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Performance of Sweet Corn, *Zea mays* L. *saccharata* Applied with Goat Manure and Bio-N®

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Abstract

In recent decades, biofertilizer has been considered as an alternative for commercial fertilizers to maximize crop yield at a minimal cost. Interaction effects involving organic fertilizer and biofertilizer have been investigated to further economize on fertilizer inputs. This study aimed to evaluate the performance (growth parameters, yield, and yield components) of sweet corn *Zea mays* L. *saccharata* when applied with different rates of goat manure (GM) and Bio-N (BN). The field experiment was carried out in a randomized complete block design replicated four times in a split-plot arrangement. Different treatment rates of GM improved significantly all the growth parameters of sweet corn while BN only increased significantly the plant height (milk stage), shortened days to 50% tasseling, days to commercial ear maturity, and increased the total dry matter (silking stage). The performance of sweet corn was remarkably affected by GM. No significant GM and BN interaction was observed. This study provides relevant information that could help sweet corn farmers to avail of an alternative scheme in generating good harvest without sacrificing soil sustainability.

Keywords: biofertilizer, growth, silking, tasseling, yield

Introduction

Sweet corn (*Zea mays* L. *saccharata*), also known as sugar corn or sweet maize, is a popular multi-purpose cereal crop of the family *Poaceae* (Muhumed et al., 2014). This hybridized variety of maize is specifically bred to increase sugar content in its kernels. It is annually cultivated as a field crop (Remison, 2005) and grown extensively in temperate, subtropical, and tropical regions (Haghighat et al., 2012). This maize variety is distinguished from other varieties due to its delicious taste, wrinkled, translucent kernels when dry, and high sugar content (5-6%) at optimum market maturity stage (Oktem & Oktem, 2005). Its delightful sweetness, being the most important factor in consumer satisfaction (Evensen & Boyer, 1986), generates demand in three distinct markets: fresh, canning, and freezing (Lertrat & Pulam, 2007).

As a heavy feeder crop, sweet corn requires more essential nutrients from the soil (Akintoye & Olaniyan, 2012). Soil fertility is usually enhanced with inorganic or organic fertilizer to support the crop vigor and growth (Efthimiadou et al., 2010). The use of inorganic fertilizers is effective and convenient but it poses environmental threats and damage on the soil after prolonged and repeated application. On the other hand, organic fertilizers enhance nitrogen availability, improve soil structure, and increase water retention and soil organic matter (Li et al., 1990; Ancheng & Xi, 1994).

One organic fertilizer that could be used in crop production is goat manure. The virtually odorless, pelleted, animal manure has a higher content of nitrogen due to urine collected in goat droppings (Phipps, 2013) as well as phosphoric acid (Rowell & Hadad, 2004). Continued use of goat manure builds organic matter in soils and improves soil structure. This modification of soil structure helps improve water-holding capacity, aeration, friability, and drainage (Rowell & Hadad, 2004).

In recent decades, the application of biofertilizer has also been considered as an alternative for commercial fertilizers. Bio-N® is a microbial-based fertilizer for rice and corn. It is composed of

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Azospirillum (*A. brasiliense* and *A. lipoferum*) isolated from 'talahib' (*Saccharum spontaneum*) (Sta. Cruz et al., 2012). This biofertilizer hastens better consumption of nitrogen by converting airborne nitrogen into ammonia, which penetrates the plant's root zone and provides 50% nitrogen required by plants (Doguiles, 2013). The microorganisms in Bio-N also produce phytohormones, including gibberellins (Cassan et al., 2001) which promote plant growth. This hormone improves root growth, absorption of water and minerals (Okon & Kapulnik, 1986; Al Abboud et al., 2014; Adiwiganda et al., 2016) that eventually yield larger, and in many cases, more productive plants (Dobbelaere et al., 2001). This regimen reduced the use of chemical fertilizer by 15-50% and increased yield by 5-30% (Fages & Arsac, 1991; Hungria et al., 2010). The use of Bio-N® maximizes crop yield by providing fixed-nitrogen and growth-promoting substances with lower costs in fertilizer inputs (Ghosh & Mohiuddin, 2000; Wu et al., 2005; Chen, 2006; Mehnaz, 2015).

However, despite the campaign promoting the use of organic farming and discouraging the use of inorganic fertilizer, the overdependence of corn growers to the latter still persists. This long-time problem prompted various agencies to conduct research to look for convenient alternatives without compromising crop yield. Thus, this study aimed to determine the performance of sweet corn applied with goat manure and Bio-N® at different rates through growth parameters, and yield and yield components. Furthermore, the synergistic effect of goat manure and Bio-N® was also determined. This study provides relevant information that could help sweet corn farmers to avail of an alternative scheme in generating good harvest without sacrificing soil sustainability.

Materials and Methods

Experimental site

The field experiment was conducted at the Misamis University Agroforestry Farm ($8^{0}11^{'}4^{"}$ N longitude $123^{0}45^{'}59^{"}$ E latitude) at Brgy. Capucao Proper, Ozamiz City in the province of Misamis

Occidental, Philippines from October 2012 to February 2013. A 0.25- hectare farm lot was used as the experimental site. The area has been fallowed for more than five years with grasses as the dominant plant species. Manual clearing was employed followed by plowing, harrowing, and leveling to prepare the experimental site.

Experimental design and crop management

The field experiment was carried out in a Randomized Complete Block Design (RCBD) and replicated four times in a split-plot arrangement following the procedures of Gomez and Gomez (1984). Each block was composed of 20 plots. Seven rows were established for each plot. Four different rates of properly composted goat manure (GM): GM_0 = 0 (control); GM_1 = 3tons/ha; GM_2 = 6 tons/ha; GM_3 = 9 tons/ha; GM_4 = 12 tons/ha and 3 different rates Bio-N® (BN): BN_0 = 0 (control); BN_1 = 600 g/ 18 kg seeds; BN_2 = 1,200 g/18 kg seeds; BN_3 = 1800 g/18 kg seeds were used in this study. The composted goat manure was applied to the respective plots basally one week before sowing.

This study used the F_1 hybrid (Macho) seeds from East-West Seeds Inc. which were inoculated with BN according to the treatment prior to sowing. Two F1 hybrid seeds were sowed per hill. After 15 days, the seedlings were later thinned to one per stand, giving a plant density of 47,619 plants per hectare at 0.70 m inter-rows and 0.30 m intra-row spacing throughout the experiment. Table 1 shows the treatment schedule for the 20 plots.

Table 1. Treatment schedule.

Treatment Number	Treatment combination	Treatment Number	Treatment combination
T1	GM_0BN_0 (Control)	T11	GM_1BN_3
T2	GM_1BN_0	T12	GM_2BN_1
T3	GM_2BN_0	T13	GM_2BN_2
T4	GM_3BN_0	T14	GM_2BN_3
T5	GM_4BN_0	T15	GM_3BN_1
T6	GM_0BN_1	T16	GM_3BN_2
T7	GM_0BN_2	T17	GM_3BN_3
T8	GM_0BN_3	T18	GM_4BN_1
T9	GM_1BN_1	T19	GM_4BN_2
T10	GM_1BN_2	T20	GM_4BN_3

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Before the establishment of the experimental set-up, soil composite sample was taken from the area of study. The composite sample and the composted goat manure were analyzed for important nutrients at Mindanao University of Science and Technology Laboratory. Table 2 shows the chemical composition of the soil and composted goat manure.

Table 2. Chemical composition of the soil and composted goat manure.

Properties	Soil	Goat Manure
pH	5.84	--
Organic matter, %	7.90	--
Phosphorus, ppm	32.0	0.82
Potassium, ppm	56.0	1.42

Crops were rain-fed with varying amounts of water all throughout the cropping period. Supplemental watering was done weekly to avoid plants from water stress. Tricho (*Trichogramma evanescens*) cards were applied to the set-ups to control common pests infestation and diseases. Manual removal of diseased plants and weeding by manual hand hoeing were done at four and eight weeks after planting. The ears were harvested manually exactly 75 days after planting (DAP).

Measurements and analysis of data

Most growth parameters were determined from ten randomly selected maize crops from three central rows of each plot. These parameters included: *Plant Height* (PH) was measured in centimeters from the base of the plant to the tip of the flag leaf using a meter tape, taken at 30 DAP and at milking stage (MS); *Ear height* (EH) was measured in centimeters from ground level to the first ear's insertion node; *Number of days to 50% tasselling* (DT 50%) was recorded from sowing until 50% of the plants per plot showed at least five centimeter tassel emergence; *Number of days to 50% silking* (DS 50%) was determined from sowing until at least 50% of the plants per plot showed at least three centimeter silk emergence; *Days to commercial ear maturity* (DCEM) was determined from sowing until 50% of the ears per plot reached the milking stage. *Total dry matter* (TDM) yield was determined by weighing in kilograms five sun-dried (to at least 10% moisture content) representative samples taken from border rows in each plot at 30 DAP and at silking stage (SS).

Yield and yield components include: *Ear length* (EL) was measured in centimeters from the tip to the butt end of the ears; *Ear diameter* (ED) was measured in centimeters from the middle portion (girth) of each ear; and the *Number of marketable ears* (NME) was determined by weighing 10 ears per plot with a size ranging from 200g and above. Total number of marketable ears per treatment was then converted in terms of hectare.

Data gathered were analyzed and interpreted using Analysis of Variance (ANOVA) of split plot arrangement in Randomized Complete Block Design. Differences among treatment means were compared throughTukey post hoc test.

Results and Discussion

A. Growth parameters

Table 3 presents the data on growth parameters of sweet corn in control and experimental set-up. All growth parameters increased at increasing rates of GM while plant height at milking stage (PH-MS), DS50%, DCEM and TDM-SS were the parameters affected by BN. The individual effect of GM is still more remarkable compared to BN. This result suggests that GM influenced greatly the growth of sweet corn compared to BN.

The results of this study may be due to the high N content of GM which provides essential nutrients to plants and enhanced soil structure that subsequently promotes good habitat for microorganisms like *Azospirillum*. On the other hand, *Azospirillum* increased root growth as well as nitrogen and phosphorus uptake (Abbasi et al., 2015) which consequently enhanced the growth of plants.

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Table 3. Data on growth parameters of sweet corn in control and experimental set-up.

Treatments	PH (cm)		EH (cm)	DT 50%	DS 50%	DCEM	TDM	
	30 DAP	MS					30 DAP	SS
T_1 - GM_0BN_0	47.10	96.05	50.25	60.25	64.25	75.00	6.75	16.08
T_2 - GM_1BN_0	82.93	118.63	59.75	56.00	60.00	74.75	9.25	21.30
T_3 - GM_2BN_0	80.08	118.43	58.18	55.50	59.50	72.75	11.50	26.93
T_4 - GM_3BN_0	85.20	135.83	67.08	54.00	58.00	70.50	14.75	33.23
T_5 - GM_4BN_0	87.93	139.15	70.48	54.00	58.00	69.00	14.75	35.28
T_6 - GM_0BN_1	56.83	100.40	51.98	59.75	63.75	75.00	7.38	17.33
T_7 - GM_0BN_2	48.85	99.28	50.73	59.50	63.50	74.75	7.75	18.18
T_8 - GM_0BN_3	48.98	100.68	51.83	59.25	63.25	74.25	7.88	18.28
T_9 - GM_1BN_1	72.93	122.45	61.33	56.00	60.00	73.75	9.13	21.13
T_{10} - GM_1BN_2	75.40	125.00	62.53	55.75	59.75	74.75	10.00	23.68
T_{11} - GM_1BN_3	77.35	125.45	64.48	55.50	59.50	73.75	10.88	24.75
T_{12} - GM_2BN_1	83.08	127.33	63.60	55.75	59.75	72.75	12.50	28.05
T_{13} - GM_2BN_2	82.43	127.58	64.00	55.25	59.25	72.00	11.88	28.10
T_{14} - GM_2BN_3	86.23	130.88	66.08	55.50	59.50	72.25	12.50	28.28
T_{15} - GM_3BN_1	88.38	135.98	66.63	53.75	57.75	70.25	13.50	32.28
T_{16} - GM_3BN_2	94.65	142.68	71.95	54.25	58.25	70.00	14.13	33.90
T_{17} - GM_3BN_3	88.43	150.18	72.10	54.00	58.00	69.50	14.25	33.78
T_{18} - GM_4BN_1	97.90	144.88	72.73	53.75	58.00	69.00	14.38	35.88
T_{19} - GM_4BN_2	96.78	150.53	74.60	53.50	57.50	68.25	14.63	35.65
T_{20} - GM_4BN_3	91.83	145.38	74.93	53.75	57.50	68.00	14.63	37.33

Growth parameters: PH – Plant height; EH – Ear height; DT 50% – Days to 50% tasseling; DS 50% – Days to 50% silking; DCEM – Days to commercial ear maturity; TDM – Total dry matter
*DAP – Days after planting; MS – Milk stage; SS: Silking stage

Plant height

There was an increase in plant height at 30 DAP and MS. The increase in plant height may be attributed to the additive effect brought about by the presence of nitrogen in GM and the growth-promoting effects of *Azospirillum*. The findings of Uwah et al. (2005) and Onasanya et al. (2009) also showed positive increase of plant height in response to N application. Rahman et al. (2008) opined that nitrogen enhances the growth of crop by synthesizing more protein and chlorophyll while El-Gizawy (2005) added that N fertilization stimulates cell division and elongation which consequently increase distance between internodes. The result conforms to that of Amanullah et al. (2009) which observed increased ear height with highest rate of 180 kg N ha^{-1}.

A relative increase in height of plants inoculated with BN was also noted. However, GM-fertilized plants were taller compared to BN inoculated. Based on the result, BN inoculation also increased plant height even without GM application. The relative increase may be attributed to the growth-promoting effects of *Azospirillum*. The bacterium was reported to promote morphological and physiological changes of the inoculated plant roots and enhancement of water and mineral uptake (Fallik et al., 1994). The presence of free-living *Azospirillum lipoferum* in inoculated maize seeds was also found to have the ability to fix nitrogen and to release phytohormones similar to gibberellic acid and indoleacetic acid, which could stimulate plant growth, nutrient absorption and photosynthesis (Fayez et al., 1985).

It was noted that sweet corn produced the tallest plants with GM application rate of 12 t ha^{-1} and BN at 600 g/18 kg seeds for 30 DAP and 12 t ha^{-1} GM and 1,200 g/18 kg seeds for MS. The results indicate that higher rate of fertilization and seed inoculation influenced the growth of sweet corn.

Ear height

As observed, there was an increase in the height of ears with increased GM rate. This increase might be due to the positive effect of nitrogen which stimulates cell division and elongation, consequently more distant internodes (El-Gizawy, 2005). The result conforms to that of Amanullah et al. (2009) which observed increased ear height with highest rate of 180 kg N ha^{-1}. The height of the main ear is an important breeding characteristic since the higher it is, the more ears can be developed from the nodes below (Youssef & Eissa, 2014).

Meanwhile, a relative increase in ear height of BN-inoculated plants was also noted. However, GM-fertilized plants were taller compared to BN-inoculated. Based on the result, BN inoculation also increased ear height even without GM application. The relative increase in ear height may be attributed to the N-fixing capacity of *Azospirillum*.

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The fixed nitrogen stimulates cell division and elongation consequently increasing distance between internodes resulting to higher ears in corn plants. The finding supports the study of Picaza (2007) and Sumagaysay (2014). It was noted that sweet corn produced plants with highest ear height with GM application rate of 12 t ha^{-1} and BN at 1,800 g/18 kg seeds. The result indicates that higher rate of fertilization and inoculation influenced the height of corn ears.

Days to 50% tasseling and 50% silking

The number of days to 50% tasseling and 50% silking was shortened in response to increased rate of GM. The reduction in the number of days to tasseling and silking could be attributed to the relatively inherent nutrients in GM, particularly nitrogen, which promoted vigorous foliage growth, increased plant meristematic and physiological activities which favored the synthesis of more photoassimilates and early flowering in crops (Effa et al., 2011). This result conforms with the findings of Gökmen et al. (2001) and Efthimiadou et al. (2010).

A relatively shortened number of days to attain 50% tasseling and silking was also noted in plants inoculated with BN. However, GM-fertilized plants matured earlier compared to BN inoculated treatments. Based on the result, BN inoculation also hastened tasseling and silking periods even without GM application. The relative increase in plant reproductive development may be attributed to the growth-promoting hormones produced by *Azospirillum* and increased plant root absorption which consequently enable the plants to store more nutrients for their physiological needs. These findings conform to that of Picaza (2007).

In this study, the higher rates of fertilization and seed inoculation influenced the maturity of sweet corn plants. The results may be due to the effect of nitrogen in GM which increases plant meristematic and physiological activities in plants favoring the synthesis of more photoassimilates and early flowering in crops. Also, *Azospirillum* in BN may increase plant root absorption which consequently enables plants to store more nutrients for crop's physiological needs.

It was noted that sweet corn produced earliest tasseling plants with GM application rate of 12 t ha^{-1} with 1,200 g BN/18 kg seeds and earliest silking plants at 12 t ha^{-1} with rates 1,200 g BN/18kg and 1,800 g BN/18 kg seeds, respectively. The result indicates that higher rates of fertilization and seed inoculation influenced the maturity of sweet corn plants.

Days to commercial ear maturity

Shortened days to commercial ear maturity were attained with increased GM rate. This result may be due to the inherent nutrients in GM which triggered the vigorous plant growth, thereby achieving higher leaf area index thus hastening flowering and maturity of ears.

Meanwhile, a relatively shorter number of days to commercial ear maturity was also noted on plants inoculated with BN. However, GM-fertilized plant ears matured earlier compared to BN- inoculated. Based on the result, BN-inoculation also hastened ear maturity even without GM application. Increasing rates of BN cause corresponding effect on hastening the maturity of sweet corn ears. This might be due to the presence of *Azospirillum* which increases plant root absorption enabling the plants to store more nutrients for their physiological needs. This result is contrary to the findings of Picaza (2007).

It was noted that sweet corn produced early maturing ears with GM application rate of 12 t ha^{-1} and BN at 1,800 g/18 kg seeds. The result indicates that higher rate of fertilization and seed inoculation influenced the maturity of sweet corn ears.

Total Dry Matter (TDM)

There was an increase in the total dry matter of corn with increased GM rate. The increase may be attributed to the positive effect brought about by the presence of nitrogen in GM. Nitrogen increased leaf area index (LAI) which intercepts light radiation resulting in higher solar capture and radiation use efficiency (Akmal et al., 2010) and increased photosynthetic rates leading to an improved net assimilation and increased contribution of assimilates to dry matter accumulation

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(Rekhi et al., 2000). The result conforms to the findings of Khan et al. (1996), Shahjalal et al. (1996), and Rahman et al. (2008).

Meanwhile, a relative increase in TDM of BN-inoculated plants was also noted. However, GM-fertilized plants produced higher TDM compared to BN-inoculated. Based on the result, BN-inoculation also increased TDM even without GM application. A relative increase in TDM may be attributed by *Azospirillum* in increasing the dry matter accumulation of crops. The result conforms to that of Reis Junior et al. (2008). The result implies that increasing rates of BN cause a corresponding increase in dry matter accumulation at the early stage of plant growth (30 DAP) only.

It was noted that sweet corn produced the highest TDM with GM application rate of 12 t ha^{-1} and BN at 1,200 g/18 kg seeds to 1,800 g/18 kg seeds for 30 DAP and 12 t ha^{-1} GM and BN at 1,800 g/18 kg seeds for silking stage. The results indicate that higher rate of fertilization and seed inoculation influenced the dry matter accumulation of sweet corn.

B. Yield and yield components of sweet corn

Ear length

There was an increase in ear length with increased GM rate (Table 4). This increase is mainly due to the presence of nitrogen in GM. Nitrogen increased the length of ears by increasing photosynthetic activities of corn plants (Khan et al., 2008), thus enhanced the length of ears. This finding is supported by Lee et al. (2005) and Thakur and Sharma (1999). Meanwhile, a relative increase in ear length of BN-inoculated plants was also noted. However, GM-fertilized plants produced longer ears compared to BN-inoculated. Based on the result, BN inoculation also increased ear length even without GM application. A relative increase may be attributed to *Azospirillum*'s ability to fix nitrogen, enhance nutrient absorption, and photosynthesis (Fayez et al., 1985) which consequently increased the length of corn ears.

It was noted that sweet corn produced the longest ears with GM application rate of 12 t ha^{-1} and BN at 1,800 g/18 kg seeds. The result indicates that higher rate of fertilization and seed inoculation influenced the length of sweet corn ears.

Table 4. Data on yield and yield components of sweet corn in control and experimental set-up.

Treatments	EL (cm)	ED (cm)	NME
T_1 - GM_0BN_0	16.02	4.44	27,530
T_2 - GM_1BN_0	16.50	4.76	38,194
T_3 - GM_2BN_0	17.59	4.80	44,891
T_4 - GM_3BN_0	18.41	5.11	46,131
T_5 - GM_4BN_0	19.49	5.49	46,627
T_6 - GM_0BN_1	16.06	4.67	32,738
T_7 - GM_0BN_2	16.16	4.62	33,234
T_8 - GM_0BN_3	16.74	4.75	35,962
T_9 - GM_1BN_1	16.55	4.78	38,442
T_{10} - GM_1BN_2	16.90	4.89	39,931
T_{11} - GM_1BN_3	17.31	4.85	42,411
T_{12} - GM_2BN_1	17.60	4.85	44,395
T_{13} - GM_2BN_2	17.76	4.84	45,635
T_{14} - GM_2BN_3	18.32	4.90	44,643
T_{15} - GM_3BN_1	18.50	5.10	45,883
T_{16} - GM_3BN_2	18.64	5.29	46,875
T_{17} - GM_3BN_3	19.21	5.34	47,619
T_{18} - GM_4BN_1	19.64	5.58	46,875
T_{19} - GM_4BN_2	19.75	5.75	47,619
T_{20} - GM_4BN_3	20.06	5.86	47,123

EL – Ear length; ED – Ear Diameter; NME: No. of marketable ears

Ear diameter

There was an increase in ear diameter with increased GM rate. The result might be due to increasing photosynthetic activities of corn plants on account of sufficient nitrogen supplied by GM. Khan et al. (2008) suggest that more photosynthetic activities occur on plants in response to adequate supply of N from animal manures which resulted to increased ear diameter. Ogunlela et al. (1988) reported that ear diameter and other parameters increased as N fertilization rate was increased up to 100 or 150 kg N ha^{-1}. Similar result was observed by other researchers (Saruhan & Sireli, 2005; Sharifi & Taghizadeh, 2009).

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Meanwhile, a relative increase in ear diameter of plants inoculated with BN was also noted. However, GM-fertilized plants' diameter was thicker compared to BN-inoculated. Based on the result, BN inoculation also increased ear diameter even without GM application. A relative increase may be attributed to *Azospirillum*'s ability to fix nitrogen, enhance nutrient absorption and photosynthesis (Fayez et al., 1985) which then produced photoassimilates stored in corn ears, thus increasing ear thickness. Guimaraes et al. (2012) verified that the inoculation of corn seeds with *Azospirillum* spp. in combination with nitrogen fertilization resulted in ears with higher diameter and higher number of grain rows.

It was noted that sweet corn produced the thickest ears with GM application rate of 12 t ha^{-1} GM and BN at 1,800 g/18 kg seeds. The result indicates that higher rate of fertilization and seed inoculation influenced the ear diameter of sweet corn.

Number of marketable ears

There was an increase in the number of marketable ears with increased GM rate. The increase in the number of marketable ears may be attributed to the effect of essential nutrients, particularly nitrogen, in GM. The result agrees with the findings of Thakur and Sharma (1999) and Lee et al. (2005) that higher N rate increases ear length and ear diameter (Ogunlela et al., 1988). Nitrogen helps in the formation of more number of grains per ear thereby influencing higher weight of ears per plant (Effa et al., 2011). The weight of individual ears has been the basis for determining their marketability and they are classified into sizes (small, medium, large). The number of marketable ears is influenced by the ear length and diameter which are important yield contributing parameters in maize as they contribute substantially to the yield by influencing the number and size of maize kernels.

Meanwhile, a relative increase in the number of marketable ears on BN-inoculated plants was also noted. However, GM-fertilized plants produced more marketable ears compared to BN-inoculated. Based on the result, BN-inoculation also increased marketable ears even without GM application. A relative increase may be attributed to *Azospirillum*'s ability to fix nitrogen, enhance water and nutrient absorption, and increase photosynthetic activities (Fayez et al., 1985) which then produced photoassimilates stored in corn ears increasing their weight.

It was noted that sweet corn produced plants with the highest number of marketable ears with GM application rate of 9 t ha^{-1} and BN at 1,200 g/18 kg seeds and 12 t ha^{1} and BN at 1,800 g/18 kg seeds. The result indicates that higher rate of fertilization and seed inoculation influenced the weight of ears (marketable ears).

C. Analysis of variance

Different treatment rates of GM affected significantly all the growth parameters of sweet corn considered in this study at $p \leq 0.05$ while BN only affected PH-MS, DS50%, DCEM and TDM-SS (Table 5). The performance of sweet corn was remarkably affected by GM. No significant GM and BN interaction was observed.

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Table 5. ANOVA on the effects of GM and BN on the growth parameters, yield and yield components of sweet corn.

Source of Variation	df	PH		EH	DT 50%	DS 50%	DCEM	TDM		EL	ED	NME
		30 DAP	MS					30 DP	SS			
Replication	3	672.41	91.59	61.06	1.03	1.03	0.11	1.30	1.27	0.74	0.01	26456838.47
GM (A)	4	4603.55*	5280.17*	1130.29*	90.53*	90.53*	113.54*	145.04*	920.52*	31.59*	2.74*	612751230.08*
Error A	12	146.56	155.44	65.54	1.23	1.23	0.69	0.78	2.31	0.24	0.01	8814542.12
BN (B)	3	42.25^{ns}	305.88*	83.95^{ns}	0.50^{ns}	0.67*	3.65*	1.84^{ns}	15.50*	2.16*	0.18*	30887705.77*
Error B	45	55.21	46.83	9.46	0.19	0.18	0.13	0.67	1.00	0.02	0.02	9511645.38
A x B	12	69.80^{ns}	34.22^{ns}	8.21^{ns}	0.24^{ns}	0.24^{ns}	0.14^{ns}	0.98^{ns}	2.09	0.06	0.01	2042271.78

PH – Plant height; DAP – Days after planting; MS – Milk satge; DT 50% – Days to 50% tasseling; DS 50% – Days to 50% silking; EH – Ear height; DCEM – Days to commercial ear maturity; TDM – Total dry matter; EL – Ear length; ED – Ear diameter; NME – Number of marketable ears

*Significant at 0.05 level, ns: non-significant difference

Conclusion and Recommendations

The performance of sweet corn, *Zea mays* L. *saccharate*, was mainly enhanced with the application of goat manure as organic fertilizer providing all essential nutrients needed by the plants for growth and development. Thus, an expected response of crops was manifested. Bio-N® inoculation, on the other hand, tends to hasten ear maturity, increase the total dry matter and the number of marketable ears. It is therefore concluded that Bio-N® is a good supplement to goat manure for increased growth and yield of sweet corn despite the absence of significant interaction. It is recommended to maximize input of goat manure fertilizer up to 12 t ha^{-1} in order to meet the nutritional requirements of the crops for normal growth and development and optimized yield capacity.

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