Annals of Tropical Research 40 (1):1-17(2018)

Response of sweetpotato to the combined application of organic and inorganic fertilizers in marginal upland

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ABSTRACT

Marginal uplands are characterized by low soil fertility and crop productivity. To alleviate the problem, organic amendments combined with inorganic fertilizer were tested to assess their effects on the growth and yield performance of sweetpotato; determine the option treatment combination; and assess the soil physicochemical properties. A Randomized Complete Block Design (RCBD) was used with 3 replications and 7 treatments, namely: T_0 = (0-0-0); T_1 = 1 t ha^{-1} Evans + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}; T_2 = 1 t ha^{-1} Wellgrow + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}; T_3 = 15 t ha^{-1} chicken dung alone; T_4 = 10 t ha^{-1} chicken dung + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}; T_5 = 15 t ha^{-1} Vermicast alone; and T_6 = 10 t ha^{-1} Vermicast + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}. Application of 10 t ha^{-1} of either chicken dung or vermicast plus 30-30-30 kg N, P_2O_5, K_2O ha^{-1} in Inopacan, Leyte produced higher total root yield over the control. Root yield during the second cropping greatly increased to 16.19 t ha^{-1} which is almost 3 times higher than the first crop when 15 t ha^{-1} chicken dung alone (T_3) was used. In Sta. Rita, Samar, most of the growth, yield, and yield parameters of sweetpotato were not affected by the treatments. Moreover, only a slight improvement in soil properties was noted.

Keywords: chicken dung, marginal uplands, organic fertilizers, sweetpotato, vermicast

INTRODUCTION

Sweetpotato (*Ipomoea batatas* L.) is one of the most commonly grown agronomic crops in marginal uplands. It is highly resilient to unfavorable weather condition such as typhoon. While it is a good substitute for rice and corn in times of food scarcity, it can also be used as feeds to poultry and livestock and as raw material for industrial products. There is a need, for management strategies for sustainable sweetpotato production especially in unproductive soils.

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DOI: 10.32945/atr4011.2018

Farmers often obtain low yields in marginal uplands due to poor agroecological conditions, lack of appropriate technologies and government support (Alcober et al 2014, Lina et al 2014). The sloping topography enhances runoff and erosion resulting in the loss of organic matter which results to the decline in soil fertility and thus, crop productivity (Ayoola & Makinde 2007, Ratilla et al 2014). In developing countries, Scialabba & Hattam (2002) reported that organic farming has potential to increase natural resources by improving soil water retention, reducing soil erosion, improving organic matter, and increasing biodiversity and carbon sequestration. Johnston et al (2009) stressed that the level of soil organic matter significantly affects soil fertility, sustainability of the agricultural system, and crop productivity. Branca et al (2013) stated that organic fertilizer application is one potential practice towards sustainable land management, enhancing carbon storage as well as reducing gas emission.

Inorganic fertilizers can greatly improve any yields but long-term application can have negative environmental impacts. Moreover, the continuous price hike of inorganic fertilizers aggravates the farmers' economic burden in the uplands since most of them do not have the financial capacity. Thus, recent production trends have utilized organic-based inputs for positive effects on soil, crop, and the environment.

Organic fertilizers are good sources of nutrients when fully decomposed. They build up soil organic matter which improves the physical, chemical, and biological properties of soil through mineralization; organic fertilizer supplies nutrients, enhances cation exchange capacity, root and nutrient interactions, pH, and recycles nutrients like N, P, and K (Azeez 2010, Hichman 2002, Schmitt et al 2001). They provide food to microbes which are crucial for nutrient element cycling (FlieBbach et al 2007). Recent researches have indicated that organic-based fertilizers can promote long term benefits. Yang et al (2016) reported that the combined application of organic and inorganic fertilizers substantially increased soil organic matter and crop yields. In rice, Gaurana (2016) found that after three croppings of continuous organic production system, such system has a potential as an alternative to the conventional production system. In corn, Ratilla et al (2014) found that combined application of either chicken litter or vermicast at 10 t ha^{-1} + 45-30-30 kg N, P_2O_5, K_2O ha^{-1} significantly improved its agronomic characteristics and yield but not the soil physical and chemical properties after two croppings.

This study evaluated the efficacy of organic-based inputs on sweetpotato grown in Eastern Visayas, Philippines. Specifically, it aimed to assess the effects of various organic-based fertilizers applied alone or in combination with inorganic fertilizers on the performance of sweetpotato, determine the appropriate combination for optimum yield, and assess their effects on the physical and chemical properties of the soil.

MATERIALS AND METHODS

Description of the Study Site

The study was conducted for two croppings at two sites, one in Sitio Batuan, Bgy. Linao, Inopacan, Leyte, and another in Brgy. Caticugan, Sta. Rita, Samar. The first and second croppings represented the dry and wet season, respectively. The first site (Leyte) had a slope of approximately 10 percent with clay loam soil having a

4.8 pH, 1.66% OC, 0.21%, total N, 0.74mg P kg^{-1}soil and 81.58mg K kg^{-1} soil. Based on Landon (1991), this soil was very strongly acidic, had low organic matter, nitrogen and extractable potassium and very low phosphorus contents. The area has been left idle for 18 years with *Imperata cylindrica*, Saccharum *spontaneum* and *Melastoma sp.* as the dominant vegetation cover. The second site (Samar) was relatively flat and had been left idle for about 7 years with *Imperata cylindrica* and *Mimosa pudica* as the dominant vegetation cover. Soil test results showed that it was very strongly acidic, with medium in organic matter content had very low nitrogen and phosphorus, and medium amount of exchangeable K (Landon 1991).

Land Preparation, Soil Sampling and Analysis

More plowing (5 times) and harrowing (3 times) operations were done in Inopacan, Leyte than in Sta. Rita Samar (2 times) due to differences in the thickness & composition of the vegetation cover and length of time the area was left idle. Thereafter, furrows were constructed at a distance of 0.75m apart.

Prior to plowing, soil samples were collected for bulk density determination. Another set of soil samples were randomly collected from the area at a depth of 0-20cm. These were composited, air dried, sieved and analyzed for soil pH (potentiometric method at 1:2.5 soil water ratio), organic matter (modified Walkley-Black method), total N (modified Kjeldahl method), available phosphorus (modified Olsen's method) and exchangeable K (ammonium acetate method pH 7.0 for extraction and quantified using Varian 220 FS Atomic Absorption Spectrometer) at the Central Analytical Services Laboratory (CASL), PhilRootcrops, Visayas State University. For the final analysis, soil samples were taken from each treatment plot, composited and analyzed for the same aforementioned parameters.

Experimental Design and Treatments

The experiment was laid out in randomized complete block design (RCBD) with three replications. Plot size was 4m x 5.25m ($21m^2$) with alleyways of 1 m between replications and 0.5m between treatments. Organic fertilizers available in the market such as (Evans, Wellgrow), chicken dung and vermicast were tested either applied alone or in combination with inorganic fertilizers. The treatments included the following: T_0 = (0-0-0); T_1 = 1 t ha^{-1} Evans + 30-30-30kg N, P_2O_5, K_2O ha^{-1}; T_2 = 1 t ha^{-1} Wellgrow + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}; T_3 = 15 t ha^{-1} chicken dung; T_4 = 10 t ha^{-1} chicken dung + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}; T_5 = 15 t ha^{-1} Vermicast; and T_6 = 10 t ha^{-1} Vermicast + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}. Organic fertilizers were basally applied in furrows at the rates specified in the treatments prior to planting. For the inorganic supplements, complete fertilizer was used and applied basally before planting.

Planting and other Management Practices

Sweetpotato cuttings (NSIC Sp 25) were planted in furrows at a distance of 0.75m between rows and 0.50m between hills at two cuttings per hill. Weeds were controlled by hand weeding and hilling up was done manually prior to root bulking stage. The crop was harvested 120 days after planting by carefully digging the roots with a bolo after cutting the vines. Sorting of roots was done after scraping the mud that adhered to the fleshy roots.

Data Gathered

The data gathered for sweetpotato included fresh herbage yield (t/ha) and yield components, namely: root size, number and weight of marketable and non-marketable roots, and total root yield (t/ha^{-1}) as well as harvest index. Marketable roots are those with a length of not less than 6.5cm and a diameter of not less than 4cm with no remarkable damage due to pests.

Data Analysis

The data were analyzed using SAS version 6.02 and treatment means for significant parameters were compared using Tukey's Studentized Range (HSD) test.

Meteorological Data

Total weekly rainfall throughout the duration of the study was obtained from the nearest meteorological station of the experimental site, namely: in VSU, Visca, Baybay City, Leyte for Inopacan, Leyte and in Babatngon, Leyte for Sta. Rita, Samar Site.

RESULTS AND DISCUSSION

Meteorological Data and General Observation

Figures 1 and 2 show the total weekly rainfall during the entire duration of the experiment for each study site. During the first cropping in Inopacan Leyte, the total weekly rainfall was very low such that it greatly affected the growth and development of sweetpotato. In the second cropping however, rainfall was sufficient resulting to a better growth of the crops. The availability of water is very critical especially in the dissolution and absorption of nutrients. No matter how high the applied fertilizer is as in the first cropping, its nutrients cannot be fully utilized by the crop unless water is sufficient in the soil. Sweetpotato needs 750mm to 1250mm of water throughout its growing period and it grows well when the average day time temperature ranges from 18^0C to 40^0C. Vigorous growth of sweetpotato in the latter part of the first cropping was observed in plots applied with 15 t/ha^{-1} vermicast but it yielded low similar to control and those plots applied with either Evans or Wellgrow at 1 t/ha^{-1} supplemented with inorganic fertilizer. The over production of vegetative parts with 15 t/ha^{-1} vermicast could have also affected assimilate partitioning to the roots. This implies that timing of rainfall availability is crucial to consider for a successful sweetpotato production.

In Sta. Rita, Samar, the first cropping also experienced water stress during the first three months of growth which delayed root formation on the main stem. During the second cropping however, excessive rainfall during the early growth stage had compacted the soil which affected root bulking and formation.

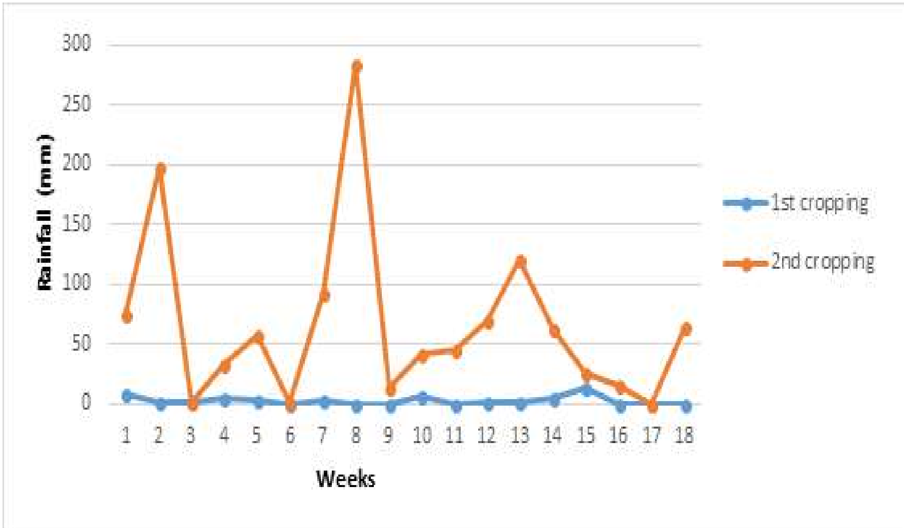

Figure 1. Total weekly rainfall in Brgy. Linao, Inopacan, Leyte grown to sweetpotato applied with various organic-based fertilizers combined with inorganic fertilizers

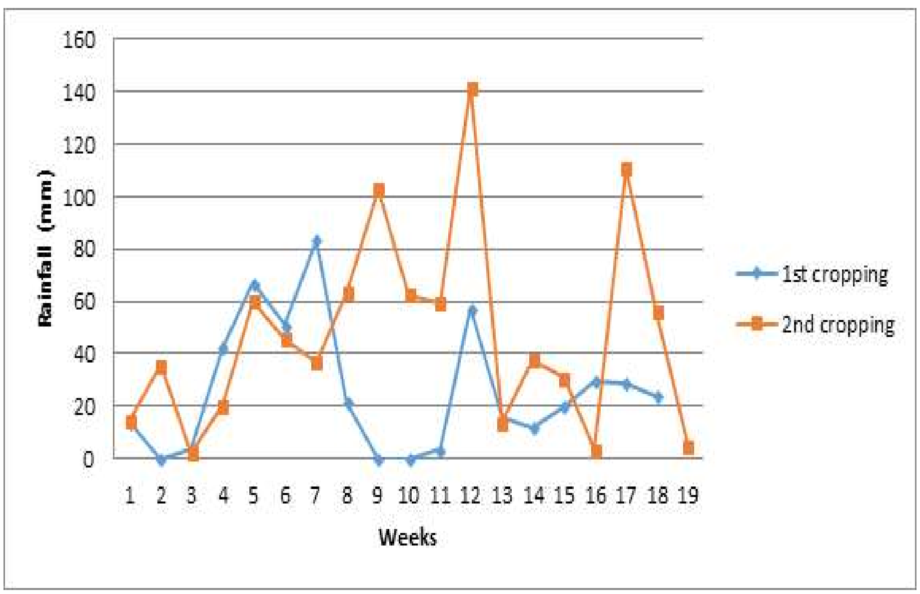

Figure 2. Total weekly rainfall in Brgy. Caticugan, Sta. Rita, Samar grown to sweetpotato applied with various organic-based fertilizers combined with inorganic fertilizers

Chemical and Physical Properties of Soil and the Applied Organic Fertilizers

Initial soil analysis showed that the experimental area in Inopacan, Leyte had a pH value of 4.8, 1.66 % organic C, 0.21% N, 0.74mg kg^{-1} available phosphorus and 81.58mg kg^{-1} exchangeable potassium (Table 1) indicating that the soil was very strongly acidic, with very low organic matter, low nitrogen, phosphorus, and potassium contents (Landon 1991). Final soil analyses revealed that there was only a very slight increase in these parameters relative to the initial values. Moreover, no significant variation was noted among treatments which means that values obtained after the first cropping were more or less the same.

Table 1. Bulk density and soil chemical properties before and after harvest of sweetpotato as affected by the application of various organic-based fertilizers in marginal upland of Inopacan, Leyte

Treatments	Bulk Density (Db)	Soil pH (1:2.5)	OM (%)	Total N (%)	Available P (mg/kg)	Exchange-able K (mg/kg)
Initial	**1.08**	**4.80**	**1.66**	**0.21**	**0.74**	**81.58**
1st cropping						
T_0	1.07	5.16	2.32	0.24	2.68	135.23
T_1	1.16	5.20	2.13	0.26	2.38	119.90
T_2	1.09	5.18	2.05	0.24	3.15	126.88
T_3	1.12	5.22	1.70	0.22	3.04	149.44
T_4	1.14	5.17	1.97	0.22	2.30	164.00
T_5	1.09	5.19	1.90	0.25	2.44	125.95
T_6	1.13	5.15	2.05	0.26	2.30	109.85
Mean	**1.11**	**5.18**	**2.02**	**0.24**	**2.61**	**133.04**
2nd cropping						
T_0	1.28	4.69	3.77	0.24	1.19	128.83
T_1	1.37	4.50	4.23	0.26	1.49	112.18
T_2	1.32	4.53	3.94	0.25	1.79	121.47
T_3	1.36	4.53	3.98	0.26	13.45	168.77
T_4	1.35	4.55	4.10	0.27	16.97	217.65
T_5	1.30	4.41	4.09	0.26	2.12	109.94
T_6	1.34	4.44	4.12	0.27	1.72	117.53
Mean	1.30	**4.52**	**4.03**	**0.26**	**5.53**	**139.48**

Legend: T_0 = 0-0-0 (control), T_1 = 1 t ha^{-1} Evans + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}, T_2 = 1 t ha^{-1} Wellgrow + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}, T_3 = 15 t ha^{-1} chicken dung alone, T_4 = 10 t ha^{-1} Chicken dung + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}, T_5 = 15 t ha^{-1} Vermicast alone, T_6 = 10 t ha^{-1} Vermicast + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}

The experimental site in Sta. Rita, Samar had a soil pH of 4.72 with low soil fertility (Table 2). Based on Landon (1991) the soil was very strongly acidic, medium in organic matter, had very low nitrogen and phosphorus, but with medium amount of exchangeable K. Results after the first and second croppings revealed a slight increase in pH, total nitrogen, and available phosphorus but a decrease in organic matter and exchangeable K contents.

Table 2. Bulk density and soil chemical properties before and after harvest of sweetpotato as affected by the application of various organic-based fertilizers in marginal upland of Sta. Rita, Samar

Treatments	Bulk Density (Db)	Soil pH (1:2.5)	OM (%)	Total N (%)	Available P (mg/kg)	Exchange-able K (mg/kg)
Initial	**1.19**	**4.72**	**7.33**	**0.14**	**2.47**	**25.50**
1st cropping						
T_0	1.65	5.27	2.886	0.158	2.393	<0.003
T_1	1.68	5.16	2.574	0.144	1.839	<0.003
T_2	1.60	5.25	3.120	0.158	3.172	15.575
T_3	1.60	5.05	2.574	0.187	5.25	14.5
T_4	1.36	5.15	2.886	0.173	13.678	29.65
T_5	1.42	5.26	2.692	0.173	2.47	<0.003
T_6	1.56	5.28	2.808	0.202	4.884	33.75
Mean	**1.55**	**5.20**	**2.790**	**0.17**	**4.81**	**23.37**
2nd cropping						
T_0	0.81	5.42	2.96	0.17	0.25	<0.003
T_1	0.82	5.37	2.50	0.17	0.73	<0.003
T_2	0.80	5.51	3.20	0.20	0.86	<0.003
T_3	0.74	5.73	2.89	0.18	14.4	<0.003
T_4	0.78	5.76	3.04	0.18	9.97	<0.003
T_5	0.87	5.60	2.93	0.19	1.93	<0.003
T_6	0.74	5.44	3.04	0.18	1.43	<0.003
Mean	**0.79**	**5.55**	**2.94**	**0.81**	**4.22**	

Legend: T_0 = 0-0-0 (control), T_1 = 1 t ha^{-1} Evans + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}, T_2 = 1 t ha^{-1} Wellgrow + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}, T_3 = 15 t ha^{-1} chicken dung alone, T_4 = 10 t ha^{-1} Chicken dung + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}, T_5 = 15 t ha^{-1} Vermicast alone, T_6 = 10 t ha^{-1} Vermicast + 30-30-30 kg N, P_2O_5, K_2O ha^{-1}

Chemical analysis of the various organic-based inputs (Table 3) revealed that Wellgrow was the most alkaline (pH 8.17) with Evans as the most acidic (pH 4.66). Vermicast and chicken manure had a near neutral pH of 6.40 and 6.98, respectively. Evans had the highest organic C (49.44%) and total N (4.26%) contents but had the lowest K (0.23%). Chicken dung had the highest P (0.46%) while vermicast had the lowest (0.25%) content. The analyses indicate that the organic materials varied in nutrient contents; thus, their capacity to supply nutrients to the growing plant. Since water availability during the first cropping was limited, this probably affected the availability of nutrients for plant uptake.

Table 3. Chemical analysis of the different organic fertilizers used in the study

Samples	pH	OC (%)	Total N (%)	Total P (%)	Total K (%)
Vermicast	6.40	29.16	2.65	0.25	0.91
Evans	4.66	49.44	4.26	0.46	0.23
Wellgrow	8.17	34.67	2.36	0.36	2.70
Chicken dung	6.98	19.61	2.80	0.49	2.41

Growth and Yield Performance of Sweetpotato in Inopacan, Leyte

Herbage yield of sweetpotato

Fresh herbage yield of sweetpotato grown in Inopacan, Leyte was significantly affected by the different organic-based treatments during the second cropping only (Figure 4). Application of chicken dung at 15t/ha^{-1} and at 10 t ha^{-1} but supplemented with 30-30-30kg N, P_2O_5, K_2O ha^{-1} produced significantly higher fresh herbage yield compared to those supplied with the organic fertilizer Evans. The former treatments produced higher herbage yield comparable to those applied with vermicast, and Wellgrow and the untreated control. The acidic nature of Evans fertilizer (Table 3) could have further increased soil acidity and subsequently affected the availability of nutrients from the added inorganic fertilizers, thus limited the foliage and vine growth of the crop.

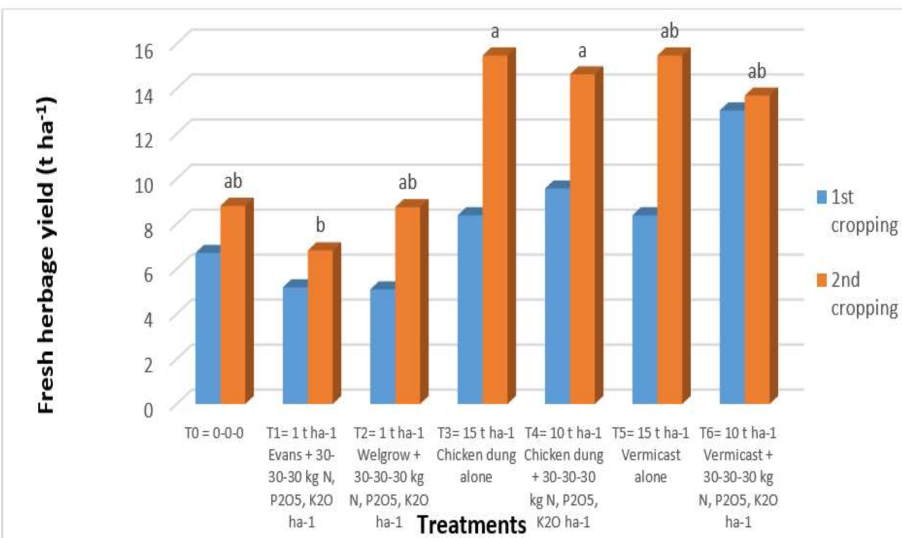

Figure 4. Fresh herbage yield (t ha^{-1}) of sweet potato during 1st and 2nd cropping as affected by the application of various organic-based fertilizers in climate change vulnerable marginal uplands of Inopacan, Leyte

Yield and yield components and harvest index of sweetpotato in Inopacan, Leyte

Results revealed that the number of marketable and non-marketable roots, root size as well as the total root yield of sweetpotato in the first cropping was generally lower than the second cropping (Figures 5, 6 and 7). This is because of the limited moisture availability during the first cropping (Figure 1). Sweetpotato applied with either chicken dung or vermicast alone or in combination with inorganic fertilizers produced significantly more and bigger marketable roots and consequently had higher total yield as compared to the rest of the treatment, but it was lower than what was produced in the second cropping. The yield obtained in the second cropping was almost three times higher than the first cropping. This could be explained by the availability of rainfall which helped in the dissolution and eventual availability of nutrients for plant uptake. Branca et al (2013) emphasized that rainfall distribution is a key determinant not only for better crop growth but also in adopting a specific sustainable land management practice: the effect of which is higher in higher rainfall areas.

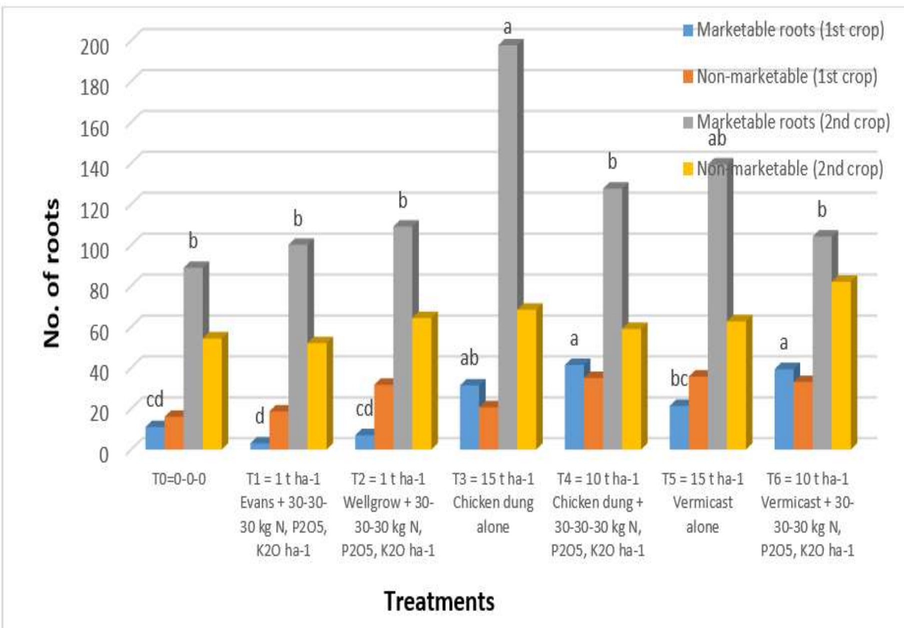

Figure 5. Number of roots plot^{-1} of sweetpotato during 1st and 2nd cropping as affected by the application of various organic-based fertilizers in climate change vulnerable marginal uplands of Inopacan, Leyte

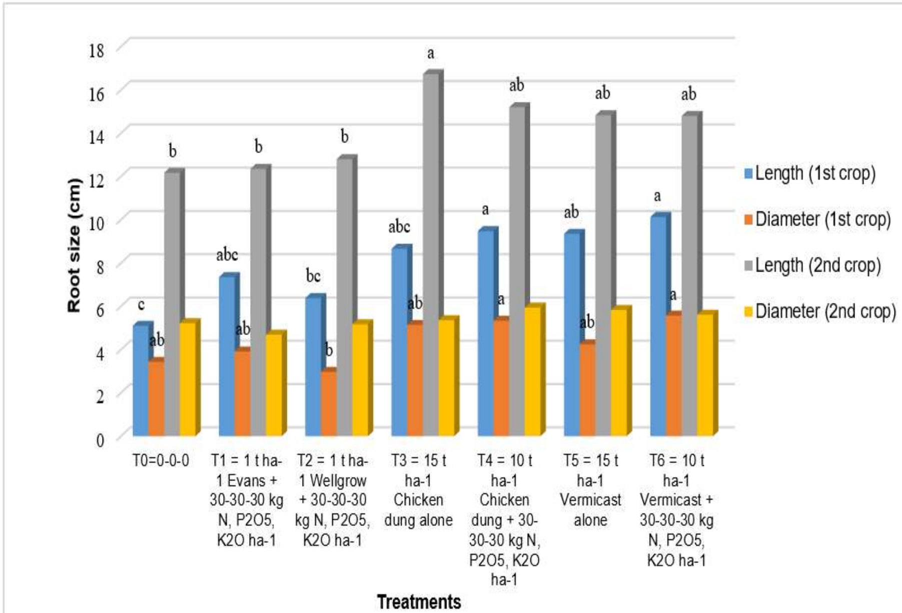

Figure 6. Root size of sweetpotato during the 1st and 2nd cropping as affected by the application of various organic-based fertilizers in climate change vulnerable marginal upland of Inopacan, Leyte

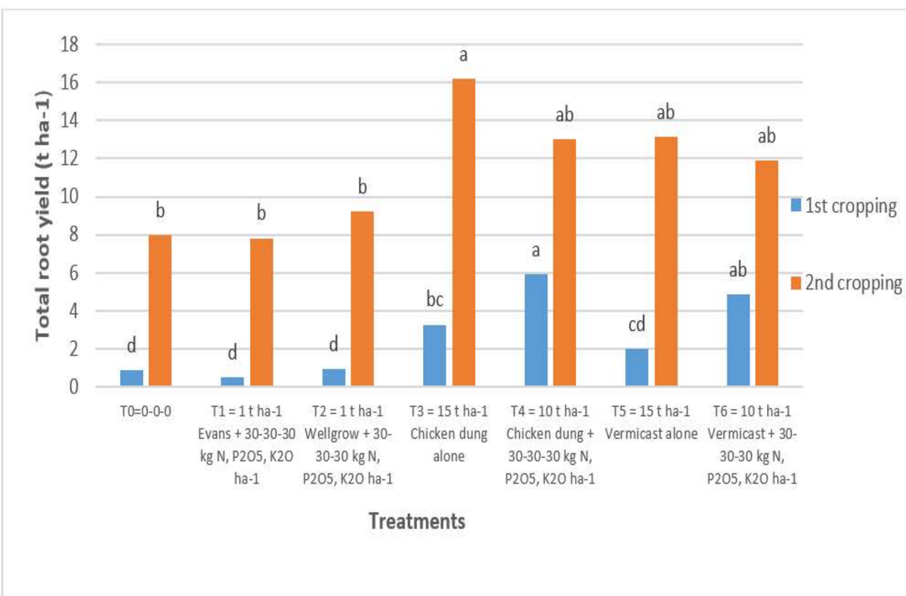

Figure 7. Total root yield of sweetpotato during the 1st and 2nd cropping as affected by the application of various organic-based fertilizers in climate change vulnerable marginal upland of Inopacan, Leyte

The higher total root yield produced in both croppings was the result of the development of more and bigger marketable roots. Total root yield of the control plants and those treated with Evans, Wellgrow, and Vermicast alone remained considerably low due to the smaller root size. Application of vermicast at 15 t/ha^{-1} during the first cropping resulted in a low yield which was comparable with the control and those treated with either Evans or Wellgrow. It was noted that there was over production of vegetative parts in the later part of growth which was partly due to the occurrence of rain. In the 2nd cropping, adjustment was made by reducing the amount of vermicast to 5 t/ha^{-1} only. This finding indicates that overproduction of vegetative parts in sweetpotato should also be avoided in order not to affect the partitioning of photosynthates to roots.

During the second cropping, the number and weight of marketable roots as well as root length were significantly increased which led to a markedly heavier total root yield. This cropping also showed improvements in yield relative to the 1st cropping especially for treatments with either chicken dung or vermicast with or without inorganic supplements. Application of chicken dung alone at 15 t ha^{-1} produced the highest yield of 16.19 t ha^{-1} as compared to those plants that received Evans and Wellgrow combined with inorganic fertilizer and the control (7.82- 9.20 t ha^{-1}). This superior response was nonetheless comparable with those applied with lower rates of vermicast and chicken dung but combined with inorganic fertilizer. The residual effects of the previous application could have also contributed to the increase in yield despite the reduction in the amount of vermicast applied to 5 t ha^{-1}. The results further indicate that among the organic nutrient fertilizers used, chicken dung and vermicast with or without inorganic supplements were best for the production of higher total root yield. These particular treatments have also been found promising for corn production under the marginal uplands of Inopacan, Leyte (Ratilla et al 2014 and Lina et al 2014).

Harvest index (Figure 8) was also significantly affected by the treatments employed during the second cropping. Higher harvest indices were noted on treated plots. This implies the necessity of supplying the needed nutrients to sweetpotato especially in marginal uplands for more efficient conversion of the products of photosynthesis into roots. Application of chicken dung or vermicast alone at 15 t ha^{-1} and applied at 10 t ha^{-1} but combined with 30-30-30 kg N P_2O_5, K_2O ha^{-1} from inorganic fertilizer resulted in higher economic yield relative to its biological yield as compared to the untreated control.

Growth and Yield Performance of Sweetpotato in Sta. Rita, Samar

Herbage yield of sweetpotato

Application of different organic fertilizers in both croppings did not significantly affect herbage yield of sweetpotato at the Sta. Rita site (Figure 9). This means that herbage production was more or less the same irrespective of the different organic nutrient sources used. However, application of 15 t ha^{-1} chicken dung alone (T_3) with 10 t ha^{-1} + 30-30-30 kg N, P_2O_5, K_2O ha^{-1} consistently showed slightly higher values than the rest of the treatments.

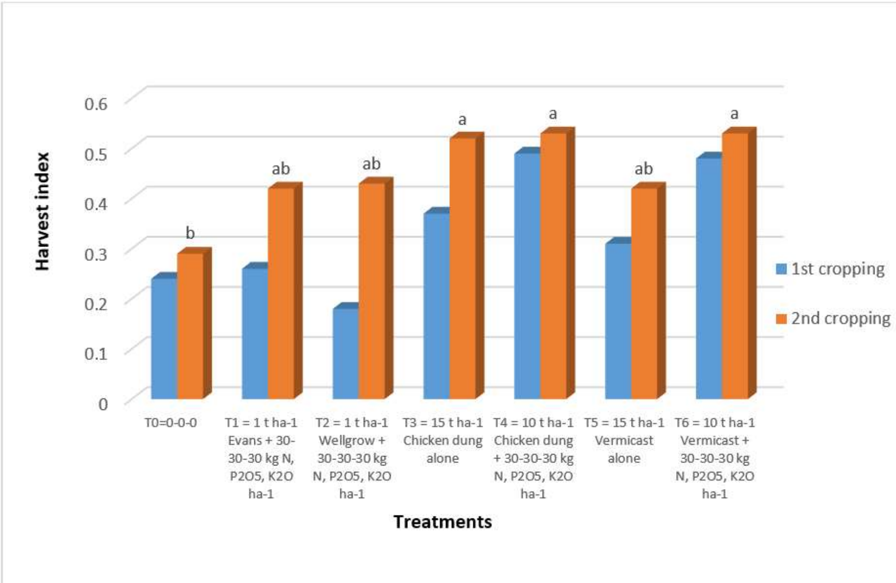

Figure 8. Harvest indices of sweetpotato during the 1st and 2nd cropping as affected by the application of various organic-based fertilizers in climate change vulnerable marginal upland of Inopacan, Leyte

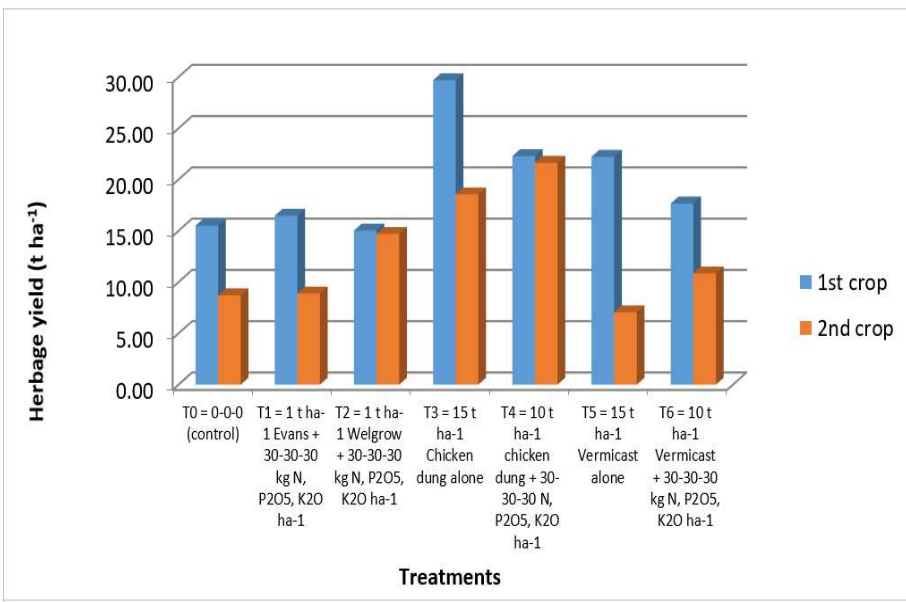

Figure 9. Herbage yield of sweetpotato during the 1st and 2nd cropping as affected by the application of various organic-based fertilizers in climate change vulnerable marginal upland of Sta. Rita, Samar

Yield and Yield Components and Harvest Index of Sweetpotato in Sta. Rita, Samar

Results of the experiment in Sta. Rita, Samar showed that only root length during the first cropping was significantly affected by the treatments (Figure 10). The rest of the yield and yield components (Figure 11-13) were not significantly affected in both croppings. Application of 15 t ha^{-1} chicken dung alone produced slightly longer roots than the untreated control, but it was comparable to those applied with the different treatments. Total root yield was not significantly affected by the treatments, but slightly higher root formation was noted with application of 15 t ha^{-1} chicken dung alone. In the 2^{nd} cropping no significant variation was observed among treatments. The variability of rainfall distribution in the site greatly affected the crops' growth and yield performance.

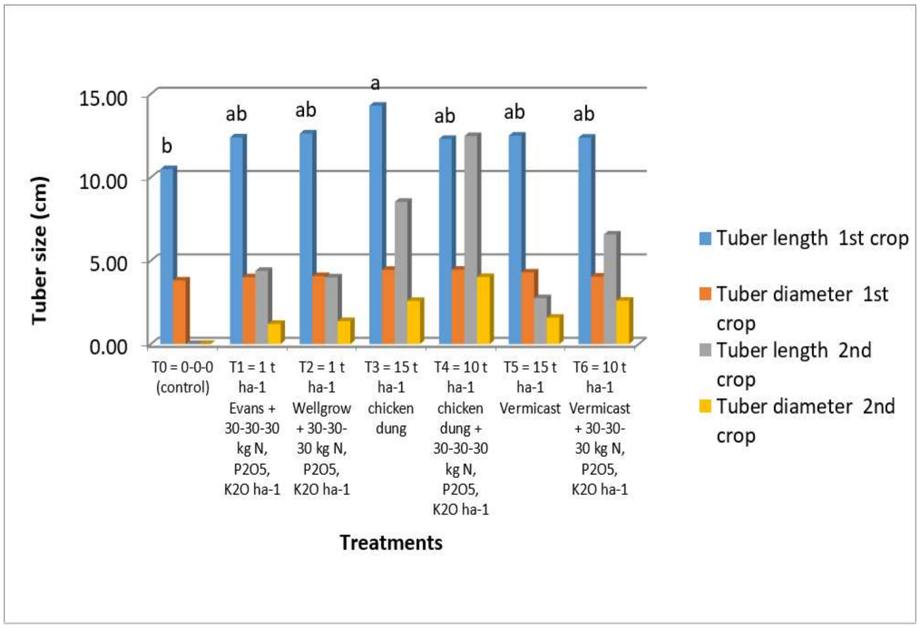

Figure 10. Tuber size of sweetpotato during the 1^{st} and 2^{nd} cropping as affected by the application of various organic-based fertilizers in climate change vulnerable marginal upland of Sta. Rita, Samar

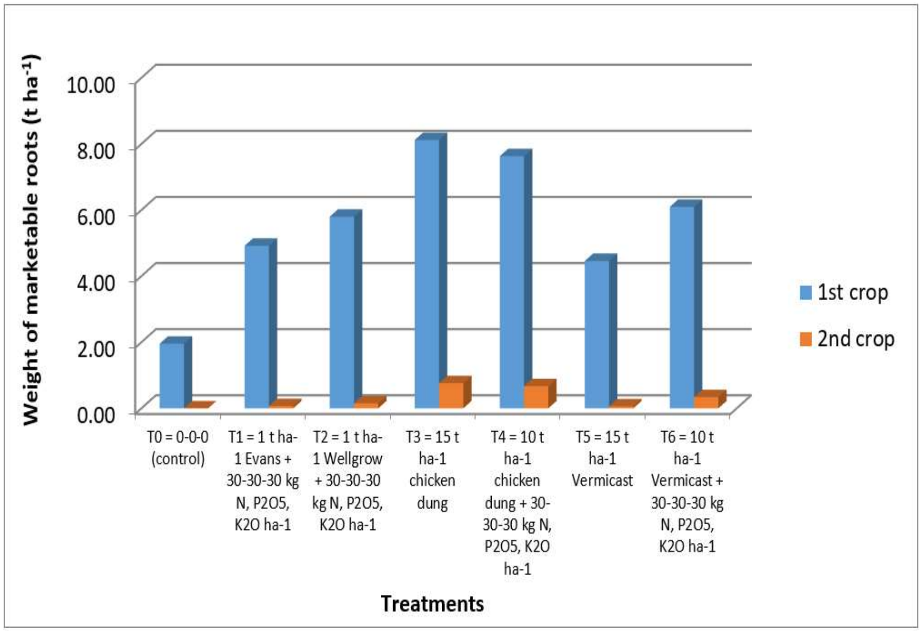

Figure 11. Weight of marketable roots of sweetpotato during the 1st and 2nd cropping as affected by the application of various organic-based fertilizers in climate change vulnerable marginal upland of Sta. Rita, Samar

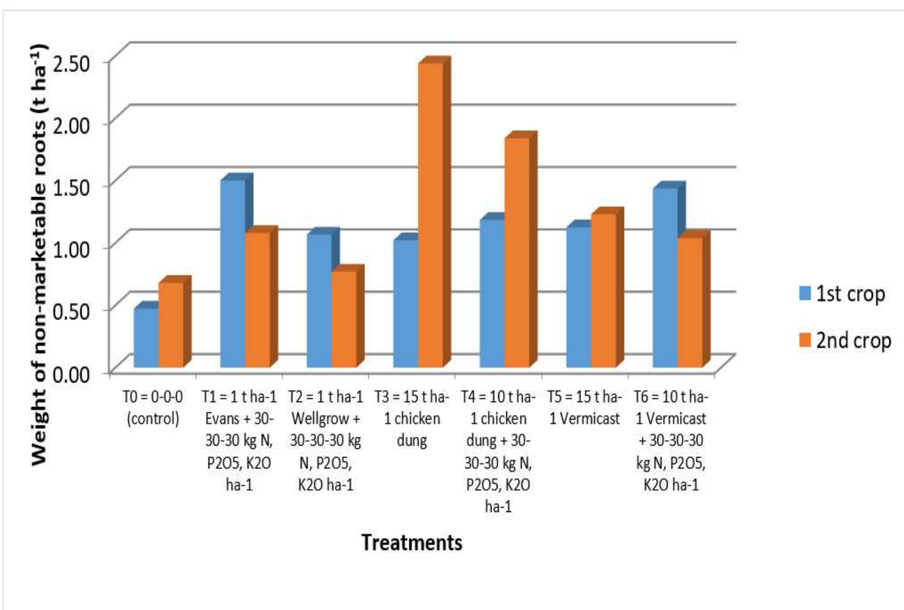

Figure 12. Weight of non-marketable roots of sweetpotato during the 1st and 2nd cropping as affected by the application of various organic-based fertilizers in climate change vulnerable marginal upland of Sta. Rita, Samar

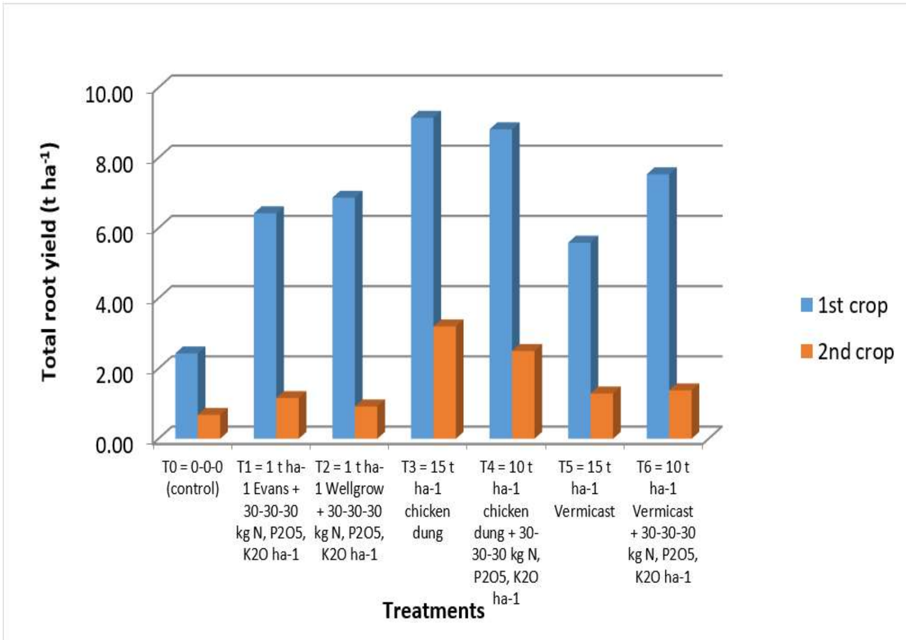

Figure 13. Total root yield of sweetpotato during the 1st and 2nd cropping as affected by the application of various organic-based fertilizers in climate change vulnerable marginal upland of Sta. Rita, Samar

During the first cropping, rainfall was so low and it was only after its second month of growth that rain occurred. This probably decreased the development and root bulking activity of the crop. In fact, harvesting was delayed for a month because of lack of prominent fleshy root formation on the main stem. Most of harvested roots came from the lateral stems. In the second cropping, however, the high rainfall during the early growth stage of sweetpotato negatively affected the root bulking. Fleshy roots produced during the second cropping were more of non-marketable quality. Likewise, it also promoted vegetation over root formation on the later part of development. Hence, for better sweet potato production, proper timing of planting amidst this changing climate is necessary because no matter how much inputs are employed, if rainfall is low or excessive, then it negatively influences sweetpotato root production. Muller et al (2011) stated that under situations of water deficit, source to sink relationship weakens or is modified, thus putting tuberous root formation in the case of sweetpotato at a disadvantage. This finding also confirms that marginal uplands are vulnerable to changing climate aside from having scarcity in some other resources.

CONCLUSIONS

Based on the results of the study, the following conclusions can be drawn:

1. The application of either chicken dung or vermicast with or with inorganic supplement at 30-30-30 kg N, P_2O_5, K_2O ha^{-1} in Inopacan, Leyte significantly increased herbage yield and total root yield as a result of bigger root size, and numerous marketable roots. A comparable response in most parameters was observed in Sta. Rita, Samar.

2. Application of 15 t ha^{-1} chicken dung or 10 t ha^{-1} of either chicken dung or vermicast + 30-30-30 kg N, P_2O_5, K_2O ha^{-1} appeared as promising options in both marginal uplands.

3. No remarkable change in soil physical and chemical properties was noticed after the second cropping of sweetpotato in both locations as compared to the initial determination.

RECOMMENDATIONS

1. Though yield levels increased with slight improvement in soil properties, studies on organic fertilization need to be extended for several croppings for long term assessment.

2. Despite the availability and affordable cost of organic inputs in the locality, cost and return analysis after at least four croppings need to be considered to determine its profitability.

3. Promising treatments need to be tried in areas of even rainfall distribution to really evaluate their efficacy on sweetpotato.

ACKNOWLEDGEMENT

The authors wish to thank the Commission on Higher Education-Philippine Higher Education Research Network (CHED PHERNet) for the financial support of this research.

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