American Journal of Multidisciplinary Research & Development (AJMRD)
Volume 04, Issue 03 (March - 2022), PP 25-32
ISSN: 2360-821X
www.ajmrd.com

Research Paper **Open Access**

Sweet corn (*Zea mays* Saccharata Sturt L.) Growth and Yield Response to Tomato Extract Liquid Organic Fertilizer

Nanik Setyowati [1*], Mohammad Chozin[1], Yohanes Arnol Nadeak[2], Kanang Setyo Hindarto[3], Zainal Muktamar[3]

[1] *(Department of Crop Production, Faculty of Agriculture, University of Bengkulu, Indonesia)*
[2] *(Agroecotechnology Study Program, Faculty of Agriculture, University of Bengkulu, Indonesia)*
[3] *(Department of Soil Science, Faculty of Agriculture, University of Bengkulu, Indonesia)*

ABSTRACT: Sweet corn (*Zea mays Saccharata* Sturt L.) is valuable and highly demand horticultural crop due to its widespread use. Sweet corn productivity can still be boosted by using appropriate fertilizers. However, unappropriated application of synthetic fertilizers has a detrimental effect on humans and the environment. Organic fertilizer can substitute synthetic fertilizer. Organic fertilizers are available both solid and liquid. Tomato waste is commonly used as source of liquid organic fertilizer (LOF). This study aims to compare the response of sweet corn to various LOF tomato extract concentrations and times of application. This study was conducted in Pondok Kelapa, Central Bengkulu, Indonesia. A completely randomized design (CRD) with two factors was used in the experiment. The first factor was LOF concentration, ranging between 0 and 15 mL/L. The second factor was LOF application time, consisting of 2 to 8 weeks after planting (WAP), 4 to 8 WAP, and 6 to 8 WAP and applied every week. Each treatment combination was repeated three times. The results indicated no interaction between the LOF concentration and application time on sweet corn growth and yield. The application of liquid organic fertilizer tomato waste did not increase sweet corn yield or yield components. Sweet corn growth was significantly greater in treatments with LOF applications from 2 to 8 WAP than in shorter application duration.

Keywords- liquid organic fertilizer, tomato waste, sweet corn, *Zea mays*

I. INTRODUCTION

Sweet corn (*Zea mays* Saccharata Sturt L.) is a horticulture crop with high economic value and has significant contribution to the national economy due to its multiple uses. Aside from the seeds, its young stems and leaves benefit for animal feed, old stems and leaves (after harvest) for green manure/compost, dry stems and leaves for fuel as a substitute for firewood, young maize fruit for vegetables [1].

The national demand for sweet corn increases as the population increases and high nutritional value of sweet corn. [2] findings confirm that 100 g of sweet corn provides 19 g of carbohydrates, 3.2 g of sugar, 2.7 g fiber, 90 kcal, 3.2 g of protein, 1.2 g fat, 1% vitamin A, 12% vitamin B9, 4% iron, 10% magnesium, 6% potassium, and 24 g of water. This leads to high demand of this agricultural commodity

Increasing sweet corn demand both quality and quantity can be accomplished through various approaches, one of which is the application of fertilizer [3]. Sweet corn requires appropriate nutrients to attain optimal production. Plants obtain nutrients from the soil through synthetic and organic fertilizers [4].

Synthetic fertilization has been used to meet the nutritional needs of sweet corn. In addition to the practical usage, the benefit of utilizing synthetic fertilizers is that the fertilizer is easily found in the market and its nutrients are easily available for sweet corn. However, the usage of synthetic fertilizers has a detrimental effect. Long term application of this fertilizer causes soil degradation, increases soil bulk density, preventing infiltration and water absorption, leading to detrimental on plant growth and development. The fertility of degraded soils cannot be easily restored even with the high application of synthetic fertilizer; hence limited use of this fertilizer is necessary [5] [6].

Application of organic fertilizers are an alternative to reduce the harmful impact of synthetic fertilizer. Organic fertilizers are those derived from plants or livestock manure. Organic fertilizers supply necessary macro and micronutrients for plant growth and development. Organic fertilizers also assist to improve the soil's physical, chemical, and biological activity [7] [8]. Physically, organic matter can loosen the soil, leading to enhanced aeration and more plant root penetration. Organic matter in sandy soil enhances particle bonds and increases the water holding capacity. Organic matter affects soil chemical characteristics by increasing cation exchange capacity and nutrient availability. Likewise, organic matter affects soil biology by increasing the energy required by soil microbes and increases microbial biomass carbon (MBC) [9] [10]. Organic fertilizers are available in both solid and liquid forms.

Liquid organic fertilizer (LOF) provides nutrients easily absorbed by plants. LOF can be applied by spraying it on plants. Liquid organic fertilizer can be prepared using various organic matter sources [11], one of which is tomato waste. This LOF source are abundant when the demand is lower than the commodity production. The LOF of tomato extract contains nitrogen (N) of 0.04 %, phosphorus (P) of 0.01 %, and potassium (K) of 0.07 % [12].

[13] found that 4 cc/L of LOF Super Aci combined with the recommended dosages of synthetic N, P, and K resulted in the longest and heaviest sweet corn cobs. According to [1] Santamicro LOF at a concentration of 3 ml/L water yielded the highest yields in terms of ear length, diameter, weight per plant, and weight per plot. Furthermore, [14] found that applying LOF of goat urine two weeks after planting (WAP) had a significant effect on plant height, fresh plant weight, fresh leaf weight, leaf number, leaf area, plant dry weight, and leaf dry weight. [15] reported that the fertilizing time of LOF Bio-Slurry 2 WAP and 4 WAP increased plant dry weight.

Tomato fruit production is extraordinarily high during particular growing seasons, leading to low tomato prices. As a result, the fruit products are unsold and piled up, causing environmental problem. Tomato waste can be used as source of LOF beneficial to plants to reduce environmental pollution. LOF from tomato waste has not been evaluate intensively, therefore, the investigation of LOF doses and its application time is necessary. The study aimed to compare the response of sweet corn to different concentrations of LOF of tomato extract and its application time.

II. METHODOLOGY

The research was conducted in Pondok Kelapa Village, Central Bengkulu, Indonesia. The design of this study was a Completely Randomized Block Design (RCBD), with two factors. The first factor was the LOF concentration of tomato extract which consists of 4 levels: N_0 =0 ml/L N_1 = 5 ml/L N_2 = 10 ml/L N_3 = 15 ml/L and the second factor was the time of LOF application which consists of 3 levels, namely: V_1 = 2, 3, 4, 5, 6, 7 and 8 WAP (weeks after planting) V_2 = 4, 5, 6, 7 and 8 WAP V_3 = 6, 7 and 8 WAP. The experimental plot size was 0.75 m x 5 m and repeated three times. Each experimental plot consisted of 12 plants with five plants as samples.

LOF preparation

Liquid organic fertilizer was prepared as follows: the starting solution of effective microorganism solution was prepared by dissolving 20 mL EM-4 and 0.25-kilogram brown sugar in 1 L of water. The solution was covered using white cloth and incubated for 2 days. Twenty-five kg of tomato waste was placed in plastic container and 1 l of starting solution was transferred to the container. The volume of the solution was made to 100 l. The solution was mixed and incubated for 2 weeks. The mixer was stirred every week. After the incubation, the solution was filtered using white cloth and ready for application.

Land Preparation

Land was prepared by turning the soil upside down using hoe to the depth of 25 cm below the surface, two weeks before planting. A week later, the second tillage was performed to get better growing environment for plant. The land was divided into 3 replications, each one with 12 experimental units, measuring 0.75 cm x 5 m. The distance was 0.5 between plots and 1 m between replications.

Soil Analysis

Soil was compositely sampled from 5 points at the depth of 0-20 cm. Five hundred g of sample was collected form each point, placed in the plastic tray, and incorporated homogeneously. The sample was air-dried, sieved with 0.5 mm screen, and analyzed for the content of N, P, K, pH, and C-organic.

Fertilization

Manure was applied at the dose of 10 tons/ha as a basal fertilizer. The amendment was homogeneously spread out and incorporated at 0-10 cm layer of the soil. Furthermore, the LOF of tomato extract was applied at treatment doses of 0 mL/L (control), 5 mL/L, 10 mL/L, and 15 mL/L, with application times varying from 2 WAP to 8 WAP. LOF was dispersed around the stem (root area) of sweet corn.

Planting

Sweet corn was planted at a depth of 5 cm from the soil surface at spacing of 75 cm x 25 cm spacing. Two seeds were placed in each planting hole. Thinning was conducted two weeks after planting by leaving the healthier plant. The plant was watered twice a day, in the morning and the afternoon, when necessary. Weed control was performed both manually and mechanically. Pest and disease were controlled chemically, with pesticide and fungicide at the recommended rates.

Harvesting

Sweet corn harvesting was carried out 75 days after planting (DAP), designated by 75% of the plant population has reached the ripe stage. The sweet corn seed has ripened, indicated by white paste when pressed and the cob hair has turned brown.

The variables observed included plant height, leaves number, flowering time, stem diameter, cob weight, cob length, cob diameter, plant yield, and fruit sweetness. Data were analyzed using analysis of variance (ANOVA), F test at 5% level. Treatment means were separated using LSD at 5% [16].

III. RESULTS AND DISSCUSSION

Overview of the Research

One WAP, the corn seeds did not grow uniformly, so replanting was conducted. Grasshoppers attacked the plants in WAPs 2 and 3. These pests were manually controlled, and they have almost no impact on crop. Grasshoppers are pests that frequently damage sweet corn plants in various environments [17] [18]. Grasshopper damage to plants is dependent on the stage of plant growth and the rainfall. The findings of [19] study demonstrate that the strength of grasshopper invasions is high when the plants are young and the rainfall is high; however, the intensity of attacks decreases when the plants are mature, even when the rain is high.

Stem borer (*Ostrinia furnacalis* Guenee) injured several plants during the generative phase. Stem borer pests attacked sweet corn during 54 to 75 DAP at 7.62 %, 8.50 %, and 11.62 %, respectively, in 3 different locations [20] Additionally, sweet corn was attacked by the cob borer (*Helicoverpa armigera* Hubner). *H.armigera* can lay up to 1000 eggs on the hair of sweet corn cobs [21]. Both pest species were manually controlled.

Description of sweet corn population is presented in Tabel 1. Sweet corn growth was lower than its potential. The plant's height ranged from 82.20 cm - 216.80 cm, with an average of 163.98 cm, the number of leaves ranged from 8.6 - 13.2, with an average of 11.48, and the stem diameter ranged from 12.03 mm - 26,58 mm, with an average of 18.79 mm. These findings show that the plant growth is lower than other studies. Sweet corn can reach a height of 250 cm under optimum conditions, with a stem diameter of 20-40 cm [22] and a leaf number of 10-18 [23].

Table 1. The performance of sweet corn population.

Variables	Minimum	Maximum	Average	CV(%)
Plant height (cm)	82.20	216.8	163.98	16.95
Stem diameter (mm)	12.03	26.58	18.79	18.78
Leaves number	8.60	13.20	11.48	10.57
Tasseling (DAP)	44.20	50.60	47.60	2.97
Ear emergence (DAP)	47.00	53.00	49.96	2.44
Length of husked cob (cm)	15.70	29.14	22.74	14.40
Diameter of husked cob (mm)	23.60	61.44	42.09	19.41
Weight of husked cob (g)	50.78	329.3	181.12	38.60
Length of unhusked cob (cm)	10.70	20.70	17.05	14.57
Diameter of unhusked cob (mm)	20.24	55.00	36.86	18.31
Weight of unhusked cob (g)	37.08	264.4	132.56	40.76
Fruit sweetness (ºBrix)	10.00	16.00	13.03	14.03
Crop yield (kg)	0.05	4.90	1.94	67.08

The emergence of tassel and ear represents the transition from the vegetative to the generative stage of sweet corn life cycle. On average, sweet corn tassel emerged at 47.6 DAP and ear at 49.9 DAP. Tasseling was earlier than the research results conducted in the lowlands by [24], which showed ear arose at 50.3 DAP and tassel at 53.3 DAP. The study results by [25] showed that the tasseling of sweet corn tends to be slower as the altitude increases.

The length of husked cobs ranged from 15.7 cm - to 29.14 cm, with an average of 22.74 cm while unhusked cobs ranged from 10.7 cm - 20.7 cm, with an average of 17.05 cm. In this study, the cob is shorter than that resulted by [26] which cob length was 21.40 cm when treated with synthetic fertilizer and 21.07 cm by LOF Bionutri treatment.

The study found that the diameter of husked cobs ranged from 2.36 cm - 6.14 cm with an average of 4.2 cm, which was lower when compared to the result of the study by [27]. Their results showed that the husked cob diameter was 4.7 cm; 4.9 cm; and 5.1 cm when fertilized with 0 tons/ha, 10 tons/ha, and 20 tons/ha organic fertilizer, respectively while at the same fertilization, the unhusked cob diameters were ranged from 2.2 cm - 5.5 cm. with an average of 3.6 cm. Likewise, our study resulted in higher unhusked cob diameter that that foud by [28] where the unhusked cob diameter was 2.6 cm at treatment rate of 15 tons/ha.

In general, the weight of sweet corn is 200 and 300 g [29]. Our study showed that the weight of the husked cob ranged from 50.7 g - 329.3 g with an average of 181.12 g, while the weight of unhusked cob was 37 g - 264.3 g with an average of 132.56 g. On the average, sweet corn yield was 1.94 kg per plot. This result is lower than that reported by [30] where the cob weight was 260.8 g, 311.9 g, 295.4 g when sweet corn fertilized with manure, NPK fertilizer, and NASA POC fertilizer, respectively. The quality of sweet corn is indicated by its sweetness where sweeter the corn has higher quality [31]. This study showed that the sweetness of sweet corn ranged from 10 to 17 ^{o}Brix, with an average of 13.03 ^{o}Brix. The sweetness level is similar to the sweetness level of Bonanza sweet corn, which is 13-15 ^{0}Brix.

The coefficient of variation (CV) is a measurement to compare the degree of variance among variables. The yield per plot showed the highest diversity with CV=67.08 %. According to [32] sweet corn yield per plot reflects the end product of crop growth and was heavily influenced by the environment. In addition, tasseling has the lowest CV (2.44 %), indicating the most uniform characteristics among other plant variables.

Diversity analysis

The findings of the analysis of variance on the 13 observed variables are shown in Table 2. All performance indicators were unaffected by the LOF dose, timing of application, or interaction between the two treatments, but plant height, stem diameter, and yield per plot.

Table 2. F-test treatment of dose and time of application of LOF of tomato extract and its interaction on growth and yield of sweet corn.

No	Variables	F-calculated		
		Dosage (D)	Application time (A)	D x A
1	Plant height	2.49 ns	5.05 *	1.75 ns
2	Stem diameter	1.79 ns	7.21 *	2.20 ns
3	Leaves number	1.16 ns	1.53 ns	2.07 ns
4	Tasseling	0.54 ns	0.31 ns	0.74 ns
5	Ear Emergence	0.73 ns	0.03 ns	0.69 ns
6	Length of husked cob	0.23 ns	1.12 ns	0.79 ns
7	Diameter of husked cob	0.33 ns	0.88 ns	0.48 ns
8	Weight of husked cob	1.63 ns	0.58 ns	0.74 ns
9	Length of unhusked cob	0.47 ns	1.01 ns	0.94 ns
10	Diameter of unhusked cob	0.57 ns	1.31 ns	0.52 ns
11	Weight of unhusked cob	0.83 ns	1.13 ns	0.52 ns
12	Fruit sweetness	2.87 ns	1.93 ns	1.77 ns
13	Crop yield	1.41 ns	4.19 *	0.36 ns

Note: ns=non-significant; * = significantly different

Liquid organic fertilizer often contains low plant nutrients. Our study found that tomato extract based LOF had 1.05 % N, 2.44 % P_2O_5, and 0.81 % K_2O. As indicated earlier that the LOF concentrations in this study were 5ml/L, 10ml/L, and 15ml/L. Sweet corn. on the other hand, requires 300kg/ha urea. 150kg/ha SP-36. and 100kg/ha KCl [33] which is equivalent to 135kg/ha N, 54kg/ha P_2O5, and 50kg/ha K_2O, or N 2.54 g; P_2O_5 1.01 g; K_2O 0.9 g per plant. As a result, nutrient supply from LOF might not sufficient for sweet corn growth and development even though additional organic fertilizer was applied at 10 tons/ha.

Decomposition of LOF form tomato extract releases nutrients for sweet corn, leading to the improvement of its growth, such as plant height, stem diameter, and corn yield. A weekly application of LOF provides sufficient nutrients required for sweet corn plants during vegetative and generative growth. The decomposition of organic matter, which produces nutrients available to plants, was influenced by the timing of the application of organic matter [34]. The response between variables of plant on nutrient availability varies [35]. Plant height, stem diameter, and yield per plot were responsive to available nutrients from LOF.

Growth and yield of sweet corn at various LOF concentration of tomato extract

Table 3 shows sweet corn growth and yield performance as affected by LOF tomato extract.

Table 3. Vegetative growth of sweet corn fertilized with LOF of tomato extract

Concentration (mL/L)	Plant height (cm)	Leaves number	Stem diameter (mm)	Tasseling (DAP)	Emergence of ear (DAP)
0	170.9	19.1	11.60	48.0	50.2
5	160.5	17.8	11.33	47.7	50.1
10	151.2	17.9	11.06	47.6	50.1
15	173.3	20.2	11.91	47.1	49.4

LOF of tomato extract did not affect plant growth as indicated in Table 3. In general, plant growth fertilized with LOF was still lower than its potential. Based on variety description, Bonanza sweet corn plant height is 220 cm - 250 cm; stem diameter is 20 mm - 30 mm. the number of leaves is 18 - 20 [23]. LOF also did not affect tasseling, even though it was earlier than the variety description which was 55-60 DAP. Variations in the growth environment might have caused the difference in tasseling.

The length of the cob, the diameter, and the weight of cob influence sweet corn yield. According to the variety description, the Bonanza produced cobs averaging 20 cm - 22 cm in length, 5.3 cm - 5.5 cm in diameter, 467 g - 495 g husked cob weight, 300 g - 325 g in unhusked cob weight, and 13^o – 15 ^{o}Brix in sweetness. Tables 4 and 5 reveal that all cob-related components have values lower than the potential yield. The application of LOF tomato extract up to a concentration of 15 mL/L did not improve sweet corn yield. This result might have been related to insufficient nutrients supply by LOF for the cob growth process. Lack of nutrient uptakes by plant affected its growth, leading to lower yield. Insufficient nitrogen content, for example, causes stunted plant growth, yellow leaves, as well as paler green foliage [36]. Phosphorus deficiency causes plant tissue to shrink and the color of the leaves to turn purplish or brownish [37]. Potassium deficiency symptoms appear on the lower leaves; the tips turn yellow and die, and the symptoms progress to the leaf edges. Furthermore, a shortage of potassium causes lower the sweet corn cobs yield.

Table 4. Yield components of sweet corn fertilized with LOF of tomato extract.

Concentration (mL/L)	Cob length (cm)		Cob diameter (mm)	
	husked	unhusked	husked	unhusked
0	22.52	16.70	41.94	35.98
5	22.17	16.85	40.96	35.70
10	22.97	16.76	41.22	36.42
15	23.30	17.87	44.22	39.34

Table 5. Yield components and yield of sweet corn as affected LOF of tomato extract

Concentration (mL/L)	Cob weight (g)		Seed sweetness (^{o}brix)	Yield /plot (kg)
	husked	unhusked		
0	168.08	120.99	12.55	1.38
5	166.38	121.28	12.44	2.29
10	183.72	133.94	14.33	1.75
15	247.93	154.01	12.77	2.33

The sweetness of the seeds determines sweet corn yield quality. Higher sugar content will improve its quality. In general, the sweetness level of the kernel from all treatments falls within the range described for the Bonanza variety, namely 13^o – 15 ^{o}Brix. Kernels' sweet flavor reflects the total dissolved solids content. The sweet corn storage space temperature significantly impacts the total dissolved solids content. At room temperature, corn sweetness will last for 4 days, but increase to 9 days at 5^{o}C [38].

Table 5 shows the yield per plot as the marketable weight of the cobs. Sweet corn may produce 14-18 tons of cobs per acre if nutrients are adequate for plant growth. In this study, the cob yield was 8.8 tons/ha, which was much lower than earlier study. Application of LOF had not provided sufficient nutrient for plant even at highest concentration (15 ml/l), indicating nutrient insufficiency during the plant growth.

Sweet corn growth, yield, and yield components at varied times of LOF application.

Although LOF concentrations did not affect plant growth and development, the application time did lead to variations in plant height and stem diameter (Table 6). The maximum average plant height (177.41 cm) was obtained when LOF was applied every 7 days from 2 WAP to 8 WAP. The LOF, applied every 7 days from 2 to 8 WAP, likewise had the largest stem diameter (20.75 mm). However, LOF application times did not influence leaves number, tasseling and emergence of sweet corn ear.

Table 6. Vegetative growth performance of sweet corn fertilized with LOF tomato extract at different application times.

Application times	Plant height (cm)	Stem diameter (mm)	Leaves number	Tasseling (DAP)	Emergence of ear (DAP)
2 – 8 WAP	177.41 a	20.75 a	11.85	47.31	49.88
4 – 8 WAP	162.06 ab	18.85 ab	11.45	47.78	50.01
6 – 8 WAP	152.46 b	16.74 b	11.13	47.70	49.98

Note: the numbers followed by different letters in the same column are significantly different according to the LSD level of 5%.

Cob length, diameter, and weight are unaffected by LOF of tomato extract application time, as demonstrated in Tables 7 and 8. This indicates that nutrient supply from LOF is insufficient even though the application for 6 weeks. This result confirms that LOF at concentration of 15 ml/l does not sufficient to supply nutrient for sweet corn growth and development. Findings by [39] also reveal that the time interval for NASA's LOF application has not boosted sweet corn yield. Other study by [40] showed the time interval for LOF Enviro treatment did not influence plant growth and development. The application of LOF of tomato extract at 2 – 8 WAP, on the other hand, led to more marketable cobs yield than the other treatments. The higher yield might be attributed to the decomposition of basal manure fertilization which released plant nutrient at longer period for sweet corn yield.

Table 7. Yield components of sweet corn fertilized with LOF tomato extract at different application times.

Application times	Cobs length (cm)		Cob diameter (mm)	
	husked	unhusked	husked	unhusked
2 – 8 WAP	23.69	17.82	44.50	39.36
4 – 8 WAP	22.74	16.85	40.74	36.02
6 – 8 WAP	21.79	16.46	41.02	35.20

Table 8. Yield components of sweet corn fertilized with LOF tomato extract at different application times (cont.)

Application times	Cobs weight (g)		Seed sweetness (°brix)	Yield/plot (kg)
	husked	unhusked		
2 – 8 WAP	205.74	150.72	13.66	2.72 a
4 – 8 WAP	168.85	123.37	13.00	1.60b
6 – 8 WAP	200.00	123.58	12.41	1.49 b

Note: numbers followed by different letters in the same column are significantly different at 5% LSD.

IV. CONCLUSIONS

The application of tomato liquid organic fertilizer from tomato extracts up to 15 ml/l did not affect sweet corn and yield. Moreover, the application time of LOF tomato extract from 2 to 8 WAP improves the yield of sweet corn per plot even though has no effect on sweet corn growth. Future study is necessary to increase the concentration of LOF to provide sufficient nutrients for sweet corn growth.

REFERENCES

[1] I. Syofia, A. Munar, and M. Sofyan, Pengaruh pupuk organik cair terhadap pertumbuhan dan hasil dua varietas tanaman jagung manis [Effect of liquid organic fertilizer on growth and yield of two varieties of sweet corn], *J. Agrium,* 18*(3)*, 2014, 208-218.

[2] Arianigrum, 2013, *Kandungan kimia jagung dan manfaatnya bagi kesehatan* [The chemical content of corn and its health benefits], http://www.staff.uny.ac.id//tmp/artikel-ppm-jagung2.doc.

[3] H.A. Putri, *Pengaruh pemberian beberapa konsentrasi Pupuk Organik Cair Lengkap (POCL) Bio Sugih terhadap pertumbuhan dan hasil tanaman jagung manis (Zea mays* Saccharata Sturt.*)* [The effect

of Bio Sugih Liquid Organic Fertilizer (LOF) concentration on sweet corn growth and yield (*Zea mays* Saccharata Sturt.)], theses, Fakultas Pertanian, Universitas Andalas Padang, Indonesia, 2011.

[4] W. Sari, I. Fajriani and S. Sudiarso, Growth response of sweet corn (*Zea mays* Saccharata Sturt) addition of various doses of organic fertilizer vermicompost and inorganic fertilizer, *Jurnal Produksi Tanaman*, 4*(1)*, 2016, 57 – 62.

[5] U. Made, Respons of various sweet corn (*Zea mays* Saccharata Sturt.) plant population on urea fertilizer application, *Jurnal Agroland*, 17*(2)*, 2010, 138 – 143.

[6] Z. Muktamar, D. Putri, and N. Setyowati, Reduction of synthetic fertilizer for sustainable agriculture: influence of organic and nitrogen fertilizer combination on growth and yield of green mustard, *International Journal on Advanced Science Engineering Information Technology*, 6 *(3)*, 2016, 361- 364, DOI: http://dx.doi.org/10.18517/ijaseit.6.3.802

[7] W. Prasetyo, M. Santoso. and T. Wardiyati, The effect of various dosages of organic and anorganic fertilizers on plant growth and yield of sweet corn (*Zea mays* Saccharata Sturt), *Jurnal Produksi Tanaman*, 1*(3)*, 2013, 79-86.

[8] Z. Muktamar, S. Sudjatmiko, F. Fahrurrozi, N. Setyowati and M. Chozin, Soil chemical improvement under application of liquid organic fertilizer in closed agriculture system. *International Journal of Agricultural Technology*, 13 *(7.2)*, 2017, 1715-1727.

[9] Z. Muktamar, B. Justisia, and N. Setyowati, Quality enhancement of humid tropical soils after application of water hyacinth (*Eichornia crassipes*) compost, *Journal of Agriculture Technology*, 12*(7.1)*, 2016, 1209-1225.

[10] R. Sutanto, *Penerapan pertanian organik* [Organic farming practice] (Penerbit Kanisius, Yogyakarta, 2006).

[11] Z. Muktamar, F. Fahrurrozi, S. Sudjatmiko, M. Chozin, and N. Setyowati. Quality of enriched liquid organic fertilizer from dairy cattle wastes for closed agriculture system. *International Journal on Advanced Science, Engineering, Information and Technology (IJASEIT)*, 10*(4)*, 2020, 1682- 1687. DOI:10.18517/ijaseit.10.4.5068

[12] B.P. Sari, S. Bambang, and H.S. Istiqomah, Pemanfaatan limbah tomat sebagai pupuk organic cair di Pasar Giwangan Yogyakarta [Utilization of tomato waste as liquid organic fertilizer in Giwangan market, Yogyakarta], *Sanitasi:Jurnal Kesehatan Lingkungan*, 8*(4)*, 2017, 189-194.

[13] M.G.M. Polii and S. Tumbelaka, The effects of organic fertilizer application to the production of Super Aci plant of sweet corn (*Zea mays* Saccharata L.), *J. Eugenia*, 18*(1)*, 2012, 56-64.

[14] H.I. Purwanti, J. Syakiroh and F. Anwar. Pengaruh konsentrasi dan saat pemberian pupuk organik cair (POC) berbasis urin kambing terhadap pertumbuhan dan produksi tanaman pakchoy (*Brasicca chinensis* L.). *Program Studi Agroteknologi. Fakultas Pertanian Universitas Pekalongan Indonesia*, 2014.

[15] V. Oktavia, *Respon pertumbuhan dan hasil tanaman jagung manis (Zea mays Saccharata* Sturt.*) terhadap pengaruh dosis dan waktu pemupukan pupuk cair bio-slurry*, theses, Fakultas Pertanian Universitas Lampung Bandar Lampung, Indonesia, 2017.

[16] K.A. Gomez and A.A. Gomez, *Statistical Procedures for Agricultural Researc*h (John Wiley. Sons. Inc. Laguna, 1984).

[17] F. Fitriani, *Hama dan penyakit jagung manis (Zea mays* Saccharata Sturt.*) di desa Benteng Cibanteng dan Nagrog Kecamatan Ciampea Kabupaten Bogor Jawa Barat* (Departemen Proteksi Tanaman IPB, Indonesia, 2009).

[18] S.F. Rondo, I.M. Sudarma and G. Wijana, Dynamics of pest population and main diseases of sweet corn plants (*Zea mays* Saccharata Sturt) at wetland with conventional cultivation system and their effect on yields in Denpasar-Bali, *Agrotrop: Journal on Agriculture Science*, 6*(2)*, 2016, 128-136.

[19] N.K. Kadir, *Kajian populasi hama Belalang (Locusta migratoria) pada tanaman Jagung (Zea mays L.)* doctoral diss., Universitas Negeri Gorontalo, Indonesia, 2014.

[20] S.A. Pratama, J.B. Kaligis, and J. Rimbing, Population and percentage pest attack stem borer (*Ostrinia furnacalis* Guenee) in maize (*Zea mays* Saccharata Sturt.) in the district of North Tomohon Tomohon. Cocos 6*(11)*, 2015, https://doi.org/10.35791/cocos.v6i11.8425

[21] Surtikanti, *Hama dan penyakit penting tanaman jagung dan pengendaliannya* (Balai Penelitian Tanaman Serealia, 2011)

[22] Warisno, *Budidaya jagung hibrida* [Hybrid corn cultivation] (Kanisius Jakarta, 1998).

[23] A. Subekti and Jafri, *Penampilan karakter agronomis dan hasil beberapa varietas jagung pada lahan ultisol Singkawang. Kalimantan Barat* (Seminar Nasional Serealia, 2011). https://docplayer.info/88941311-Penampilan-karakter-agronomis-dan-hasil-beberapa-varietas-jagung-pada-lahan-ultisol-singkawang-kalimantan-barat.html

[24] E. Lorenza, M. Chozin, and N. Setyowati, Traits association in sweet corn as grown on organic cropping system, *Akta Agrosia*, 19*(2)*, 2016, 129-138. https://doi.org/10.31186/aa.19.2.129-138

[25] M. Chozin and S. Sudjatmiko, 2018), Performances of sweet corn hybrids under organic crop management across three agro-climatic zones of the tropics, *International Journal of Agricultural Technology*, 14*(7)*, 2018, 1129-1140.

[26] H.D. Pangaribuan, Y.C.Ginting, and L.P.Saputra, Application of organic-liquid fertilizer and inorganic fertilizer on growth, production, and postharvest quality of sweetcorn (*Zea mays* Saccharata Sturt). *Jurnal Hortikultura Indonesia*, 8*(1)*, 2017, 59-67. DOI: https://doi.org/10.29244/jhi.8.1.59-67

[27] B.A. Sinuraya and M. Melati, Growth and production of sweet corn (*Zea mays* var. Saccharata Sturt.) with various rates of goat manure, *Bul. Agrohorti* 7*(1)*, 2019, 47-52. DOI: https://doi.org/10.29244/agrob.v7i1.24407

[28] A. Mamahit, P. Tumewu and M. Todung. The response of sweet corn *(Zea mays* Saccharata Sturt) to organic fertilizer, 2020, https://ejournal.unsrat.ac.id/index.php/cocos/article/view/27342/26903

[29] S. Suarni and M. Yasin, Jagung sebagai sumber pangan fungsional. *Iptek Tanaman Pangan*. 6*(1)*, 2009, 41-56. http://repository.pertanian.go.id/handle/123456789/6770

[30] Syafruddin, Nurhayati and R.Wati, Effect of kinds of fertilizer on growth and yield of several sweet corn varieties, *Jurnal Floratek* , 7*(1)*, 2012, 107-114.

[31] L.W. Lass, Callihan and Everson, Forecasting the harvest date ang yield of sweet corn by complex regression models, *Journal of Agricultural*, 118*(8)*, 1993, 450-455.

[32] Soegito and Adie, *Teknik bercocok tanam jagung* [Corn farming techniques] (Kanisius Yogyakarta, 1993).

[33] A. Widodo, P.S. Akas and S. Helda, Effect of plant spacing and NPK Phonska fertilizer on the growth and production of sweet corn (*Zea mays Saccharata* Sturt), Sweet Boy Variety, *Jurnal Agrifor*. 15*(2)*, 2010, 171-178.

[34] J. Irawan, *Pengaruh macam bahan organik dan pupuk N pada pertumbuhan dan hasil jagung manis* (*Zea mays Saccharata* Sturt), theses. Universitas Brawijaya Malang Indonesia, 2016. http://repository.ub.ac.id/id/eprint/131132

[35] A. Asroh, *Pengaruh takaran pupuk kandang dan interval pemberian pupuk hayati terhadap pertumbuhan dan hasil tanaman jagung manis (Zea mays* Saccharata Linn*)*, theses, Fakultas Pertanian Universitas Baturaja Sumatera Selatan Indonesia, 2010.

[36] K.A. Wijaya, *Nutrisi tanaman* [Plant Nutrition] (Prestasi Pustaka. Jakarta, 2008).

[37] A.N. Rosmarkam and W. Yuwono, *Ilmu kesuburan tanah* [Soil fertility] (Kanisius Yogyakarta, 2002)

[38] R. Khathir, Ratna and M.A. Puri, Shelf life estimation of sweet corn based on its total soluble solid by using arrhenius model, *AGRITECH.* 35*(2)*, 2015, 200-204. DOI: https://doi.org/10.22146/agritech.13831

[39] M.S. Pasaribu, W.A.Barus, and H. Kurnianto, Pengaruh konsentrasi dan interval waktu pemberian pupuk organik cair (POC) Nasa terhadap pertumbuhan dan produksi jagung manis (*Zea mays Saccharata* Sturt). *AGRIUM: Jurnal Ilmu Pertanian*, 17*(1)*, 2011, 46-52. http://dx.doi.org/10.30596%2Fagrium.v17i1.260

[40] Jumini, Nurhayati, and Murzani, Efek kombinasi dosis pupuk NPK dan cara pemupukan terhadap pertumbuhan dan hasil jagung manis, *Jurnal Floratek*, 6*(2)*, 2011, 165-170. http://www.jurnal.unsyiah.ac.id/floratek/article/view/510