Borneo Akademika *Volume 6* (2) December 2022, 55-61
UiTM Cawangan Sabah

BIOCHAR AND COMPOST AMENDMENT TO ENHANCE SWEET CORN GROWTH

NUR SURAYA ABDULLAH[1], MUHAMMAD ARSYAD ABDUL RAHMAN[1] & NOORSHILAWATI ABDUL AZIZ[2*]

[1]Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA, 77300 Merlimau, Melaka, Malaysia
[2]Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA, 26400 Bandar Jengka, Pahang, Malaysia

noorshilawati@uitm.edu.my

ABSTRACT

Planting in polybags is a common solution to the issue of limited land for agricultural activity in urban areas. The proper use of planting medium and amendment with beneficial organic compounds such as biochar and compost could provide high yield in return. The present study aimed to evaluate the effects of biochar and compost application in the medium for corn grown in polybags. Five treatments comprised of T0 (soil) as control, T1 (soil and compost at ratio 1:1), T2 (soil and biochar at ratio 1:1), T3 (soil, compost, and biochar at ratio 1:1:0.5), and T4 (soil, compost, and biochar at ratio 1:2:2) were prepared. The experiment was arranged in a randomized complete block design (RCBD) with four replications. The results indicated that the highest corn performance was recorded in T2. The mean values were significantly different in some growth parameters such as stem diameter (2.82 cm), fruit weight (307.25 cm), fruit diameter (5.71 cm), and plant fresh weight (324.00 g) as compared to control and other treatments. The results also found that biochar is more efficient for corn grown in polybags than compost. However, soil amended with a high amount of biochar and compost has reduced corn growth. The study provides beneficial information and contributions to the existing literature on the optimization of suitable medium for promoting corn growth in polybags. Using biochar and compost can reduce dependency on extensively used inorganic fertilizer, which is harmful to the environment.

Keywords: Biochar, Growth performance, Organic fertilizer, Sweet Corn, *Zea mays*

1. Introduction

The urbanization and utilization of agricultural land for household development led to a narrower and reduced land for planting activities (Sitawati et al., 2016; Paiman & Effendy, 2020). Consequently, people's intention to participate in agricultural activity will be reduced. Growing plants in polybags can assist in resolving this issue (Paiman & Effendy, 2020). Additionally, employing existing space optimally for agricultural operations reduces the cost of purchasing food and may also be a source to generate additional income. With the correct usage, planting trees in polybags can also give high returns.

Due to the short growing period, sweet corn or scientifically known as *Zea mays* L. is considered a suitable plant to be grown using a polybag. Typically, sweet corn is cultivated for fresh consumption as well as for use as a raw ingredient in the canning industry (Najeeb et al., 2011). Coşkun et al. (2006) declared that corn is among the beneficial grains for human daily intake after rice, and it contains many sources of nutritional properties such as 3.35 g protein, 10 g oil, 221 g carbs, 0.03 g calcium, 1.11 g phosphorus, and 2.8 g potassium per kilograms.

Recently, the application of organic materials such as compost and biochar in planting mediums has increased due to the great concern on the negative effects of extensive use of chemical fertilizer on the soil and environmental health. Organic fertilizer could enhance the microbial population and activity of microbial enzymes (Hussain et al., 2020). Compost and biochar are widely used organic materials containing living microorganisms or microbes that are beneficial to promote crop growth and supply nutrients (FAO, 2012).

Biochar is developed from burning plant-derived biomass either by man-induced or natural fires (Schmalzer et al., 2007). Biochar is typically created by pyrolyzing biomass at temperatures between 300°C to 600°C. The natural organic biomass combustion produces black carbon, which accounts for a significant amount of the organic carbon in the soil (Atkinson et al., 2010). Applying biochar to soil may increase soil fertility and carbon storage. Due to its porous substance, biochar can absorb and hold vast quantities of water (Liu et al., 2012). Omara et al. (2020) stated that adding biochar derived from timber had increased the retention of N in soil and uptake of N into crop biomass, thus reducing the leaching of NH^{4+}. Thus, nutrients on the soil surface are available for plant uptake (Zwieten, 2012). Besides, Lubis et al. (2021) found that treatment with 50 g/polybag of biochar increased the corn plant height up to 176.17 cm. Adding biochar may retain more water and alter the pore space of the soil, allowing roots to grow freely and absorb many nutrients. In addition, Jatav et al. (2020) also claimed that biochar could significantly alter the soil's role in enhancing plant growth, water holding capacity, fertility retention, mineralization of organic phosphorus, quantity, and quality improvement of several crop species, and carbon sequestration.

Besides that, adding compost in planting medium has also received a lot of attention among farmers since it is among the ecologically friendly waste treatment solutions to overcome the pollution problems. Composting aids nutrient management and may assist in counteracting soil organic matter loss and erosion (Mclauchlan, 2007). Adding compost to the soil is seen as a means of preserving or recovering the condition of soils, owing to the organic matter fertilizing or enhancing characteristics. Additionally, it may aid in carbon isolation and may be used to partly replace peat and fertilizers (Tweib et al., 2011).

Applying biochar and compost, either alone or in combination, give different responses to plants. Agegnehu et al. (2016) indicated that using biochar has resulted in the greatest total biomass and grain production. The study found that compost and combination of biochar-compost application with a small amount of chemical fertilizer had significantly increased grain weights and improved grain filling. Thus, the study was conducted to evaluate the response of sweet corn grown in polybags towards the different compositions of biochar and compost application in the planting medium. The information gained from this study will provide significant literature on the beneficial use of biochar and compost in promoting corn growth in polybags.

2. Materials and Method

2.1 *Seed Preparation and Germination*

The F_1 King Corn 988 hybrid was purchased from a local supplier and used as a source of planting material. Corn seeds were soaked in water for 24 hours prior to being placed onto a seedling tray containing peat moss for germination. Seeds were raised for about two weeks, and uniform and healthy seeds were used in the study.

2.2 *Medium and Treatments Preparation*

The biochar and compost were purchased from a local market. Five treatments, namely T0 (Soil) as control, T1 (soil and compost at ratio 1:1), T2 (soil and biochar at ratio 1:1), T3 (soil, compost, and biochar at ratio 1:1:0.5), and T4 (soil, compost and biochar at ratio 1:2:2) were prepared. Biochar and compost were mixed with the soil before being used in the study. About

10 kg of mixtures for each treatment was filled in a polybag. The treatments were arranged in randomized complete block design (RCBD) with four replications Cultural Practices. NPK green fertilizer at a ratio of 15:15:15 with a rate of 150 kg/ha was used to promote corn growth as suggested by the Department of Agriculture (2014). The fertilizer was applied twice a month, and seedlings were watered two times per day. Pest and disease control were done manually.

2.3 *Parameter Measurement and Data Collection*

Table 1 presents the growth parameters consisting of plant height (PH), leaf area (LA), stem diameter (SD), fruit weight (FW), fruit length (FL), fruit diameter (FD), plant fresh weight (PFW), and plant dry weight (PDW). Data were recorded at the maturity and harvesting stages according to the method described by Akanbi et al. (2010).

Table 2: Parameter Measurement

Parameter	Descriptions
Plant height	Plant height was determined using measuring tape from the plant base to the end tip of the higher leaf.
Leaf length, width, and area	The leaf length and width were measured using a measuring tape. The value of leaf length and leaf width was used to determine the leaf area and calculated as leaf length x leaf width x 0.75, as described by Arthur (2014).
Stem diameter (plant girth)	Plant girth refers to cylindrical, sturdy and clear separation between internodes and nodes. Nodes retain the leaves, while internodes are the gaps in between. The stem diameter was determined using a digital caliper.
Fruit weight	The fruit weight was measured when the fruit matured using a weighing scale.
Fruit length and diameter	The measurement of fruit length and fruit diameter was done immediately after harvest. Fruit length was measured using a ruler while fruit diameter was determined using a digital caliper.
Plant fresh weight and dry weight	The fresh weight of the plant was determined after harvesting and before drying in an oven at a temperature of 60ºC until a constant weight was obtained for determination of its dry weight.
Water content percentage	The water content percentage in plants was determined according to the difference between fresh and dry weight.

2.4 *Statistical Analysis*

Data were subjected to analysis of variance (ANOVA) using Statistical Package Social Science (SPSS) Software Version 26. Means comparisons were made using the Duncan New Multiple Range Test (DNMRT) at a $P < 0.05$. Pearson correlation analysis was conducted to determine the correlation among the parameters studied.

3. Results and Discussion

The performance of sweet corn toward different ratios of biochar and compost was successfully determined through the identification of growth parameters such as plant height, stem diameter, leaf area, fruit length, fruit weight, fruit diameter, plant fresh weight, plant dry weight, and water content percentage. The mean performance for each parameter is presented in Table 2.

Table 2: Growth Performance of Sweet Corn after 70 Days of Planting

Treatment	PH (cm)	SD (cm)	LA (cm^2)	FL (cm)	FW (g)	FD (cm)	PFW (g)	PDW (g)	WC (%)
T0	189.18[a]	2.66[b]	697.98[ab]	32.38[a]	256.00[b]	5.16[b]	302.25[b]	72.00[a]	74.43[bc]
T1	161.05[c]	2.30[c]	497.38[c]	29.73[b]	215.50[d]	4.88[b]	278.75[c]	75.00[a]	73.11[c]
T2	192.43[a]	2.82[a]	733.30[a]	32.38[a]	307.25[a]	5.71[a]	324.00[a]	80.25[a]	75.23[bc]
T3	175.55[b]	2.67[b]	648.52[b]	29.40[b]	227.50[c]	5.05[b]	254.50[d]	47.25[b]	81.43[a]
T4	145.35[d]	2.10[d]	309.95[a]	23.90[c]	106.75[a]	3.40[c]	162.75[e]	34.25[c]	78.85[ab]

[a]Means followed by the same letter in the same column do not differ statistically by Duncan New Multiple Range Test (DNMRT) at level $P < 0.05$.
[b]Growth parameters consist of plant height (PH), stem diameter (SG), leaf area (LA), fruit weight (FW), fruit length (FL), fruit diameter (FD), plant fresh weight (PFW), plant dry weight (PDW), and water content (WC).

The results of the study indicated that sweet corn treated with treatment T2 (soil amended with biochar alone at ratio 1:1) recorded the highest mean value and were significantly different in several growth parameters such as stem diameter (2.82 cm), fruit weight (307.25 cm), fruit diameter (5.71 cm), and plant fresh weight (324.00 g) as compared to control and other treatments. Mahdian et al. (2020) found that total dry biomass and yield of corn were the highest in soil supplemented with 100% biochar derived from sago bark. The study conducted by Huang et al. (2019) showed that the application of biochar on saline soil enhanced the growth of sweet corn. Besides that, the application of biochar could also improve the photosynthetic process in plants, thus resulting in high production and marketable produce.

In contrast, treatments T1, T3, and T4 consisted of planting mediums added with compost. The results showed that T1 (soil amended with compost alone at a ratio of 1:1) had significant differences in plant height, stem diameter, leaf area, fruit length, fruit weight, and plant fresh weight as compared to the control. However, all growth parameters' averages were relatively low compared to the control. Compared to T1, the T3 treatment (soil amended with compost and biochar at ratio 1:1:05) showed that adding biochar in a medium containing compost could improve some growth parameters of sweet corn. The results indicated that the addition of biochar gave significant differences in plant parameters and increased plant height (161.05 cm to 175.55 cm), stem diameter (2.30 c to 2.67 cm), leaf area (497.38 cm^2 to 648.52 cm^2), fruit weight (215.50 g to 227.50 g), and water content (73.11% to 81.43%).

Treatment 4 (soil amended with compost and biochar at a ratio of 1:2:2) recorded the lowest value in most parameters except for water content. Significant differences were recorded in growth parameters such as plant height, stem diameter, fruit length, fruit diameter, plant fresh weight, and plant dry weight as compared to the control. The results showed that high amounts of compost and biochar in the planting medium will reduce plant growth and negatively affect the yield. The mechanism of plant growth reduction found in this study also could be due to the application of immature and high amounts of compost.

Biochar plays an important role in the development of a sustainable agricultural system. Application of biochar in soil is particularly beneficial in terms of improving soil quality and stimulating plant growth (Rawat, 2019). A study conducted by Mensah and Frimpong (2018) also found that the addition of biochar to acidic soil has increased maize plant height which could be due to improved soil pH and increased phosphorus availability. Besides that, Sun et al. (2017) reported that biochar treatment at the rates of 1% to 5% resulted in maize plant growth and physiological changes, including increases in plant height and stem diameter. Moreover, biochar as soil amendment resulted in increased water holding capacity and silt in soil, which promoted stem growth (Jatav et al., 2020).

The study also found that applying biochar in the soil can increase the leaf area, shoot dry and fresh weight, and root dry weight of maize plants. According to Tanure et al. (2019), biochar creates more biomass, and this will increase water absorption and improve soil fertility, subsequently providing greater nutrient accumulation which could promote corn growth. The increase in grain weight, grain length, and fruit diameter is also in line with Agegnehu et al. (2016) who reported that a combination of biochar and compost with fertilizer also could give higher grain weight and grain filling. The results also found that T3 and T4 have high water content because both T3 and T4 use a high rate of biochar. This shows that biochar exhibited a high-water holding capacity which can retain water for plant uptake. Tanure et al. (2019) also confirmed that water availability in the soil increases with biochar application resulting in higher water content in the crop.

The current study also found that the application of compost reduced some plant growth parameters. Jakubus (2020) stated that compost could give a positive effect on stimulating seed germination and root growth. However, the maturity and stability of compost play essential roles in enhancing plant growth. Gao et al. (2016) reported that the presence of phytotoxic compounds in immature compost might restrict plant growth. Fuchs et al. (2014) also informed that the reduction in plant growth is due to the unavailability and immobilization of nitrogen in immature compost. The results are also in line with Nur Aqeela et al. (2021) who found that the addition of 50% compost in planting medium has restricted and reduced some plant growth parameters such as plant height, leaf area and plant width. The authors recommended that the addition of 5% to 20% of compost in the planting medium is sufficient to give the greatest results and promote plant growth.

The Pearson correlation analysis is presented in Table 3. The results showed that most parameters have moderate to strong positive correlation at a significant level of 0.01 among each other except with water content. A negative and low relationship was recorded in water content with all parameters. The analyses also found that plant height, stem diameter, leaf area, fruit weight, fruit diameter, fresh weight, and dry weight were not correlated with water content and showed no significant difference.

Table 3: Pearson Correlation Analysis

	PH	SD	LA	FW	FL	FD	PFW	PDW	WC
PH	1	.931**	.955**	.917**	.808**	.817**	.866**	.623**	-.129
SD		1	.953**	.911**	.792**	.818**	.806**	.521*	-.020
LA			1	.939**	.878**	.880**	.884**	.633**	-.139
FW				1	.896**	.928**	.967**	.785**	-.307
FL					1	.789**	.908**	.789**	-.470*
FD						1	.902**	.726**	-.264
FDW							1	.872**	-.431
PDW								1	-.768**
WC									1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

4. Conclusion

The application of biochar to polybag-growing medium for sweet corn has improved most of the growth parameters. The study found that application of biochar alone with a ratio to the soil medium 1:1 can perform better than control treatment. The application of biochar together with compost also showed promising results. However, the study found that addition of compost in polybag-growing medium for sweet corn caused a reduction in plant growth parameters compared to control treatment and others. The results also found that, with increased compost and biochar application, most of the growth parameters were reduced. Hence, further research is needed to measure the quality of compost and biochar used, which immaturity may affect plant performance. The study also has provided beneficial information and contributions to the existing literature on the optimization of suitable medium for promoting sweet corn growth in polybags. The use of biochar and compost also can reduce dependency on extensively used inorganic fertilizer, which is harmful to the environment. Lastly, the result of this study can also encourage people to be involved in agricultural activities even when there is limited space.

References

Agegnehu, G., Bass, A. M., Nelson, P. N. and Bird, M. I. (2016). Benefits of biochar, compost and biochar-compost for soil quality, maize yield and greenhouse gas emissions in a tropical agricultural soil. *Science of the Total Environment*, *543*, 295–306. https://doi.org/10.1016/j.scitotenv.2015.11.054

Akanbi, W. B., Togun, A. O., Adediran, J. A., and Ilupeju, E. A. O. (2010). Growth, dry matter and fruit yields components of okra under organic and inorganic sources of nutrients. *American-Eurasian Journal of Sustainable Agriculture*, *4*(1), 1–13.

Atkinson, C. J., Fitzgerald, J. D., and Hipps, N. A. (2010). *Potential mechanisms for achieving agricultural benefits from biochar application to temperate soils : a review*. 1–18. https://doi.org/10.1007/s11104-010-0464-5

Coşkun, M. B., Yalçin, I., & Özarslan, C. (2006). Physical properties of sweet corn seed (Zea mays saccharata Sturt.). *Journal of Food Engineering*, *74*(4), 523–528. https://doi.org/10.1016/j.jfoodeng. 2005.03.039

Department of Agriculture. (2008). *Pakej Teknologi Jagung manis*.

Food and Agriculture Organization (FAO). (2012). Building resilience for adaptation to climate change in the agriculture sector. *Proceedings of a Joint FAO/OECD Workshop*.

Fuchs, J.G., Fliessbach, A., Mader, P., Weibel, F.P., Tamm, L., Mayer, J. and Schleiss. (2014). Effects of compost and soil fertility parameters in short-, mid-, and long-term field experiments. Interntional Society for Horticultural Science, 1018(2), 39-46

Gao, S., Hoffman-Krull, K., Bidwell, A.L. and Deluca, T.H. (2016). Locally produced wood biochar increases nutrient retention and availability in agricultural soils of the San Juan Islands, USA. Agric. Ecosyst. Environ., 233: 43–54

Huang, M., Zhang, Z., Zhu, C., Zhai, Y., & Lu, P. (2019). Effect of biochar on sweet corn and soil salinity under conjunctive irrigation with brackish water in coastal saline soil. *Scientia Horticulturae*, *250*, 405-413.

Hussain, A., Zahir, Z. A., Ditta, A., Tahir, M. U., Ahmad, M., Mumtaz, M. Z., Hayat, K., & Hussain, S. (2020). *Production and Implication of Bio-Activated Organic Fertilizer Enriched with Zinc-Solubilizing Bacteria to Boost up Maize (Zea mays L.) Production and Biofortification under Two Cropping Seasons*.

Jakubus, M. (2020). A comparative Study of Composts Prepared from Various Organic Wastes Based on Biological and Chemical Parameters. Agronomy, 10(6), 1-15. https://doi.org/10.3390/agronomy10060869**.**

Jatav, H. S., Singh, S. K., Jatav, S. S., Rajput, V. D., Parihar, M., Mahawer, S. K. and Singhal, R. K. (2020). Importance of Biochar in Agriculture and Its Consequence. *Applications of Biochar for Environmental Safety*, *109*.

Liu, J., Schulz, H., Brandl, S., Miehtke, H., Huwe, B. and Glaser, B. (2012). *Short-term effect of biochar and compost on soil fertility and water status of a Dystric Cambisol in NE Germany under field conditions*. 698–707. https://doi.org/10.1002/jpln.201100172

Lubis, K. S., Hidayat, B., Siregar, A. Z. and Mayendra. (2021). Growth Response of Maize Plant Due to Biochar Rice and Fertilizer of Soil in Kwala Bekala, North of Sumatera. *IOP Conference Series: Earth and Environmental Science*, *709*(1), 1–7. https://doi.org/10.1088/1755-1315/709/1/012075

Mahdian, S., Mohidin, H., Man, S., Kanang, K.D. and Ali, A.S. (2021). Growth Performance of Sweet Corn (Zea Mays) On The Mineral Soil Amended With Sago Waste Biochar. Scientific Research Journal, 18(1), 45-56. https://doi.org/10.24191/srj.v18i1.11395

Mclauchlan, K. (2007). The Nature and Longevity of Agricultural Impacts on Soil Carbon and Nutrients : A Review. *Ecosystem*, 9, 1364–1382. https://doi.org/10.1007/s10021-005-0135-1

Mensah, A. K., & Frimpong, K. A. (2018). Biochar and/or Compost Applications Improve Soil Properties, Growth, and Yield of Maize Grown in Acidic Rainforest and Coastal Savannah Soils in Ghana. *International Journal of Agronomy*, 1-8. https://doi.org/10.1155/2018/6837404

Najeeb, S., Sheikh, F. and Ahangar, M. (2011). Popularization of sweet corn (*Zea mays L. saccharata*) under temperate conditions to boost the socieconomic conditions. *Maize Genetic, 85*. http://www.agron.missouri.edu/mnl/85/PDF/11najeeb.pdf

Nur Aqeela, S.A., Abu Zahrim, Y., Junidah, L., Mohd Al Mussa, U., Sariah, S. and Mariani, R. (2021). Prodcution of food waste compost and its effect on the growth of dwarf crape jasmine. *Jurnal Kejuruteraan*, 33(3),413-424. https://doi.org/10.17576/jkukm-2021-33(3)-04

Omara, P., Aula, L., Oyebiyi, F. B., Eickhof, E. M., Carpenter, J., and Raun, W. R. (2020). Biochar application in combination with inorganic nitrogen improves maize grain yield, nitrogen uptake, and use efficiency in Temperate Soils. *Agronomy*, *10* (9). https://doi.org/10.3390/agronomy10091241

Paiman and Effendy, I. (2020). The Effect of soil water content and biochar on rice cultivation in polybag. *Open Agriculture (1), 117-125.* https://doi.org/10.1515/opag-2020-0012

Rawat, J, Saxena,J. and Sanwal, P. (2019). Biochar: A Sustainable Approach for Improving Plant Growth and Soil Properties. *Biochar - An Imperative Amendment for Soil and the Environment*. doi: 10.5772/intechopen.82151

Schmalzer, P., Rasse, D., Rasse, D., Hudak, A. and Alexis, M. (2007). Fire impact on C and N losses and charcoal production in a scrub oak ecosystem Related papers. *Biogeochemistry*. https://doi.org/10.1007/s10533-006-9063-1

Sun, C. X., Chen, X., Cao, M. M., Li, M. Q., and Zhang, Y. L. (2017). Growth and metabolic responses of maize roots to straw biochar application at different rates. *Plant and Soil*, *416(1)*, 487-502.

Tanure, M. M. C., da Costa, L. M., Huiz, H. A., Fernandes, R. B. A., Cecon, P. R., Pereira Junior, J. D. and da Luz, J. M. R. (2019). Soil water retention, physiological characteristics, and growth of maize plants in response to biochar application to soil. *Soil and Tillage Research*, *192,* 164–173. https://doi.org/10.1016/j.still.2019.05.007

Tweib, S. A., Rahman, R. A. and Kalil, M. S. (2011). A Literature Review on the Composting. *International Conference on Environment and Industrial Innovation*, *12,* 124–127.

Zwieten, A. D. and L. Van. (2012). Biochar: A Coproduct to Bioenergy from Slow-Pyrolysis Technology. *Advanced Biofuels and Bioproducts*, *9781461433,* 1–1122. https://doi.org/10.1007/978-1-4614-3348-4