INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 22, No. 4, p. 148-155, 2023

RESEARCH PAPER OPEN ACCESS

Efficacy of organic fertilizers to Kalingas purple corn

Rex Saliw-An Langngag[1], Ruth Ladip-Ladwingon[*2]

Crop Science Department, College of Agriculture, Kalinga State University, Tabuk City, Kalinga, Philippines

Key words: Kalingas purple corn, Bio-synergy, Vermicompost

http://dx.doi.org/10.12692/ijb/22.4.148-155 Article published on April 22, 2023

Abstract

The study aimed to assess the growth and yield of purple corn to organic fertilizers. A field experiment was laid out following RCBD design in single factor and conducted at Agbannawag, Tabuk City, Kalinga. The treatments were designated as follows: T_0 – No fertilizer (Check), T_1 – 6kg Bio-synergy, T_2 – 12kg vermicompost, and T_3 – 3kg Bio-synergy + 6kg vermicompost. Purple corn produced tassel at 49 days, 53 days in silking, and matured at 87 days. It was observed that this cultivar changes its agronomic characteristics in a hot environment compared to its normal condition. Results of the field experiment showed that the application of 6kg bio-synergy + 12kg vermicompost revealed a highly significant number of kernel/ears of ±267.35 and ±253.56, respectively. In terms of plant height at the milk stage, the combined application of 6kg bio-synergy and vermicompost showed a significant result with a mean of ±216.51cm compared to other treatments. The combined application of 6kg of bio-synergy and vermicompost highly influenced the weight of 1000 kernel with ±283.33 g, and ±7.94kg for the biomass. No significant results found in the days to silking, tasseling, maturity, and ear height of the purple corn. Moreover, the combined application of the two organic fertilizers produced highly significant results of ±4.96 tons/ha compared to a single application of organic fertilizers. This has proven that combining the application of two organic fertilizers significantly affects the yielding character of Kalinga's purple corn.

* **Corresponding Author:** Ruth Ladip-Ladwingon ✉ ruthladip22@gmail.com

Introduction

The use of synthetic fertilizer to increase crop productivity has been widely reported to degrade soil quality, such as the increase in soil acidity and salinity (Hans *et al.*, 2015) and the formation of Al-P (McDowel *et al.*, 2002) cited by (Gerpacio, 2017; Muktamar *et al.*, 2018), as well as a decline of microbial richness (Fang *et al.*, 2012) cited by (Muktamar *et al.*, 2018) and microbial diversity in soil (Coolon *et al.*, 2013) cited by (Muktamar *et al.*, 2018). Organic fertilizer is an alternative to substitute nutrient necessity from synthetic fertilizer.

Republic Act 10068, known as the Philippines' Organic Agriculture Act of 2010, decreed the promotion and development of organic agriculture to make organic agriculture a vital contributor to the country's growth and development (Gazette, 2010) cited by (SUMAGAYSAY, 2014). It includes all agricultural systems that promote ecologically sound, socially acceptable, economically viable, and technically feasible food and fiber production. Organic agriculture dramatically reduces external inputs by not using chemical fertilizers, pesticides, and pharmaceuticals. Production, distribution, and marketing of organic fertilizer in the country play a very important role in the successful implementation of organic agriculture programs for food and feed. Organically grown food and feedstuff need certified organic fertilizers to qualify as certified organic food and feedstuff (Padilla *et al.*, 2017). With these premises, this study will be conducted to determine the productivity of Kalinga's purple corn to different organic fertilizers and specifically to evaluate the growth and yield of purple corn and its profitability.

Purple corn (Zea mays L.), also known as purple maize, is native to the Andes region of Peru. It has been widely cultivated and consumed throughout the Andean region of South America, mainly in Peru, Ecuador, Bolivia, and Argentina. It expresses one of the deepest purple shades found in the plant kingdom (Lao *et al.*, 2017). Due to its richness in purple color, purple corn pigments have long been used to color foods and beverages. In South America, purple corn extracts are widely applied in coloring homemade desserts and beverages such as chicha morada and mazamorra morada, a popular drink and dessert prepared from purple corn (FAO 2013) cited by (Lao *et al.*, 2017).

In Kalinga, purple corn is cultivated and conserved, particularly at Balbalan, Pasil, and some parts of Lubuagan; however, due to the introduction of modern varieties, these cultivars are getting genetically eroded. Most farmers preferred this purple because of its nutritional contents and its anthocyanin which has many health benefits. Purple corn is usually cultivated for three months of maturity, which is comparable to hybrid corn. Farmers in this community practice no fertilizer application, as the plants depend naturally on the nutrients from the soil. The study guides farmers in determining the right amount of different organic fertilizers to be applied to purple corn. Moreover, using different organic fertilizers with microbial-based fertilizers is beneficial for corn, rice, and other crops (Sumagaysay, 2014). Likewise, promising technology had a significant impact on the use of Bio-N organic fertilizer, increasing farm productivity of the farmers. It could help the country's dollar receive by reducing the cost of imported fertilizers (SUMAGAYSAY, 2014).

The study was carried out to assess the effect of two organic fertilizers combinations on Kalinga's purple corn on growth and yield character. Organic fertilizers have many beneficial benefits to the soil and the crop itself. To maintain this cultivar as an organically produced organic fertilizers application must be sustain to maintain its character as an organic crop.

Material and methods

Experimental site

The study was conducted at Barangay Agbannawag Sitio Pacak, Tabuk City, Kalinga, in June 2021. Soil samples were collected for a soil analysis to determine the soil fertility of the experimental site. The experimental site was a fence with barbed wire and cut bamboo to protect the experimental corn from stray animals and other pests that possibly destroy the experimental purple corn.

Site Selection, Description, and Land Preparation

The study site's selection was based on the availability of land suited and was not previously planted with corn. The total area used in the study will be 227.5 sq.m, preferably clay loam soil type having a low pH (5.0) was selected. Immediately after selection, the area was plowed and harrowed twice at the weekly interval using a disc plow mounted to a four-wheel tractor. Furrows were following the treatments immediately after the last harrowing.

Experimental Design and Layout

The following treatments were designated as follows: T_0 – No fertilizer application (Check), T1 – 6kg Bio-synergy organic fertilizer application, T_2 – 12kg vermicompost organic fertilizer application, and T_3 – 3kg Bio-synergy + 6kg vermicompost organic fertilizer application. The experiment was laid out in Randomized Complete Block Design (RCBD) in a factorial experiment with four treatments replicated three times. Each replication was divided into four plots. Each plot was measured to 4m x 4m (16m) with seven rows. Both replication and treatment plots were separated by 2m alleyways to facilitate farm operations and management and data gathering.

Fertilizer Application, Planting, and Care Management

The application of organic fertilizer was made one week before planting. The amount of bio-synergy organic fertilizer and vermicompost organic fertilizer was based on the soil analysis of the organic fertilizer's soil and nutrient analysis. The bio-synergy organic fertilizer and vermicompost organic fertilizer are applied in furrows per plot. Seeds of Purple were sown in furrows following the treatment. Corn plants were thinned to two plants per hill one week after sowing. The replanting of missing hills was done one week after seedling emergence to meet the desired plant population. Weeds were controlled to avoid the competition of light, nutrients, space, and host for insect pests. Hilling-up was done manually in each treatment plot. The presence of Armyworms during the vegetative stage of the purple corn was controlled manually by picking.

Tagging of Data Plants

Ten (10) sample plants were randomly selected from data rows in each experimental plot.

A color gray straw was cut into 6 inches, and it was tied to the stalk of the corn plant to each data plant to serve as a marker and guide during data collection.

Harvesting

This was done when the purple corn had reached 90% maturity as indicated change in color of the husks and leaves from green to brown, as indicated by the brown in the color of the husks ready for harvesting (Lina *et al.*, 2014). Only plants in the five inner rows in each treatment plot were harvested, excluding the border rows and one end hill in each row. The harvested sample ears were husked before weighing.

Data Gathering Procedures

The following are agronomic characteristics and yield and yield components were gathered in the study:

Agronomic and Yield Character

1. Mean Number of Days from Sowing to Tasseling. This was done by counting the number of days from sowing and when the corn plants produced 50% tassel.
2. Mean Number of Days from Sowing to Silking. This was done by counting the number of days from sowing and when the corn plants produced 50% flower.
3. Mean Number of Days from Sowing to Maturity. When about 90% of corn plants had reached maturity, as indicated by the change in the husks' color and leaves from green to brown.
4. Mean Number of Kernel Per Ear. This was done by counting the number of kernels per ear.
5. Plant Height at after milk stage (cm). The average plant height was measured at 60 and 70 DAS (at harvest) within each plot's harvest area. Data was sourced from the ten tag plants in every experimental plot. Measurements were done by measuring the plant from the base to its longest leaf.

6. Mean of Ear Height (cm). The ear height data were obtained from the same tag plants using the primary ear (first ear from above). A measuring stick was used to measure the height from the base of the plant toward the bottom portion of the primary ear.
7. Mean Ear Diameter (cm). In determining the average ear diameter, the ears were first to be husked, followed by gripping a measuring tape around the ear body. This was done on the ears of the ten (10) tag plants.
8. Mean Ear Length (cm). In determining the average ear length, the ears were first husk, followed by gripping a measuring tape on the ear's length. This was done on the ears of the ten (10) tag plants.
9. Bio-mass of Corn Stover. After harvesting, each sample plant's corn stover was uprooted and washed to remove soil, and it was sundried. After sun drying, it was weighed to get the biomass yield.
10. Mean of Grain yield (t/ha-1). Grain yield per plot was converted to grain yield tons/ha after drying.

Data Analysis

The data obtained were subjected to analysis of variance (ANOVA). Duncan's Multiple Range Test (DMRT) was used to compare the treatment means at a 5% and 1% level of significance.

Result

Table 1. Agronomic character of Kalingas purple corn.

Treatments	Agronomic Characters				
	Days to Tasseling	Days to Silking	Days to Maturity	Height at Milk Stage (cm)	Ear Height (cm)
T_0-No fertilizer	$\pm 51^{a}$	$\pm 55.83^{a}$	$\pm 88.83^{a}$	$\pm 185.77^{b}{}_{.5}$	$\pm 38.63^{a}$
T_1-6kg/plot bio-synergy organic fertilizer of the recommended rate	$\pm 49^{a}$	$\pm 53.33^{a}$	$\pm 86.33^{a}$	$\pm 192.87^{b}{}_{.5}$	$\pm 41.01^{a}$
T_2-12kg/plot vermicompost organic fertilizer of the recommended rate	$\pm 47^{a}$	$\pm 52.16^{a}$	$\pm 85.16^{a}$	$\pm 216.42^{a}{}_{.5}$	$\pm 36.55^{a}$
T_3-3kg bio-synergy + 6kg/plot vermicompost organic fertilizer of the recommended rate	$\pm 47^{a}$	$\pm 52.16^{a}$	$\pm 88^{a}$	$\pm 206.80^{ab}{}_{.5}$	$\pm 40.35^{a}$

Note: Means not sharing letter in common differ significantly by Duncan's Multiple Range test

Table 2. Yield and yield character of Kalingas purple corn.

Treatments	Yield and Yield Components				
	Number of kernel/ear	Weight of 1000 kernel (g)	Yield/plot (kg)	Yield tons/ha^{-1}	Biomass yield (g)
T_0-No fertilizer application	$\pm 220.46^{b}{}_{.01}$	$\pm 258.33^{b}{}_{.5}$	$\pm 4.45^{b}{}_{.01}$	$\pm 2.78^{b}{}_{.01}$	$\pm 826.66^{a}{}_{.01}$
T_1-6kg/plot bio-synergy organic fertilizer of the recommended rate	$\pm 253.56^{b}{}_{.01}$	$\pm 256.66^{b}{}_{.5}$	$\pm 4.11^{b}{}_{.01}$	$\pm 2.56^{b}{}_{.01}$	$\pm 164.25^{b}{}_{.01}$
T_2-12kg/plot vermicompost organic fertilizer of the recommended rate	$\pm 267.35^{a}{}_{.01}$	$\pm 271.66^{ab}{}_{.5}$	$\pm 6.45^{a}{}_{.01}$	$\pm 4.03^{ab}{}_{.01}$	$\pm 906.66^{a}{}_{.01}$
T_3-3kg of bio-synergy + 6kg/plot vermicompost organic fertilizer of the recommended rate	$\pm 243.88^{ab}{}_{.01}$	$\pm 283.33^{a}{}_{.5}$	$\pm 7.94^{a}{}_{.01}$	$\pm 4.96^{a}{}_{.01}$	$\pm 933.33^{a}{}_{.01}$

Note: Means not sharing letter in common differ significantly by Duncan's Multiple Range test

Fig. 1. Soil sample collection.

Fig. 2. Experimental site.

Fig. 3. Field lay-out.

Fig. 4. Crop stand at vegetative stage.

Discussion

Agronomic Character of Kalinga's Purple Corn

The agronomic characteristics of Kalinga's purple corn are presented in table 1. It was observed the purple corn produced tassel at 51 days with no application of organic fertilizers (T_0), however, under T_1, T_2, and T_3 observed that they produced tassel at 49 days, 47 days, and 47 days (Table 1), respectively. It showed that the application of fertilizer might as well shorten the production of tassel although there is no significant difference from the results.

Silking of the purple corn gave no significant response to the influence of organic fertilizer. However, it was observed that purple corn with no application of organic fertilizer produced silk at 55.83 days which is comparable to T_1, T_2, and T_3 at 55.33 days, 52.16 days, and 52.16 days, respectively. Under Tabuk City condition, the purple corn matured at 88.83 days which was observed in no fertilizer application followed by T_1, T_2, and T_3. Statistical data showed no significant differences in the results. The data showed a parallel result on the days to tasseling, silking, and maturity.

In terms of the height of purple corn, it was revealed in the field experiment that the application of 12kg of vermicompost (100% of the recommended rate) significantly influenced the height of the purple corn. Results showed that purple corn applied with 12kg of vermicompost produced the tallest plant height of 216.41cm, followed by plants in T_3 with a value of 206.80cm, T_1 of 192.86cm, and the lowest value was obtained in T_0 with no fertilizer application of 185.76cm. The same findings were obtained in the study (Samsami, 2016) 100% of vermicompost led to a 21, 42, 61, and 54% increase in plant height in comparison to the control. Application of 30 Mg ha-1 vermicompost exhibits taller sweet corn as much as 85% and 35% compared to that of control for first and second plantings, respectively (Muktamar *et al.*, 2018). The amounts of soil nitrogen increased significantly after incorporating vermicompost into soils (Sreenivas, 2000; Kale, 1992; Nethra, 1999) and the amounts of P and K available also increased (Venkatesh, 1998) which can influence plant growth.

The average ear height of the purple corn gave no significant results; however, the application of bio-synergy obtained the highest ear height at 41.01cm, T_3 at 40.35, and T_0 with a value of 38.63cm, and lowest in T_2 with a value of 36.54cm. Further, observed the disparity of the results in terms of the average ear height of purple corn. The results of the study are alike to the findings of (Canatoy, 2018) that vermicompost did not influence the ear height of the corn.

Yield and Yield Components

Table 2 shows the effect of organic fertilizers on the number of kernels/ears, the weight of 1000 kernels, yield/plot, yield ton/ha, and biomass yield. Organic fertilizer (bio-synergy and vermicompost) significantly affected the number of kernels, weight of kernel, yield/plot, yield tons/ha, and biomass yield of the purple corn. Purple corn plants applied with 12kg of vermicompost produced a more average number of kernels per ear with an average value of 267.35

compared to purple corn in T_0, T_1, and T_3. The results showed that there is a highly significant result on the production of kernel/ear. The findings were the same as the study (Samsami, 2016) that the application of 100% vermicompost increased the number of seeds of corn.

The weight of 1000 seeds were significantly higher in the combined application of bio-synergy and vermicompost (T_3) with a mean of 283.44 g, compared to those in T_0, T_1, and T_2 with the same results in terms of statistical analysis. This shows that the combined application of 100% bio-synergy and vermicompost affect directly the weight of kernels. The results are opposite to the findings of (Samsami, 2016) that the application of 100% vermicompost increases the weight of 1000 seeds.

The results proved that combining the application of two organic fertilizers is much more effective than the sole application. The study by (Tao *et al.*, 2020) revealed that bio-organic fertilizer is a product of the biocontrol inoculum within the organic amendment and its impact on the resident soil microbiome. The addition of compost improves soil physical properties by decreasing bulk density and increasing the soil water holding capacity (Weber *et al.*, 2007) cited by (Lazcano & Domínguez, 2011).

The yield per plot of the field experiment was determined to get the actual yield per treatment as it was used to extrapolate for yield tons/ha. The yield per plot of purple corn produces the highest yield in the combine application of 3kg of bio-synergy and 6kg vermicompost of 7.94kg compare to those plants in T_0 with a value of 6.45kg, T_0 with 4.45kg, and T_2 of 4.11kg (Table 2). Statistically showed that combined application of bio-synergy and vermicompost is the same with sole application of vermicompost. Same statistical results are also found in the application of bio-synergy and with no fertilizer applied. Meaning, application of bio-synergy alone does not influence the yield of the purple corn. Combining two organic fertilizers double the presents of nutrients which they contain will have a direct effect on the yield of the purple corn.

The yield per plot was extrapolated into yield per hectare, the same results were found out the application of combined organic fertilizers produced highest value of 4.96 tons/ha^{-1} (Table 2). The applications of vermicompost alone have an impact on the yield per hectare of 4.03 which is second to the combined application. But the application of 100% bio-synergy obtained the lowest yield of 2.56 tons/ha-1, wherein no application of organic fertilizer is numerically higher in T_1 but statistically they are the same. The results imply that combined application of organic fertilizer shows a highly significant result (Table 2). Through biological nitrogen fertilizer plant vermicompost of compensates deficiency this element to crops and with the growth and development of corn and assimilate the vegetative reproductive organs improved yield (Zaremanesh, H., Nasiri, B., & Amiri, A. (2017).

According to the results of the field experiment conducted, there was a significant difference on the average biomass yield of purple corn. Results showed that application of 3kg bio-synergy and 6kg vermicompost per plot highly influenced the biomass yield with 933.33 g, with the same statistical results to T_2 (12kg of vermicompost) with a value of 906.66 g, and T_0 (No fertilizer application) with 826.66 g. Lowest biomass yield is incurred in T1 (6kg of bio-synergy) with 164.25 g. The application of vermicompost not only reduces the requirement of chemical fertilizers but also supplements important essential elements to increase crop yield besides improving the soil properties and processes (Ravi Chandra Sharma & Pabitra Banik, 2014). The application of combined organic fertilizer, vermicompost alone, and no fertilizer application revealed the same results (Table 2) in terms of the biomass yield. Improvement of soil chemical properties due to vermicompost application is followed by taller plants and higher biomass (Muktamar *et al.*, 2018).

Conclusion

The results of the field experiment undertaken toward soil at Sitio Pacak, Agbannawag, Tabuk City, Kalinga planted with purple corn influenced yield and yield character.

The application of organic fertilizer improved crop yield and increased the soil pH and organic matter as well as soil microorganism. Statistical results showed that parameters on the average days to tassel, silking, maturity, ear diameter, and ear height did not show significant differences. A highly significant results are observed in the number of kernel/ears, yield/plot, yield tons/ha, and biomass yield. While significant difference results are observed in plant height and weight of 1000 kernel. The combined application of bio-synergy plus vermicompost may consider as influence on the productivity of purple corn. Thus, the combined application of two organic fertilizers improved yield productivity of Kalinga's purple corn under Tabuk City condition.

Recommendation(S)

Based on the results of the field experiment conducted at Agbannawag, Tabuk City, Kalinga. The combine application of 3kg (50% of the recommended rate) and 6kg of vermicompost (50% of the recommended rate) may consider since it provides a significant yield of Kalingas purple corn.

References

Canatoy Ronley. 2018. Effects of Vermicompost on the Growth and Yield of Sweet Corn in Bukidnon, Philippines. Asian Journal of Soil Science and Plant Nutrition **3(2),** p.1-8.

Domínguez J. 2004. State-of-the-Art and New Perspectives on Vermicomposting Research. Earthworm Ecology 401-424.

FAO. 2013. Traditional High Andean Cuisine. In Food and Agriculture Organization of the United Nations Regional Office for Latin America and the Caribbean (FAO/RLC). http://www.fao.org/3/i1466e

Gazette O. 2010. Mga B4Tas Republika **5,** 3759-3766.

Lao F, Sigurdson G T, Giusti MM. 2017. Health Benefits of Purple Corn (Zea mays L.) Phenolic Compounds. Comprehensive Reviews in Food Science and Food Safety **16(2),** 234-246.

Lazcano C, Domínguez J. 2011. The Use of Vermicompost in sustainable agriculture:Impact on plant growth. Nova Science Publishers, Inc p.1-23.

Lina S, Maranguit D, Asio V, Sabijon J, Demain K L, Bolledo A. 2014. Growth Performance of Corn as Influenced by the Combined Application of Organic and Inorganic Fertilizers in a Marginal Upland Soil. Annals of Tropical Research **29,** p. 16-29. https://doi.org/10.32945/atr36s2.2014

Muktamar Z, Adiprasetyo T, Yulia, Suprapto, Sari L, Fahrurrozi F, Setyowati N. 2018. Residual effect of vermicompost on sweet corn growth and selected chemical properties of soils from different organic farming practices. International Journal of Agricultural Technology **14(7),** p.1471-1482.

Padilla NE, Cañete DC, Simbulan VS. 2017. Organic Fertilizer Value Chain Opportunities and Challenges in Cagayan Valley, Philippines. Journal of Advanced Agricultural Technologies **4(2),** 128-133. https://doi.org/10.18178/joaat.4.2. p.128-133

Ravi Chandra Sharma, Pabitra Banik. 2014. Vermicompost and Fertilizer Application: Effect on Productivity and Profitability of Baby Corn (Zea Mays L.) and Soil Health, Compost Science & Utilization **22(2),** 83-92, https://doi.org/10.1080/1065657X.

Rosen CJ, Allan DL. 2007. Exploring the Benefits of Organic Nutrient Sources for Crop Production and Soil Quality.

Samsami S. 2016. Effect of Vermicompost on Yield and Yield Components of Two Corn Cultivars. International Journal of Environment, Agriculture and Biotechnology **1(3),** p. 445-447. https://doi.org/ 10.22161/ijeab/1.3.21

Samsami S. 2016. Effect of Vermicompost on Yield and Yield Components of Two Corn Cultivars. International Journal of Environment, Agriculture and Biotechnology **1(3),** 445–447. https://doi.org/ 10.22161/ijeab/1.3.21

Senarathne SHS. 2018. Effect of Vermicompost on Growth of Coconut Seedlings under Field Conditions in Sri Lanka. Cord **34(1),** 6.

Shi Y, Yang J, Liu X. 2013. Effect of Different Mixed Fertilizer on Yield, Quality and Economic Benefits in *Stevia rebaudiana* Bertoni. Advance Journal of Food Science and Technology **5(5),** p. 588-591.

Sumagaysay CL. 2014. The International Journal of Biotechnology Bio N Fertilization for Corn **3(6),** p. 85-90.

Tao C, Li R, Xiong W, Shen Z, Liu S, Wang B, Ruan Y, Geisen S, Shen Q, Kowalchuk GA. 2020. Bio-organic fertilizers stimulate indigenous soil Pseudomonas populations to enhance plant disease suppression. Microbiome **8(1),** 1-26.

Weber J, Karczewska A, Drozd J, Licznar M, Licznar S, Jamroz E, Kocowicz A. 2007. Agricultural and ecological aspects of a sandy soil as affected by the application of municipal solid waste composts. In Soil Biology and Biochemistry **39,** Issue 6, pp. 1294-1302).

Zaremanesh H, Nasiri B, Amiri A. 2017. The effect of vermicompost biological fertilizer on corn yield. J. Mater. Environ. Sci **8(1),** p. 154-159.