Eurasian Journal of Agricultural Research 2020; Vol: 4, Issue: 1, pp: 1-10

Effects of Timing of Goat Manure and Inorganic Fertilizer Application on Productivity and Profitability of Sweetpotato (*Ipomoea batatas* (L.) Lam.)

Rizal John C. Caruana, Ulysses A. Cagasan*

Department of Agronomy, Visayas State University Visca, Baybay City, Leyte 6521-A, Philippines

**Corresponding author: ulycagasan@vsu.edu.ph*
ORCID: 0000-0003-1849-2261

Abstract

It is known to everyone that organic fertilizer must be applied a month before planting to decompose and efficiently utilized by the growing plants. Organic fertilizer like goat manure may improve the agronomic characteristics and yield components of sweetpotato. Hence, this study was conducted to evaluate the effects, determine the appropriate and assess the profitability of sweetpotato as influenced by the timing of goat manure application. The treatments as follows; T_1 = No fertilizer application (control), T_2 = 45-45-45 kg ha^{-1} N, P_2O_5, K_2O applied 1 week after planting, T_3 = 10 t ha^{-1} goat manure applied 4 weeks before planting, T_4 = 10 t ha^{-1} goat manure applied 2 weeks before planting; and T_5 = 10 t ha^{-1} goat manure applied at planting. An experimental area of 341 m^2 was prepared and the experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Sweetpotato plants applied with 10 t ha^{-1} goat manure applied at planting (T_5) had the longest main vine with more number of lateral vines comparable to inorganic fertilizer application at the rate of 45-45-45 kg ha^{-1} N, P_2O_5, K_2O (T_2) as compared to other treatment plants. Plants applied with organic fertilizers regardless of timing of application was comparable in fresh herbage yields. With regards to yield components, plants applied with 10 t ha^{-1} goat manure regardless of timing in the application obtained number of marketable roots, weight of marketable roots (t ha^{-1}) and total root yield (t ha^{-1}) comparable to the unfertilized plants. The highest values on these parameters were obtained from those applied with inorganic fertilizer at 45-45-45 kg ha^{-1} N, P_2O_5, K_2O (T_2). Highest harvest index was obtained by 10 t ha^{-1} goat manure applied at planting (T_5) but comparable to 10 t ha^{-1} goat manure applied 2 weeks before planting (T_4). Plants with 10 t ha^{-1} goat manure applied at planting (T_5) seemed to enhance the root yield of sweetpotato resulting in the higher gross margin of PhP12,016.75 ha^{-1}. This was low compared to plants applied with 45-45-45 kg ha^{-1} N, P_2O_5, K_2O of inorganic fertilizers.

Keywords: Organic production, assessment, timing, fertilizer, yield and income

Research article

INTRODUCTION

Sweetpotato (*Ipomoea batatas* (L.) Lam) locally known as "camote" is a viny annual crop belonging to family Convolvulaceae which is generally cultivated for its enlarged roots. It is widely grown as one of the staple food crops aside from cereals in many parts of the tropics and subtropics regions. This crop is highly recognized for its various uses as food, feed and raw material for industrial food products. It is also adapted to various production systems in a wide range of environmental conditions. It ranks fifth as the most important food crop after rice, wheat, maize and cassava in developing countries (Som, 2017). The crop is known as a highly tolerant root crop to high temperatures, poor soils, floods and had resistance to some pests and diseases. BAS (2013) reported that production of sweetpotato in Leyte and Samar Philippines is 527.69 thousand metric tons. In 2020, the world average annual yield for sweetpotato crop was 13.2 tons per hectare. However, our sweetpotato in the country is faced with production and economic constraints. Labor costs are high in some localities while yields remained low due to low soil fertility, post-harvest losses and low price. Onunka et al., (2012) added that yield of sweetpotato is also restricted by presence of weeds, insects and disease and some inappropriate management practices. Hence, strategies to increase crop yield like integrated nutrient management should be employed. Growers still prefer to use inorganic fertilizer to increase yield but due to prohibitive cost, they look for alternative source of fertilizer. The common organic materials that are readily available in farms are crop residues and animal manures.

Animal manure as fertilizer can add nitrogen, phosphorus and potassium to the soil. It is one of the potential sources of organic fertilizers. When properly decomposed, it improves the structure, aggregation, permeability and water holding capacity of the soil. In addition, organic fertilizer affects the chemical properties of the soil. However, timing of nutrient application is guided by some basic considerations which include nutrient availability when crops need it, avoiding waste and enhancing nutrient use efficiency (Brady and Weil, 2008). Kolawole (2014) reported that in Nigeria, poultry manure applied two weeks before planting improved maize grain yield and nutrient uptake compared with poultry manure applied at 2 weeks after planting and at planting. Abrantes (2014) cited that application of 10 t ha^{-1} goat manure at 2 weeks before or during planting + 30 or 60 kg ha^{-1} muriate of potash significantly increased the number of primary lateral vines, weight of marketable roots and total root yield of sweetpotato. Proper timing greatly affects availability of nutrients and consequently the growth and yield performance of the crop. Hence, this study was conducted to assess the productivity and profitability of sweetpotato production using goat manure and inorganic fertilizer as influenced by the timing of application.

MATERIALS and METHODS

An experimental area of 341 m^2 was used in this experiment. It was plowed and harrowed twice at weekly interval using tractor-drawn implement. This operation was done to pulverize the soil, allow decomposition of weeds and crop stubbles, improve soil tilth and minimize weed population. After the last harrowing, ridges were prepared 75 cm apart. Initial soil analysis, ten (10) soil samples were collected randomly from the experimental area before planting at a depth of 20 cm. These were composited, air-dried, pulverized and sieved through a 2-mm wire mesh and placed in labeled bags.

The composite sample was submitted to Central Analytical Services Laboratory (CASL), PhilRootcrops, VSU, Visca, Baybay City, Leyte for the determination of soil pH (Potentiometer Method at 1:1 soil water ratio), % Organic Matter (Modified Walkley-Black Method), total Nitrogen (Kjeldahl Method) extractable P (Modified Olsen Method) and exchangeable K (Atomic absorption spectrophotometer after extraction with ammonium acetate). Five soil samples were collected separately per treatment plot after harvest for the final soil analysis evaluated of the same soil parameters. The different treatments were designated as follows: T_1 = No fertilizer application (control), T_2 = 45-45-45 kg ha^{-1} N, P_2O_5, K_2O applied 1 week after planting, T_3 = 10 t ha^{-1} goat manure applied 4 weeks before planting, T_4= 10 t ha^{-1} goat manure applied 2 weeks before planting, T_5 = 10 t ha^{-1} goat manure applied at planting. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Each replication was divided into five plots measuring 18 m^2 (4 m x 4.5 m) with six rows and 16 hills per row. A one m alleyway between replication and 0.5 m between treatment plots were provided to facilitate farm operation and data gathering.

Analysis and Application of Fertilizers

Goat manure was procured at the Department of Animal Science, VSU, Visca, Baybay City, Leyte. A 100 g sample was taken and brought to Central Analytical Services Laboratory (CASL), PhilRootcrops, VSU, Visca, Baybay City, Leyte for the analysis of total Nitrogen, Phosphorus, Potassium, % OM and pH. Goat manure analysis showed that the goat manure had a pH of 6.64, 4.56% organic matter, 4.16% total N, 0.13 mg kg^{-1} available P and 0.95 me $100g^{-1}$ exchangeable K. Goat manure was applied by hand and incorporated along the furrows at 10 cm deep and was covered thinly with soil at the time of application specified in the treatment. Complete fertilizer was applied one week after planting 10 cm away from the base of the plants at a depth of 10 cm at 6 g per hill. The rates of fertilizer were based on the specified treatments per plot.

Planting Materials, Planting, Care and Management

Sweetpotato (NSIC Sp25) tip cuttings with lengths of 25-30 cm were gathered from healthy plants. A total of 1440 cuttings for the whole experiment were procured at PhilRootcrops, VSU, Visca, Baybay City, Leyte a day before planting. To prevent dehydration, it was stored in a moist and shady area near the experimental site a day prior to planting. One cutting was planted per hill on the ridges at a distance of 75 cm between rows and 25 cm between hills. Replanting was done one week after planting to meet the desired population of 53,333 plants per hectare. Hand weeding was done two weeks after planting using bolo to control the weeds. It was followed by hilling up using a bolo two weeks later to loosen up the soil and enhance the development of the roots. Occasional hand weeding operation was done on each treatment plot and surroundings to maintain the cleanliness of the experimental area. Harvesting was done 4 months after planting. This was done by using bolo to dig up the fleshy roots within the harvestable area of 10.5 m^2 with 4 rows and 14 hills per row. Each plot had six rows with one border row in each side and one end plant in each end of the row. Extra care and attention was observed to minimize damage of the fleshy roots. The roots were cleaned and classified into marketable and non-marketable one. The marketable roots were those free from damage and measured 2.5 cm in diameter and 6.5 cm in length. The non-marketable roots were those that do not qualify the marketable category. The sorted roots were counted and weighed per treatment plot.

Data Gathered

Agronomic Characteristics

1. Length (cm) of the main vine. This was obtained by measuring the main vine of the plant from the base to the tip of the vine using ten (10) sample plants per treatment plot. This was done by carefully locating the specific vine of the particular sample where the lateral vines were connected.
2. Number of primary lateral vines per plant. This was recorded by counting the number of primary lateral vines from ten (10) sample plants in each treatment plot.
3. Leaf area index (LAI). This was obtained by measuring the length and width of all functional leaves within the 50 cm ×50 cm quadrat at 60 days after planting. The product was multiplied by the correction factor of 0.497 (Cajefe, 2003). The total leaf area within the quadrat was divided by the effective ground area (cm^2) within the quadrat to get the leaf area index (LAI).

$$\text{TLA} = \text{Sum}\ (\text{L} \times \text{W})\text{CF}(0.497)$$

$$\text{LAI} = \frac{\text{Total Leaf Area (TLA)}}{\text{Area of the quadrat } (2{,}500\ \text{cm}^2)}$$

4. Fresh herbage yield ($t\ ha^{-1}$). This was determined by weighing the vines of all the harvested plants from the four inner rows in each treatment plot, excluding the border row in each side of the plot and 1 end plant in each row. This was converted into tons per hectare using the formula:

$$\text{Herbage yield } (\text{t ha}^{-1}) = \frac{\text{Fresh herbage yield } (\text{kg ha}^{-1})}{\text{Harvestable area } (10.5\ \text{m}^2)} \times \frac{10{,}000\ \text{m}^2\ \text{ha}^{-1}}{1{,}000\ \text{kg ton}^{-1}}$$

Yield and Yield Components

1. Number of marketable and non-marketable roots per hill. This was obtained by sorting the marketable and non-marketable roots of 5 sample hills within the harvestable area per plot. Marketable storage roots were those that have 2.5 cm diameter and 6.5 cm long and were healthy and free from pest and diseases. Those that did not meet the criteria were considered as non-marketable roots.
2. Weight (g) of marketable and non-marketable roots per hill. This was obtained by weighing separately the marketable and non-marketable fleshy roots from 5 sample hills within the harvestable area per treatment plot.
3. Number of marketable and non-marketable roots per plot. This was obtained by sorting the marketable and non-marketable roots from the inner rows within the harvestable area per treatment plot.
4. Weight ($t\ ha^{-1}$) of marketable and non-marketable roots. This was obtained by weighing separately the marketable and non-marketable fleshy root harvested per treatment plot and converting it into tons per hectare using the formula:

$$\text{Root yield } (\text{t ha}^{-1}) = \frac{\text{Root yield } (\text{kg plot}^{-1})}{\text{Harvestable area } (10.5\ \text{m}^2)} \times \frac{10{,}000\ \text{m}^2\ \text{ha}^{-1}}{1{,}000\ \text{kg ton}^{-1}}$$

5. Total root yield (t ha^{-1}). This was obtained by adding the weights of the marketable and non-marketable fleshy roots in tons per hectare using the formula:
   Total root yield (t ha^{-1}) = wt. of marketable roots (t ha^{-1}) + wt. of non- marketable roots (t ha^{-1})

Other Parameters

Harvest Index was evaluated using the formula:

$$\text{HI} = \frac{\text{Total root yield (5 sample plants)}}{\text{Total root yield} + \text{fresh herbage yield (5 sample plants)}}$$

Gross margin was computed by subtracting the total variable cost from the gross income using the formula: Gross Margin = Gross Income – Total Variable Cost

Data on total monthly rainfall (mm), average daily minimum and maximum temperatures (˚C) and relative humidity (%) from the time of planting up to the time of harvesting were taken from the records of the Philippine Atmospheric Geophysical Astronomical Services Administration (PAGASA) Station, Visayas State University, Visca, Baybay City, Leyte. The data were computed and the analysis of variance (ANOVA) was analyzed using Statistical Tool for Agricultural Research (STAR) software. Comparison of means was done using Fisher's Least Significant Difference (LSD) Test.

RESULTS and DISCUSSION

Soil Analysis

Table 1 presents the initial and final soil analysis. Result showed that the soil had a pH of 5.40, 2.50% organic matter, 0.47% total nitrogen, 1.75 mg kg^{-1} available phosphorus and 0.85 $me100g^{-1}$ exchangeable K. The results indicated that the soil is strongly acidic, low in organic matter, medium total N, very low available P and high exchangeable K (Landon, 1991).

Table 1. Soil test results before planting and after harvest of sweetpotato (NSIC Sp25) as influenced by timing of goat manure application

Treatment	Soil pH (1:2.5)	Organic Matter (%)	Total N (%)	Available P (mg kg^{-1})	Exchangeable K ($me100g^{-1}$)
Initial Analysis	5.40	2.50	0.47	1.75	0.85
Final Analysis					
T_1	5.55	2.00	0.50	0.71	0.48
T_2	5.00	1.00	0.59	1.57	0.66
T_3	5.30	1.50	0.51	1.15	0.53
T_4	5.20	2.00	0.54	1.23	0.56
T_5	5.30	2.50	0.57	1.48	0.61
Mean	5.29	1.92	0.53	1.32	0.62

Legend:
T_1 = No fertilizer (control)
T_2 =45-45-45 kg ha-^{1} N, P_2O_5, K_2O applied 1 week after planting
T_3 =10 t ha^{-1}goat manure applied 4 weeks before planting
T_4 =10 t ha^{-1} goat manure applied 2 weeks before planting
T_5=10 t ha^{-1} goat manure applied at planting

Final soil analysis revealed that total N slightly increased after harvest which could be due to the added goat manure into the soil. However, soil pH, % organic matter, available P and exchangeable K slightly decrease. The decrease in soil pH was due to the application of goat manure that released carbonic acids during the decomposition process (Cosico, 2005). On the other hand, the decrease in organic matter, available P and exchangeable K could be attributed to crop removal and losses due to leaching. Similarly, Onunka, et al., 2012) attributed the decrease in exchangeable K to plant uptake and assimilation. Goat manure analysis showed a pH of 6.64, 48.56% organic matter, 4.16% total N, 0.13 mg kg^{-1} available P and 0.95 me 100g^{-1} exchangeable K. Results indicate that goat manure contain high organic matter, high nitrogen content, very low available P and exchangeable K (Landon, 1991).

Agronomic Characteristics

Table 2 presents the agronomic characteristics of sweetpotato as influenced by timing of goat manure application. Statistical analysis revealed that the length of main vines (cm) and leaf area index (LAI) were markedly affected by the treatments applied. Sweetpotato plants applied with 10 t ha $^{-1}$ goat manure applied at planting (T_5) significantly produced longer main vines (319.47 cm) which was higher than T_3 plants (224.13 cm) and T_4 plants (281.67 cm) and the unfertilized plants T_1 (216 cm) but comparable to plants applied with 45-45-45 kg ha^{-1} N, P_2O_5, K_2O (T_2). Plants applied with 10 t ha^{-1} goat manure 4 weeks before planting (T_3) had comparable length of main vines to unfertilized plants (T_1).

Table 2. Agronomic characteristics of sweetpotato (NSIC Sp25) as influenced by timing of goat manure application

Treatment	Length of main vines (cm)	Number of primary lateral vines	Leaf Area Index	Fresh Herbage Yield (t ha^{-1})
T_1	216.00 c	5.00 b	0.62 d	7.49 c
T_2	329.43 a	6.67 a	2.44 a	16.54 a
T_3	224.13 c	5.50 b	1.05 cd	10.70 b
T_4	281.67 b	5.73 b	1.09 c	10.42 b
T_5	319.47 a	6.50 a	1.95 b	12.24 b
Mean	274.14	5.68	1.43	11.68
CV (%)	7.25	7.25	17.05	14.59

Means within the same column followed by a common letter are not significantly different from each other at 5% level using LSD Test.

Legend:

T_1 = No fertilizer (control)
T_2 =45-45-45 kg ha-^{1} N, P_2O_5, K_2O applied 1 week after planting
T_3 =10 t ha^{-1}goat manure applied 4 weeks before planting
T_4 =10 t ha^{-1} goat manure applied 2 weeks before planting
T_5 =10 t ha^{-1} goat manure applied at planting

The number of primary lateral vines of plants applied with 10 t ha^{-1} goat manure regardless of timing of application (T_3-T_5) were comparable to the unfertilized plants (T_1). Plants applied with 45-45-45 kg ha^{-1} N, P_2O_5, K_2O (T_2) obtained the most primary lateral vines. In terms of LAI, plants applied with 10 t ha^{-1} goat manure at planting (T_5) obtained bigger LAI among the treatments tested but lower than that plants applied with 45-45-45 kg ha^{-1}, P_2O_5, K_2O (T_2). LAI of plants with 10 t ha^{-1} goat manure applied 2 weeks before planting (T_4) were comparable to plants applied with 10 t ha^{-1} goat manure applied 4 weeks before planting (T_3). Plants with 10 t ha^{-1} goat manure applied 4 weeks before planting had LAI (1.05) comparable to the unfertilized plants which obtained the lowest LAI value (0.62). On the other hand, plants with 10 t ha^{-1} goat manure applied at planting (T_5) obtained fresh herbage of 13.24 t ha^{-1} comparable to T_4 plants (10.42 t ha $^{-1}$) and T_3 plants (10.79 t ha^{-1}) but lower than that applied with 45-45-45 kg ha^{-1} N, P_2O_5, K_2O (T_2) of 16.54 t ha^{-1}.

However, T_4 plants (10.42 t ha^{-1}) and T_3 plants (10.70 t ha^{-1}) were comparable to unfertilized plants T_1 (7.49 t ha^{-1}). The differences of the aforementioned parameters could be attributed to the amounts of macronutrients that supported the growth and development of longer main vine, broader LAI and apparently higher fresh herbage yield of sweetpotato.

According to Brobbey (2015), sweetpotato plants increase its main vine length and leaf area when applied with complete fertilizer as it is readily available for plant use as compared to organic sources which had a gradual release of nutrients to soil. The findings imply that application of 10 t ha^{-1} goat manure at planting (T_5) seemed the best time application as it achieved longer length of main vines (cm) and broader leaf area index (LAI) than other time of application but lower compared to plants applied with 45-45-45 kg ha^{-1} N, P_2O_5, K_2O (T_2) from inorganic fertilizers. This result can be attributed to the finding of (Montecalvo, 2011; Sorita, 2010) that sweet corn yield increases when applied goat manure during planting.

Yield and Yield Components and Harvest Index

Yield and yield components and harvest index of sweetpotato as influenced by timing of goat manure application is presented in Table 3. Analysis of variance revealed that the number of marketable roots, marketable root yield (t ha $^{-1}$), total root yield (t ha^{-1}) and harvest index of sweetpotato were significantly affected by the timing of application of 10 t ha^{-1} goat manure and inorganic fertilizer.

Table 3. Yield and yield components and harvest index of sweetpotato (NSIC Sp25) as influenced by timing of goat manure application

Treatment	Number of Roots ha^{-1}		Root Yield ($t\ ha^{-1}$)		Total Root Yield ($t\ ha^{-1}$)	Harvest Index (HI)
	Marketable	Non marketable	Marketable	Non marketable		
T_1	20.67 b	38.67	1.65 b	1.16	2.81 b	0.25 d
T_2	60.67 a	47.00	6.13 a	1.70	7.82 a	0.53 a
T_3	27.00 b	44.00	2.27 b	1.72	3.97 b	0.31 cd
T_4	28.67 b	40.67	2.38 b	1.14	3.52 b	0.37 bc
T_5	35.00 b	49.00	2.68 b	1.57	4.25 b	0.41 b
Mean	34.40	43.87	3.02	1.46	4.47	0.37
CV (%)	25.53	18.63	34.25	31.97	26.06	12.27

Means within the same column followed by a common letter are not significantly different from each other at 5% level using LSD Test.

Legend:

T_1 = No fertilizer (control)
T_2 =45-45-45 kg ha-^{1} N, P_2O_5, K_2O applied 1 week after planting
T_3 =10 t ha^{-1}goat manure applied 4 weeks before planting
T_4 =10 t ha^{-1} goat manure applied 2 weeks before planting
T_5 =10 t ha^{-1} goat manure applied at planting

Sweetpotato plants applied with 10 t ha^{-1} goat manure regardless of timing of application (T_3, T_4 and T_5) obtained marketable roots $plot^{-1}$ comparable to the unfertilized plants (T_1). Plants applied with 45-45-45 kg ha^{-1} N, P_2O_5, K_2O (T_2) of inorganic fertilizer (60.67) gave the highest number of marketable roots $plot^{-1}$. The same trend was noted in the marketable root yield (t ha^{-1}) and total root yield (t ha^{-1}). Those applied with 45-45-4 kg ha^{-1} N, P_2O_5, K_2O obtained the highest values in the aforementioned parameters. This is expected as inorganic fertilizers are immediately bioavailable to plants thus resulting in enhanced growth and yield (Brady and Weil, 2008). Moreover, harvest indices of T_4 (0.37) and T_5 plants (0.41) were comparable but markedly lower than plants applied with inorganic fertilizers (0.53). According to Suge et al., (2011), organic inputs alone would not meet the nutritional needs of crops because they contain comparatively low quantity and slow availability of nutrients than inorganic fertilizers. The unfertilized plants (T_1) obtained the least harvest index value (0.25). The findings imply that application of 10 t ha^{-1} goat manure at planting seemed the best time application as it obtained more number and higher yield of marketable roots than other time of application and consequently high total root yield (t ha^{-1}). This was lower compared to plants applied with 45-45-45 kg ha^{-1} N, P_2O_5, K_2O from inorganic fertilizers.

Cost and Return Analysis

The cost and return analysis of sweetpotato production as influenced by timing of goat manure and inorganic fertilizer application is shown in Table 4. Sweetpotato applied with inorganic fertilizer (45-45-45 kg ha^{-1} N, P_2O_5, K_2O) obtained the highest gross income of (PhP85,800.75 ha^{-1}) among treatments.

On the other hand, plants applied at planting of goat manure organic fertilizer 10 tha^{-1} obtained the highest gross margin of (PhP12,016.75.00 ha^{-1}). This could be attributed to the marketable yields obtained on this treatment.

Table 4. Cost and return analysis ha^{-1} of sweetpotato (NSIC Sp25) production as influenced by timing of goat manure application

Treatment	Marketable Roots ($t\ ha^{-1}$)	Gross Income (PhP)	Total Variable Cost ($PhP\ ha^{-1}$)	Gross Margin ($PhP\ ha^{-1}$)
T_1	1.65b	33,000.00	28,833.25	4,166.75
T_2	6.13a	122,600.00	36,799.25	85,800.75
T_3	2.27b	45,400.00	41,333.25	4,066.75
T_4	2.38b	47,600.00	41,083.25	6,516.75
T_5	2.68b	53,600.00	41,583.25	12,016.75

The gross income was based on the prevailing market price of PhP 20.00 per kg of sweetpotato during the time of harvest.

Legend:
T_1 = No fertilizer (control)
T_2 =45-45-45 kg $ha\text{-}^{1}$ N, P_2O_5, K_2O applied 1 week after planting
T_3 =10 t ha^{-1}goat manure applied 4 weeks before planting
T_4 =10 t ha^{-1} goat manure applied 2 weeks before planting
T_5=10 t ha^{-1} goat manure applied at planting

This was followed by application 2 weeks before planting (PhP6,516.75 ha^{-1}) and 4 weeks before planting (PhP4,166.75 ha^{-1}). Unfertilized plants (T_1) gave the lowest gross margin (PhP4,666.75 ha^{-1}) due to low gross income as a result of low marketable root yield compared to fertilized plants. Vincent et al., (2005) reported that the primary objective of producers is profit maximization but the quantity of fertilizer being used is quite high resulting in high variable cost hence, gross margin remained low, (Aviles, 2010).

CONCLUSION

1. Plants applied with goat manure (10 t ha^{-1}) at planting (T_5) obtained significantly longer main vines, leaf area index as well as harvest index but lower than the plants applied with 45-45-45 kg ha^{-1} N, P_2O_5, K_2O inorganic fertilizer (T_2).
2. Plants applied with 45-45-45 kg ha^{-1} N, P_2O_5, K_2O inorganic fertilizer gave the highest total root yield 7.82 tha^{-1}.
3. Timing of goat manure application on sweetpotato did not differ significantly in yield and yield components except on harvest index.
4. Application of 10 t ha^{-1} goat manure at planting obtained a higher gross margin of PhP12,016.75 compared to unfertilized plants due to production of more marketable roots, but significantly lower than the plants applied with 45-45-45 kg ha^{-1} N, P_2O_5, K_2O inorganic fertilizer of (PhP85,800.75) due to the cost of organic fertilizer.

RECOMMENDATION

1. Application of inorganic fertilizer at the rate of 45-45-45 kg ha^{-1} N, P_2O_5, K_2O (T_2) is recommended to produce higher marketable roots of sweetpotato**.**
2. Application of 10 t ha^{-1} goat manure is recommended for sweetpotato production if growers had access to goat manure in the locality.
3. A follow up study is strongly recommended in similar condition using other sweetpotato cultivars and / or varieties.

REFERENCES

Abrantes, R. C. 2014. growth and yield performance of sweetpotato (*Ipomoea* batatas (L.) Lam.) as influenced by timing of goat manure and rates of muriate of potash application. undergraduate thesis. VSU, Baybay City, Leyte. 53 pp.

Aviles, M. A. Jr. 2010. Integration of Bio-N with vermicast and inorganic fertilizer as nutrient management for corn production. undergrad. thesis. VSU, Visca, Baybay City, Leyte. pp 50.

Brady, N. C. & R. R. Weil. 2008. *The nature and properties of soils*. 14th ed. p. 992. prentice-hall inc. new jersey, usa.

Brobbey, A. 2015. Growth, yield and quality factors of sweetpotato (*Ipomoea batatas* L.) as affected by seedbed type and fertilizer application. School of Graduate Studies. Kwame Nkrumah University of Science and Technology, Kumasi. 43-45 pp.

Bureau of Agricultural Statistics. 2013. Production of sweet potato in Samar and Leyte Philippines. http://www.ptvnews.ph/bottom-newslife2/13.html.

Kolawole, G.O. 2014. Effect of time of poultry manure application on the performance of maize in Ogbomoso, Oyo State, *Nigeria. J. Appl. Agric*.res. 6 (1), 253–258.

Landon, J. R. 1991. Booker tropical soil manual. longnam scientific and technical. Essex England. 474 pp.

Montecalvo, G. V. 2011. Response of corn to different levels of goat manure as organic fertilizer. undergraduate thesis. VSU, Baybay City, Leyte. 52 pp.

Onunka, N. A., L. I. Chukwu, E. O. Mbanasor & C. N. Ebeniro.2012. Effect of organic and inorganic manures and time of application on soil properties and yield of sweet potato in a tropical ultisol. *Journal of Agriculture and Social Research* vol. 12 no. 1. pp. 182-193.

Som, D. H. 2017. Handbook of horticulture. New Delhi, India council of agricultural research. pp. 512-416.

Sorita, M. T. 2010. Growth and yield performance of glutinous corn for green production as influenced by goat manure. undergraduate thesis. VSU, Baybay City, Leyte. 51 pp.

Suge, J. K, M. E Omunyin & E. Nomani. 2011. Scholars research library. archives of applied science research. development of seed crop and horticultural sciences. MOI University. 470-479 pp.

Usman, M. 2015. Cow, goat and poultry manure and their effects on the average yield and growth parameters of tomato crop. *Journal of Biology, Agriculture and Health Care* 5(5): 7-10 pp.