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Influence of Longan Wood Biochar on the Growth of Pure White Hokkaido Sweet Corn and Siamese Ruby Queen Corn

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Abstract

Sweet corn is a cash crop that can be grown all year round, which is considered as one of the causes of soil fertility degradation. Biochar is a highly porous material, able to absorb water and nutrients well. It has the potential to be used as an ingredient in soil improvement. The objective of this study was to investigate the effect of Longan wood biochar on the growth of Hokkaido Pure White sweet corn and Queen Ruby Siam corn. Method: A completely randomized design was conducted by dividing into experimental kits according to the strain of sweet corn. Each strain has a ratio of Longan wood biochar mixed in 0% (control), 5% and 10% of planting material. The results showed that the ratio of longan wood biochar was 10% of planting material which had the higher stem, and higher reproductive growth, and found to have significant differences statistically. Studies revealed that using biochar as an ingredient in planting material can help increase the growth and yield of Hokkaido Pure White Sweet Corn and the Siamese Ruby Queen, as well as reduce agricultural waste. Keywords: biochar, sweet corn, planting material

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1. Introduction

Thailand's northern region is the main source of sweet corn production. There is a variety of sweet corn. Among them are popularly grown sweet corn that can be eaten fresh, which is Pure White Hokkaido originated from Japan, and Queen Ruby Siamese sweet corn originated in Thailand. With its outstanding sweet properties, it is two to three times more sweet than regular sweet corn. However, Thailand's agricultural production is on a downward trend. In particular, the production of sweet corn in Thailand has been the number one export champion in the world for decades. In 2020, Thailand's total production of sweet corn was 498,699 tons, while in 2021, the total production of sweet corn in the country was 494,108 tons (decreased by 4,591 tons). The trend is steadily decreasing [1], mainly due to natural disasters and improper farming behavior of farmers. In addition, it is due to soil degradation. As a result of low soil adhesion, there is leaching of plant nutrients in the soil, leading to soil infertility and unsuitable for agriculture [2]. Compared to other plants, the macronutrient requirements are as follows: organic matter content of more than 3%, phosphorus (available P, Bray II) of more than 20 ppm, and exchangeable potassium (Exchangeable K) of more than 60 ppm.[3]

Therefore, many researchers are trying to devise a method that can help restore the quality of degraded soil suitable for growing crops, namely Biochar [4]. It is a material produced from agricultural waste from annual longan pruning in the northern region [5], which is an important source of sweet corn cultivation in Thailand through the process of thermal decomposition at 350-500 degrees Celsius. Without oxygen, it is called slow pyrolysis [6] until the material is obtained with a very high surface area and porosity (93.36 m3/g), which is a property that can increase water absorption and plant nutrients in the soil [7]. This helps to reduce the leaching of nitrogen in the soil from water by absorbing ammonium ions, so it has the potential to be used as a soil modifier, especially the pH of the soil [8], which is better than using lime in the same ratio[9]. Biochar also helps to store carbon in the soil [10]. With the current biochar efficacy limitations, it also depends on the usage ratio and strain of

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cultivated plants [11].

The objective of this research was to compare the effects of biochar as an ingredient in planting material on the growth of Pure White Hokkaido sweet corn and the Siamese Ruby Queen corn to increase the quality of planting material for sweet corn planting. This experiment provided the optimal biochar ratio for sweet corn. Moreover, the acquisition of biochar is the utilization of agricultural waste and decrease in production costs.

2. How to conduct research

2.1 Experimental planning

The first step of the research was to plan a completely randomized design trial experiment. The Completely Randomized Design (CRD) experiment consisted of 5 iterations with 2 factors: the ratio of biochar and the growth of sweet corn. According to Suksawat et al. [5], the 5% and 10% biochar blends responded to pH changes 10% faster than the 10% biochar blends. Therefore, the ratio of biochar is 0% (control), 5% and 10% of 10 liters of planting material.

2.2 Biochar production

The longan branches were chopped to length 50 centimeters. They left to air dry for a month before being burned in a 200-liter metal fuel tank with a maximum temperature of 550 degrees Celsius for 3.5 hours to make biochar. After that, it was sifted in a sieve with a resolution of 2 mm. The properties of the resulting biochar were pH 7.7-8.0, Phosphorus 124 ppm and Potassium 1100 ppm.

2.3 Planting and care

The experiment was conducted in greenhouse conditions. The plant house was 2.7 x 4 x 3 meters, divided into 3 rows with 1 m spacing between rows and 30 cm spacing between plants. Pure White Hokkaido and Siamese Ruby queen sweet corn was sowed in randomly arranged planting bags. Each planting pack contains three seeds. The seeds were placed in a hole about 3 mm deep and then sprayed water moderately. After that, the plants were watered once a day (approximately 500 ml/plant in the morning).

2.4 Recording of experimental results

The growth of Pure White Hokkaido sweet corn and the Siamese Ruby Queen corn in each batch were then measured. It is based on the principle of morphological change according to the method of Ritchie et al. [12] divided in 2 stage:

2.4.1 Vegetative stage: Next, the plant height, stem diameter, number of leaves, weight above the ground, and root parts of the cultivated corn after 55 days were collected.

2.4.2 Reproductive stage: The length, diameter and weight of corn pods in the shell were collected. Corn pods were harvested after 35 days of full pollination.

2.5 Statistical data analysis

The growth and yield data of Pure White Hokkaido Sweet Corn and Queen Ruby Siamese varieties grown in each experimental batch were calculated such as mean, variance (ANOVA), and statistical differences for comparison using the Duncan's new multiple range test at 95.0% confidence with SPSS Statistics 26.0.

3. Results

3.1 Vegetative stage

The stem and leaf growth of Hokkaido Pure White sweet corn grown in biochar-material in different ratios is shown in Table 1. Height, trunk diameter, fresh and dry weight of 10% biochar ratio has an average of 74.51 cm, 15.39 mm, 155.44 g, and 32.11 g, which are higher 0% and 5% biochar ratios with a significant difference ($p > 0.01$). 0% biochar ratios having an average of 63.84 cm,12.17 mm, 114.07 g, and 19.35 g, respectively, while 5% biochar ratio has an average of 64.86 cm, 12.43 mm, 117.68 g, and 20.58 g, respectively. However, no significant difference was found between leaf number and biochar ratios.

The stem, branches, and leaf growth of the Queen Ruby Siamese sweet corn species grown in biochar-containing planting material in different ratios is shown in Table 2. Height, trunk diameter, fresh and dry weight of 10% biochar ratio has an average of 101.23 cm, 16.50 mm, 216.27 g, and 70.01 g, which is the higher than 0% and 5% biochar ratios with a significant difference ($p > 0.01$). 0% biochar ratios have an average of 75.43 cm, 12.45 mm, 142.70 g, and 44.03 g, respectively, while 5% biochar ratio has an average of 67.93 cm, 12.77 mm, 145.01 g, and 45.42 g, respectively. However, no significant difference was observed between leaf number biochar ratios.

3.2 Reproductive Stage

The reproductive growth of Pure White Hokkaido sweet corn grown in biochar-containing planting material in different ratios is shown in Table 4. There is a significant difference (p¡0.01) with biochar ratios of 0% and 5% with average pod lengths of 13.83 and 14.07 cm, respectively. Corn pod diameter and weight tend to be in the same direction as corn pod length. Sweet corn grown with a biochar ratio of 10% has an average diameter and weight of 39.98 mm and 106.25 g, respectively. There is a significant difference ($p > 0.01$) in biochar ratios of 0% and 5%, with pod diameters of 36.54 and 37.19 mm and pod weight of 61.96 and 62.83 g, respectively. While the length, diameter and weight of corn pods grown with 0% and 5% biochar ratios did not make significant differences.

Table 1. Growth of Pure White Hokkaido Sweet Corn

Biochar Content (%)	Height (cm)	Number of leaves (leaves)	Trunk diameter (mm)	Weight (g)	
				fresh	dry
0	63.84±3.31 b	7.07 ± 7.70 a	12.17 ± 1.25 c	114.07 ± 5.48 b	19.35 ± 1.14 b
5	64.86±2.48 b	7.20 ± 0.68 a	12.43 ± 0.80 bc	117.68 ± 4.46 b	20.58 ± 1.45 b
10	74.51±3.37 a	7.33 ± 0.49 a	15.39 ± 0.58 a	155.44 ± 5.26 a	32.11 ± 2.12 a
F-test	**	ns	**	**	**
C.V. (%)	8.35	8.59	12.80	14.99	24.80

** = significantly different at the 99 % (p<0.01) respectively
ns = Not Statistically Significant
Means with the different letter are significant different test with Duncan's multiple range test

Table 2. Growth of sweet corn varieties of Queen Ruby Siam

Biochar Content (%)	Height (cm)	Number of leaves (leaves)	Trunk diameter (mm)	Weight (g)	
				fresh	dry
0	75.43±2.82 b	7.20 ± 0.56 a	12.45 ± 0.80 b	142.70 ± 5.13 b	44.03 ± 1.95 b
5	67.93±1.81 b	7.40 ± 0.51 a	12.77 ± 0.70 b	145.01 ± 2.68 b	45.42 ± 1.74 b
10	101.23±3.58 a	7.80 ± 0.86 a	16.50 ± 0.83 a	216.27 ± 2.09 a	70.01 ± 2.02 a
F-test	**	ns	**	**	**
C.V. (%)	14.36	9.19	14.29	20.43	22.72

** = significantly different at the 99 % (p<0.01) respectively
ns = Not Statistically Significant
Means with the different letter are significant different test with Duncan's multiple range test

Table 3. Size and weight of Pure White Hokkaido sweet corn pods

Biochar Content (%)	Length (cm)	Diameter (mm)	Weight (g)
0	13.83±0.71 b	36.57±1.53 c	61.96±2.07 b
5	14.07±0.57 b	37.19±1.13 bc	62.83±2.37 b
10	15.45±0.68 a	39.98±1.11 a	106.25±2.06 a
F-test	**	**	**
C.V. (%)	6.58	4.98	25.99

** = significantly different at the 99 % (p<0.01) respectively
ns = Not Statistically Significant
M eans with the different letter are significant different test with Duncan's multiple range test

Table 4. Size and weight of Pure White Hokkaido sweet corn pods

Biochar Content (%)	Length (cm)	Diameter (mm)	Weight (g)
0	13.79±0.560d	41.31±1.05 d	107.61±2.66 c
5	14.33±0.75 b	42.07±1.18 cd	108.43±1.96 b
10	16.21±0.66 a	46.61 ± 1.34 b	139.45±2.31 a
F-test	**	**	**
C.V. (%)	8.22	6.03	12.65

** = significantly different at the 99 % (p<0.01) respectively
ns = Not Statistically Significant
M eans with the different letter are significant different test with Duncan's multiple range test

The reproductive growth of the Queen Ruby Siamese sweet corn strain grown in biochar-containing planting material in different ratios is shown in Table 4. There was a significant difference (p¡0.01) in biochar ratios of 0% and 5% with average pod lengths of 13.79 and 14.33 cm, respectively Corn pod diameter and weight tend to be in the same direction as corn pod length. Sweet corn grown with 10% biochar has an average diameter and weight of 39.98 mm and 145.35 g, respectively. There is a significant difference ($p > 0.01$) in biochar ratios of 0% and 5% with pod diameters of 36.54 and 37.19 mm and pod weights of 110.40 and 128.23 g, respectively. However, no significant differences were found between corn grown with 0% and 5% biochar mixture in length, diameter and weight of corn pods.

4. Discussion

The study compared the ratio of Longan wood biochar to growing soil to the growth of Pure White Hokkaido sweet corn and Siamese Ruby Queen corn. It was showed that both varieties of sweet corns were effectively grown with a biochar ratio of 10% as planting material. The growth of height, stem, diameter, fresh and dry weight were the highest, and there was a significant difference ($p > 0.01$) from the use of 0% biochar ratios and 5% of planting material. It is consistent with a study by Intanoo and Kongklay [13] which was found that the height and stem size of both eggplant and kale had higher growth than using planting material without biochar as an ingredient. It is also found that the length diameter and weight of both varieties of sweet corn cob corresponds to an increased biochar blend rate. Due to the high porous properties of biochar, the surface area is a gap for air circulation, absorb water and plant nutrients [7]. As a result, the concentration of nitrogen, potassium, iron and zinc are more abundant than planting materials containing no biochar [14]. Watering causes some nutrients to leach away from the planting material. However, biochar is also a source of microorganisms that help break down organic matter from organic matter [15; 16] into smaller molecules into nutrients that plants can use for growth. Microbial activity also contributes to the growth of root length [17]. As a result, the roots have a higher efficiency in the absorption of nutrients, which has a direct influence on the growth of the above-ground parts, including corn pods as well [18]. In [18][18][18]addition, biochar has a low decomposition rate [19] and can be reused to reduce the cost of planting material and help to make good use of agricultural waste obtained from pruning Longan [20; 21].

5. Conclusion

From the experiment of growing Pure White Hokkaido sweet corn and Queen Ruby Siam corn and comparison of the biochar ratio in planting material that affects stem growth and creeping, it was found that the biochar ratio of 10% of planting material gave the best results in terms of stem diameter, fresh and dry weight, aboveground and root parts. The growth stages include length, diameter, and weight of sweet corn pods. Biochar plays an important role in the growth of sweet corn, which is related to the nutrients of the bush and microbial activity. The results show the relationship between biochar content and the growth of sweet corn that can be used as an ingredient to improve planting material quality.

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