Physiological Efficiency of Sweet Corn (Zea Mays L. Var Saccharata) as Influenced by Indigenous Microorganisms (IMO) 7 and Biofertilizers

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Abstract — *There is a growing popularity of organic farming in the modern era because of its potential contributions in sustaining crop production without impairing the natural condition of the environment. In this study, the physiological parameters of sweet corn applied with rates of indigenous microorganisms (IMO) 7 such as: (120 kg N - 90 kg P_2O_5 - 60 kg K_2O, IMO 7 at 7.5 t ha^{-1}, 15 t ha^{-1}, and 22.5 t ha^{-1}) and biofertilizers - fish amino acid (FAA), fermented plant juice (FPJ), and fermented seaweed (FS) were evaluated at different crop stages at 45, 55, 65, and 75 days after planting. The study was conducted in a 4 x 4 factorial in Randomized Complete Block Design (RCBD) with three replicates. Rates of IMO 7 significantly influenced on the crop growth rate (CGR) at 55-65 days after planting (DAP), and carbon productivity (CP) while biofertilizers influenced on weight per ear, the number of kernels per ear, ear yield, and leaf area ratio (LAR) at 65 DAP. Synthetic fertilizers (120 kg N, 90 kg P_2O_5, 60 kg K_2O) and IMO 7 at 22.5 t ha^{-1} gave the highest carbon productivity at harvest of 10.58 t ha^{-1} and 10.38 t ha^{-1}, respectively. Fermented seaweed gave the highest ear yield, weight per ear, and the number of kernels per ear. IMO 7 at the rate of 22.5 t ha^{-1} gave the highest CGR at 19.5 mg g^{-1} day^{-1} or 25.64% higher than those plants treated with the minimum rate of 7.5 t ha^{-1}. The results of the study provide information on the potentials of using IMO 7 in combination with fermented seaweed as organic fertilizers for sustainable sweet corn production.*

Keywords — *Biofertilizer, carbon productivity, IMO 7, physiological, sweet corn.*

I. INTRODUCTION

Sweet corn (Zea mays L. var saccharata) is one of the most popular crops because of its sweet taste, nutritional content and economic values (Najeeb, Rather, Sheikh, Ahanger, & Teli, 2011). The kernels contain a high amount of carbohydrates, proteins, vitamins, and minerals (Nuss & Tanumihardjo, 2010). The stalk can be processed into silage for livestock which eventually adds income for the farmers (Chaudhary, Kumar, Mandhania, Srivastava, & Kumar, 2011). Sweet corn can be grown easily for a shorter period and is more profitable than corn intended for grain production (Lucas & Salacup, 2018).

Sweet corn can be susceptible to pests and diseases (Meyer & Pataky, 2010). To minimize losses, a farmer must be knowledgeable in choosing the best variety or nutrient management to adopt. In recent practices, farmers used pesticides as their last remedy to fight pests and diseases. They used chemical fertilizers to boost crop yield. The continuous use of pesticides is very harmful to the environment. The interactions of all living organisms are greatly affected. Healthy soil is very necessary for crop production (Ella, Reyes, Mercado Jr, Adrian, & Padre, 2016). Feeding the soil with organic matter would gain a positive result in the growing crops (Diacono & Montemurro, 2011). The application of indigenous microorganisms and biofertilizers can be the best option for the farmers as an alternative to commercial fertilizers because it improves the soil fertility in the long term.

In this study, the researchers investigated the physiological efficiency of sweet corn (Zea mays L. var. saccharata) in response to the rates of indigenous microorganism (IMO) 7 and biofertilizers. The results of this study would serve as a guide for the farmers in Zamboanga del Sur who want to pursue sweet corn production using IMO 7 and biofertilizers.

II. MATERIALS AND METHODS

A. *Time and Place of the Study*

This experiment was conducted from September 2018 to December 2018 at the Crop Science Experimental Area of the Zamboanga del Sur Provincial Government College, Aurora, Zamboanga del Sur (N: 07₹ 56.7510’, E: 123₹ 35.2680’, Elevation: 270.7 meters). Fig. 1 presents the actual site of the experiment.

Fig. 1 Map showing the experimental site of the study from Google earth pro 2019.

B. *Variety and Source of Experimental Materials*

Hybrid sweet corn (*Zea mays* L.) var Macho F1 was obtained from the seed retailer in Molave, Zamboanga del Sur. Materials for IMO 7 and biofertilizers were procured from the local suppliers in Aurora, Zamboanga del Sur.

C. *Preparations of Indigenous Microorganisms (IMO)*

The methods were adopted, practiced and produced from the Nature Farming (Cho & Cho, 2010), and are modified to utilize locally available resources as suggested by the (Catholic Relief Services (CRS), 2008) as cited by (Villaver and Borres, 2018) was used as the standard for the formulation of IMO 7 as organic fertilizer. Indigenous microorganisms (IMO) 7 were produced after mixing it with the materials such as 8 sacks IMO 6, 2 sacks of vermicompost, and 2 liters of water with fermented plant juice and fish amino acid for additional sources of microorganisms.

D. *Application of IMO 7 and Biofertilizers*

IMO 7 was applied in the experimental plots according to the rates assigned for each treatment at three (3) days before planting as basal application. The amount of IMO 7 was computed in per plot to assure equal distribution. No side-dressing was done except the control treatment. Biofertilizers (FAA, FPJ, and fermented seaweed) were diluted at the rate of 20 ml/liter of water. Organic nutrient supplements were applied as foliar fertilizer at 14^{th}, 21^{st}, 28^{th}, 35^{th}, and 42^{nd} days after planting at the dilution rate of 7.68 ml/384 ml per plot or 3.2 L/10 tank loads (16 L. capacity) per hectare.

E. *Harvesting*

Ears of sweet corn were harvested at 75 days after planting. Husks were removed to determine the size and its quality. After de-husking, sorting was carried on. Products were classified into small, medium and large.

F. *Soil Analysis*

The experimental area was subjected to soil analysis in two times. The first soil analysis was done before the conduct of the experiment; second, was done after the harvest of the experiment at 75 days after planting to determine the nutrient levels like N, P, K, OM, and pH. Soil samples were submitted to the Bureau of Soil and Water Management (BSWM), Cagayan de Oro City for analysis. Table 1 presents the soil pH, organic matter, nitrogen, phosphorus, and potassium content of the soil before and after the experiment. Before the sweet corn planted, it was found out that the area was acidic with pH 5.39, organic matter (2.13%), nitrogen (0.1065 ppm), phosphorus (0.47 ppm), and potassium (222 ppm). The result in the first soil analysis revealed that the area needs a higher amount of fertilizers to attain higher production of sweet corn. After the conduct of the experiment, an increase of the soil analysis was observed in which: organic matter from 2.13 to 3.94, nitrogen from 0.107% to 0.197%, phosphorus from 0.47 to 105 ppm, potassium from 222 to 435 ppm, and pH from 5.3 to 6.71.

Table 1. Soil pH, organic matter, nitrogen, phosphorus, and potassium content of the soil before and after the experiment conducted

Parameters	Test Method	Before Planting	After Planting
Soil pH	Potentiometric	5.30	6.71
Organic matter (OM) %	Walkley and Black Spectrophotometric	2.13	3.94
Nitrogen (N) ppm	By calculation (% OM x .05)	0.107	0.197
Phosphorus (P) ppm	Olsen	0.47	105
Potassium (K) ppm	Cold H_2SO_4 Extraction	222	435

(*Integrated Laboratories Division DA RFO – 10*)

G. *Analysis of IMO 7*

Samples of IMO 7 were submitted to the Bureau of Soil and Water Management (BSWM), Cagayan de Oro City for analysis. Table 2 shows the analysis of IMO 7 in terms of nitrogen, phosphorus, potassium content, and moisture. The result showed that IMO 7 contains 2.10% N, 3.67% phosphorus, 2.56 potassium, pH 7.66 and total NPK of 8.33.

Table 2. Nitrogen, phosphorus, and potassium content, moisture, and pH of indigenous microorganisms (IMO) 7

Parameters	Test Method	Result	
		AS RECEIVED	OVEN-DRIED
Total Nitrogen (%N)	(Nitrate Containing Fertilizers) Kjeldahl	1.68	2.10
Total Phosphorus (%P_2O_5)	Vanadomolybdate	2.94	3.67
Total Potassium (%K_2O)	Flame Photometry	2.05	2.56
Total NPK	By Calculation	6.67	8.33
Moisture	Gravimetric	19.86	--
pH	Potentiometric	7.62	--

(*Integrated Laboratories Division DA RFO – 10*)

H. *Analysis of Biofertilizers*

Analysis of biofertilizers is presented in Table 3. Fish amino acid got the highest percentage of nitrogen of about 1.02%, it was followed by fermented plant juice (0.10%), and fermented seaweed with (0.06%). For the potassium content, fermented seaweed got the highest percentage of about 1.27%, followed by fermented plant juice with 0 .72%, and fish amino acid with 0.64%.

Table 3. Nitrogen, phosphorus, and potassium content of fermented plant juice (FPJ), fermented seaweed (FS), and fish amino acid (FAA)

Parameters	Test Method	FAA	FS	FPJ
Total Nitrogen (%N)	(Iron Reduced Fertilizers) Kjeldahl	1.02	0.06	0.10
Total Phosphorus (% P_2O_5)	Vanadomolybdate	₹ 0.007	₹ 0.007	₹ 0.007
Total Potassium (% K_2O)	Flame Photometry	0.64	1.27	0.72
pH	Potentiometric	4.24	4.31	4.08

(*Integrated Laboratories Division, DA RFO – 10*)

I. *Data Gathered*

The data gathered are categorized into two such as a) yield and yield components and b) physiological parameters. The yield and yield components include the weight per ear, ear diameter, ear length, number of kernel per ear and ear yield. Ear yield was computed using the formula:

$$\text{Yield (ears kg/ha)} = \text{yield/plot (kg)} \times \frac{10{,}000 \text{ sqm}}{\text{Sample area}}$$

The physiological parameters are leaf area ratio (LAR), crop growth rate (CGR), and carbon productivity. The LAR is the ratio of leaf area to the total weight. It is also a measure of the photosynthetic machinery per unit leaf biomass and is expressed in ($gm^{-2}\ d^{-1}$) (Rattin, Valinote, Gonzalo, & Di Benedetto, 2015).LAR was taken at 45, 55, 65, and 74 days after planting using the formula below:

$$LAR = \frac{LA}{W}$$

Where: LA = leaf area
W = Plant dry weight

The crop growth rate (CGR) is the increment of plant dry weight in a unit of land area per unit of time ($gm^{-2}\ d^{-1}$) (Khan et al., 2017). Calculation of this parameter at 45-55, 55 – 65, and 65 - 74 DAP was done using the formula below:

$$CGR = \frac{W_2 - W_1}{P\,(T_2 - T_1)}$$

Where, P = Ground area, W_1 = Dry weight of plant/m^2 recorded at T_1; W_2 = Dry weight of plant/m^2 recorded at T_2; T_1 and T_2 is the interval of time and was expressed in ($gm^{-2}\ d^{-1}$).

Carbon Productivity (CP) was determined at harvest by multiplying the total dry matter yield (TDMY) aboveground multiplied by a carbon (C) conversion coefficient of 0.5.

CP = TDMY at harvest x 0.5
Where: TDMY = Total dry matter yield at harvest

J. *Data Analysis*

Statistical analyses were done by using Minitab 17. Analysis of variance and Tukey's Test simultaneous 95% confidence intervals were used to compare the differences among treatment means. The Pearson correlation coefficient (r) was done to measure the association among the selected variables.

III. Results and Discussions

A. *Ear Diameter, Length (cm) and Kernel Per Ear*

The effects of rates of IMO 7 and biofertilizers on the ear diameter, ear length, and kernel per ear are presented in Table 4. As shown in the table, sweet corn applied with IMO 7 at the rate of 22.5 t/ha had the largest diameter at 4.80 cm and 15 t/ha had the smallest at 4.73. For the effects of biofertilizers, fermented seaweed had the largest ear diameter of 4.80 cm, and fermented plant juice had the smallest at 4.74 cm. Sweet corn, when applied with 120-90-60, had the longest ear length at 17.39 cm, followed by 22.5 t/ha at 17.25 cm and 15 t/ha had the shortest ear length at 16.67 cm. For the effects of biofertilizers, fermented seaweed had the longest ear length at 17.54 cm, followed by the control at 17.38 cm.

The sweet corn applied with 120-90-60 had the most number of kernels per ear at 651.70 and the smallest is 15 t/ha at 624.24. Statistical did not reveal significant results on the effects of rates of IMO 7 on the kernel per ear of sweet corn. For the effects of biofertilizers, fermented seaweed had the highest number of kernel per ear at 662.37, and the lowest is fermented plant juice with 620.10 (Fig. 2). Results suggested that the biofertilizers using fermented seaweed significantly influenced the development of kernel per ear. In the study of (Pal, Dwivedi, Maurya, & Kanwar, 2015a) revealed that seaweed saps improved the kernel development of sweet corn. Seaweed contains a sufficient amount of potassium and other micronutrients like calcium, magnesium, sulfur, boron, and many more (Matanjun, Mohamed, Mustapha, & Muhammad, 2009a). The sufficient amount of potassium in seaweed contributed to the development of kernel per ear and improving its sugar content (CAO & ZHAO, 2009). The number of kernels and its protein content also is improved with a sufficient amount of nitrogen (Oktem, Oktem, & Emeklier, 2010a) and phosphorus (Adams, Erickson, & Singh, 2015). A sufficient amount of potassium improved grain filling and the number of kernel per ear (Mahajan, Singh, & Kumar, 2013). Statistical analysis did not reveal any significant results on the interaction effects of rates of IMO 7 and biofertilizers on the ear diameter, ear length, and kernel per ear of sweet corn.

Table 4. Ear Diameter (cm), ear length (cm) and kernel per ear of sweet corn as influenced by rates of IMO 7 and biofertilizers.

Treatments	Ear Diameter (Cm)	Ear Length (Cm)	Kernel Per Ear
A - Rates of IMO 7			
120 – 90 – 60	4.77	17.39	651.70
7.5 tons/ha	4.76	17.18	644.37
15 tons/ha	4.73	16.67	624.34
22.5 tons/ha	4.80	17.25	647.20
B - Biofertilizers			
Control	4.77	17.38	647.16[ab]
Fish Amino Acid	4.75	16.99	637.90[ab]
Fermented Plant Juice	4.74	16.59	620.10[b]
Fermented Seaweed	4.80	17.54	662.37[a]
F- test:			
A	ns	ns	ns
B	ns	ns	*
A x B	ns	ns	ns
C.V. (%)	2.01	5.60	5.85

ns = non significant
* *= significant at 5% level of Tukey's test*

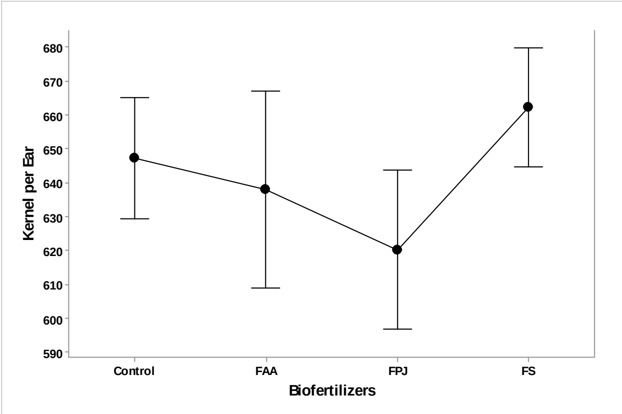

Fig. 2 Interval plot on the number of kernels per ear as influenced by biofertilizers.

B. *Weight Per Ear (g), and Ear Yield (kg/ha)*

Weight per ear and ear yield are presented in Table 5. As shown, the sweet corn applied with 22.5 t/ha had the heaviest weight per ear at 275.35 g and the lowest is 15 t/ha at 256.61 g. For the effects of biofertilizers on weight per ear, control and fermented seaweed had the heaviest weight of 276.31g and 275.50 g, respectively. Fermented plant juice had the lightest weight per ear at 255.85 g. As mentioned by (Matanjun, Mohamed, Mustapha, & Muhammad, 2009b) that seaweed contains a sufficient amount of nitrogen, phosphorus, potassium, and micronutrients like boron, zinc and many more. The said nutrients are a very important contributor to the formation of ear kernels. Nitrogen from seaweed maintains the green color of the leaves to capture more amount of sunlight for the production of photosynthesis and assimilates (Teasdale, Abdul-Baki, & Park, 2008a). Nitrogen is one of the constituents in protein synthesis. Nitrogen is very necessary for the formation of ear thereby improving its weight when the optimum amount is reached (Oktem, Oktem, & Emeklier, 2010b). Boron in seaweed affects the weight per ear since in its absence contributes to malformation (Nelson & Meinhardt, 2011). The sufficient amount of boron from seaweed improved the weight per ear and ear yield (Kaur & Nelson, 2015). Potassium is the primary element in the formation of ears. Sufficient amount of potassium improved the weight per ear and yield (Rivera-Hernández, Carrillo-Ávila, Obrador-Olán, Juárez-López, & Aceves-Navarro, 2010). The combined effects of the macro (N, P, K) and micronutrients (magnesium, manganese, boron, sulfur, zinc, calcium, etc.), present in seaweed, produced a bigger ear and yield of sweet corn (Possinger & Amador, 2016).

Sweet corn applied at the rate of 22.5 t/ha had the highest ear yield of about 12, 045 kg/ha, followed by 120-90-60 at 11,740 kg/ha, and the lowest is 7.5 t/ha with 10,922 kg/ha. For the biofertilizers, fermented seaweed had the highest yield of about 12, 588 kg/ha and the lowest are fish amino acid and fermented plant juice with 11,033 kg/ha, and 11,034 kg/ha respectively (Fig. 3). Seaweed saps better the granule yield (10.5 – 13.1%), carbohydrate (12.3 – 17.4%), and protein contented (4.8%) over the manage which conventional a suggested dose of fertilizers (Layek et al., 2015). The same authority added that the seaweed saps proved to be an eco-friendly means for enhancing the production of corn. Seaweeds contain numerous amount of macro and micronutrients which are very necessary for the production of various agronomic crops (Matanjun et al., 2009b), seaweed improved the yield of sweet corn by improving its size, grain filling, and weight (Possinger & Amador, 2016). Boron from seaweed maintains the normal formation of ears (Kaur & Nelson, 2015). Potassium from seaweed improved the sugar content as well as the yield of sweet corn (Cao et al., 2011). Application of seaweed foliar fertilizers improved the yield of corn because its nutrients are directly absorbed by the stomata of the leaves, therefore, adding some of the deficit nutrients not sufficiently supplied by the soil (Pal, Dwivedi, Maurya, & Kanwar, 2015b). Foliar application is of great benefit for the crop if applied on time in which the crop is in the stage of rapid demand and accumulation of nutrients (Kim et al., 2015). Aside from macro and micronutrients in seaweed and other liquid organic fertilizers (Muktamar, Setyowati, Sudjatmiko, & Chozin, 2016), it also contains useful microorganisms which produce useful enzymes to benefit the standing crop (Javaid, 2010).

In general, there is a consistent pattern of increase in-ear yield when the rates of IMO 7 increases further. The use of fermented seaweed as foliar fertilizer is of great benefit since it gave the highest ear yield. The interaction effects between the rates of IMO 7 and biofertilizers did not influence on the ear yield of sweet corn.

Table 5. Weight per ear, and ear yield of sweet corn as influenced by rates of IMO 7 and biofertilizers.

Treatments	Weight Per Ear (g)	Ear Yield (kg ha^{-1})
A – Rates of IMO 7		
120 – 90 – 60	274.26	11,740
7.5 tons/ha	264.31	10,922
15 tons/ha	256.61	11,237
22.5 tons/ha	275.35	12,045
B–Biofertilizers		
Control	276.31^{a}	11,319^{ab}
Fish Amino Acid	262.87^{ab}	11,003^{b}
Fermented Plant Juice	255.85^{b}	11,034^{b}
Fermented Seaweed	275.50^{a}	12,588^{a}
F- test:		
A	ns	ns
B	*	*
A x B	ns	ns
C.V. (%)	7.33	11.48

ns = non significant
** = significant at 5% level of Tukey's test*

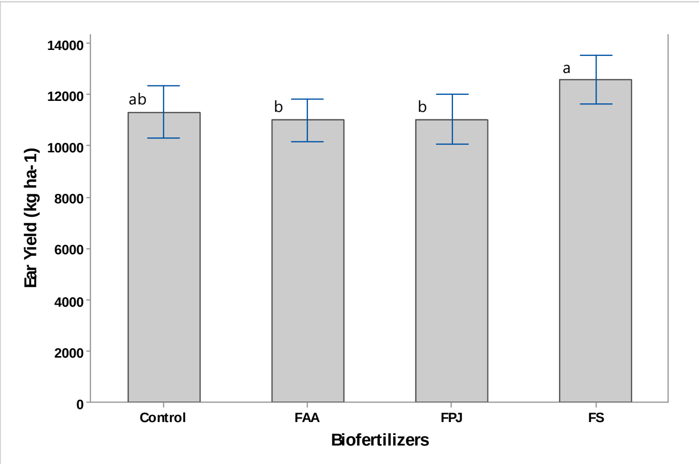

Fig. 3. Ear yield (kg ha^{-1}) of sweet corn as influenced by biofertilizers.

C. *Correlation among Ear Yield, Weight Per Ear, Kernels Per Ear, Ear Length, and Ear-Diameter*

The correlation analyses among selected parameters are presented in Table 6. Correlation analyses revealed that the ear yield of sweet corn is highly positively associated with weight per ear, kernel per ear, ear length, and ear diameter. Weight per ear is also highly positively associated with kernel per ear, ear length, ear diameter, and ear yield. Results suggested that ear yield increases when the weight per ear, length, diameter, and kernel per ear also increased. The study of (Nataraj, Shahi, & Agarwal, 2014) mentioned that the weight per ear is greatly affected by length, diameter, and kernel per ear. Ear yield is increased when the weight per ear also increased.

Table 6-The correlation coefficient (r) among ear yield (EY), weight per ear (WPE), kernels per ear (KPE), ear length (EL) and ear diameter (ED).

	WPE	KPE	EL	ED
KPE	0.870**			
EL	0.901**	0.852**		
ED	0.751**	0.727**	0.633**	
EY	0.652**	0.592**	0.525**	0.551**

***=significant at 1% level*

D. *Leaf Area Ratio (LAR)*

The leaf area ratio of sweet corn as influenced by rates of IMO 7 and biofertilizers at 45, 55, 65, and 74 days after planting is presented in Table 7. As presented, the rate of 22.5 t/ha gave the highest leaf area ratio of about 94.68 cm^2 per gram, and the least is 15 t/ha with 84.95 cm^2 per gram of dry matter.

For the biofertilizers, fish amino acid obtained the highest LAR at 97.12 $cm^2\ g^{-1}$, and the lowest is fermented plant juice at 80.52 $cm^2\ g^{-1}$. At 55 days after planting, 15 t/ha gave the highest LAR at about 68.87 $cm^2\ g^{-1}$, and the lowest is 120-90-60 at 61.20 $cm^2\ g^{-1}$. At 65 days after planting, 7.5 t/ha gave the highest LAR at about 51.58 $cm^2\ g^{-1}$, and the lowest is 120-90-60, at 49.29 $cm^2\ g^{-1}$. For biofertilizers, control gave the highest LAR at about 52.72 $cm^2\ g^{-1}$ and the lowest in the fish amino acid at 46.62 $cm^2\ g^{-1}$. Results revealed that the leaf area ratio of sweet corn applied with fish amino acid is significantly lower compared to the control treatments at 65 days after planting.

Fermented seaweed contains more amount of nitrogen (Dolomatov, Shekk, Zukow, & Kryukova, 2011) which improves the efficiency of light interception, absorption of nutrients as well as the production of photosynthesis and assimilates, thus it utilizes a smaller portion of leaves in order to produced grams of dry matter biomass (Teasdale, Abdul-Baki, & Park, 2008b). At 74 days after planting, 15 t/ha gave the highest LAR at about 34.84 $cm^2\ g^{-1}$, and the lowest is 120-90-60 with 32.53 $cm^2\ g^{-1}$. For the effects of biofertilizers on the LAR of sweet corn at 74 days after planting, control gave the highest at about 35.49 $cm^2\ g^{-1}$, and the lowest is fermented seaweed at 31.80. The data show a declining pattern of LAR as the plants grow older. The values of the leaf area ratio are higher at early crop stages and decline at the latter plant stage (Gonzaga Jr, 2014).

Table 7- Leaf area ratio (LAR) of sweet corn at 45, 55, 65, and 74 days after planting as influenced by rates of IMO 7 and biofertilizers.

Treatments	Leaf Area Ratio (LAR) $cm^2\ g^{-1}$			
	45 DAP	55 DAP	65 DAP	74 DAP
A – Rates of IMO 7				
120 – 90 – 60	85.19	61.20	49.29	32.53
7.5 tons/ha	87.63	67.38	51.58	33.17
15 tons/ha	84.94	68.87	49.42	34.84
22.5 tons/ha	94.68	68.04	47.61	32.95
B – Biofertilizers				
Control	84.49	62.20	52.72[a]	35.49
Fish Amino Acid	97.12	67.11	45.62[b]	33.15
Fermented Plant Juice	80.52	68.40	49.46[ab]	33.04
Fermented Seaweed	90.30	64.78	50.12[ab]	31.80
F- test:				
A	ns	ns	ns	ns
B	ns	ns	**	ns
A x B	ns	ns	ns	ns
C.V. (%)	10.90	10.03	14.85	10.08

ns = non significant
** = significant at 5% level of Tukey's test*
***= highly significant at 1% level of Tukey's test*
DAP= Days after planting

E. *Crop Growth Rate*

The crop growth rate of sweet corn as influenced by rates of IMO 7 and biofertilizers is presented in Table 8. The crop growth rate is the increment of plant dry weight in a unit of land area per unit of time ($gm^{-2}\ g^{-1}$). As shown in the data, 120-90-60 gave the highest CGR at 45-55 DAP of about 19.11 while 7.5 t/ha gave the lowest at 18.34 (Fig. 4). For the biofertilizers, fermented seaweed gave the highest CGR at 45-55 DAP of about 20.26 while control gave the lowest at about 17.72. At 55-65 DAP, 22.5 t/ha gave the highest CGR at about 19.53

while 7.5 t/ha gave the lowest at14.53. Statistical analysis revealed significant on the effects of rates of IMO 7 on the CGR of sweet corn at 55-65 days after planting. For the biofertilizers, fermented seaweed gave the highest CGR at about 18.27 while control gave the lowest at 14.87. At 65-74 DAP, 22.5 t/ha gave the highest CGR at about 31.01 while 7.5 t/ha obtained the lowest at 27.64. For the effects of biofertilizers, fish amino acid gave the highest CGR at about 30.15 while FPJ gave the lowest at 26.78. Statistical analysis did not reveal any significant on the effects of biofertilizers on the CGR of sweet corn at 65-74 days after planting.

Table 8. Crop growth rate (CGR) of sweet corn at 45-55, 55-65, and 65-74 days after planting as influenced by rates of IMO 7 and organic nutrient supplements

Treatments	Crop Growth Rate (CGR) mg g^{-1} day^{-1}		
	45-55 DAP	55-65 DAP	65-74 DAP
A – Rates of IMO 7			
120 – 90 – 60	19.11	18.38^{ab}	30.06
7.5 tons/ha	18.34	14.53^{b}	27.64
15 tons/ha	18.70	16.28^{ab}	28.27
22.5 tons/ha	18.80	19.53^{a}	31.01
B – Biofertilizers			
Control	17.72	14.87	29.99
Fish Amino Acid	18.90	18.23	30.15
Fermented Plant Juice	18.06	17.34	26.78
Fermented Seaweed	20.26	18.27	30.10
F- test:			
A	ns	*	ns
B	ns	ns	ns
A x B	ns	ns	ns
C.V. (%)	13.77	25.12	22.86

ns = non significant
** = significant at 5% level of Tukey's test*
DAP= Days after planting

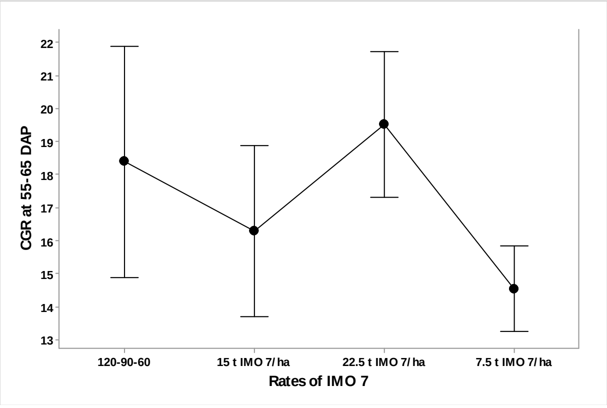

Fig. 4- The crop growth rate of sweet corn at 55-65 days after planting as influenced by rates of IMO 7.

F. *Carbon Productivity (t ha^{-1})*

Carbon productivity of sweet corn as influenced by rates of IMO 7 and biofertilizers is shown in Table 9. Synthetic fertilizer (120-90-60) and 22.5 t/ha obtained the highest at about 5.29 and 5.19 respectively while 7.5 t/ha obtained the lowest at 4.67 t/ha (Fig. 5). Statistical analysis did not reveal any significant results on carbon productivity as influenced by rates of IMO 7. For the biofertilizers, fermented seaweed gave the highest carbon productivity at about 5.33 t/ha while control obtained the lowest with 4.84 t/ha. Statistical analysis did not reveal any significant results on the effects of biofertilizers on the carbon productivity of sweet corn.

Table 9. Carbon productivity of sweet corn as influenced by rates of IMO 7 and biofertilizers.

Treatments	Carbon Productivity (CP)
A – Rates of IMO 7	
120 – 90 – 60	5.29[a]
7.5 tons/ha	4.67[b]
15 tons/ha	4.92[ab]
22.5 tons/ha	5.19[a]
B – Biofertilizers	
Control	5.01
Fish Amino Acid	4.84
Fermented Plant Juice	4.88
Fermented Seaweed	5.33
F- test:	
A	*
B	ns
A x B	ns
C.V. (%)	9.89

ns = non significant
** = significant at 5% level of Tukey's test*

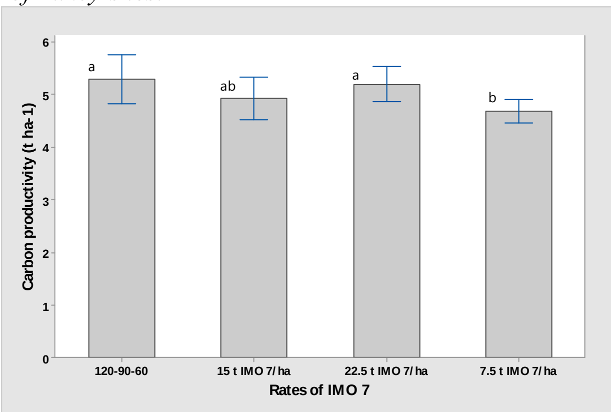

Fig. 5- Carbon productivity of sweet corn as influenced by rates of IMO 7.

IV. CONCLUSIONS

Rates of IMO 7 influenced the crop growth rate (CGR), and carbon productivity (CP). CP and CGR are higher when applied with synthetic fertilizers (120-90-60) and IMO 7 at the maximum rate of 22.5 t ha^{-1} due to the availability of more nutrients as compared to the minimum rate of 7.5 t ha^{-1}. Biofertilizers influenced on the leaf area ratio (LAR), weight per ear, number of kernels per ear, and ear yield. Fermented seaweed performed better among the biofertilizers in which it improved the ear yield, kernel per ear, and the weight per ear. The interaction effects between rates of IMO 7 and biofertilizers did not reveal any significant difference among the yield and physiological parameters of sweet corn. The study proved the potential of using IMO 7 and fermented seaweed for sustainable sweet corn production. Replication of this study in other localities is hereby recommended to confirm the results.

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