.050%, Iron (Fe^{2+}) from 0.82%–3.85%. The chemical properties of peat soil are related to the growth and biomass of the reeds distributed on it. This research helps to understand the peat soil factors in the reed vegetation in which they grow.

- Reed biochar has the ability to retain chemical elements of wastewater discharged from pig farm. In study reed plant (*Phragmites australis*) and its biochar were tested treatment wastwater, biochar improved wastwater quality to the medium quality grade [22, 23]. The elements it retains in the form of adsorption are ammonium and nitric, total nitrogen, and phosphorus. Two elements capable of reducing environmental emission are ammonium and nitric. Biochar of reed as soil improvement is when using biochar in agriculture [24]. Meanwhile, two elements that can potentially contribute to agriculture through organic biofertilizers are nitrogen and phosphorus.

- Biochar also has the ability to adsorb inorganic minerals such as phosphorus and nitrogen, which are two main components of inorganic fertilizers and pig urine filter with biochar showed many results; in study biochar from giant reed (*Arundo donax* L.) at 300 – 600 °C it can release of N, P and K and adsorption of N and P [25], so when using reed biochar in agriculture, it helps promote fertilizer efficiency and avoid losses due to evaporation and leaching waste fertilizer on plants, because biochar has the ability to retain it for plants to absorption.

- Mixed inorganic mineral fertilizer as nitrogen, phosphorus and potash with biochar and mixed biochar, peat and inorganic mineral fertilizer after five days and ten days after that analysis chemical. Its results can keeping nitrogen, phosphorus, potash very high in mixed fertilizer, this is basin to use them for planting in agriculture

- Using mixed inorganic mineral fertilizer with biochar and mixed biochar, peat with inorganic mineral fertilizer with many formulas compare biochar to planting watermelon. Result formulas with biochar, peat are growing high and biochar with inorganic are also high. This result helps us use biochar of reed to make fertilizer for agriculture

5. Conclusions

- The growth and biomass on reed plants in U Minh Thuong National Park is very high, it is an annual renewable material source, the average reserve is from 0.04–0.1 cubic meters per square meter. The dry weight of a reed plant from 127.34–358.58 grams with density very high.

- Biochar made from dry reed plants gives the following results: The weight of a plant biochar from 26.16–73.57 grams, the weight of a plant trunk biochar highest compare leaves and flowers of biochar.

- Chemical composition analysis according to peat

thickness where reed species are distributed shows that as peat thickness increases, chemical indicators also increase and decrease in two directions; the decrease indicators are P_2O_5, SO_4^{2-}, NH_4^+ and the increase indicators with peat thickness are humic acid, pH, Nitrogen total, K_2O, Fe^{2+}.

- Compare the chemical components of peat and biochar in U Minh Thuong National Park shows that biochar has lower indicators such as humic acid %, nitrogen total%, but there are also higher such as phosphorus P_2O_5%, potassium K_2O% and organic matter OM%.

- Reed biochar has the ability to retain chemical indicators of wastewater from pig farm in pig urine, the substances it is able are ammonium, nitrate, nitrogen, phosphorus; it helps to prevent environmental emission and provide nutrients for plants. At the same, it has the ability adsorb two inorganic minerals, nitrogen and phosphorus to help using inorganic biofertilizers effectively.

- Using mixed inorganic mineral fertilizer with biochar and mixed biochar, peat with inorganic mineral fertilizer with many formulas compare biochar to planting watermelon. Its results can help us to use biochar to make fertilizer and planting watermelon with growing well.

Author Contributions

Conceptualization, L.T.T.; methodology, L.T.T.; software, N.T.H.D., T.V.N., M.D.; validation, L.T.T., M.D., T.V.N.; formal analysis, L.T.T., N.T.H.D., T.V.N.; investigation, L.T.T., T.V.N.; resources, L.T.T., M.D., T.V.N.; data curation, L.T.T., M.D.; writing—original draft preparation, L.T.T.; writing—review and editing, L.T.T.; visualization, L.T.T.; supervision, L.T.T.; project administration, L.T.T.; funding acquisition, L.T.T., M.D. All authors have read and agreed to the published version of the manuscript.

Funding

This work received no external funding.

Institutional Review Board Statement

This study not involving humans or animals.

Informed Consent Statement

Where data supporting reported results can be found Kien Giang University, U Minh Thương National Park, Department of Agriculture and Environment in Kien Giang province.

Acknowledgments

Thank you for helps by Ministry Ministry of Education Training (Grand number, B2024-TKG-01); Le Huu Toan, Director of Department of Agriculture and Evironment in Kien Giang province; Hoang Van Tuan, Director and Pham Van Dien staff of UMT National Park who went the field to survey with staff of Kien Giang University; Nguyen Van Thanh, Rector of Kien Giang University, Vietnam. This study supported by the Ministry of Education Training under grand number, B2024 – TKG-01.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Vietnam Nature Conservation Center, 2004. U Minh Thuong National Park. In: Information Book on Existing and Proposed Protected Areas in Vietnam. Vietnam Nature Conservation Center: Hanoi, Vietnam.

[2] Van, D.X., 2007. Research on the distribution, growth and development of (*Phragmites australis*) on ore mining land in Thai Nguyen province.

[3] Obreja, C.D., Buruiana, D.L., Mereuta, E., et al., 2023. Detection of Reed Using CNN Method and Analysis of the Dry Reed (*Phragmites australis*) for a Sustainable Lake Area. European Journal of Plant Pathology (Plant methods). 19(1), 61. DOI: https://doi.org/10.1186/s13007-023-01042-w

[4] Trinh, M.V., 2013. Research on biochar production from rice straw and rice husk to improve soil fertility, crop productivity and reduce greenhouse emissions.

[5] Son, N.H., 2015. Research on the posibility of using boichar to replace manure and inorganic fertilizers in rice production.

[6] Nghia, N.D., 2014. The role of Biochar in effective biochar production and application. Department and Technology: Ho Chi Minh City, Vietnam.

[7] Obolewski, K., Strzelczak, A., Kiepas-Kokot, A., 2007. Chemical composition of Reed Phragmites australis (Cav.) Trin. Ex. Steud. Verus Density and Structure of Periphyton in Various Aquatic Ecosystems. Journal of Elementology. 12(1), 63–79.

[8] Khajavi-Shojaei, S., Moezzi, A., Norouzi Masir, M., et al., 2019. Study of Ammonium and Nitrate Adsorption Kinetics and Isotherm by Com-

mon reed (*Phragmites australis*) biochar from Aqueous Solution (in Persian). Iranian Journal of Soil and Water Research. 50(8), 2009–2021. DOI: https://doi.org/10.22059/iiswr.2019.274777.668111

[9] UMTNP, 2022. Investigation Report on Peatland of U Minh Thương National Park 2022. UMTNP: Kuantan, Malaysia.

[10] Nong N.N., 2015. Land Evaluation. University National of Ho Chi Minh City.

[11] De Vos, B., Lettens, S., Muys, B., et al., 2007. Walkley-Black analysis of forest soil organic carbon: Recovery, limitations and uncertainty. Soil Use and Management. 23, 221–229. DOI: https://doi.org/10.1111/j.1475-2743.2007.00084.x

[12] Bao, H., 2009. Statistics in Forestry. Apply Software Statgraphics Centurion and MS. Tay Nguyen University. Buon Ma Thuot, Vietnam.

[13] Bao, H., 2015. Statistical analysis in experimental forestry research - Forest resource management - environment.

[14] Zhang, M., Sun, R., Song, G., et al., 2022. Enhanced removal of ammonium from water using sulfonated reed waste biochar-A lab-scale investigation. Environmental Pollution.

[15] Mathurasa, L., Damrongsiri, S., 2018. Low cost and easy rice husk modification to efficiently enhance ammonium and nitrate adsorption. International Journal of Recycling of Organic Waste Agriculture. DOI: https://doi.org/10.1007/s40093-018-0200-3

[16] Wang, Y., Zhang, Y., Zhao, H., et al., 2022. The effctiveness of reed biochar in mitigating phosphorus loses and enhangcing microbially driven phosphorus dynamics in paddy soil. Journal of Environmental Management. 314(1–2), 115087. DOI: https://doi.org/10.1016/j.jenvman.2022.115087

[17] Hou, J., Huang, L., Yang, Z., et al., 2016. Adsorption of ammonium on biochar prepared from giant reed. Environmental Science and Pollution Research. 23(19). DOI: https://doi.org/10.1007/s11356-016-7084-4

[18] Qi, Y., Zhong, Y., Luo, L., et al., 2023. Preparation of Reed Biochar and Study on Its Phosphorus Adsorption Characteristics. Journal of Environmental Engineering. 149(8), 04023036.

[19] Wu, C., Wang, M., Wang, C., et al., 2023. Reed biochar improved the soil functioning and bacterial interactions: A bagging experiment using the plantation forest soil (*Fraxinus chinensis*) in the Xiong'an new area, China. Journal of Cleaner Production. 410, 137316. DOI: https://doi.org/10.1016/j.jclepro.2023.137316

[20] Engloner, A.I., 2009. Structure, Growth Dynamics and Biomass of Reed (*Phragmites australis*) - a Review. Flora. 204(5), 331–346. DOI: https://doi.org/10.1016/j.flora.2008.05.001

[21] Asaad, A.A., El-Hawary, A.M., Abbas, M.H., et al., 2022. Reclamation of wastewater in wetlands using reed plants and biochar. Scientific Reports. 12, 19516. DOI: https://doi.org/10.1038/s41598-022-24078-9

[22] Karlsson, A., Fagerstrom, P., 2021. Blue Growth: Applications and properties of biochar made out of reed [Bachelor's thesis]. KTH Royal Institute of Technology: Examensarbete Inom Teknik, Grundniva, 15 HP. Stockholm, Sweden.

[23] Zheng, H., Wang, Z., Deng, X., et al., 20132. Characteristics and nutrient values of biochars produced from giant reed at different temperatures. Bioresource Technology. 130, 463–471. DOI: https://doi.org/10.1016/j.biortech.2012.12.044

[24] Dung, D.T., et al., 2019. Research on watermelon cultivation methods in Thai Binh proviceprovince. Vietnam Agricultural Science and Technology Journal. 12(109).

[25] Zhao, Y., Huang, L., Chen, Y., 2017. Biochars derived from giant reed (*Arundo donax* L.) with different treatment: characterization and ammonium adsorption potential. Environmental Science and Pollution Research. 24, 25889–25898. DOI: https://doi.org/10.1007/s11356-017-0110-3