



Growth And Yield Performance Of Yam (*Dioscorea Alata* L.) As Influenced By Fertilization Schemes And Types Of Planting Material

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Article History	Abstract
Received: 26/03/2023 Revised: 12/07/2023 Accepted: 29/07/2023	The study aimed to determine the best fertilization rate and type of planting material for high yield performance of yam grown at Central Mindanao University, Musuan, Bukidnon, from March to December 2020. The fertilization schemes as Factor A and the three types of planting materials as Factor B were laid in a 3x3 factorial arrangement in Randomized Complete Block Design (RCBD). Results revealed that yam plants fertilized with Vermicast (5 T/ha) significantly exhibited the highest percentage survival, which differed from the rest of the fertilizer treatments. Likewise, yam plants fertilized with 5 T/ha vermicast significantly developed the longest vine from 6–12 weeks after planting. Vine cuttings as planting materials significantly exhibited the highest number of tubers per hill, the highest marketable yield of 18.40 T/ha, and a total tuber yield of 30.53 T/ha. Yam vine cuttings applied with the recommended rate of inorganic fertilizer (20–15–45 kg/ha NPK) + 2.5 T/ha Vermicast gave the highest yield of 21,400 kg/ha and a net income of ₱545,403 with an ROI of 267.88%.
CC License CC-BY-NC-SA 4.0	Keywords: Tubers, Setts, Yam, Pre-sprouted, Vine cuttings

INTRODUCTION

Yam (*Dioscorea alata* L.) belongs to the monocotyledonous family Dioscoreaceae. Although there are about 600 species of the genus *Dioscorea*, the most important edible species are *D. rotundata* and *D. alata*. They are the most preferred and cultivated yam species, accounting for a large proportion of yam production in West Africa, a region that yields 93% of the world's yam production (Agri Pinoy, 2012; Aighewi, et al., 2020).

In the Philippines, among the popular varieties of *D. alata* are Florido, Kabus-ok, Kinabayo, Kinampay, Basco, Zamabales, and Leyte. These varieties have potential yields ranging from 10 to 56 metric tons per hectare (Niether, et al., 2020). Yam, or purple yam, is an important crop due to its many uses. It is a good source of food ingredients for processed foods like ice cream, jam, yogurt, hopia, 'piyaya', cakes, pastries, and bread. It contains carbohydrates, proteins, fats, fibers, vitamins, and minerals. According to Scott et al. (2000), yams have the most complete nutrients compared to other food crops.

Yam is also very rich in antioxidants like anthocyanin (Larief et al., 2018). Due to its high anthocyanin content, it has been processed as heart tablets and wine and discovered as a potential novel medicine for hypertension and other immune-related diseases like diabetes (Scott et al., 2000). Moreover, yam production is a source of

income for many farmers. It also provides employment and foreign exchange, which contribute to the economic development of our country.

Yam grows well up to 800 meters above sea level, even in the lowlands. It reacts to an organic matter-rich soil. It adjusts well to the Philippines' diverse agroclimatic conditions. Although yam has a lot of potential and is in high demand, it is still one of the most underutilized crops in the Philippines and produces less than other nations (Darkwa, et al., 2020).

Bukidnon has a lot of potential for producing yams because of its Type IV environment, which includes year-round sunshine and uniform rainfall. About 2.5 tons per hectare are produced, which is still quite little. The high cost of high-quality yam planting materials and a lack of understanding of appropriate cultural and management techniques are two of the main obstacles to yam cultivation in Bukidnon. Typically, tubers from the previous cropping are saved and multiplied so they can be utilized in the following planting season (Okorley & Addai, 2010). Actually, in Lantapan, Bukidnon, the majority of farmers save between thirty and thirty-three percent of their produced tubers for use in the following planting season.

In the Philippines and other yam-producing nations, the similar issue persists. According to reports, the price of yam planting materials might account for up to 52% of the entire cost of production (Iornongo, 2021; Aighewi et al., 2015). Tubers might, however, be sold and provide an extra revenue stream.

It has been observed that the application of inadequate fertilization plans in traditional yam cultivation causes the soil's nutrients to be mined out and depleted during each growing cycle, either completely or only partially restored, leading to low tuber output. This might be improved by using both organic and inorganic fertilizers, which is why this study was carried out (Hammad, et al., 2020).

Objectives

The study's main goal was to assess how fertilization and different types of planting material affected the growth and yield performance of yam. Specifically, the study aimed to:

1. determine the appropriate fertilization for yam tuber production;
2. identify the best planting material for yam tuber production;
3. evaluate the best combination of fertilization and type of planting material that will give the highest tuber yield in yam production; and
4. Determine the level of profitability in yam production as it relates to fertilization and different planting materials.

MATERIALS AND METHODS

Time and Place of Study

The field study was carried out from June to December 2020 at Central Mindanao University's Agricultural Experiment Center (AEC) in Musuan, Bukidnon.

Description of the Experimental Site

The experimental site was approximately 800 meters away from the College of Agriculture. The terrain is flat with an Adtuyon clay soil type. The area had been fallowed for a year prior to the experiment and was dominated mostly by grasses.

Soil Sampling and Soil Analysis

Soil samples were taken from the experimental area before the first plowing. Twenty soil samples taken from the area at a depth of 10 cm were air-dried and mixed. A kilogram of composite samples was submitted to the Soil and Plant Analysis Laboratory (SPAL) of the College of Agriculture, Central Mindanao University. This was analyzed to determine the organic matter (OM) content, soil pH, total nitrogen, extractable phosphorus, and exchangeable potassium, and to obtain the recommended rate of inorganic fertilizer for yam production (Appendix Fig. 6). For this experiment, the recommended rates were 30, 40, and 90 kg/ha of N, P₂O₅, and K₂O, respectively.

Experimental Design and Treatments

The study was carried out in a 3 x 3 factorial experiment in a randomized complete block design (RCBD). The three rates of fertilizer application served as Factor A, while the three types of planting materials were Factor B. The treatments were replicated four times, with forty samples per replication. The experimental plot had a

length of 5.0 meters and a width of 4.0 meters, while alleys between plots and replications were set at 2.0 meters.

The treatments were as follows:

Factor A – Fertilization Rates

A₁ – Vermicast (5 T/ha)

A₂ – Recommended Rate of Inorganic Fertilizer (RRIF) (40 - 30 - 90 kg/ha NPK)

A₃ – ½ RRIF (20-15-45 kg/ha NPK) + 2.5 T/ha Vermicast

Factor B – Types of Planting Material

B₁ – Vine Cuttings (VC)

B₂ – Pre-sprouted Setts (PS)

B₃ – Unsprouted Setts (US)

The details of these treatments are shown on Table 1.

Table 1. Treatments and treatment combinations

TREATMENTS		TREATMENT COMBINATION	TREATMENT CODE
FERTILIZATION RATES	TYPES OF PLANTING MATERIAL		
A ₁ - Vermicast (5 T/ha)	B ₁ - Vine Cuttings	A ₁ B ₁	T ₁
	B ₂ - Pre-sprouted Setts	A ₁ B ₂	T ₂
	B ₃ - Unsprouted Setts	A ₁ B ₃	T ₃
A ₂ - RRIF (40-30-90 kg/ha NPK)	B ₁ - Vine Cuttings	A ₂ B ₁	T ₄
	B ₂ - Pre-sprouted Setts	A ₂ B ₂	T ₅
	B ₃ - Unsprouted Setts	A ₂ B ₃	T ₆
A ₃ - ½ RRIF (20-15- 45 kg/ha NPK) + 2.5 tons/ha Vermicast	B ₁ - Vine Cuttings	A ₃ B ₁	T ₇
	B ₂ - Pre-sprouted Setts	A ₃ B ₂	T ₈
	B ₃ - Unsprouted Setts	A ₃ B ₃	T ₉

Cultural and Management Practices

Land Preparation

A total area of 1,600 sq. m. at the Agricultural Experiment Center (AEC) was prepared for yam production. The land was plowed twice and harrowed twice at a one-week interval until a well-pulverized soil was achieved before planting.

Field Planting

1. Vine Cuttings

Forty pre-sprouted vine cuttings were removed from plastic cups and planted on the ridge at a distance of 50 cm between hills in the row and 100 cm between rows at 15 cm depth.

2. Pre-sprouted tube segments

Pre-sprouted setts from yam tubers were planted on ridges at 15 cm depth and spaced at 50 cm between hills in the row and 100 cm between rows.

3. Unsprouted Tuber Setts

The cured but unsprouted setts taken from yam tubers were planted in the field simultaneously with the rest of the treatments at 50 cm between hills in the row and 100 cm between rows at 15 cm depth. The planting materials were then covered with soil. There were four (4) rows per plot and ten (10) hills per row. Each plot represents one treatment that was replicated four times.

Fertilizer Rate and Applications

1. Vermicast

Vermicast was applied at a rate of 5 T/ha based on the nutrient analysis and recommendation from the Soil and Plant Analysis Laboratory (SPAL). Based on the recommendation, vermicast at 250 grams per hill was

thoroughly incorporated into the soil using a trowel. All vermicast was applied as a basal application during planting.

2. Inorganic Fertilizer

The recommended rate of inorganic fertilizer of 40–30–90 kg/ha NPK from the Soil and Plant Analysis Laboratory (SPAL) was used in this study. Inorganic fertilizer was applied twice: one half as basal at planting and the other half two months after planting as side dressing in time for hilling up at 20 g/hill.

3. Combination of Vermiculite and Inorganic Fertilizers

Half of the recommended amount of vermicast (2.5 T/ha) and half of the recommended rate (20–15–45 kg/ha NPK) of inorganic fertilizer were applied as basal at planting. The other half of inorganic fertilizer was applied after two months from the first application as side dressing, followed by manual hilling up.

Establishment of Trellis

Trellis made of bamboo posts and nylon strings were established when the yam vines started to climb. This was done two months after planting. Two (2)-meter-long bamboo posts were established along the row of yam plants at two meters apart. These bamboo posts were connected to each other by three strands of black nylon twine tied to each bamboo stick post. Then a white twine was used to connect the three black nylon twines where the vines climb. The trellis served as support for the yam plants until maturity.

Cultivation and Weeding

Hilling up was done two months after planting, when the yam vines started to climb. This was done using a carabao-drawn plow and a shovel. Furrow slices were turned toward the base of the plants. Manual hilling-up using a shovel was done when needed to cover the base of the plants and prevent exposure of developing tubers to sunlight. Weeds growing within the beds were removed manually because yam is very susceptible to weed competition.

Water Management

The main source of water was rainfall, but during dry months and at tuber formation, yam plants were watered using a sprinkler. The watering of plants was done as often as necessary.

Pest and Disease Management

Experimental plants were treated with Karate (a.i., Lambda cyhalothrin) insecticide at a rate of 5 tbsp. per 16 liters of water once a month. Kocide (a.i., copper hydroxide) fungicide at 4-5 tbsp/16 liters of water was applied every two weeks from three weeks after planting up to one week before harvesting. Three weeks after planting, the incidence of anthracnose disease (*Colletotrichum gloeosporioides*) was observed and progressively became severe.

Kocide fungicide was applied weekly to all experimental plants to control the disease-infected plant samples. Infected leaf samples were brought to the Plant Disease Clinic of the Plant Pathology Department for diagnosis and recommendation for control and management. Following the farmers practice in Lantapan, Bukidnon, of controlling anthracnose, the area was regularly sprayed with fungicide, but the anthracnose persisted. Plants from tuber sett materials were greatly affected. Hence, the study was terminated six (6) months after planting due to the severity of the disease.

Harvesting and Postharvest Handling

Ideally, yam is harvested when 100% of the leaves turn yellow, indicating its physiological maturity. Since the experimental plants in this study were heavily infected with anthracnose regardless of treatments, harvesting was done six (6) months after planting.

Harvesting was done carefully by removing the tubers using a pointed steel stick and a spading fork to loosen the soil and avoid damage to the tubers. Harvested tubers were cleaned manually by removing the dirt attached to them. The soil was not dry at harvest; hence, tubers were first air-dried in a cool, shady area inside the AEC building to easily remove the adhering soil (Kasan, et al., 2023).

After cleaning, the tubers were sorted and classified into marketable and non-marketable tubers. Marketable tubers were characterized as those with at least 500 grams of tuber weight, without damage from implements during harvest or from pests and diseases. Non-marketable tubers refer to tubers with less than 500 grams of weight that have incurred damage from implements, pests, and diseases (Lantapan Yam Farmers, 2020). This term, non-marketable tubers, was adopted from the Lantapan Bukidnon Farmer's practice. These non-marketable tubers were still sold at a given price since many farmers utilized them as sources of planting materials for the next season or for kitchen and restaurant uses.

Data Gathered

A. Agronomic Characters

1. Vine Length (cm)

This was measured from the base up to the tip of the longest vine of the yam plant. Data on vine cuttings was taken at 30, 45, 60, 75, and 90 days after planting.

2. Percent Survival of Yam Plants

This was done by counting the number of plants that survived at 30, 60, 120, and 183 days after planting, as computed below:

$$\% \text{ Survival} = \frac{\text{Number of Plants Survived}}{\text{Total Number of Plants planted}} \times 100$$

3. Days to Harvest Maturity

The maturity of different planting materials was not accurately determined because of anthracnose infection and other environmental factors like frequent rainfall. Ideally, the expected maturity of yam is seven to nine months; however, yam plants in this experiment were harvested at six months from planting because of anthracnose infection.

B. Yield and Yield Components

1. Number of tubers per hill

This was taken at harvest by counting the number of tubers per hill, replication, or treatment from 10 sample plants.

2. Weight of Marketable Tubers

This was obtained by weighing all the tubers with at least 500 grams of weight and without damage from ten sample plants per replication.

3. Weight of Non-Marketable Tubers

This parameter was obtained at harvest by weighing all the tubers that were less than 500 grams and incurred damages from pests and diseases and the impact of harvesting. The total weight of non-marketable tubers per treatment was taken and expressed in tons per hectare.

4. Tuber Yield

This was taken at harvest by weighing the tubers of all yam plants per plot. This was computed on a per-hectare basis using the formula:

$$\text{Tuber Yield (kg/ha)} = \text{Tuber yield/hill} \times \text{Population Density (PD) in 1 ha}$$

$$\text{Tuber Yield (T/ha)} = \frac{\text{Plot Yield (kg)}}{\text{EHA m}^2} \times \frac{10,000 \text{ m}^2}{\text{ha}} \times \frac{1 \text{ ton}}{1,000 \text{ kg}}$$

Where:

PD = Area (1 ha) divided by distance of planting (0.5 m x 1 m)

EHA (Effective harvest area) = 20 sq.m. – plot size 1 ton = 1,000 kg

5. Percent Marketable Tubers

This was computed by weighing all the marketable tubers per treatment and dividing by the total harvested tubers per treatment multiplied by 100, as shown below:

$$\% \text{ Marketable Yield} = \frac{\text{Marketable Tuber Yield}}{\text{Total Yield}} \times 100$$

6. Percent Non-Marketable Tubers

This was computed by weighing the non-marketable tubers per treatment and dividing by the total harvested tubers per treatment multiplied by 100, as shown below:

$$\% \text{ Non-Marketable Tuber} = \frac{\text{Non-Marketable Tuber Yield}}{\text{Tuber Yield}} \times 100$$

7. Return on Investment (ROI)

This was computed by dividing the net income by the production cost, as indicated in the formula below:

$$\text{ROI} = \frac{\text{Net Income}}{\text{Production Cost}}$$

Where:

Net Income = Gross income – Production Cost

Production cost = Total expenses/ha/treatment

C. Data on Insect Pests, Diseases and Weeds

Yam plants in the field were monitored for insect pests, diseases and weeds throughout the duration of the experiment. The diseased plants and plant parts were brought to the College of Agriculture Plant Disease Clinic for identification and recommendation of control.

1. Percent Anthracnose Infection

Anthracnose, caused by *Colletotrichum gloeosporioides* is one of the major constraints of yam production. Anthracnose occurrence was monitored from planting until maturity. Percent disease infection rating was based on the % of leaf and plant surface infected and was assessed at 60,120 and 183 DAP using the rating scale in table 2 below.

% INFECTION	NUMERICAL VALUE	DESCRIPTION
0-5%	1	Slight
<5-10%	2	Slightly Moderate
<10-25%	3	Moderate
<25-50%	4	Slightly Severe
<50%	5	Severe

Table 2. Percent anthracnose infection rating scale

Source: Nwadike *et al.* (2017)

3. Weeds associated with Yam

Weed identification and weed count were done one month after transplanting. The weed population was determined by counting the number of weeds present in a (0.5m x 0.5m) quadrat. The same procedure for data collection from each plot was followed before the first weeding. Dominant weed species were identified, and photographs of these weeds were taken.

Agro-Meteorological Data

Weather data such as amount of rainfall, temperature and relative humidity were obtained from the CMU–AEC SARAI Project Automated Weather Station (AWS) in Table 3.

Statistical Analysis

The data gathered were analyzed using the Analysis of Variance (ANOVA) for Factorial in Randomized Complete Block Design (RCBD). Differences between treatment means were compared using the Tukey's Honestly Significant Difference (HSD) Test.

RESULTS AND DISCUSSIONS

Results on the growth and yield performance of Yam (*Dioscorea alata* L.) as influenced by fertilization and types of planting material are presented and discussed below.

Percent Survival

Table 3 presents the percentage of yam survival at 1, 2, 4 and 6 months after planting (MAP) in response to fertilization schemes and types of planting material. Analysis of variance at different time intervals, revealed that the fertilization, types of planting material and their interaction were highly influenced the survival of yam plants.

Table 3. Percent survival of yam plants at 1, 2, 4 and 6 months after planting (MAP) as influenced by fertilization and types of planting material

TREATMENTS	% SURVIVAL			
	1 MAP	2 MAP	4 MAP	6 MAP
Fertilization Rates				
Vermicast (5 T/ha)	80.62 ^a	62.50 ^a	57.08 ^a	45.62 ^a
RRIF (40-30-90 kg/ha NPK)	53.54 ^b	37.91 ^b	31.66 ^b	22.91 ^b
1/2 RRIF (20-15-45 kg/ha NPK) + 2.5 T/ha Vermicast	43.95 ^b	33.12 ^b	26.87 ^b	20.62 ^b
F-test (A)	**	**	**	**
Types of Planting Material				
Vine Cuttings	57.50 ^b	34.37 ^b	29.78 ^b	22.91 ^b
Pre-sprouted Setts	76.45 ^a	56.87 ^a	47.70 ^a	34.58 ^a
Unsprouted Setts	44.16 ^b	42.29 ^b	38.12 ^b	31.66 ^b
F-test (B)	**	**	**	**
F-test (AB)	**	**	**	**
% CV	11.33	14.04	22.48	23.69

Means within a column followed by a common letter are not significantly different at 5% level based on HSD Test.

** -- highly significant

At the 1st month after planting, results showed that application of vermicast gave the highest percentage of survival (80.62%), followed by those fertilized with RR inorganic nutrients with 53.54%, and the least was 43.97% survival of plants applied with ½ RR inorganic + 2.5 tons of vermicast. Differences in percentage survival among fertilizer treatments were highly significant.

The survival percentage of yam plants in the field was highly affected by the planting materials. At 1 MAP, the pre-sprouted setts significantly exhibited the highest survival of 76.45%, followed by the vine cuttings with 57.50%, and the least was 44.16% from unsprouted planting materials, respectively. Differences in the percentage survival of yam planting materials were highly significant.

The interaction effects of both factors at 1 MAP, as shown in Table 3, revealed that application of vermicast (5 T/ha) on yam from pre-sprouted setts had the highest percent survival (88.12%), comparable to those in the unsprouted setts with the means of 86.25% and 76.87%, respectively. All the other treatment combinations had significantly lower survival rates.

These results indicate that the use of pre-sprouted setts of yam as planting material and fertilization with vermicast had the highest survival rate (88.12%). This may be attributed to the fact that pre-sprouted setts had developed some shoots and roots earlier and whose roots were prepared to absorb nutrients supplied by vermicast. According to Sherman (2018), vermiculite has higher nutrient levels, improves aeration, porosity, and water retention, resulting in the highest percentage of survival. Generally, pre-sprouted setts, regardless of the kind of fertilizer, have high survival rates due to their earlier development of roots and shoots.

At 2, 4, and 6 MAP, the percentage survival of yam plants, regardless of the planting materials used, followed the trend. The highest percentage survival was exhibited by those applied with vermicast, followed by those fertilized with the recommended rate of inorganic nutrients, and the lowest was from treatments given with ½ RR inorganic fertilizers combined with 2.5 tons of vermicast.

The percent survival among planting materials at 2, 4, and 6 MAP followed a similar trend. Plants grown from pre-sprouted setts significantly exhibited the highest survival rates of 56.88%, 47.70%, and 34.58%, respectively. Those grown from unsprouted setts ranked second with 42.29%, 38.12%, and 31.66% survival, respectively. Those grown from vine cuttings ranked third and had the least survival at 34.37%, 29.78%, and 22.91%, respectively.

Significant differences in the percent survival of yam plants at each time interval of data collection were found among planting materials. The results indicate that the use of pre-sprouted setts gave the highest survival, followed by unsprouted setts, and vine cutting had the least.

The interaction of both factors at 2 MAP revealed that the use of unsprouted setts fertilized with vermicast significantly gave the highest survival of 83.75% (Table 3); all the rest of the treatment combinations had significantly lower percent survivals. Along with pre-sprouted setts fertilized with vermicast (67.50%), pre-sprouted setts fertilized with RR inorganic fertilizer (57.50%) and pre-sprouted setts applied with + ½ RR inorganic nutrients + vermicast 2.5 T/ha (48.13%) survival, respectively. This may be due to their early emergence, shoot development, and roots that were established before field planting.

The pre-sprouted setts fertilized with 5 tons vermicast, pre-sprouted setts fertilized with RR inorganic fertilizer, pre-sprouted setts applied with ½ RR inorganic nutrients + 2.5 tons vermicast, vine cuttings applied with RR inorganic fertilizers, vine cuttings fertilized with 5 tons vermicast, vine cuttings ½ RR inorganic nutrients + 2.5 tons vermicast, unsprouted setts applied with ½ RR inorganic nutrients + 2.5 tons vermicast, and unsprouted setts applied with RR inorganic fertilizers were comparable based on the statistical results with the means of 67.50%, 57.50%, 48.12%, 38.75%, 36.25%, 28.12%, 23.12%, and 20%, respectively. Unsprouted setts applied with vermicast gave the highest survival of 83.75%, but survival was very few when applied with RR inorganic fertilizers (20.00%) and even with a 2.5 T/ha vermicast + ½ RR inorganic fertilizer mixture (23.13%). This may be due to the wound in unsprouted setts absorbing inorganic fertilizer as salt, which caused the collapse or plasmolysis of cells and tissues. According to Neil and Brady (2017), fertilizers like urea contain salt and may cause plasmolysis and the burning of cells. On the other hand, the application of vermicast to unsprouted setts, which led to the highest survival, may have resulted from the nutrients and beneficial microbial population that enhanced the survival of unsprouted setts (Aighehi *et al.*, 2015).

It was also observed that as the plants grew and developed towards maturity, their percentage survival markedly decreased for all fertilizer treatments. It was noted, however, that the percentage survival of plants in response to planting materials had markedly declined towards the maturity of the crops. The interaction effects of fertilization rates and types of planting materials at 4 and 6 MAP followed the same trend.

Vine Length (cm)

Table 4 shows the average vine length of yam plants at 4, 6, 8, 10, and 12 weeks after planting (WAP). It was found that the vine length of yam at 6, 8, 10, and 12 WAP was highly affected by the fertilizer treatments, types of planting materials, and the interaction of both factors employed.

At 4 WAP, the vine length of yam was not affected by the fertilization rates or interaction of both factors but was highly influenced by the types of planting materials. Both vermicast and the recommended rate of inorganic fertilizers induced the development of similar vine lengths of about 29%.

Table 4. Vine length (cm) of yam as influenced by fertilization and types of planting material at different time intervals

TREATMENTS	VINE LENGTH (CM)				
	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
Fertilization Rates					
Vermicast (5 T/ha)	28.79	102.99 ^a	166.33 ^a	211.05 ^a	264.24 ^a
RRIF (40-30-90 kg/ha NPK)	28.89	79.34 ^a	115.08 ^a	155.08 ^b	200.34 ^a
1/2 RRIF (20-15-45 kg/ha NPK) + 2.5 T/ha Vermicast	22.38	56.55 ^b	80.02 ^b	124.04 ^b	171.99 ^b
F-test (A)	ns	**	**	**	**
Types of Planting Material					
Vine Cuttings	37.18 ^a	86.24 ^a	124.43 ^b	169.84 ^b	228.99 ^b
Pre-sprouted Setts	42.88 ^a	96.79 ^a	147.67 ^a	205.88 ^a	255.83 ^a
Unsprouted Setts	0.00 ^b	55.84 ^b	89.34 ^c	114.45 ^c	151.74 ^c
F-test (B)	**	**	**	**	**
F-test (AB)	ns	**	**	**	**
% CV	22.13	26.18	27.33	24.47	23.78

Means within the same columns followed by a common letter are not significantly different at 5% level based on HSD Test.

ns – not significant

** -- highly significant

The pre-sprouted setts significantly developed the longest vine at 42.88 cm, comparable with those of vine cuttings at 37.18 cm. Those grown from unsprouted setts did not emerge or produce sprouts at all, even 4 weeks after field planting. Hence, the vine length was recorded as zero.

Data on vine length of yam at 6, 8, 10, and 12 WAP had a similar trend of results. Among the fertilizer treatments, application of vermicast at 5 tons/ha highly stimulated the development of the longest vines, which were comparable to those fertilized with the recommended rate of inorganic nutrients. The combined application of 2.5 T/ha vermicast and $\frac{1}{2}$ RR inorganic fertilizers, however, had the shortest vine length. It was further observed that differences among treatment means within each time duration of data collection were significant, but plants applied with vermicast as well as with RR inorganic fertilizers had statistically comparable vine lengths, and both differed significantly from those applied with the combination of $\frac{1}{2}$ RR inorganic and 2.5 tons vermicast treatments.

The interaction of both factors on vine length at 6, 8, 10, and 12 WAP was highly significant. It was found that at 6 weeks WAP, pre-sprouted setts applied with vermicast significantly developed the longest vines of 123.28 cm (Table 4). The pre-sprouted yam setts fertilized with inorganic fertilizers, unsprouted setts fertilized with vermicast, vine cuttings applied with RR inorganic fertilizers, and vine cuttings applied with $\frac{1}{2}$ RR of inorganic fertilizers + 2.5 T/ha vermicast had comparable vine lengths of 110.13, 109.90 cm, 98.85 cm, and 84.10 cm, respectively. They are statistically significant for those pre-sprouted setts fertilized with $\frac{1}{2}$ RR of inorganic fertilizers + 2.5 T/ha vermicast, vine cuttings fertilized with 5 T/ha vermicast, unsprouted setts fertilized with RR of inorganic fertilizers, and unsprouted setts fertilized with $\frac{1}{2}$ RR of inorganic fertilizers + 2.5 T/ha vermicast with the means of 56.95 cm, 75.78 cm, 29.03 cm, and 28.60 cm, respectively.

At 8 WAP, the interaction of both factors revealed highly significant effects on the vine length of yam. Application of vermicast on pre-sprouted yam setts significantly had the longest vine of 186.06 cm, but comparable with those fertilized with vermicast in unsprouted setts (179.69 cm), pre-sprouted setts fertilized with RR of inorganic fertilizers (177.23 cm), vine cuttings fertilized with 5 tons of vermicast (133.25 cm), and pre-sprouted sets applied with RR inorganic fertilizers (177.23 cm) showed statistically comparable yam vine lengths (Table 4).

The vine cuttings applied with RR inorganic fertilizers, vine cuttings fertilized with $\frac{1}{2}$ RR of inorganic fertilizers + 2.5 tons vermicast, pre-sprouted setts fertilized with $\frac{1}{2}$ RR inorganic fertilizers + 2.5 tons vermicast, unsprouted setts fertilized with RR inorganic fertilizers, and unsprouted setts fertilized with $\frac{1}{2}$ RR inorganic fertilizers + 2.5 tons vermicast significantly had the least vine length of 122.88 cm, 117.15 cm, 79.72 cm, 45.13 cm, and 43.19 cm, respectively.

The interaction effects of fertilizers and planting materials were highly significant at 10 and 12 WAP and followed the same trend (Figure 2). Results showed that pre-sprouted setts applied with RR inorganic fertilizers significantly exhibited the longest vine of 236.98 cm and 297.03 cm at 10 and 12 WAP, respectively. This treatment, however, did not differ significantly from those pre-sprouted setts, unsprouted setts, and vine cuttings fertilized with vermicast, which showed comparable vine lengths of 232.33 cm, 218.88 cm, and 181.93 cm, respectively.

Common Weeds Associated with Yam

Weeds associated with yam in the production area were common regardless of treatments. These weeds were identified as itch grass (*Rottboellia cochinchinensis* L.), centrosema (*Centrosema pubescens*), mimosa (*Mimosa pudica*), and white kyllinga (*Cyperus kyllinga*). Among the weeds identified per square meter in each treatment, itch grass had the highest population density, followed by Mimosa, Centrosema, and White Kyllinga.

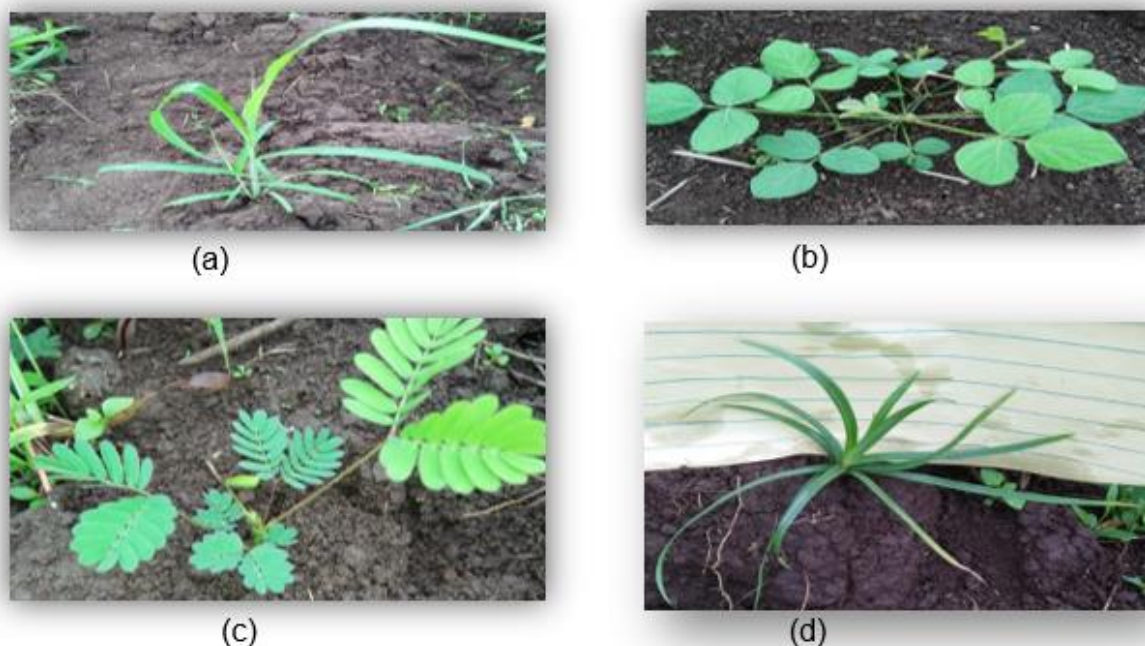


Figure 9. Identified weeds that associated with yam (a) Itch grass (*Rottboellia cochinchinensis* L.), (b) Centrosema (*Centrosema pubescens*), (c) Mimosa (*Mimosa pudica*) and (d) White Kyllinga (*Cyperus kyllinga*)

Conclusion

In conclusion, Results revealed that yam plants fertilized with Vermicast (5 T/ha) significantly exhibited the highest percentage survival, which differed from the rest of the fertilizer treatments. Likewise, yam plants fertilized with 5 T/ha vermicast significantly developed the longest vine from 6–12 weeks after planting. Vine cuttings as planting materials significantly exhibited the highest number of tubers per hill, the highest marketable yield of 18.40 T/ha, and a total tuber yield of 30.53 T/ha. Yam vine cuttings applied with the recommended rate of inorganic fertilizer (20–15–45 kg/ha NPK) + 2.5 T/ha Vermicast gave the highest yield of 21,400 kg/ha and a net income of ₱545,403 with an ROI of 267.88%.

Conflict of Interest

There were no competing interests disclosed by the author.

References:

1. Agri Pinoy. 2012. *Ubi Production Guide*. Department of Agriculture, Regional Field Office No. 02, High Value Crops Development Program.
2. Aighewi, B., N. Maroya, R. Asiedu, D. Aihebor, M. Balogun, & D. Mignouna. 2020. Seed yam production from whole tubers versus minisetts. *Journal of Crop Improvement*, 34(6), 858-874.
3. Aighewi, B.A., R. Asiedo, N. Maroya, & M. Balogun. 2015. *Improved Propagation Methods to Raise the Productivity of Yam (Dioscorea rotundata Poir.)*. This Article is Published with open Access at *Springerlink.com*. 7:823-834.
4. Darkwa, K., B. Olanmi, R. Asiedu, & A. Asfaw. 2020. Review of empirical and emerging breeding methods and tools for yam (*Dioscorea* spp.) improvement: Status and prospects. *Plant Breeding*, 139(3), 474-497.
5. Hammad, H. M., A. Khaliq, F. Abbas, W. Farhad, S. Fahad, M. Aslam, ... & H.F. Bakhat. 2020.
6. Comparative effects of organic and inorganic fertilizers on soil organic carbon and wheat productivity under arid region. *Communications in Soil Science and Plant Analysis*, 51(10), 1406-1422.
7. Iornongo, T., 2021. *Effect Of Rainfall Variability on Yield of Selected Crops in Benue State, Nigeria* (Doctoral Dissertation).
8. Kasan, T.K., Y.T. Hadji Kasan., & S.A. Fadare. 2023. Agriculture 4.0: Impact and Potential Challenges Of blockchain Technology in Agriculture and Its Management. *Russian Law Journal*, 11 (8s): 417- 427. <http://dx.doi.org/10.52783/rj.v11i8s.1356>

9. Larief, R., A. Dirpan, & Theresia. 2018. *Purple Yam Flour (Dioscorea alata L.) Processing Effect on Anthocyanin and Antioxidant Capacity in Traditional Cake “Bolu Cukke” Making.*
10. Niether, W., J. Jacobi, W.J. Blaser, C. Andres, & L. Armengot. 2020. Cocoa agroforestry systems versus monocultures: a multi-dimensional meta-analysis. *Environmental Research Letters*, 15(10), 104085.
11. Okorley, L.E., & O.E, Addai. 2010. Factors Influencing the Accessibility of Yam Planting Materials in the Techiman District Of Ghana. *Ghana Journal of Development Studies*, 7(2):47-52.
12. Scott, G.J., R. Best, M., Rosegrant, & M. Bokanga. 2000. Roots and tubers in the global food system: A vision statement of the year 2020. *A co-publication of the International Potato Center (CIP)*, Centro Internacional de Agricultura Tropical (CIAT), International Food Policy Research Institute (IFRI), International Institute of Tropical Agriculture (IITA), and *International Plant Genetic Resources Institute (IPGRI)*. Printed in Lima, Peru: International Potato Center