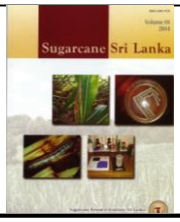
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RESEARCH

A Comparison of the Effect of Sugarcane Bagasse-Based Biochar and Boiler Ash on Soil Physicochemical Properties and Initial Growth of Sugarcane

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ABSTRACT

Long-term sugarcane monoculture degrades soil. Applying sugarcane by-products can improve soil properties. This study compared the effects of sugarcane bagasse-based boiler ash versus bagasse-based biochar on soil physicochemical properties and initial growth of sugarcane variety SL 96 128. A pot experiment was conducted under shade house conditions using a randomized complete block design with four replications. Treatments consisted of four application rates of biochar and boiler ash (1, 2, 4, and 6 t ha^{-1}) along with the recommended N: P: K rates for sugarcane, recommended N: P: K rates only, and a zero-amendment as control. Plant growth performance and soil physicochemical properties were assessed three months after planting. The results indicated that the application of biochar and boiler ash improved nutrient availability to sugarcane plants. Both biochar and boiler ash amendments exhibited similar effects, while the zero-amendment control was found to be inadequate for the sugarcane variety SL 96 128. Regarding pH buffering capacity, the highest application rate of boiler ash (6 t ha^{-1}) resulted in low buffering capacity, suggesting that boiler ash should be applied under well-monitored conditions. Nevertheless, the application of boiler ash up to 6 t ha^{-1} combined with recommended chemical fertilizers showed no negative impact on sugarcane plants within the first three months. Further studies are required to evaluate the effects of boiler ash on soil physicochemical properties and sugarcane growth under field conditions.

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INTRODUCTION

Sugarcane is one of the crops which removes a higher amount of nutrients from the soil and continuous cultivation can be affected crop sustainability [1]. Approximately, the average nutrient removal is about 15 kg/ha of Nitrogen, 38.91 kg/ha Phosphorous, 347.76 kg/ha of Potassium, 76.45 kg/ha of Calcium and 48.92 kg/ha of Magnesium at the harvesting of sugarcane crop [2]. Therefore, the management of soil fertility in sugarcane is a key component to maintaining its productivity.

The soil physical, chemical and biological properties determine the fertility level of the soil [3] and deterioration of those properties leads to soil degradation directly. Under Sri Lankan conditions, the long-term monoculture of sugarcane can lead to soil degradation and the identification of correct methods to improve sugarcane growing soils is timely required. Organic amendments play a vital role for enhance soil physical, chemical and biological properties for improving soil fertility [3]. Soil incorporation of biochar as a soil amendment in agriculture is a proven strategic technique to improve soil physical, chemical and biological properties [4]. The application of biochar can improve soil porosity, water holding capacity and decrease the soil bulk density [5]. Biochar is produced through a pyrolysis process [6]. Production of biochar is energy consuming process and the application of a large amount of biochar to the sugarcane growing fields is somewhat difficult to achieve. Therefore, as a solution for that, sugarcane wastes can be used as soil amendments to enhance soil's physical and chemical properties [7].

In the manufacturing process of sugar, several by-products such as bagasse, molasses, filter-mud and vinasse are produced. Out of those, at the factory level, bagasse is utilized for the cogeneration process and it produces another by-product called boiler ash [8]. In the Sri Lankan sugar manufacturing process, up to 3-5% of the total weight of sugarcane bagasse is utilized in the cogeneration process and can be produced as sugarcane boiler ash [9]. All the functioning sugar mills in Sri Lanka are facing the problem of the correct handling of sugarcane boiler ash in a recyclable manner. Improper disposal of boiler ash may create considerable environmental issues [10] and it can pose a huge threat to the ecosystem [7].

Boiler ash has the ability to provide a significant amount of macro and micronutrients to the soil such as Potassium (K), Phosphorous (P), Magnesium (Mg), Copper (Cu), Sulphur (S) and Ferrous (Fe) for plant nutrient aspects [7]. The direct application of the boiler ash to the soil as an organic amendment can enhance the soil's physical properties including water-holding capacity and soil porosity [7]. Further, it declines the dry bulk density of soil and it is important to improve plant root growth [7]. However, the soil chemical parameters such as pH and Electrical conductivity (EC) of soil can be increased by a considerable level when the application of boiler ash [11]. Therefore, the direct application of boiler ash into the soil should be done carefully. However, only limited information is available on sugarcane bagasse-based boiler ash and its utilization as a soil amendment in Sri Lanka. Hence, this study was carried out to identify the correct levels of boiler ash for direct soil application and its consequences in sustainable soil management for environmental and economic aspects.

MATERIALS AND METHODS

The sugarcane bagasse and boiler ash were collected from the Lanka Sugar Company Private Limited, Pelwatte. Biochar was prepared from the sugarcane bagasse through the barrel method. The soil was collected from SRI research farm at Uda Walawe. Chemical analyses of biochar and boiler ash were done to find their chemical composition. The experiment was conducted at the Crop Nutrition Division, Sugarcane Research Institute (SRI) Uda Walawe located at 6° 24'N, 80° 49'E and 74 m above sea level.

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Table 1. Treatments of pot experiment

Treatment number	Treatment
T1	1.0t/ha Biochar + N:P:K recommendation of SRI
T2	2.0t/ha Biochar + N:P:K recommendation of SRI
T3	4.0t/ha Biochar + N:P:K recommendation of SRI
T4	6.0t/ha Biochar + N:P:K recommendation of SRI
T5	1.0t/ha Boiler ash + N:P:K recommendation of SRI
T6	2.0t/ha Boiler ash + N:P:K recommendation of SRI
T7	4.0t/ha Boiler ash + N:P:K recommendation of SRI
T8	6.0t/ha Boiler ash + N:P:K recommendation of SRI
T9	N:P:K recommendation of SRI (control-1)
T10	Zero amendments (control-2)

Note: (N: P: K recommendation of SRI: Urea-300kg/ha, Muriate of Potash-225kg and Triple Super Phosphate-50kg/ha)

Experimentation

Ten treatments were established with four replicates in a Randomized Complete Block Design (RCBD) to study the effect of sugarcane bagasse-based biochar and boiler ash on soil physical properties and initial growth of sugarcane (Table: 1). Under shade house conditions, variety of SL 96 128 single-budded sets of sugarcane was grown in the pots. Plants were grown in each and every treatment replicate to compare the effect of sugarcane bagasse-based boiler ash and biochar on soil physical and chemical properties and the initial growth of the variety SL 96 128.

Data collection

Soil samples of the pot experiment were taken at the beginning without applying treatments and after three months after planting to analyze the soil physical and chemical parameters. The prepared soil samples were analyzed for physicochemical parameters including EC, pH, CEC, organic carbon content, total N, available P, exchangeable K, Available Zn, Cu, Fe, water holding capacity and soil bulk density. After 3 months of planting, the plant height, shoot dry weight, root dry weight and total dry weight of plants.

Soil, biochar, boiler ash analysis

Collected soil samples, biochar and boiler ash were analyzed for the identification of their chemical and physical properties by following standard analytical procedures. Soil texture was determined through hydrometer method. Soil water holding capacity was determined through percolation method. Soil bulk density was determined through core sampler method. The chemical parameter, soil cation exchange capacity was analyzed through 95% ethanol and standard Na stock solution method. pH was determined by using the 1:2.5 soil to water suspension method by using pH meter (pH/EC meter Model HQ40d. EC was determined using 1:5 soil to water ratio method by using the electrode of EC meter (pH/EC meter Model HQ40d) by immersing it into the supernatant solution. Walkley and Black method was followed for analyse organic carbon content in soil, biochar and boiler ash.

Total N analysis was done through standard Kjeldhal procedure with modified colorimetric method by using UV-Spectrophotometer (Model: Shimadzu, UV-2600). Available P was analyzed through standard Olsen method by using the UV-Spectrophotometer (Model: Shimadzu, UV-2600). The exchangeable K was analyzed through ammonium acetate extraction method by using Atomic Absorption Spectrophotometer (Model: Shimadzu, AA-6300). Exchangeable Zn, Cu and Fe were analyzed through diethylenetriaminepentaacetic acid (DTPA) extraction method by using the Atomic Absorption Spectrophotometer (Model: Shimadzu, AA-6300).

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Testing of pH buffering capacities

pH buffering capacities were tested for the biochar and boiler ash treated soils of the pot experiment. Four days after treatment applications, soils were collected from the pots for every treatment replicate. After collecting the soil samples were air-dried for 3 days and ground and sieved through a 2 mm sieve. The same treatments were used to prepare a composite. A freshly prepared 0.22 M $Ca(OH)_2$ liming solution was introduced to each treated soil at the rates of 0, 1 ml and 2 ml $Ca(OH)_2$ to 20g of air dried soil. The resulting pH was measured using a pH meter Model HQ40d after 10, 20, 40 minutes and 1 hour, 1 hour and 20 minutes, 2 hours, 4 hours and 6 hours to ascertain the time required for maximum neutralization [12].

Data analysis

Each data set was analyzed by using the SAS software system. Analysis of variance (ANOVA) was used to compare the effects of treatment combinations. By using the Turkey procedure, the treatment means were set apart from the control at the 0.05 level of significance.

RESULTS AND DISCUSSION

Physicochemical properties of biochar and boiler ash

Before starting the experiment biochar and boiler ash were analyzed to determine their physicochemical properties and the results are depicted in table 2.

Table 2. Physicochemical properties of sugarcane bagasse biochar and boiler ash

Characteristic	Biochar	Boiler ash
Bulk density (g/cm^3)	0.14	0.16
pH	10.65	9.41
EC (mS/cm)	1.923	0.5625
Organic carbon %	1.56	14.09
Total N (mg kg^{-1})	Nil	Nil
Available P (mg kg^{-1})	85	390
Exchangeable K (mg kg^{-1})	337	364
Exchangeable Ca (mg kg^{-1})	15.85	24.84
Exchangeable Mg (mg kg^{-1})	10.56	21.38
Available Zn (mg kg^{-1})	0.259	0.445
Available Cu (mg kg^{-1})	0.0492	0.1374
Available Fe (mg kg^{-1})	3.29	10.25

The results showed that the bulk density of the boiler ash is higher than the biochar and it exists more weight of boiler ash in a defined volume comparatively. This physical character of both biochar and boiler ash is directly affected when it is used as soil amendments practically. When considering the pH and EC of these two amendments, the highest pH and EC were recorded in biochar samples. There was no detected amount of Nitrogen in boiler ash [7] and biochar. But in other elemental constituents, boiler ash recorded higher values compared to the biochar for available P, exchangeable K, Ca, Mg, available Zn, Cu and Fe.

Initial physicochemical properties of the soils used in the pot experiment

The soil for the pot experiment was collected from the research farm of SRI and it belonged to the Reddish Brown Earths local soil category (USDA - Order: Alfisols, Suborder: Ustalfs, Great group: Haplustalfs) [13]. According to texture analysis, the collected soils were in the sandy clay loam textural class category. The rest of the other physicochemical properties are shown in table 3. According to the analytical results, the used soil for the pot experiment was in averagely favorable condition for sugarcane cultivation.

Pot experimental results

Soil physicochemical properties in the pot experiment at three months after planting

At three months after planting, pot soils were analyzed for their physicochemical properties and table 4 and 5 depicted the analytical results.

Table 3. Initial physicochemical properties of the pot experimental soil

Soil parameter	Amount/level
Bulk density (g/cm^3)	1.37
Water holding capacity (%)	44.9
pH	6.35
EC (µS/cm)	50.18
CEC (meq/100 g)	2.41
Organic carbon %	1.68
Total N (mg/kg)	817.4
Available P (mg/kg)	12.5
Exchangeable K (mg/kg)	238.7
Available Zn (mg/kg)	1.29
Available Cu (mg/kg)	2.42
Available Fe (mg/kg)	4.73

Table 4. Mean values of soil physicochemical properties in the pot experiment at three months after planting

Treatment	Bulk Density (kg/m^3)	Water Holding Capacity%	pH	EC (µS/cm)	CEC (meq/100g)	OC %
T 1	1.37	52.5	6.34	78.20	2.99	2.55
T 2	1.36	50.3	6.40	54.76	2.77	2.66
T 3	1.35	54.2	6.41	49.44	2.46	2.43
T 4	1.34	54.7	6.47	54.41	2.77	2.50
T 5	1.37	53.3	6.37	51.76	2.13	2.53
T 6	1.38	54.3	6.37	40.31	3.21	2.40
T 7	1.37	55.8	6.48	49.81	3.27	2.41
T 8	1.36	56.5	6.53	54.80	2.68	2.41
T 9	1.39	49.8	6.35	61.62	3.04	2.34
T 10	1.38	47.5	6.78	45.06	1.44	2.34

Table 5. Mean values of major macro and micro elemental properties in the pot experiment at three months after planting

Treatment	Total N (mg/kg)	Available P (mg/kg)	Exch. K (mg/kg)	Available Zn (mg/kg)	Available Cu (mg/kg)	Available Fe (mg/kg)
T 1	614.81	4.3^{bc}	332.93^{a}	0.39	1.22	4.06
T 2	550	3.71^{c}	265.80^{ab}	0.35	1.44	4.15
T 3	574.48	3.83^{c}	295.76^{ab}	0.43	1.58	4.30
T 4	572.86	4.18^{bc}	287.59^{ab}	0.48	1.68	4.36
T 5	562	4.26^{bc}	288.95^{ab}	0.34	1.42	3.90
T 6	542.05	4.16^{bc}	243.72^{ab}	0.20	1.45	4.08
T 7	548.05	4.91^{abc}	266.46^{ab}	0.20	1.54	4.24
T 8	548.19	4.86^{abc}	261.66^{ab}	0.20	0.71	3.97
T 9	540.98	3.88^{c}	244.70^{ab}	0.21	1.39	3.70
T 10	546.83	5.25^{a}	232.40^{b}	0.39	1.22	4.06

Within columns, means followed by the same letter are not significantly different at 0.05 significance level

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(T1: 1.0t/ha Biochar + N:P:K recommendation of SRI, T2: 2.0t/ha Biochar + N:P:K recommendation of SRI, T3: 4.0t/ha Biochar + N:P:K recommendation of SRI, T4: 6.0t/ha Biochar + N:P:K recommendation of SRI, T5: 1.0t/ha Boiler ash + N:P:K recommendation of SRI, T6: 2.0t/ha Boiler ash + N:P:K recommendation of SRI, T7: 4.0t/ha Boiler ash + N:P:K recommendation of SRI, T8: 6.0t/ha Boiler ash + N:P:K recommendation of SRI, T9: N:P:K recommendation of SRI (Control-1), T10: Zero amendments (Control-2))

Regarding soil physicochemical properties, only available P and exchangeable K were showed significant changed with the different levels of biochar and boiler ash. The highest P value was showed from the treatment ten and the lowest value was showed from the treatment two. The highest level of K was showed from treatment one, which contained 1t/ha biochar with N: P: K recommendation of SRI. The lowest level of K was shown from treatment ten which was zero amendment treatment. With the amendment of different treatment combinations, the other physical and chemical parameters were not significantly different among the treatments.

Analysis of soil pH buffering capacities with the different levels of biochar and boiler ash

Figure 1 to figure 10 shows the pH variation with time in the different volumes of Calcium hydroxide solution and generated equations for each treatment.

When comparing biochar treated and boiler ash treated soils, the boiler ash treated soils have taken more time when applying 1 ml and 2 ml $Ca(OH)_2$. Treatment eight has taken maximum time to become the equilibrium level which was 6.0 t/ha boiler ash with N: P: K recommendation of SRI.

Based on the generated equation, the gradients of the slope were used to create the pH buffering groups as high pH buffering soils, medium pH buffering soils and low pH buffering soils [12]. The formulated pH buffering classes and classification of the different treatment combinations as per their pH buffering capacities are depicted in table 6.

Table 6. Formulated pH buffering classes and pH buffering capacity classification

High pH buffering soils (0.99 -1.08)	Medium pH buffering soils (1.09-1.18)	Low pH buffering soils (1.19 - 1.28)
Treatment 3 (1.01)	Treatment 2 (1.14)	Treatment 1 (1.25)
Treatment 4 (1.07)	Treatment 6 (1.115)	Treatment 5 (1.21)
	Treatment 7 (1.155)	Treatment 8 (1.19)
	Treatment 10 (1.185)	Treatment 9 (1.255)

According to the pH buffering results, treatments three and four which were biochar applied soils have shown high buffering capacity than boiler ash treated soils. Boiler ash treated soils have gone in to medium buffering and low buffering soils categories. The highest amount of boiler ash treated soil (6.0 t/ha Boiler-ash + N: P: K recommendation of SRI) was categorized in a low buffering soil

Sugarcane plant growth performance under different treatments

With the amendment of biochar and boiler ash with N: P: K: recommendation, there were no toxic effects on the sugarcane plants. The mean values of plant height, shoot dry weight, root dry weight and total dry weight of pot cultured sugarcane at three months after planting are shown in table 7. Three months after planting, there was a significant difference ($P<0.05$) in plant height, shoot dry weight, root dry weight and total dry weight of sugarcane plants. There was a significant difference between treatment ten and other treatments for plant height.

Among other treatments, there was no significant difference. The maximum plant height was recorded from treatment two which was 2.0 t/ha of biochar with N: P: K recommendation of SRI. The highest shoot dry weight were showed treatment 6 that was 2t/ha boiler ash with N: P: K recommendation of SRI. The lowest shoot dry weight was showed from treatment 10 that was zero amendment treatment. The highest and lowest root dry weights were showed from treatment 9 and treatment 10 respectively.

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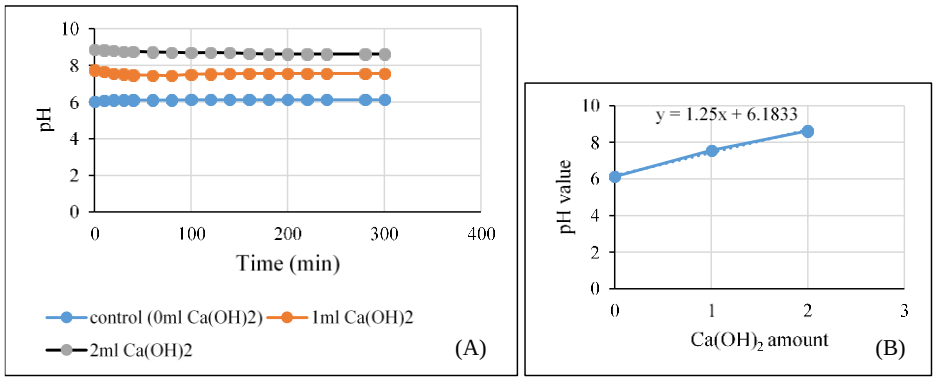


Figure 1. Treatment 1 (A) pH variation with time in different $Ca(OH)_2$ rates (B) Generated equation

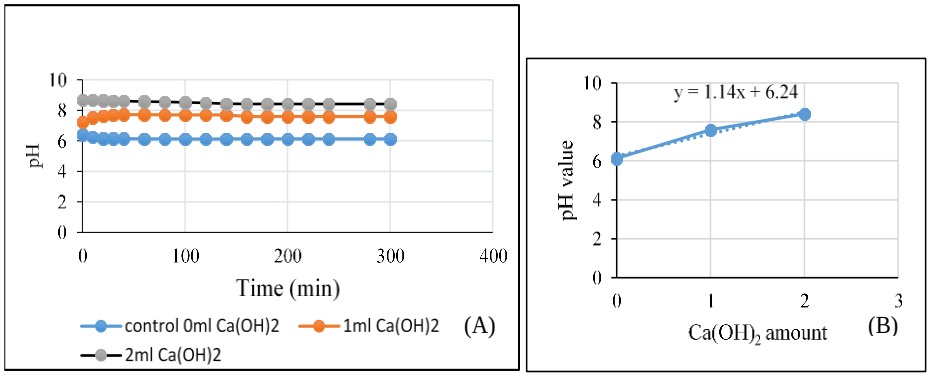


Figure 2. Treatment 2 (A) pH variation with time in different $Ca(OH)_2$ rates (B) Generated equation

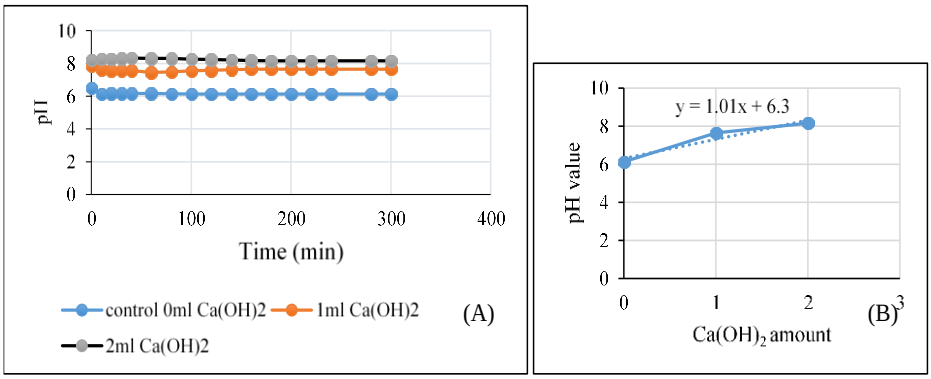


Figure 3. Treatment 3 (A) pH variation with time in different $Ca(OH)_2$ rates (B) Generated equation

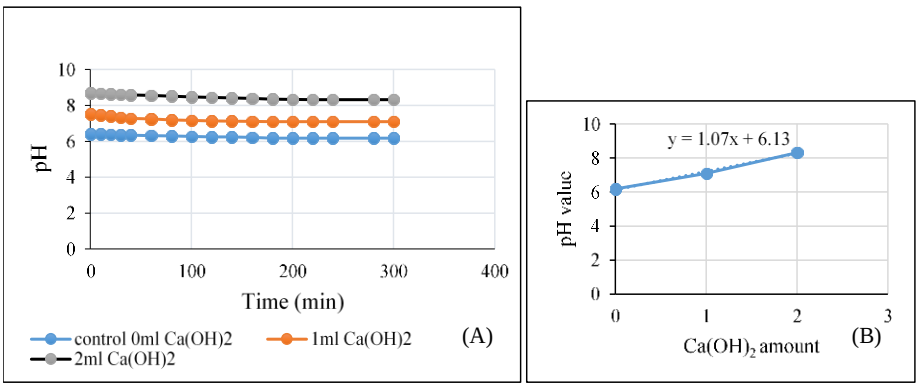


Figure 4. Treatment 4 (A) pH variation with time in different $Ca(OH)_2$ rates (B) Generated equation

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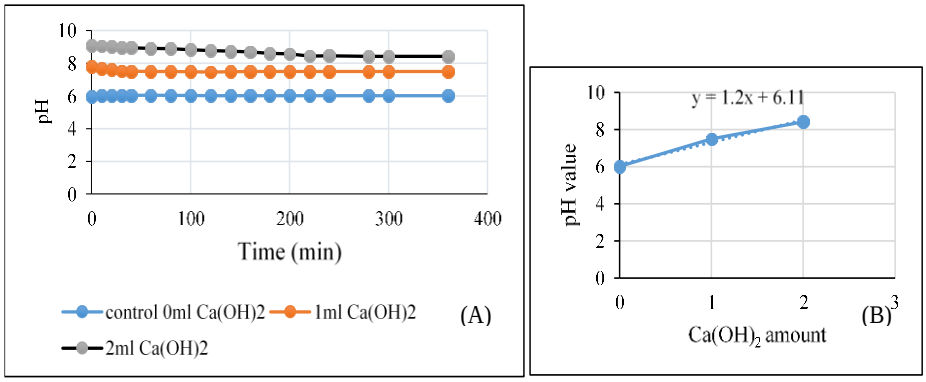


Figure 5. Treatment 5 (A) pH variation with time in different $Ca(OH)_2$ rates (B) Generated equation

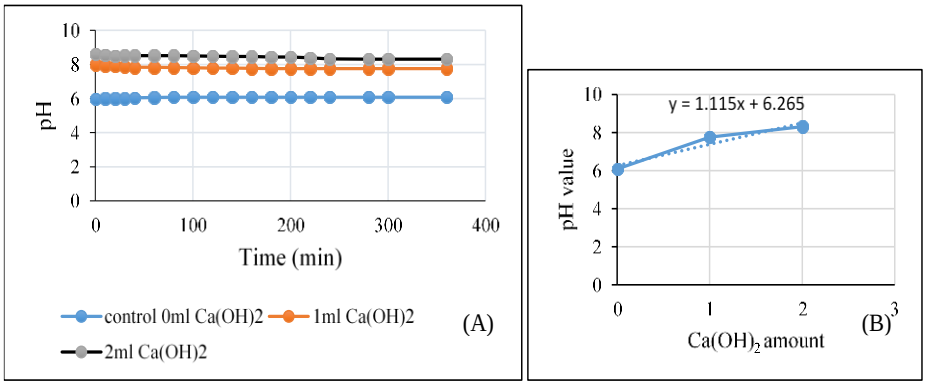


Figure 6. Treatment 6 (A) pH variation with time in different $Ca(OH)_2$ rates (B) Generated equation

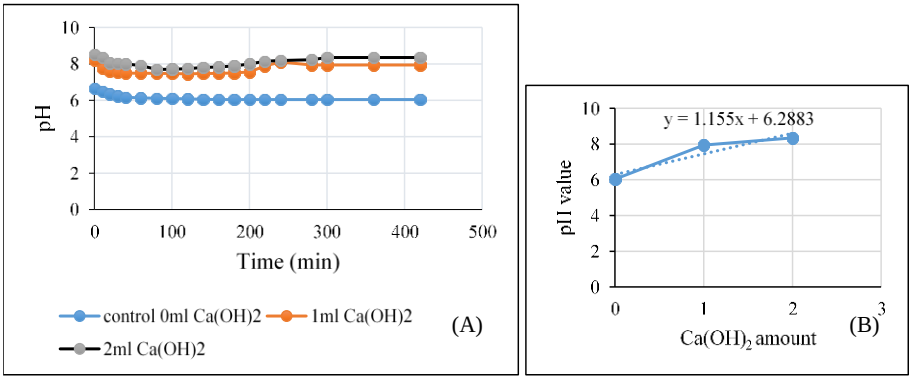


Figure 7. Treatment 7 (A) pH variation with time in different $Ca(OH)_2$ rates (B) Generated equation

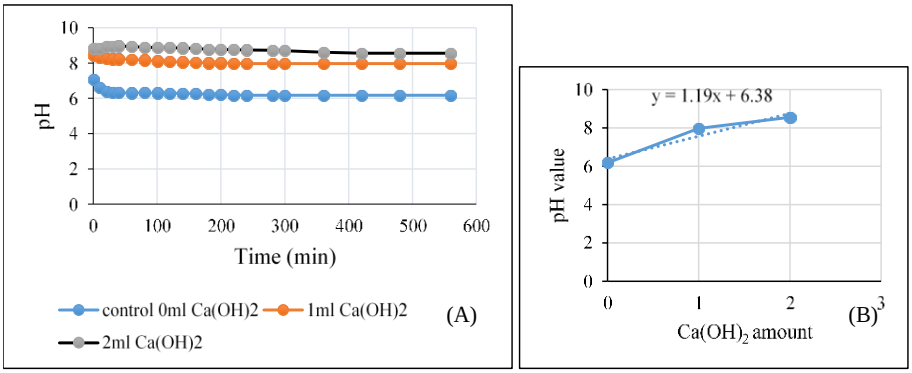


Figure 8. Treatment 8 (A) pH variation with time in different $Ca(OH)_2$ rates (B) Generated equation

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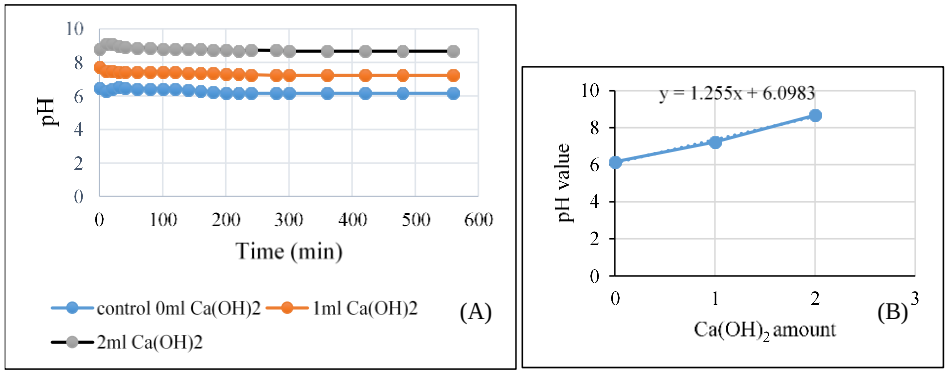


Figure 9. Treatment 9 (A) pH variation with time in different $Ca(OH)_2$ rates (B) Generated equation

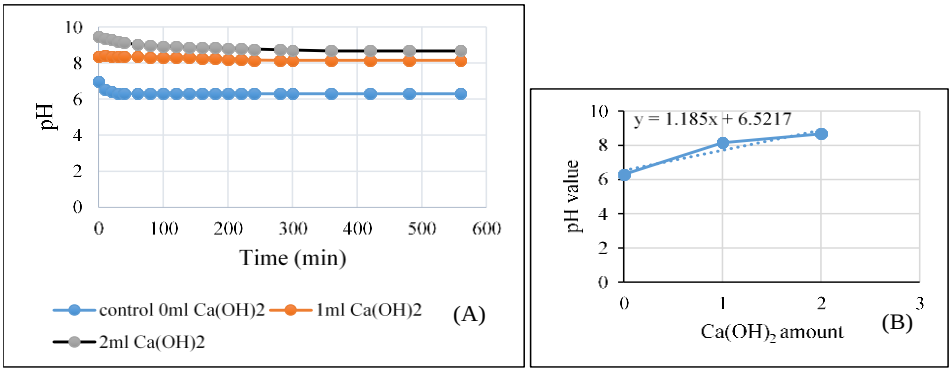


Figure 10. Treatment 10 (A) pH variation with time in different Ca(OH)2 rates (B) Generated equation

Table 7. Mean value of sugarcane plant growth parameters

Treatment	Plant height (cm)	Shoot dry weight (g)	Root dry weight (g)	Total dry weight (g
T 1	177a	38.97b	21.43a	60.4ab
T 2	191a	58.42a	30.73a	89.15a
T 3	186.8a	51.63ab	29.91a	80.54a
T 4	172.3a	49.77ab	30.45a	80.22a
T 5	186.8a	54.45ab	32.83a	87.28a
T 6	182.5a	60.23a	36.86a	97.09a
T 7	186a	53.77ab	29.52a	83.29a
T 8	181.5a	58.18a	33.60a	91.78a
T 9	190.8a	57.92a	37.49a	95.41ab
T 10	116b	12.25c	7.09b	19.34b

The highest total dry weight was recorded from treatment six, which was 2.0t/ha boiler ash with N: P: K recommendation of SRI and lowest total dry weight was recorded from treatment ten. However, boiler ash with N: P: K recommendation applied plants were grown -well same as the recommended N: P: K applied plants without a significant difference.

CONCLUSIONS

Results generated from this study showed that bagasse-based boiler ash is rich in plant nutritional characteristics compared to bagasse-based biochar. Especially, boiler ash recorded higher values for available P, exchangeable K, Ca, Mg, available Zn, Cu and Fe compared to biochar. According to the pot experimentation, incorporation of both biochar and boiler ash into the soil exhibited positive advancements in soil physical properties that increment water holding capacity and the reduction of soil bulk density levels. According to the analysis of soil chemical properties at three months, it was able to identify a significant difference among the treatments only in the soil available P, exchangeable K and available Zn contents. Those results revealed that the amended biochar and boiler ash had been facilitated to increase the plant availability of P, K and Zn in the potting soil.

According to the obtained results for pH buffering capacity analysis, the study confirmed that the higher amounts of boiler ash and only chemical fertilizer added soils lead to reduce soil pH buffering capacity and all the treatments belonged to the boiler ash amended were belonging to low and medium pH buffering categories. But, the biochar amended treatments along with the SRI recommended N: P: K showed high pH buffering capacities. During the three months of the experiment, there were no any toxicity effects for sugarcane plants and it concludes that the application of boiler ash up to 6t/ha is not badly affected the sugarcane plants for the initial growth. However, the conducted experiment was limited to the pot level and further field-level studies are needed to confirm the findings by using complete cropping cycle of sugarcane.

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REFERENCES

[1] Gopalasundaram, P., Bhaskaran, A., & Rakkiyappan, P. (2012). Integrated Nutrient Management in Sugarcane. Sugar Tech, 14(1), 3–20. [CrossRef]

[2] Bodhinayake, W. L., & Dharmawardene, N. (2001). Studies on Nutrient removal from alfisols by sugarcane variety CO 775 under irrigation. Journal of Soil Sciences Society Sri Lanka, vol 13.

[3] Aytenew, M., & Bore, G. (2020). Effects of Organic Amendments on Soil Fertility and Environmental Quality: A Review. Journal of Plant Sciences, 8(5), 112. [CrossRef]

[4] Ding, Y., Liu, Y., Liu, S., Li, Z., Tan, X., Huang, X., Zeng, G., Zhou, L., & Zheng, B. (2016). Biochar to improve soil fertility. A review. Agronomy for Sustainable Development, 36(2). [CrossRef]

[5] Aslam, Z., Khalid, M., & Aon, M. (2014). Impact of Biochar on Soil Physical Properties. Scholarly Journal of Agricultural Science, 4(5), 280–284.

[6] Inyang, M., Gao, B., Pullammanappallil, P., Ding, W., & Zimmerman, A. R. (2010). Biochar from anaerobically digested sugarcane bagasse. Bioresource Technology, 101(22), 8868–8872. [CrossRef]

[7] Khan, M. J., & Qasim, M. (2008). Integrated use of boiler ash as organic fertilizer and soil conditioner with NPK in calcareous soil. Songklanakarin Journal of Science and Technology, 30(3), 281–289.

[8] Kulasekara, B. R., Weerasinghe, H. A. S., & Ariyawansha, B.D.S.K. (2021). Research Article Production of Organic Fertilisers by Using Sugarcane Industry By- products of Sri Lanka : A Preliminary Investigation. 3(June), 76–89.

[9] Prabhath, N., Kumara, B. S., Vithanage, V., Samarathunga, A. I., Sewwandi, N., Maduwantha, K., Madusanka, M., & Koswattage, K. (2022). A Review on the Optimization of the Mechanical Properties of Sugarcane-Bagasse-Ash-Integrated Concretes. Journal of Composites Science, 6(10), 283. [CrossRef]

[10] Bajirao, G., Nitinkumar, R., & Durgude, S. A. (2021). Effect of Bagasse Ash on Physico-Chemical Properties of Soil Effect of Bagasse Ash on Physico-Chemical Properties of Soil.

[11] Prem, K., Ghosh, A.K., & Kumar, D., (2010). Use of Flyash in Agriculture: A Way to Improve Soil Fertility and its Productivity. Asian Journal of Agricultural Research 4(1): 1-14.

[12] Liyanage, M., & Jayakody, A. N. (2012). Feasibility of using soil pH Buffering Capacity for Dolomite Recommendation for tea growing soils in Sri Lanka Feasibility of using soil pH Buffering Capacity for Dolomite Recommendation for tea growing soils in Sri Lanka 1 – Tea Research Institute of Sri. November 2016.

[13] Mapa, R., Somasiri, S. and Dassanayaka, A.R., (2010). Soils of the dry zone of Sri Lanka - Morphology, Characterisation and Classification (pp. 319). Sarvodaya Publishers, Sri Lanka.