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Growth and Production Response of Corn (Zea mays L.) by Bokashi of Cow Waste and Tempe Industrial Liquid Waste

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Abstract. The study aims to investigate the response of growth and production of the corn plant (Zea mays L.) due to the provision of bokashi cow dung and Tempe industrial liquid waste. This study was conducted in February 2017 until June 2017 at Lahan Perkebunan Rakyat Jalan Manunggal Ujung, Desa Bandar Klippa, Kecamatan Percut Sei Tuan, Medan Tembung. The design used was Factorial Randomized Block Design (RBD) with 3 replications and consisted of two factors studied: Bokashi consisting of four levels, e.i : B_0 : Control, B_1 : 15 ton/ha, B_2 : 30 ton/ha and B_3 : 45 ton/ha. The use of industrial liquid waste Tempe consisting of four levels, namely, e.i: L_0 : Control, L_1 : 30 ml/l, L_2 : 60 ml / l, L_3 : 90 ml/l. The observation data was followed by Duncan Multiple Range Test (DMRT). The results showed that the use of bokashi cow dung had a significant effect on the observation parameters of height, leaf length and cob weight in corn plants that have been observed and not significant to the observation of leaf number, leaf area, dry seed weight each plot. The use of industrial effluent of Tempe has a significant effect on leaf length parameter at age 6 weeks after planting and cob weight/plant each plot but not significant effect on observation of plant height, leaf number, leaf area, dry seed weight each plot.

Keyword: bokashi, corn, industrial liquid, waste tempe

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1. Introduction

Corn is a cereal plant which is an important food ingredient because it is the second carbohydrate source after rice. As one source of food, corn has become a major commodity after rice. For Indonesians corn is the second staple food after rice. One area where people consume corn as a substitute for rice in Southeast Sulawesi. The low national average yield of corn is due to the not yet widespread superior varieties and has not paid attention to the use of quality seeds at the farmer level [1].

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Some Indonesians consume corn as a substitute for rice, as a step in participating in the implementation of food diversification launched by the government and related institutions. Therefore many farmers who plant corn as an alternative to staple food in the form of rice. Cultivation of corn is now a lot of interest from farmers because the price is in the market between Rp3,500-5,000/kg and easy maintenance and high-profit potential. The potential for corn harvest is very tempting because the harvest time is short between 60 days - 110 days, production up to 20 tons/ha [2].

Hybrid and synthetic varieties are known to have higher yield potential compared to composite varieties. The use of hybrid varieties in developed countries is more than 99% of the hybrid varieties used in developed countries and only 39% in developing countries such as Indonesia so that the production of sweet corn in Indonesia is broadly lower than developed countries [3].

In corn cultivation, it must pay attention to fertilization problems, because fertilizers greatly contribute to corn yields. Fertilizer is a material that is used to change the physical, chemical or biological properties of soil so that it is better for plant growth. In a special sense, fertilizer is a material that contains one or more nutrient plants. As is well known that fertilizers produced and circulated in the market are very diverse, both in terms of type, shape, size, and packaging. These fertilizers are almost 90% already able to meet nutrient requirements for plants, from macro elements to micro-shaped elements [4].

Organic fertilizers contain macronutrients which are low but contain sufficient amounts of micronutrients which are very necessary for plant growth. Organic fertilizers also affect the physical and chemical properties, as well as the biological properties of the soil, also prevent erosion and reduce the occurrence of soil cracks. Fertilization generally aims to maintain or improve soil fertility so that plants can grow faster, fertile and healthier. Fertilization is intended to replace the loss of nutrients in the media or soil and is one of the important efforts to increase plant growth and production [5].

A decoction of soybeans from the remaining liquid waste from the tempeh and tofu industry has not been used optimally by food-making entrepreneurs made from soybeans. The amount of nutrient content found in tofu liquid waste is N at 164.9 ppm, P at 15.66 ppm, K at 625 ppm and pH at 3.9. Nutrients can be utilized optimally by kale, melon and chilli plants. The liquid waste knows after being deposited for 2 weeks, the C/N = 5 ratios are obtained. The liquid waste content of Tempe industry can be used as organic fertilizer by farmers to optimize corn production. Therefore, the authors conducted a study entitled Response of Bokashi Cow and Tempe Liquid Waste to the Growth and Production of Corn Plants.

2. Materials and Methods

The research was carried out at the on Jalan Manunggal Ujung, Bandar Klippa, Percut Sei Tuan Subdistrict, Medan Tembung. The implementation of this research was conducted from January to May 2017. This research used Factorial Randomized Block Design (RBD) with two factors treatment, namely: Cow faces Bokashi application (B) with 4 levels, namely: B0 = Control, B1 = 15 tons/ha, B2 = 30 tons/ha, B3 = 45 tons/ha. The Tempe (L) Industrial Waste with 4 levels, namely: L0 = Control, L1 = 30 ml/l, L2 = 60 ml/l and L3 = 90 ml/l. The data analysis model used in this study was factorial Randomized Block Design (RBD) and continued with the Duncan Multiple Range Test (DMRT) follow-up test at the 5% real difference level.

3. Results and Discussion

3.1. Plant Height

Based on the analysis of variance (ANOVA) with factorial Randomized Block Design (RBD) showed that the Bokashi treatment had a significant effect on the observation of maize plant age 2, 4, 6 MST, while the treatment of wastewater in the Tempe industry had no significant effect and both interactions, were significant.

Based on the average difference test from treatment with Duncan's Multiple Range Test (DMRT) can be seen in Table 1.

Table 1. Corn Plant Height Age 6 MST (cm) in Bokashi Cow Manure Treatment

Treatment	L_0	L_1	L_2	L_3	Average
B_0	195.23	190.26	184.44	191.30	190.31c
B_1	189.93	190.81	194.27	185.73	190.19c
B_2	188.27	190.91	202.60	175.72	189.38c
B_3	201.27	191.56	196.79	204.06	198.42a
Average	193.68	190.88	194.53	189.20	192.07

Description: Numbers followed by letters that are not the same in the same column are significantly different according to the 5% DMRT Test

In Table 1 it can be seen that the highest corn plant was found in Bokashi B_3 treatment (45 tons/ha) which was 198.42 cm which was significantly different from the treatment B0 (control) which was 190.31 cm and the same as treatment B1 (15 tons/ha) ie 190.19 cm and treatment B2 (30 tons/ha) which is 189.38 cm. The treatments, where the application of cow manure Bokashi 45 tons/ha and Tempe 90 ml/plant Industrial Liquid Waste. Therefore enough nutrient supply can stimulate and accelerate the growth of plant organs so that the plant provides a greater end result for corn crop production. According to [6] that a plant will grow and reach a high level of production if the nutrients needed by plants are in sufficiently available and balanced conditions in the soil and elements N, P, K are three (3) of the 6 elements macro nutrients that are absolutely necessary for plants. If one of these elements is lacking or not available in the soil, it will affect plant growth and production.

3.2. Number of Leaves

Based on the analysis of variance (ANOVA) with factorial Randomized Block Design (RBD) showed that bokashi treatment of cow dung, treatment of tempe industrial wastewater and the interaction of the two treatments had no significant effect on the number of leaves on corn plants. Based on the average difference test from treatment with Duncan's Multiple Range Test (DMRT) can be seen in Table 2.

Table 2. Average Number of Leaves of Corn Plants Age 6 MST (strands)

Treatment	L_0	L_1	L_2	L_3	Average
B_0	6.67	7.11	7.11	7.11	7.00
B_1	7.44	7.33	7.11	7.33	7.31
B_2	7.11	7.11	7.22	6.89	7.08
B_3	7.44	7.33	8.00	7.00	7.44
Average	7.17	7.22	7.36	7.08	7.21

In this study N nutrients were less available from the treatment given so that the number of leaves did not have a clear effect which caused leaves to grow only slightly. And the weather is very hot and rainy at the time of the study making the process of formation of leaves inhibited. According to [7] states that the formation of the number of leaves is largely determined by the number and size of cells, also influenced by nutrients absorbed by the roots to be used as food ingredients. The presence of Nitrogen which functions as a constituent of enzymes and chlorophyll molecules, radium functions as an activator for various protein synthesis enzymes and carbohydrate metabolism, phosphorus plays an active role in transferring energy in plant cells and magnesium as a constituent of chlorophyll and helps translocate phosphorus in plants.

3.3. Leaf Length

Bokashi treatment significantly affected the observation of leaf length of corn plants aged 2, 4, 6 MST while the treatment of wastewater in the tempe industry had no significant effect and both interactions had a significant effect. Based on the average difference test from treatment with Duncan's Multiple Range Test (DMRT) can be seen in Table 3.

Table 3. Average Leaves of Corn Plants Age 6 WAF (cm) in Bokashi Treatment for Cow Manure and Tempe Industry Liquid Waste

B/L	L_0	L_1	L_2	L_3	Average
B_0	93.30	92.19	92.92	93.49	92.98a
B_1	93.07	92.50	92.66	92.97	92.80b
B_2	89.94	90.20	95.32	95.47	92.73b
B_3	94.01	92.36	97.40	100.88	96.16c
Average	92.58a	91.81b	94.58c	95.70c	93.67

Description: Numbers followed by letters that are not the same in the same column are significantly different according to the 5% DMRT Test

In Table 3 it can be seen that the highest maize plants with bokashi treatment were found in B3 treatment (45 tons/ha) which was 96.16 cm which was significantly different from treatment B2 (30 tons/ha) which was 92.73 cm and similar to treatment B0 (control) namely 92.98 cm and the treatment of B1 (15 tons/ha) is 92.80 cm. The relationship between the height of corn plant age 6 MST and bokashi treatment can be seen in Figure 1.

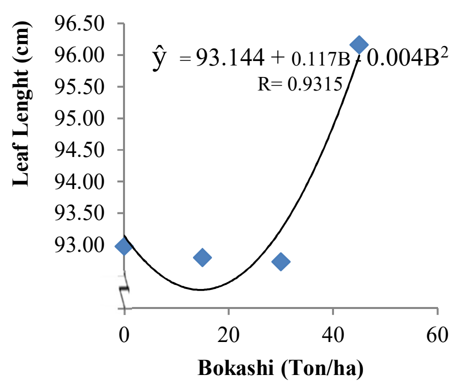

Figure 1. Graph between Plant Leaves Length (cm) Corn 6 MST by Giving Bokashi Cow Manure

From Figure 1 shows that the treatment of B3 gives the highest yield on the height of corn plants 6 MST with an average of 96.16 cm and the lowest plants found in treatment B2 with an average of 92.98. This is caused because B3 contains a lot of Nitrogen contained in the bokashi, which spurs the growth of the length of the leaves of the plant, while in B2 the availability of nutrients is less so it requires a long time for the decomposition process to the soil. According to [8], which states that the addition of organic material (bokashi) into the soil can increase the content of organic matter and soil nutrients. This is because the more bokashi fertilizer doses are given, the more N contained in bokashi fertilizer is also received more by the soil. N element is a very important nutrient because it is the most needed element for plant growth. Nitrogen functions as a constituent of amino acids, a protein component of chlorophyll pigments that is important in the process of photosynthesis. Conversely, if the deficiency of N causes plant growth and development to be disrupted and the yield decreases caused by disruption of chlorophyll formation which is very important for photosynthesis. The relationship between the length of the leaves of the corn plant and the treatment of tempe industrial wastewater can be seen in Figure 2.

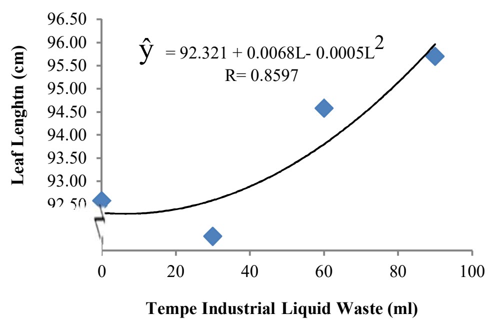

Figure 2. Graph between Plant Leaves Length (cm) of Corn 6 MST and Provision of Tempe Industrial Liquid Waste

From Figure 3 shows that the treatment of L_3 gives the highest yield on the height of corn plants 6 MST with an average of 95.70 cm and the lowest plants found in treatment B1 with an average of 91.81. This is because the nutrients available are sufficient and the given dosage is appropriate which will facilitate the entry of nutrients into the root tissue so that the transport of nutrients into the plant will be smooth which results in the growth and development of plants to be good, so that leaf formation is spurred. [9] states that element N is a constituent component of many essential compounds for plants, which are contained in chlorophyll. The presence of nutrient N stimulates the formation of leaf green which is very important for photosynthesis. The longer the leaves of the plant, the more sunlight is absorbed by the plant.

3.4. Leaf Area

Based on the analysis of variance (ANOVA) with factorial Randomized Block Design (RBD) showed that the treatment of bokashi cow manure, soybean industrial wastewater, and interaction between the two treatments showed an unrealistic effect.

Based on the average difference test from treatment with Duncan's Multiple Range Test (DMRT) can be seen in Table 4.

Table 4. Leaf Area of Corn Plants Age 6 WAP

Treatment	L0	L1	L2	L3	Average
B0	696.39	676.78	642.80	667.66	670.91
B1	664.62	662.58	656.69	672.40	664.07
B2	621.96	647.26	719.45	671.48	665.04
B3	662.25	704.12	764.68	779.71	727.69
Average	661.31	672.68	695.90	697.81	681.93

Description: Numbers followed by letters that are not the same in the same column and row are significantly different according to the 5% DMRT Test

The highest average leaf area of corn plants in bokashi treatment of cow dung was found in B3 treatment and followed by B_0, B_1, B_2 and the average treatment of liquid waste in the highest tempe industry was found in treatment L3 and followed by L_0, L_1, L_2. This is due to different doses given to each treatment which results in an imbalance of nutrients received by these plants. This is consistent with what was stated by [10] who stated that the balance of nutrients in the soil needs to be maintained because it can cause disruption of plants. In the treatment of B3, B2 and L3, L2 has a better balance of nutrients in the soil, because the given dose is higher than the other treatments.

3.5. Cob Weight/Plants per Sample

The Bokashi treatment had a significant effect on the observation of ear weight and for the treatment of effluent wastes the influential tempe industry had significant and both interactions were not real. Based on the average difference test from treatment with Duncan's Multiple Range Test (DMRT) can be seen in Table 5.

Table 5. Average Cob Weight/Plant per Plot (g) in Bokashi Treatment for Cow Manure and Tempe Industry Liquid Waste

Treatment	L_0	L_1	L_2	L_3	Average
B_0	183.39	213.86	219.76	220.75	209.44a
B_1	244.67	233.33	230.18	248.48	239.17b
B_2	224.44	233.92	264.82	237.04	240.06b
B_3	261.38	280.29	277.35	281.58	275.15c
Average	228.47a	240.35a	248.03b	246.96c	240.95c

Description: Numbers followed by letters that are not the same in the same column are significantly different according to the 5% DMRT Test

In Table 5, it can be seen that the highest weight of corn cobs with bokashi treatment is found in B3 treatment (45 tons/ha) which is 275.15 cm which is significantly different from treatment B0 (control) which is 209.44 cm and similar to treatment B1 (15 tons/ha), namely 239.17 cm and treatment B2 (30 tons/ha) which is 240.06 cm. And the highest treatment of wastewater from the tempe industry was found in the treatment of L2 (60 ml/l) which was 248.03 g which was significantly different from the treatment of L0 (control) ie 228.47 g and the treatment of L1 (15 ml/l) namely 240.35 g and L3 90 treatment (ml/l) which is 246.96 g. The relationship between the weight of cob corn and bokashi treatment can be seen in Figure 3.

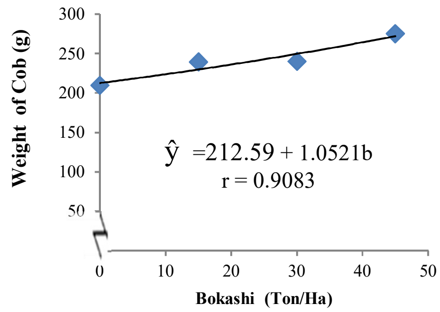

Figure 3. Cob Weight per Plant in 6 WAP with Cattle Bokashi Giving

From Figure 3 shows that the treatment of B3 gives the highest yield on the cob weight of corn plants with an average of 275.15 cm and the lowest plants found in treatment B0 with an average of 209.44. This is due to the fact that cow manure contains phosphorous and nitrogen which is equally good so it stimulates the growth of corn plants in the generative phase which causes the growth of corn cobs to grow well. Phosphorus is also needed by plants for the process of forming seeds, tubers and fruit. And the environment also plays a role in the process of forming cob on corn plants. According to [11], sweet corn yield is influenced by available P-land, ie 85% of the weight of sweet corn cobs is determined by the above variables and the rest is determined by other factors. The same thing was expressed in Ayunda (2014), phosphorus can increase fruit formation, besides the availability of phosphorus as an ATP builder will ensure the availability of energy for growth so that the formation of assimilates and transport to storage can run well. This causes the cob to be produced in large diameter. The phospor element functions in perfecting the cob, and the potassium element is also important for filling the cob, which is to make the cob full of seeds. Phospor greatly influences the formation of cob.

The relationship between the weight of corn cob and the treatment of tempe industrial wastewater can be seen in Figure 4.

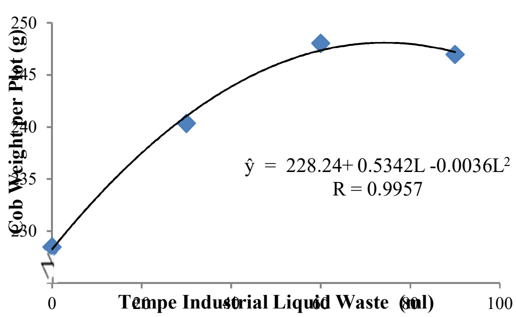

Figure 4. Cob Weight per Plot by Tempe Industrial Liquid Waste Application

From Figure 4 shows that the L_2 treatment gives the highest yield on the cob weight of corn plants with an average of 248.03 cm and the lowest plant is found in treatment B0 with an average of 228.47. This is caused by the fact that in the tempe wastewater there are organic compounds which can help the process of forming fruit/cob on corn plants and also organic compounds in helping the process of growing corn plants and their development. As well as the industrial wastewater from tempe has the content of phosphate which can be absorbed well by the roots of corn plants for the process of absorption of nutrients needed by corn plants. This is in accordance with what was stated by [12] which states that the PO4-3 content in liquid waste from the tempe industry is high enough to be applied directly to the soil and according to [13] fertilization by combining fertilizer inorganic and organic further increases the production of corn plants both cob length, ear circle and dry dry shelled weight. The liquid waste content of tempe industry also contains organic compounds which can help in the formation of fruit or cob. Tempe industrial wastewater also has a phosphate content that can be absorbed by plant roots, although in a low amount it can increase the growth of corn cobs in terms of a single treatment with 60% concentration of tempeh industrial wastewater capable of increasing cob weight 1.15 - 1.25 times more weight compared to the concentration of tempe industry wastewater giving 20% and 40%.

3.6. Weight of Dry Beans per Plot (g)

The treatment of bokashi cow manure, soybean industrial wastewater, and interaction between the two treatments showed an unrealistic effect. Based on the average difference test from treatment with Duncan's Multiple Range Test (DMRT) can be seen in Table 6.

Table 6. Average Weight of Dry Beans per Corn Plant Plot (g)

Treatment	L_0	L_1	L_2	L_3	Average
B_0	166.50	165.33	171.11	133.33	159.07
B_1	158.64	160.13	172.22	156.11	161.78
B_2	161.73	163.42	170.72	170.10	166.49
B_3	165.56	176.67	176.67	165.61	171.13
Average	163.11	166.39	172.68	156.29	164.62

The highest average dry seed weight per plot of corn plant in bokashi treatment of cow dung was found in B3 treatment and followed by B_0, B_1, B_2 and the average treatment for wastewater in the highest tempe industry was found in treatment L2 and followed by L_0, L_1, L_3. This is caused by the inability of nutrients in each treatment to supply the needs of corn plants and climate factors that always change when entering the harvest period of corn plants. Concentrations of 40% tempe industry wastewater and plant waste bokashi were unable to provide N and P nutrient availability and increase corn crop production. According to [14] states that the lack of N supply in plants will inhibit plant metabolism to carry out photosynthesis to produce carbohydrates, proteins, nucleic acids, energy and the formation of new cells.

4. Conclusions

The application of bokashi cow manure affects plant height, leaf length, ear weight found in B_3 treatment (45 tons/ha). Application of Tempe industrial wastewater affects the weight of the ear found in the L_2 (60 m/l) treatment. There is an interaction of bokashi cow manure and Tempe industrial wastewater at plant height in treatment B_3 (45 tons/ha) and L_3 (90 m/l).

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