Original Research Article

Effects of Vermicompost on the Growth and Yield of Sweet Corn in Bukidnon, Philippines

ABSTRACT

Aims: To determine the influence of fertilizer on the growth and yield of sweet corn grown under Bukidnon, Philippines condition.

Place and Duration of Study: Research Station of IPB-UPLB, Central Mindanao University, Musuan, Bukidnon, Philippines on February 2016 to May 2016.

Methodology: Soil samples were taken from the site for initial characterization. Six treatments were employed; T_1- no fertilizer,T_2- Recommended rate of inorganic fertilizer (RRIF) based on soil analysis of the experimental area (70 – 50 – 0 N, P_2O_5, K_2O kg ha^{-1}), T_3- 2 tons ha-^{1} Vermicompost, T_4- ½ RRIF (35 – 25 – 0 N, P_2O_5, K_2O kg ha^{-1}) + 1 ton ha^{-1} Vermicompost, T_5- ½ RRIF (35 – 25 – 0 N, P_2O_5, K_2O kg ha^{-1}) + 2 tons ha^{-1} Vermicompost and T_6- RRIF (70 – 50 – 0 N, P_2O_5, K_2O kg ha^{-1}) + 1 ton Vermicompost. Harvesting proceeded at 70 days after sowing (DAS).

Results: The application of Full RRIF + 1 ton Vermicompost ha^{-1} significantly influenced the plant height of sweet corn at 20 DAS. Soil's negative logarithm of hydrogen ions present or pH was greatly affected by the application of inorganic fertilizer alone. Moreover, the application of ½ RRIF + 2 tons of Vermicompost ha^{-1} caused significant effects towards the organic matter content (%) of the soil at harvest. On the other hand, the yield of sweet corn measured by the number of ears expressed in per hectare basis shows to be highly affected by the application of Full RRIF along with 1 ton Vermicompost ha^{-1}.

Conclusion: The combined application of the recommended rate of inorganic fertilizer and Vermicompost are possible ways that may be undertaken in order to yield sweet corn in higher portion under Bukidnon condition as well as maintaining the quality of the soil of Bukidnon, Philippines.

Keywords: Growth; Yield; Sweet corn; Fertilizer; Bukidnon.

1. INTRODUCTION

Sweet corn scientifically known as *Zea mays* L. *var Saccharata* is a variety of maize with a high sugar content. Sweet corn is the result of a naturally occurring recessive mutation in the genes which control conversion of sugar to starch inside the endosperm of the corn kernel. Unlike field corn varieties, which are harvested when the kernels are dry and mature (dent stage), sweet corn must be picked when immature (milk stage) and prepared and eaten as a vegetable, rather than a grain. Since the process of maturation involves converting sugar to starch, sweet corn stores poorly and must be eaten fresh, canned, or frozen, before the kernels become tough and starchy [1].

The key to high quality sweet corn is rapid growth, adequate soil moisture and nutrients, and harvesting the ears at optimum maturity. Sweet corn requires rich soil with ample nitrogen and moisture. Soil moisture is found critical for the germination of sweet corn, as it absorb more water than other types for germination to occur [2]. A wide variety of soils is suitable, moreover, it is important that the soil be well drained and well supplied with organic matter. The optimum range of pH for this crop is 5.8 to 7.0.

Fertilizer, natural or artificial substance containing the chemical elements that improve growth and productiveness of plants. Fertilizers enhance the natural fertility of the soil or replace the chemical elements taken from the soil by previous crops [3]. Inorganic fertilizer contains a combination of chemicals and minerals that were produced in a refinery, and it offers gardeners and farmers a more reliable form of plant nourishment because its nutrient levels are calculated to be consistent, thus, nutrients are already in their available form allowing them to be easily absorbed and metabolized by the growing plants. However, inorganic fertilizer also affects soil in ways that can harm plants if the fertilizer is not applied carefully. Inorganic fertilizers provide the same three major nutrients that organic fertilizers do: nitrogen, phosphorus and potassium, however, the organic fertilizers can provide all the nutrients needed by the plants to complete its life cycle. Plants receive these nutrients more quickly from inorganic fertilizer, however, because the refinery has already broken them down into a digestible form; organic fertilizers must dissolve in the soil first, and the amount of nutrition they deliver is imprecise. For these reasons, inorganic fertilizer has a swifter, more efficient effect on plants [21].

The province of Bukidnon is considered to be the food basket of Mindanao, being the major producer of rice and corn in the region. Products from plantations in the province also include pineapples, bananas and sugarcane. Two types of climate prevail between the northern and southern sections of Bukidnon, The northern part is classified as belonging to Type III, that is, there is no pronounced rain period but relatively dry during the months of November to May. In the southern portion of the province, the climate is classified as Type IV with no dry season [4].

2. MATERIALS AND METHODS

2.1 Location

The field experiment was conducted at the Research Station of IPB-UPLB (7° 51' 31.788'' N and 125° 3' 40.4568'' E), Central Mindanao University, Musuan, Bukidnon, Philippines.

2.2 Collection, preparation and characterization of soil samples

Surface soil samples at 0-20 cm depth were collected randomly from the experimental area following a zigzag direction prior to the land preparation. The collected soil samples were placed in cellophane bags and then brought to the Soil and Plant Analysis Laboratory (SPAL), Department of Soil Science, College of Agriculture, Central Mindanao University, Musuan, Bukidnon, Philippines wherein laboratory analyses were conducted. Prior to analysis, the collected soil samples were air-dried at room temperature for about a week, and passed through a 2-mm sieve and were stored in a clean plastic containers. Soil samples were also collected from each experimental plot after harvest of sweet corn. The chemical and physical properties of the soil were determined and analyzed at the Soil and Plant Analysis Laboratory (SPAL). The properties tested include; soil pH in 0.01 M $CaCl_2$ at a soil to solution ratio of 1:5 [6]; organic matter content by the Walkley and Black method [7]; extractable P using the Bray 2 method [8] and exchangeable K using 1N NH_4OAc buffered at pH 7.0 using a Flame photometer [5].

2.3 Characteristics of soil in the experimental area

Table 1 shows that the soil samples collected from the experimental area has a pH value of 5.52 and is classified as strongly acidic [11]. The soil has organic matter content of 3.90% which is considered marginal [5]. For the extractable phosphorus, it has a value of 17.37 mg kg^{-1} and is classified as medium in amount [10]. On the other hand, exchangeable potassium was found high in amount because of its value 1.11 cmol kg^{-1} [10]. Hence, the fertilizer recommendation for the experimental site was 70-50-0 kg ha^{-1} of N, P_2O_5 and K_2O.

2.4 Experimental design and treatments

The field experiment was laid out in a Randomized Complete Block Design (RCBD) with six (6) treatments and replicated three (3) times. Treatments include: T_1- no fertilizer,T_2- Recommended rate of inorganic fertilizer (RRIF) based on soil analysis of the experimental area (70 – 50 – 0 N, P_2O_5, K_2O kg ha^{-1}), T_3- 2 tons ha-^{1} Vermicompost, T_4- ½ RRIF (35 – 25 – 0 N, P_2O_5, K_2O kg ha^{-1}) + 1 ton ha^{-1} Vermicompost, T_5- ½ RRIF (35 – 25 – 0 N, P_2O_5, K_2O kg ha^{-1}) + 2 tons ha^{-1} Vermicompost and T_6- RRIF (70 – 50 – 0 N, P_2O_5, K_2O kg ha^{-1}) + 1 ton Vermicompost.

2.5 Land preparation and lay-outing

The total land area used in the experiment was 463.75 m^2 (35 m x 13.25 m). It was divided into three (3) blocks and each block had a dimension of 131.25 m^2. A one meter space was provided between blocks and experimental plots as alleyways. The field was plowed using an animal-drawn moldboard plow. Plowing was done twice at one week interval to destroy the emerging weeds. Harrowing was done after plowing to further pulverize larger soil aggregates. Furrows were made at the time of planting at a distance of 75 cm between rows and 25 cm between hills.

Table 1. Chemical properties of soil in the experimental soil (0-20 cm)

Properties	Value	Methods
pH	5.52	0.01 M $CaCl_2$
Organic Matter Content, %	3.90	Walkley-Black
Extractable Phosphorus, mg kg^{-1}	17.37	Bray P_2
Exchangeable Potassium, cmol kg^{-1}	1.11	1N NH_4OAc / Flame photometer

2.6 Fertilizer application and vermicompost composition

The Vermicompost was sourced out from one of the Vermi farms in Valencia City, Bukidnon, Philippines. The Vermicompost was applied in those plots assigned with organic fertilizer as treatment following the rate of two (2) tons ha^{-1}. It was carefully broadcasted within each plot before the seeding operation. While basal application of inorganic fertilizer was done in treatments assigned to inorganic fertilizer. Inorganic fertilizers were placed in a hole in the furrow covered with a thin layer of soil then followed by the sowing of seeds and then covered again with soil to have a close contact between the seed and the soil, thus, would facilitate uniform germination.

The chemical composition of Vermicompost used in the experiment include: pH of 6.52 and an organic matter content of 32.45 %. For the nutrient content, total nitrogen of 2.82 %, total phosphorus of 1.14 % and total potassium of 0.45 %.

2.7 Care and management

Care and management immediately started right after seeding up to the harvesting period. Weed population was closely monitored to avoid possible competition of nutrients. Moreover, disease monitoring was also done. Application of pesticides was also employed due to the evident infestation of insect pests. Due to adverse climatic condition during the conduct of the experiment, irrigation was done once a week to sustain the water need of the crop. Irrigation ceased when the experimental plants were about to be harvested at 65 DAS.

2.8 Tagging of Data Plants

Ten (10) sample plants were randomly selected from data rows in each experimental plot. A sheet of white paper was stapled to each data plants to serve as marker and guide during data collection.

2.9 Statistical analysis

Statistical analysis was done after tabulating the gathered data through the Statistical Tool for Agricultural Research (STAR) software. Moreover, some parameters were found significant as manifested in the F computed value, comparison of means then proceeded using Honestly Significance Difference (HSD) test as the Post hoc test undertaken [9].

3. RESULTS AND DISCUSSION

3.1 Growth of sweet corn as affected by fertilizer applications

The mean values of plant height at 20, 40, 60 DAS and ear height in plots treated with different fertilizers are presented and discussed in this section.

3.1.1 Plant height at 20 DAS

Table 2 shows the mean plant heights of sweet corn measured at 20, 40 and 60 DAS. Based on statistical analysis, it was found out that height of sweet corn at 20 DAS was significantly affected by the fertilizers applied. Where plots treated with Full RRIF + 1 ton Vermicompost ha^{-1} (T_6) got the tallest plants, however, post hoc analysis would say that T_6 has no significant difference with T_2, T_3, T_4 and T_5. But significantly different with that of T_1 (no fertilizer). These results are in agreement with the findings of other researchers [12,13] who reported that there is a significant increase in growth

Table 2. Plant height at 20, 40, 60 DAS and ear height of sweet corn as affected by fertilizer application

TREATMENTS		PLANT HEIGHT, cm			Ear height, cm
CODE	DESCRIPTION	20 DAS†	40 DAS	60 DAS	
T_1	No fertilizer	37.48 b	117.22	195.30	85.23
T_2	Full RRIF	43.20 ab	135.18	207.87	95.40
T_3	2 tons Vermicompost ha^{-1}	43.27 ab	137.65	209.67	95.30
T_4	½ RRIF + 1 ton Vermicompost ha^{-1}	40.50 ab	121.85	188.90	89.53
T_5	½ RRIF + 2 tons Vermicompost ha^{-1}	41.41 ab	136.00	202.60	94.30
T_6	Full RRIF + 1 ton Vermicompost ha^{-1}	44.58 a	135.10	198.70	90.97

† Means followed by the same letter(s) are not significantly different at 5% level of significance based on HSD

parameters including plant height and number of leaves of corn plants when applied with NPK fertilizers. At 40 and 60 DAS, no significant difference was noted among plants treated with different fertilizer materials, however, this result is contradictory to the report of [14] that application of fertilizer particularly nitrogen could cause increase in height of corn as it will promote more cell division.

3.1.2 Ear height of plants

Ear heights of sweet corn plants were measured and is presented in Table 2. Analysis of variance declares no significant influence was observed among the sweet corn plants by the imposed treatments.

3.2 Yield components and yield of sweet corn as affected by fertilizer application

The mean values of ear diameter, ear length and yield (number of ears per hectare) in plots treated with different fertilizers are presented and discussed in this section.

3.2.1 Ear diameter and ear length of sweet corn

The ear diameter of sweet corn is presented in Table 3. Fertilizer treatments gave no significant effects towards the ear diameter of sweet corn. Largest ear diameter was observed in those plots applied with 2 tons ha^{-1} of Vermicompost (T_3) with a value of 5.13 cm while smallest was observed in those plots with no fertilizer application (T_1) with a value of 4.73 cm. These results were opposite to the report of [15] who reported that application of amendments like fertilizer with NPK can lead into an increase in plant height, stem girth, number of leaves, leaf area, number of cobs, ear diameter and length, weight of cob, 100-grain weight, and grain yield of maize.

Ear length of sweet corn gave no significant response on the influence of fertilizers applied. Ear length in plots treated 2 tons ha^{-1} of Vermicompost gave the longest length with 20.47 cm. Shortest length was observed in those plots treated with ½ RRIF + 2 tons Vermicompost ha^{-1} (T_5). Results were conflicting to the results of [12,1314,15] who reported that application of fertilizers could cause improvements and increase in corn growth and yield performance as it will supply the nutrients needed by the planted crop.

3.2.2 Yield (number of ears) of sweet corn per hectare

Highest number of ears was observed in those plots applied with Full RRIF + 1 ton Vermicompost ha^{-1} (T_6) with a value of 48820 ears per hectare. Moreover, lowest yield was noted in those plants that were applied with ½ RRIF + 2 tons Vermicompost ha^{-1} having a value of 42222 ears per hectare.

Table 3. Ear diameter, ear length and yield of sweet corn as affected by fertilizer application

TREATMENTS		Ear diameter, cm	Ear length, cm	Yield † (number of ears) ha^{-1}
CODE	DESCRIPTION			
T_1	No fertilizer	4.73	19.93	43757 b
T_2	Full RRIF	5.00	19.43	45197 b
T_3	2 tons Vermicompost ha^{-1}	5.13	20.47	43596 b
T_4	½ RRIF + 1 ton Vermicompost ha^{-1}	4.93	19.40	44406 b
T_5	½ RRIF + 2 tons Vermicompost ha^{-1}	4.93	19.20	42222 b
T_6	Full RRIF + 1 ton Vermicompost ha^{-1}	4.97	19.83	48820 a

† Means followed by the same letter(s) are not significantly different at 5% level of significance based on HSD

Statistical analysis declares that the yield of sweet corn is significantly affected by the treatments. Moreover, post hoc test reveals that T_6 (Full RRIF + 1 ton Vermicompost ha^{-1}) is significantly the highest among all the treatments imposed. Reports of [16,17] show that there was an increase in yield among sweet corn plants treated with inorganic fertilizers, organic fertilizers and their combinations. It was known that application of inorganic fertilizer would lead to an increased yield due to the readily available and mineralized nutrients present in inorganic fertilizers along with constant release of nutrients by organic fertilizers. Thus, these reports were confirmations to the results and findings of this study, that fertilizers can cause increase in the yield of sweet corn. Moreover, the report of [20] revealed the same results as to with the influence of available nutrients from fertilizers (organic and inorganic) with regards the highest yield obtained in T_6.

The experimental area has a marginal amount of organic matter [7] making sweet corn plants still very productive amidst no application of fertilizer in T_1. Thus, showing no significant difference as observed in terms of yield and other growth parameters for treatments T_1, T_2, T_3, T_4 and T_5.

3.3 Soil chemical properties at harvest as affected by fertilizer application

The mean values of soil pH, organic matter content (%), extractable P (mg ka^{-1}) and exchangeable K (cmol kg^{-1}) in plots treated with different fertilizers are presented and discussed in this section.

3.3.1 Soil chemical properties at harvest

The pH was significantly affected by the imposed fertilizer treatment based on soil analysis conducted [6] after harvest as presented in Table 4. Plots with no fertilizer application (T_1) had the highest pH value of 5.85 which was significantly higher with those plots treated with Full RRIF + 1 ton Vermicompost ha^{-1} (T_6). However, post hoc analysis using HSD at 5% level of significance revealed that T_1 pH value has no significant difference with of T_2, T_3, T_4 and T_5. Results presented by [18] is opposite to the findings of the study. The reason is due to the short period of time that sweet corn stays in the field. Sweet corn plants are harvested in less than 3 months which would cause incomplete reactions in the soil. Leading to a change in pH.

Organic matter content of the soil was found significantly affected by the imposed treatments based on statistical analysis. Highest organic matter content was observed in plots applied with ½ RRIF + 2 tons Vermicompost ha^{-1} (T_5) followed by those plots treated with 2 tons Vermicompost ha^{-1} (T_3), ½ RRIF + 1 ton Vermicompost ha^{-1} (T_4), Full RRIF + 1 ton Vermicompost ha^{-1} (T_6) and lastly T_1 (no fertilizer) and T_2 (Full RRIF). Post hoc test reveals that T_5 value was not significantly different with that of T_3, T_4 and T_6. But significantly higher with that of T_1 and T_2. Application of organic fertilizer like Vermicompost can readily increase and improve the amount of organic matter in the soil as reported by [19]. The extractable P measured in mg kg^{-1} was not significantly affected by fertilizer treatments. However, highest value was obtained by those plots applied with ½ RRIF + 2 tons Vermicompost ha^{-1} (T_5). Exchangeable K was also not significantly affected by the imposed treatments of fertilizer. Highest value was also obtained by those plots treated with ½ RRIF + 2 tons Vermicompost ha^{-1} (T_5). Treatment 5 got the highest values for extractable P and exchangeable K at harvest.

Table 4. pH, organic matter content, extractable P and exchangeable K of soil at harvest as affected by fertilizer application

TREATMENTS		Some Soil Chemical Properties at Harvest			
CODE	DESCRIPTION	pH †	Organic Matter † Content, %	Extractable P, mg kg^{-1}	Exchangeable K, cmol kg^{-1}
T_1	No fertilizer	5.85 a	3.93 b	11.00	1.24
T_2	Full RRIF	5.59 ab	3.93 b	14.33	1.20
T_3	2 tons Vermicompost ha^{-1}	5.84 a	4.11 ab	14.17	1.21
T_4	½ RRIF + 1 ton Vermicompost ha^{-1}	5.72 ab	4.05 ab	10.17	1.13
T_5	½ RRIF + 2 tons Vermicompost ha^{-1}	5.65 ab	4.15 a	16.33	1.26
T_6	Full RRIF + 1 ton Vermicompost ha^{-1}	5.54 b	4.00 ab	13.33	1.23

† Means followed by the same letter(s) are not significantly different at 5% level of significance based on HSD

4. CONCLUSION

Results of this study show that the application of inorganic fertilizer and Vermicompost toward Bukidnon soil planted to sweet corn affect productivity as revealed in the statistical analysis undertaken. The combined effcts of both type of fertilizer is promising towards the productivity and maintenance of soil quality and fertility. Greater yield, being the common objective of any farmer particularly in Bukidnon area, may consider the combined influence of inorganic fertilizer and Vermicompost in sweet corn production. Thus, the combined application of fertilizers caused promising growth performance towards sweet corn plants planted under Bukidnon, Philippines condition.

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