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Growth and Yield of Sweet Corn (*Zea mays* L.) Varieties as Affected by Integrated Nutrient Applications

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ABSTRACT

Organic manures can be used as an alternative to inorganic fertilizers. However, application of organic inputs alone cannot meet the nutritional requirements of the crop. There is a need to combine them with inorganic fertilizers in order to attain better yields. This study was conducted to evaluate the effects of integrated nutrient applications on the growth and yield performance of sweetcorn varieties. The experiment was laid out in a split plot design arranged in RCBD with 3 replications. Different hybrid sweetcorn varieties were designated as the main plot (M_1 – Macho F1, M_2 – Sweet Grande F1, and M_3 – Sweet Supreme F1). The treatments were as follows: (T_0 - Control (no fertilizer applied), T - 5 t ha^{-1} of vermicompost, T_2 - 5 t ha^{-1} of poultry manure, T - 2.5 t ha^{-1} of vermicompost + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O, T_4 - 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P O_2, K O_2 and T_5 - Inorganic fertilizer at 120-60-60 kg ha^{-1} N, P O , K_2O_5. Plants applied with vermicompost, poultry manure and combined with inorganic fertilizers (T_3, T_4) had comparable plant height, leaf area index, fresh stover yield, total ear yield (t ha^{-1}) and harvest index.

Keywords: Growth, integrated nutrient applications, poultry manure, sweetcorn, vermicompost, and yield

INTRODUCTION

Corn (*Zea mays* L.) is one of the country's main crops grown by Filipino farmers. In terms of production area, it accounts for over 70% of animal mixed feeds, and is the raw material for high-value products such as maize starch, corn oil, gluten, and snack foods. More crucially, it provides a source of income for 600,000 small-scale farmers (DuPont Pioneer 2008). Sweetcorn, often known as sugar corn, is one of the varieties of corn. It is a cultivated plant that is grown for human consumption and is used in the food industry as a raw or processed resource (Aslam 2018). Sweetcorn is best eaten fresh because of its excellent flavor and soft, sweet texture (FAO nd).

One of the management practices under intensive cultivation is the application

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of fertilizers. Organic fertilizers are naturally available mineral sources, such as animal manure and agricultural leftovers, and include a moderate amount of plant-needed nutrients, as well as the ability to mitigate problems on global warming due to the overuse of inorganic fertilizers (Hitha 2021). However, due to the relatively low nutrient content and sluggish release of plant nutrients, various research findings suggest that organic fertilizers alone cannot meet the crop's requirements, requiring the use of inorganic fertilizers to produce superior crop growth, quality, and yields. Researchers have made a strategy on how to reduce the effects on soil fertility and crop productivity.

Integrated nutrient management is a strategy that reduces synthetic nutrient usage by reducing the amount of fertilizer used. Chemical fertilizers combined with animal manure, agricultural wastes, green manure, and composts have proven to be extremely useful. Under field conditions, N, P, and K fertilizer, combined with organic fertilizers help in reducing micronutrient deficiencies. Moreover, the effects of combining organic with inorganic nutrients on soil fertility increase nutrient availability to crops while also increasing soil moisture retention. Gabriel (2010) stated that the combined application had higher nutrient absorption than the single application yet there are no guidelines for their management. The goal is to enhance nutrient availability to crops by combining organic and inorganic fertilizers. When compared to inorganic fertilizers applied alone, combined nutrient inputs result in higher nutrient recovery and residual effects.

Recent research revealed that vermicompost treatment promoted crop development and improved nitrogen and phosphorus resulting in higher agricultural yields (Arancon et al 2004). Aziz et al. (2010) reported that the integration of organic fertilizer with inorganic fertilizer was a more feasible and effective way for soil fertility and productivity maintenance. In comparison to the control plots, the growth of the plants was boosted when integrated with natural and synthetic fertilizers, such as chicken manure and complete fertilizers. Corn plants fertilized with chicken manure combined with 12% complete fertilizer developed more silk and tassels and matured faster than corn plants fertilized with synthetic fertilizers solely. The findings of the study agree with Zhao et al. (2009) which found that combining animal manure with complete fertilizers produced a higher increase in maize output than those not treated. Amanullah (2015) revealed that combining main plant nutrients with various organic manures and biofertilizers enhanced soil health, maize production, and grower revenue. Microbial activity improved, thus improving immobilized nutrient uptake in the soil. During the mineralization process, microbial usage decomposers can transform these immobilized nutrients into usable forms for plants. Sarker et al (2004) reported that microbial actions also improved the physical condition of the soil. Hence, this study was conducted to evaluate the effects of integrated nutrient applications on the growth and yield of different sweetcorn varieties and assess the profitability (ha^{-1}) of growing sweetcorn varieties as affected by integrated nutrient applications.

MATERIALS AND METHODS

The study was conducted at the experimental area of the Department of

Agronomy, Visayas State University, Visca, Baybay City, Leyte. An experimental area of 1,026.88 m^2 was plowed and harrowed twice at weekly intervals to pulverize the soil. This was done to incorporate the weeds in the soil and provide good soil conditions for seed germination. Furrows were made at a distance of 0.75 m between rows after the second harrowing.

Experimental Design and Treatments

The experimental area was laid out in a split plot arranged in a Randomized Complete Block Design (RCBD) with three replications. Different hybrid sweetcorn varieties were designated as the main plot (M_1 – Macho F1, M_2 – Sweet Grande F1, and M_3 – Sweet Supreme F1) and the integrated nutrient applications served as the subplot T_0 - Control (without fertilizer applied), T_1 - 5 t ha^{-1} of vermicompost, T_2 - 5 t ha^{-1} of poultry manure, T_3 - 2.5 t ha^{-1} of vermicompost + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O, T_4 - 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O and T_5 - Inorganic fertilizer at 120-60-60 kg ha^{-1} N, P_2O_5, K_2O. Each replication was divided into three (3) main plots with six (6) subplots measuring 4 m X 3.75 m. There were 54 plots in the experiment. An alleyway of 1 m was provided between replications and 0.50 m between treatment plots to facilitate farm operations and data gathering.

Cultural Management Practices

Seeds were sown directly in the field after 14 days of organic application at a planting distance of 0.25 x 0.75 m with 1 plant $hill^{-1}$ to attain the desired plant population of 53,333 plants ha^{-1}. Off-baring was done using a carabao drawn implement to turn the soil away from the base of the plants for better soil aeration and control of weeds at 15 DAP. Hilling-up was employed 30 DAP to cover the side-dressed fertilizer on the second application, better anchorage, stability, and to minimize the occurrence of weeds.

Spot weeding was done to remove the weeds within the experimental area after hilling-up but the weeds in the surrounding area (not in the experimental area) were maintained to conserve the population of the natural enemies. Sweetcorn was harvested at the boiling stage or the green cob stage when it reached its R3 stage. All sample plants for gathering agronomic characteristics, yield and yield components and harvest index were taken within the harvestable area (6.75 m^2). Ears from harvestable area were detached from its stover and dehusked.

Data Gathered

The agronomic characteristics gathered were the number of days from sowing to emergence, number of days from sowing to tasseling, number of days from sowing to silking, number of days from sowing to boiling stage, plant height (cm), Leaf Area Index (LAI), and fresh stover yield (t ha^{-1}). For yield and yield components, the following parameters were gathered: number of ears $plant^{-1}$, ear length (cm), ear diameter (cm), number of marketable and non-marketable ears $plot^{-1}$, weight of marketable and non-marketable ears (t ha^{-1}), total ear yield (t ha^{-1}), and harvest index.

Statistical Analysis

The analysis of variance (ANOVA) of all data was done using Statistical Analysis System (SAS) Statistic software. Tukey's test was used for comparison among treatment means.

RESULTS AND DISCUSSION

Agronomic Characteristics of Sweetcorn

The agronomic characteristics of different hybrid sweetcorn varieties as affected by integrated nutrient application are shown in Tables 1 and 2. Results revealed that integrated nutrient applications on the different hybrid sweetcorn varieties significantly affected the number of days from sowing to tasseling, silking and boiling stage, plant height (cm), leaf area index, and fresh stover yield (t ha^{-1}) except the number of days from sowing to emergence.

Among the three sweetcorn varieties planted, Sweet Supreme F1 (M_3) reached the silking and boiling stage longer than the other two varieties. All plants applied with integrated nutrients regardless of sources (T_1, T_2, T_3, T_4,) and corn plants applied with pure inorganic fertilizer (T_5) showed a significantly earlier maturity compared to plants not applied with fertilizer (T_0). Plants applied with pure inorganic fertilizer (T_5) reached the boiling stage earlier but it was comparable to plants applied with poultry manure combined with inorganic fertilizer (T_4), followed by T_3 which was comparable to T_1 and T_2. Joyo (2007) reported that unfertilized corn developed slower compared to fertilized plants. This result confirmed the findings of Sailer (2012) that boiling stage and maturity are delayed in corn planted in less fertile soil.Chen (2006) also reported that the application of combined organic manure and inorganic fertilizers enhances the growth and development of corn, thus the crop matured earlier. The availability of nutrients released from the applied fertilizer material enhanced the growth and development of sweetcorn leading to earlier reproductive development (Bernal 2013).

Sweet Supreme F1 (M_3) had the highest leaf area index and the heavier fresh stover weight (t ha^{-1}). Sweet Supreme F1 (M_3) obtained a higher stover yield due to its late reproductive stage (silking). This implies that early maturing varieties could not produce more vegetative parts as these produced its reproductive parts shorter. Similarly, Ahmad et al (2010) found that late maturing maize hybrid exhibited higher leaf area index and fresh stover yield (t ha^{-1}). Thus, varieties that silk earlier produced lower biomass.

Plants applied with combined organic and inorganic fertilizers (T_3, T_4) had height and leaf area index comparable with inorganic fertilizers alone at the rate of 120-60-60 kg ha^{-1} N, P_2O_5, K_2O (T). Moreover, it was significantly taller and had a higher leaf area index than 5 t ha^{-1} of vermicompost and poultry manure fertilizers alone (T_2, T_1) and without fertilizers applied (T_0). Meanwhile, plants applied with combined organic fertilizer with inorganic fertilizers (T_3, T_4) obtained heavier fresh stover yield (t ha^{-1}) of 18.46 t ha^{-1} than 5 t ha^{-1} of vermicompost and poultry manure fertilizers alone (T_2, T_1). On the contrary, the unfertilized plants had the lowest fresh stover yield (t ha^{-1}). The superior growth performance of plants that received inorganic fertilizer at the rate of 120-60-60 kg ha^{-1} N, P_2O_5, K_2O (T_5) and a combination of inorganic and organic fertilizer over those that received organic fertilizers alone at the rate of 5 t ha^{-1} (T_2 and T) is due to the readily available nutrients from inorganic fertilizer. This conforms to the findings of Elisan (2015) that the application of combined organic and inorganic fertilizers significantly increased the height of glutinous corn plants during the early vegetative up to the reproductive stage. This result can be attributed to the adequate amount of nutrients from the fertilizers applied, thus elongating the internode of sweetcorn. As the internodes elongate, the stalks increase their length, hence increasing the fresh stover weight.

Table 1. Number of days from planting to emergence, tasseling, silking and boiling stage of different hybrids sweetcorn varieties as affected by integrated nutrient applications

TREATMENT	NUMBER OF DAYS FROM SOWING TO			
	EMERGENCE	TASSELING	SILKING	BOILING STAGE
a. Sweetcorn Varieties				
M_1 = Macho F1	3.50	52.44	57.00^b	67.77^b
M_2 = Sweet Grande F1	3.77	52.33	57.77^b	66.94^b
M_3 = Sweet Supreme F1	3.05	52.94	58.00^a	68.11^a
F test	Ns	ns	*	*
b. Integrated Nutrient Applications				
T_0	4.22	54.88^a	60.88^a	71.11^a
T_1	3.66	52.66^b	58.00^b	68.00^b
T_2	3.77	52.55^{bc}	58.11^b	68.11^b
T_3	3.66	52.33^{bc}	56.88^{bc}	66.88^{bc}
T_4	3.66	51.66^{bc}	56.11^c	66.11^{cd}
T_5	3.33	51.33^c	55.55^c	65.44^d
F test	Ns	**	**	**
C.V. (a) %	15.91	1.87	1.25	1.39
C.V. (b) %	16.59	1.66	1.83	1.46

Means within a column followed by the same letter are not significantly different at 5% level, HSD.

Legend:

T_0 = Control (without fertilizer applied)
T_1 = 5 t ha^{-1} of vermicompost
T_2 = 5 t ha^{-1} of poultry manure
T_3 = 2.5 t ha^{-1} of vermicompost + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_4 = 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_5

= K O

Inorganic fertilizer at 120-60-60 kg ha^{-1} N, P O ,

Table 2. Plant height (cm), leaf area index, and fresh stover yield (t ha^{-1}) of different hybrid sweet corn varieties as affected by integrated nutrient applications

TREATMENT	PLANT HEIGHT (cm)	LEAF AREA INDEX	FRESH STOVER YIELD (t ha^{-1})
a. Sweetcorn Varieties			
M_1 = Macho F1	223.78	2.34^{b}	13.91^{ab}
M_2 = Sweet Grande F1	215.77	2.24^{b}	13.51^{b}
M_3 = Sweet Supreme F1	232.64	3.09^{a}	17.32^{a}
F test	ns	**	*
b. Integrated Nutrient Applications			
T_0	185.31^{c}	1.90^{c}	7.60^{d}
T_1	204.03^{b}	2.29^{b}	11.09^{c}
T_2	211.08^{b}	2.51^{b}	11.63^{c}
T_3	243.72^{a}	2.85^{a}	16.99^{b}
T_4	246.03^{a}	2.88^{a}	18.46^{b}
T_5	254.21^{a}	2.91^{a}	23.73^{a}
F test	**	**	**
C.V. (a) %	7.44	9.62	19.68
C.V. (b) %	5.17	8.12	14.79

Means within a column followed by the same letter are not significantly different at 5% level, HSD.

Legend:

T_0 = Control (without fertilizer applied)
T_1 = 5 t ha^{-1} of vermicompost
T_2 = 5 t ha^{-1} of poultry manure
T_3 = 2.5 t ha^{-1} of vermicompost + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_4 = 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_5 = Inorganic fertilizer at 120-60-60 kg ha^{-1} N, P_2O_5, K_2O

Yield and Yield Parameters of Sweetcorn

The yield and yield parameters of different hybrid sweetcorn varieties applied with different integrated nutrient applications are presented in Tables 3 and 4. Results revealed that yield and yield parameters significantly differed among varieties except for the number of ears per plant, length of ears, number of non-marketable ears and non-marketable ear yield per hectare as well as the harvest index of sweetcorn plants while integrated nutrient applications affected all the yield and yield parameters as well as the harvest index of sweetcorn varieties.

Table 3. Number of ears per plant, ear length, ear diameter, number of marketable and non-marketable ears per plot of sweetcorn varieties as affected by integrated nutrient applications

TREATMENT	NUMBER OF EARS PLANT $^{-1}$	EAR (cm)		NO. OF EARS (ha $^{-1}$)	
		LENGTH	DIAMETER	MARKET - ABLE	NON-MARKETABLE
a. Sweetcorn Varieties					
M_1 = Macho F1	1.12	12.27	4.33^{a}	13086^{b}	28148
M_2 = Sweet Grande F1	1.09	11.45	4.12^{b}	12428^{b}	25185
M_3 = Sweet Supreme F1	1.06	12.35	4.38^{a}	24444^{a}	29136
F test	Ns	ns	*	**	ns
b. Integrated Nutrient Applications					
T_0	0.93^{d}	8.58^{e}	3.60^{c}	1481^{d}	34074^{a}
T_1	1.00^{cd}	9.66^{d}	4.10^{b}	6914^{c}	30974^{ab}
T_2	1.02^{cd}	10.09^{d}	4.31^{ab}	11029^{c}	34403^{a}
T_3	1.07^{bc}	13.47^{c}	4.51^{a}	21399^{b}	26831^{bc}
T_4	1.17^{b}	14.60^{b}	4.53^{a}	23539^{b}	24198^{c}
T_5	1.34^{a}	15.75^{a}	4.62^{a}	35556^{a}	14468^{d}
F test	**	**	**	**	**
C.V. (a) %	17.77	8.48	3.94	26.13	22.76
C.V. (b) %	8.74	5.91	6.02	16.79	14.21

Means within column followed by the same letter are not significantly different at *5%* level, HSD.

Legend:

T_0 = Control (without fertilizer applied)
T_1 = 5 t ha^{-1} of vermicompost
T_2 = 5 t ha^{-1} of poultry manure
T_3 = 2.5 t ha^{-1} of vermicompost + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_4 = 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_5 = Inorganic fertilizer at 120-60-60 kg ha^{-1} N, P_2O_5, K_2O

Table 4. Ear yield and harvest index of sweet corn varieties as affected by integrated nutrient applications

TREATMENT	EAR YIELD (t ha $^{-1}$) MARKETABLE	NON-MARKETABLE	TOTAL EAR YIELD (t ha $^{-1}$)	HARVEST INDEX
a. Sweetcorn Varieties				
M_1 = Macho F1	2.51^{b}	2.76	5.27^{b}	0.23
M_2 = Sweet Grande F1	2.38^{b}	2.50	4.88^{b}	0.24
M_3 = Sweet Supreme F1	4.43^{a}	2.62	7.05^{a}	0.27
F test	**	ns	**	ns
b. Integrated Nutrient Applications				
T_0	0.14^{d}	2.12^{bc}	2.26^{d}	0.17^{c}
T_1	1.11^{c}	2.52^{abc}	3.63^{c}	0.22^{bc}
T_2	1.86^{c}	2.95^{ab}	4.81^{c}	0.21^{bc}
T_3	3.67^{b}	3.11^{a}	6.78^{b}	0.26^{b}
T_4	4.29^{b}	3.30^{a}	7.59^{b}	0.25^{b}
T_5	7.57^{a}	1.75^{c}	9.32^{a}	0.37^{a}
F test	**	**	**	**
C.V. (a) %	16.78	24.59	14.78	17.00
C.V. (b) %	23.91	15.05	15.69	15.43

Means within column followed by the same letter are not significantly different at *5%* level, HSD.

Legend:

T_0 = Control (without fertilizer applied)
T_1 = 5 t ha^{-1} of vermicompost
T_2 = 5 t ha^{-1} of poultry manure
T_3 = 2.5 t ha^{-1} of vermicompost + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_4 = 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_5 = Inorganic fertilizer at 120-60-60 kg ha^{-1} N, P_2O_5, K_2O

Results indicated that Sweet Supreme F1 and Macho F1 had similar ear diameters, which are significantly broader than that of Sweet Grande F1. The bigger ears and numerous kernels produced contributed to the heavier weight of marketable ears.

The non-fertilized control plants produced the least ears per plant but was comparable to plants that received pure vermicompost and poultry manure fertilizer (T_1, T_2). Generally, all fertilized plants regardless of the variety produced significantly more ears per plant compared to the non-fertilized control plants.

Among the fertilizer-treated plants, those that applied vermicompost and poultry manure combined with inorganic fertilizer (T_3, T_4) had comparable ears per plant. Meanwhile, plants that received vermicompost and poultry manure fertilizer alone at the rate of 5 t ha^{-1} (T_1, T) had a comparable number of ears per plant with those that received 2.5 t ha^{-1} of vermicompost + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O. The highest number of ears per plant, longest ears, and fewest number of non-marketable ears were obtained in plants applied with inorganic fertilizer at the rate of 120-60-60 kg ha^{-1} N, P_2O_5, K_2O (T_5). Plants without fertilizer (T) produced the smallest ears. This conforms to the findings of Biñas (2018) that the applications of different various organic materials combined with inorganic fertilizers on hybrid sweetcorn significantly had longer and bigger ears (cm), with more and heavier marketable ears (kg ha^{-1}) and total ear yield (t ha^{-1}) than the untreated plants. Thus, the fertilized plants significantly obtained higher ear yield than the untreated plants.

A significant interaction effect was observed between integrated nutrient applications and different hybrid sweetcorn varieties on the number of marketable ears (Table 5). Among the three sweetcorn varieties, it was Sweet supreme F1 that positively increased in number of marketable ears per hectare regardless of the integrated nutrients application. Of all treated corn plants regardless of the integrated nutrient application, it was the sweet supreme variety that produced more marketable ears per hectare compared to plants which were not applied with any fertilizers (T_0). Application of inorganic fertilizer alone at the rate of 120-60-60 N, P_2O_5, K_2O (T_5) increased the number of marketable ears per hectare of Macho F1 and Sweet Grande F1. This conforms to the study of Biñas (2018) that the applications of various organic materials combined with inorganic fertilizers on hybrid sweetcorn significantly produced more marketable ears per hectare than the untreated control. Hence, the application of inorganic fertilizer at 120-60- 60 kg ha^{-1} N, P_2O_5, K_2O dramatically increased the number of marketable ears per hectare of Sweet Supreme F1 but not for Macho F1 and Sweet Grande F1.

A significant interaction effect was observed between integrated nutrient applications and different hybrid sweetcorn varieties on the weight of marketable ears (Table 6).

Table 5. Interaction effect on the number of marketable ears (ha^{-1}) between hybrid sweetcorn varieties and integrated nutrient applications

INTEGRATED NUTRIENT APPLICATIONS	NUMBER OF MARKETABLE EARS (ha^{-1})		
	MACHO F1	SWEET GRANDE F1	SWEET SUPREME F1
T_0	1481 hi	1481 hi	1481 hi
T_1	5926 fghi	3457 ghi	11358 efgh
T_2	10370 efghi	10370 efghi	12346 efgh
T_3	14815 defg	18765 cde	30617 bc
T_4	17778 de	15802 def	37037 b
T_5	28148 bc	24691 cd	53827 a

Means within a column followed by the same letter are not significantly different at *5%* level, HSD.

Legend:

T_0 = Control (without fertilizer applied)
T_1 = 5 t ha^{-1} of vermicompost
T_2 = 5 t ha^{-1} of poultry manure
T_3 = 2.5 t ha^{-1} of vermicompost + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_4 = 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O

T_5 = Inorganic fertilizer at 120-60-60 kg ha^{-1} N, P_2O_5, K_2O

Table 6. Interaction effect on the weight of marketable ears (t ha^{-1}) between hybrid sweet corn varieties and integrated nutrient applications

INTEGRATED NUTRIENT APPLICATIONS	WEIGHT OF MARKETABLE EARS (t ha^{-1})		
	MACHO F1	SWEET GRANDE F1	SWEET SUPREME F1
T_0	0.10^{k}	0.10^{k}	0.23^{jk}
T_1	1.10^{hijk}	0.50^{ijk}	1.74^{ghij}
T_2	1.83^{ghij}	1.81^{ghij}	1.95^{fghi}
T_3	3.82^{cde}	2.42^{efgh}	4.78^{bcd}
T_4	3.51^{def}	3.28^{defg}	6.10^{b}
T_5	5.58^{b}	5.21^{bc}	11.92^{a}

Means within a column followed by the same letter are not significantly different at *5%* level, HSD.

Legend:

T_0 = Control (without fertilizer applied)
T_1 = 5 t ha^{-1} of vermicompost
T_2 = 5 t ha^{-1} of poultry manure
T_3 = 2.5 t ha^{-1} of vermicompost + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_4 = 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_5 = Inorganic fertilizer at 120-60-60 kg ha^{-1} N, P_2O_5, K_2O

Among the three sweetcorn varieties, it was Sweet Supreme F1 that positively increased in weight of marketable ears (t ha^{-1}) by the application of 2.5 t ha^{-1} poultry manure combined with inorganic fertilizer (T_4). However, Macho F1 increased its weight of marketable ears with the application of vermicompost combined with inorganic fertilizer (T_3) but it was comparable to Sweet Grande F1.

A significant interaction between hybrid sweetcorn varieties and integrated nutrient applications was noted (Table 7). Macho F1 (M1) produced a comparable weight of non-marketable ears. However, Sweet Grande F1 obtained the heaviest non-marketable ears when applied with organic manures combined with inorganic fertilizer (T_4, T_3) but it was comparable to Sweet Supreme F1 and Macho F1.

A significant interaction effect was observed between different hybrid sweetcorn varieties and integrated nutrient applications on the total ear yield (t ha^{-1}) of sweetcorn (Table 8). Among the three sweetcorn varieties, it was Sweet Supreme (M3) F1 that had the positively heaviest total ear yield (t ha^{-1}). Application of 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O increased the yield of Sweet Supreme F1 but not for Sweet Grande F1 and Macho F1.

Table 7. Interaction effect on the weight of non-marketable ears (t ha^{-1}) between hybrid sweet corn varieties and integrated nutrient applications

INTEGRATED NUTRIENT APPLICATIONS	WEIGHT OF NON -MARKETABLE EARS (t ha^{-1})		
	MACHO F1	SWEET GRANDE F1	SWEET SUPREME F1
T_0	1.82^{abc}	1.30^{bc}	3.25^{ab}
T_1	2.13^{abc}	2.23^{abc}	3.19^{ab}
T_2	2.61^{abc}	2.66^{abc}	3.60^{ab}
T_3	3.03^{abc}	4.00^{a}	2.32^{abc}
T_4	3.43^{ab}	3.89^{a}	2.59^{abc}
T_5	2.00^{abc}	2.48^{abc}	0.77^{c}

Means within a column followed by the same letter are not significantly different at *5%* level, HSD.

Legend:

T_0 = Control (without fertilizer applied)
T_1 = 5 t ha^{-1} of vermicompost
T_2 = 5 t ha^{-1} of poultry manure
T_3 = 2.5 t ha^{-1} of vermicompost + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_4 = 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_5 = Inorganic fertilizer at 120-60-60 kg ha^{-1} N, P_2O_5, K_2O

Table 8. Interaction effect on the total ear yield (t ha^{-1}) between hybrid sweet corn varieties and different integrated nutrient applications

INTEGRATED NUTRIENT APPLICATIONS	TOTAL EAR YIELD (t ha^{-1})		
	MACHO F1	SWEET GRANDE F1	SWEET SUPREME F1
T_0	1.92^{gh}	1.40^{h}	3.48^{fgh}
T_1	3.23^{fgh}	2.73^{fgh}	4.94^{cdefg}
T_2	4.44^{efgh}	4.61^{defg}	5.41^{cdef}
T_3	5.46^{cdef}	6.41^{bc}	7.10^{bcde}
T_4	6.71^{bcde}	6.82^{bcde}	8.69^{b}
T_5	7.69^{bcd}	7.58^{bc}	12.69^{a}

Means within a column followed by the same letter are not significantly different at *5%* level, HSD.

Legend:

T_0 = Control (without fertilizer applied)
T_1 = 5 t ha^{-1} of vermicompost
T_2 = 5 t ha^{-1} of poultry manure
T_3 = 2.5 t ha^{-1} of vermicompost + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_4 = 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_5 = Inorganic fertilizer at 120-60-60 kg ha^{-1} N, P_2O_5, K_2O

Macho F1 plants applied with pure vermicompost and poultry manure fertilizer alone (T_1, T_2) did not have significant increase in yield over the unfertilized control plants (T_0). However, in Macho F1 and Sweet supreme F1 applied with 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O (T) and inorganic fertilizer alone at the rate of 120-60-60 kg ha^{-1} N, P_2O_5, K_2O (T) had only comparable yield. Sofyan et al (2019) stated that under the integrated application of organic and inorganic fertilizer there was a great increase in yield and yield components of sweetcorn and nutrient concentration of maize crop compared to the single application and the control plants.

An interaction effect was likewise observed between different hybrid sweetcorn varieties and integrated nutrient applications on the harvest index (Table 9). Among the three sweetcorn varieties, Macho F1 reduced its harvest index drastically than other varieties when unfertilized (T_0). The non-fertilized plants produced the lowest harvest index but was comparable to plants that received 5 t ha^{-1} of vermicompost and poultry manure fertilizers alone at the rate of 5 t ha^{-1} (T_1, T).

Table 9. Interaction effect on the harvest index between hybrid sweet corn varieties and different integrated nutrient applications

INTEGRATED NUTRIENT APPLICATIONS	HARVEST INDEX		
	MACHO F1	SWEET GRANDE F1	SWEET SUPREME F1
T_0	0.04^{d}	0.23^{c}	0.25^{c}
T_1	0.19^{c}	0.22^{c}	0.24^{c}
T_2	0.19^{c}	0.23^{c}	0.23^{c}
T_3	0.28^{bc}	0.23^{c}	0.27^{bc}
T_4	0.26^{bc}	0.24^{c}	0.26^{bc}
T_5	0.42^{ab}	0.30^{abc}	0.39^{ab}

Means within a column followed by the same letter are not significantly different at *5%* level, HSD

Legend:

T_0 = Control (without fertilizer applied)
T_1 = 5 t ha^{-1} of vermicompost
T_2 = 5 t ha^{-1} of poultry manure
T_3 = 2.5 t ha^{-1} of vermicompost + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_4 = 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
T_5 = Inorganic fertilizer at 120-60-60 kg ha^{-1} N, P_2O_5, K_2O

CONCLUSION

The number of days from sowing to tasseling, silking and boiling stage, plant height (cm), leaf area index, and fresh stover yield (t ha-1), ear diameter (cm), number of marketable ears (ha^{-1}), weight of marketable ears (ha^{-1}) and total ear yield (t ha^{-1}) were significantly affected by the different hybrid sweetcorn varieties and integrated nutrient applications. Plants applied with pure inorganic fertilizer (T_5)

reached the boiling stage earlier but it was comparable to plants applied with poultry manure combined with inorganic fertilizer (T_4), followed by T_3 which was comparable to T_1 and T_2. On the other hand, the boiling stage was last obtained in plants not applied with any fertilizers (T_0). Moreover, plants applied with combined organic fertilizer with inorganic fertilizers (T_3, T_4) had taller plant height, higher leaf area index, heavier fresh straw yield (t ha^{-1}) comparable with inorganic fertilizers alone at the rate of 120-60-60 kg ha^{-1} N, P_2O_5, K_2O (T).

Among the fertilizer-treated plants, those that were applied with vermicompost and poultry manure combined with inorganic fertilizer (T_3, T_4) had comparable ears per plant. Meanwhile, plants that received vermicompost and poultry manure fertilizer alone at the rate of 5 t ha^{-1} (T_1 , T) had a comparable number of ears per plant with those that received 2.5 t ha^{-1} of vermicompost + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O.

The highest number of ears per plant, longest ears and lowest number of non-marketable ears were obtained in plants applied with inorganic fertilizer at the rate of 120-60-60 kg ha^{-1} N, P_2O_5, K_2O (T).

Among the three sweetcorn varieties, it was Sweet Supreme F1 and Sweet Grande F1 that positively increased in weight of marketable ears (t ha^{-1}) by the application of 5 t ha^{-1} poultry manure combined with inorganic fertilizer (T_4). However, Macho F1 increased its weight of marketable ears with the application of vermicompost combined with inorganic fertilizer (T_3) but it was comparable to Sweet Grande F1. On the other hand, Sweet Supreme F1 had the positively heaviest total ear yield (t ha^{-1}). Meanwhile, Macho F1 plants applied with pure vermicompost and poultry manure fertilizer alone (T_1, T_2) did not have significant increase in yield over the unfertilized control plants (T_0). However, Macho F1 and Sweet supreme F1 applied with 2.5 t ha^{-1} of poultry manure + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O (T_2) and inorganic fertilizer alone at the rate of 120-60-60 kg ha^{-1} N, P_2O_5, K_2O (T_5) had only comparable yield.

RECOMMENDATION

Sweetcorn Sweet Supreme F1 variety using 2.5 t ha-1 of poultry manure combined with 60-30-30 kgha-1 N, P_2O_5, K_2O could be adopted for higher net income and ROI. But the application of inorganic fertilizer alone at the rate of 120-60-60 kg ha^{-1} N, P_2O_5, K_2O (T) is still superior, obtaining the highest yield and ROI. Another study to be conducted at different locations under different climatic conditions is recommended to validate the results of this study.

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