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Varietal Performance of *Ipomoea Batatas L.* To Fertilization Strategies as Intercropped in Mulberry Trees

Marjohn V. Anislag
Suigao State College of Technology, Magpayang, Mainit,
Surigao del Norte Philippines

Abstract:- The study used a randomized complete block design (RCBD) were varieties of sweet potato are plot and fertilized with different strategies during and within the experiments the following materials used were sharp bolo, pruning shear and pruning saw, rice sacks, water pump, garden hose, sweet potato varieties, chicken compost, urea and complete fertilizers, carabao drawn plow, meter stick and tape measure, paints, bamboo sticks, hand trowel, weighing scale, vernier caliper, knife, spading pork, wheel borrow, and strainer, shredder, net bags, preserving cloth, pail, basin, plastic tray, and office supplies. Variety of sweet potato were intercrop under the Mulberry trees, climatological data on temperature range, relative humidity and warm environment is prevalent during the growing seasons, favorable for the growth of sweet potato. Soil pH increased, organic matter increased, while available P and K decreased after the growing period of sweet potato varieties applied with different fertilization strategies. And results recommends that the Seven Flores variety in mulberry trees could be adopted due to the production of highest storage roots per subplot, hectare and consequently has obtained the highest income. The fertilizer application of ½ RR organic and ½ RR inorganic and RR inorganic N alone were the two systems that produced the highest yield of storage roots.

Keywords:- *Sweet Potato, Fertilizers Strategies, Mulberry Trees, Intercrop, Randomized Complete Block Design.*

I. INTRODUCTION

The world has been experiencing the rise of hunger and undernourished people from around 804 million in 2016 and increased to nearly 821 million in the year 2017 with poverty and inequity as the root causes of insecurity and malnutrition (FAO, 2018). The Philippines is predominantly an agricultural country composed of small farms with a mean area of 2.0 ha per farm. Widespread poverty continues to be a big problem in the country, Filipino adults and children continue to be afflicted by various forms of malnutrition, such as underweight, under height, and wasting. In the year 2011, anthropometric survey conducted by the Food and Nutrition Research Institute (FNRI) of the Department of Science and Technology (DOST) among 0-5 year-old children, the national prevalence rates for stunting, underweight, and wasting were 33.6%, 20.2%, and 7.3%, respectively indicating that in the Philippines, stunting is the most prevalent indicator of malnutrition. In the first semester of 2012, poverty statistics released by the National Statistical Coordination Board showed that poorest provinces are located in Mindanao (De Guzman et al., 2015).

The government considers a Filipino family poor if monthly earnings are less than the poverty threshold. In the first semester of the year 2012, poverty threshold for a family of 5 was at P5, 458.00 per month (US$ 124.13) to meet basic food needs. If non-food needs, such as clothing, housing, transportation, health, and education expenses, and others, are added to the threshold, cut off in 2012 went up to P7,821.00 (US$ 177.87) earnings a month (Ordinario, 2013).

Because of the high poverty and malnutrition status of the Philippines and other countries of the world, the future challenge for research and implementation is to bridge the gap between agriculture and nutrition for the benefit of improving food security from individual to household and community level. In this context, the emerging concept of nutrition-sensitive agriculture incorporates explicitly nutrition objectives into agriculture and takes more into account the utilization, dimension of food and nutrition security, including health, education, economic and social aspects. By doing so, the concept promises to narrow the gap between available and accessible food and the food needed for a healthy balanced diet (Virchow, 2013).

To improve the livelihood and nutrition status of the people of the Philippines and the world as well, the viable agricultural solution to this problem is to adopt the practice of agroforestry systems. Agroforestry is the combination of agriculture and forestry practices within a farming system. It involves the combination of trees and crops that increase the medicinal, environmental, and economic value of land with much profit and food security (Sobola et al., 2015). Among the agroforestry systems that would be an effective tool to solve the problems mentioned above is the practice of intercropping. According to Finley et al. (2018), intercropping can be used to increase crop yields through resource partitioning and facilitation in addition to achieve greater productivity. Dai et al. (2017) mentioned that governments in developing countries often promote intercropping (crops intercropped with fruit trees on cultivated land) schemes in order to improve smallholders income. Mousavi et al. (2011) stated that intercropping is among the ways to increase diversity in an agricultural ecosystem. Row-intercropping, mixed-intercropping, strip-intercropping and relay intercropping are the most important types of intercropping. Crops yield increases with intercropping due to higher growth rate, reduction of weeds, pests and diseases and more effective use of resources.

One of the agricultural crops that could be used to intercrop with other crops in order to solve and reduce the malnutrition and poverty of most people of the world is sweet potato. Sweet potato originated from Central America and was discovered in Peruvian caves by Christopher Columbus (WH Foods, 2012). Nedunchezhiyan et al. (2012) suggested that sweet potato can be grown as intercrop in plantation for attaining maximum productivity and profitability. Sweet potato scientifically known as *Ipomoea batatas* L. is an important crop with varied and extensive consumption among significant portion of the world's population. Its prominence among the major crops of the world is highly and widely recognized as an important food crop for humans and animals due to its desirable starch, sugar, protein and vitamins content (Ozturk et al., 2012). According to Serenje and Mwala (2010), the nutritional significance of sweet potato has increased along with its role as a key source of income for small-scale farmers. This is especially true for those farmers with access to major highways or those able to transport the produce to formal markets for sale. Abidin et al. (2017) stated that benefits of intercropping sweet potato with other crops will increase diversity of crops and foods grown, increased efficiency of labor, increased productivity per unit of area, reduced risk of total crop failure compared to when just one crop is grown. Study conducted in Bangladesh by Islam, et al. (2014) on the hybrid maize and sweet potato intercropping, results showed that sweet potato produced higher yield and yield components of maize. This study concluded that maize paired row + two rows sweet potato combination could be suitable for increasing productivity and profitability for hill farmers of Khagrachari in Bangladesh.

Ezin et al. (2018) stated that sweet potato plays an important role of ensuring food security and incomes for local communities. Moreover, Delmo (2010) mentioned that sweet potato is now regarded as a "cash crop" due to its versatility and high nutritive value, making it among the most in-demand agri-commodity in the market. It provides good ground cover, grows on soils with limited fertility, low available moisture and has a short growth period with high yields (Helen Keller International Tanzania, 2012).

Belen et al. (2018) revealed that sweet potato is an important crop ranking seventh in terms of world-wide production and has played an important role as food source in Asia. No part of this crop is particularly wasted because the roots are often used as substitute for rice and corn while the vines as potential source of feed to supplement the usual diets of animals. It provides strategic opportunities to improve nutrition and rural incomes in several countries and regions affected by micronutrient deficiencies. It is well established as a food security crop in many densely populated countries in the world. Further, Zannou et al. (2017), stated that sweet potato is an important source of carbohydrates (96%), in the form of simple carbohydrates and dietary fibers, which play an important role in energy deficiencies. It is also good source of vitamin A compared to other roots and tubers. Its vitamin C content is also remarkable. It contains vitamins E, B1, B2 and folic acid and rich in minerals essential to the functioning of the body such as zinc and calcium.

Sweet potatoes are grown and consumed worldwide and have been recording growth since 2012 and trade is on the rise. All in all, growers are not too afraid, because sweet potatoes are recording increasing demand worldwide (Mulderi, 2016). Global sweet potato production volume showed an increasing annual total production worldwide from 2010 to 2016 ranging from 102.43 million metric tons to 105.19 million metric tons. Philippine Statistics Authority (2018) reported that the production status of sweet potato in the Philippines in 2018 was 132.15 thousand metric tons. In 2017, sweet potato production in the province of La Union was 600.63 metric tons. Likewise, LGU (2017) reported that the municipality of Bacnotan, La Union produced 120 metric tons of sweet potatoes in the year 2017.

Common characteristics of sweet potato in the Philippines are long and tap ward tuberous root with smooth skin whose color ranges between yellow, orange, red, brown, purple, and beige. Its flesh ranges from beige through white, red, pink, violet, yellow, orange, and purple. Sweet potato varieties with white or pale yellow flesh are less sweet and moist than those with red, pink or orange flesh (Philippine Statistics Authority, 2014). Each variety of sweet potatoes has different quality and characteristics. High yielding sweet potatoes can lead to high production which in turn can augment income of the farmers. Variety identification is an indispensable tool to assure tuber purity and quality. Identifying variety can be done by human experts or by the help of technology. One way of recognition is through image processing (Unajan et al., 2017). Sweet potato varieties can be spreading, semi-erect or erect. They also range from early maturing (3 months after planting) through to late maturing (8 up to 10 months after planting) and can be ready for harvesting from 3 to 8 months after planting (Abidin et al., 2017).

Ezin et al. (2018) concluded from their study that calls for the attention of public and private sectors and policy makers for more investment in sweet potato research.

Avenues for further research on sweet potato have also been suggested.

Because of the information mentioned above that sweet potato is one of the agricultural crops deserving to be intercropped with other plantation crops as mentioned by Nedunchezhiyan et al. (2012) and Islam et al. (2014), the researcher has explored to intercrop sweet potato varieties in mulberry (*Morus alba* L.*)* trees (alfonso variety). This variety (Alfonso) has elliptic base shape; serrate leaf margin and purple color of the young leaves, create leaf margin and green young shoots, semi-erect branches, leaves significantly the highest protein and moisture and proved to be the best for silkworms both in bivoltine and multivoltine strains (Villamor, 2008)

According to Ghosh et al. (2017), mulberry is a very hardy and fast growing perennial plant belonging to the genus Morus of the family Moraceae. The leaf of mulberry is solely used for feeding and rearing of the silkworm, *Bombyx mori* for the production of silk yarn. It is estimated that mulberry silk contributes around 90% of the total global raw silk production and it is a very attractive economic activities mostly to the rural people. In addition to the utilization of mulberry leaves as silkworm feed, it is also used for many other purposes such as the fruit. The mulberry fruit due to its high nutritive value and delicious taste is getting importance as valuable foodstuff. The mulberry bark and wood are also useful for the manufacturing of paper and sports good items. Moreover, Palb (2013) found out in his study on intercropping of legumes on the growth and yield of mulberry and rearing performance of the silkworm *Bombyx mori* L. that mulberry (*Morus alba* L.*)* trees intercropped with French bean recorded significantly higher net returns as compared from other intercropping systems. Locally, farmers and researchers of Sericulture Research and Development Institute (SRDI) tried intercropping legumes, cereals and other crops yielded promising results. Intercropping cereals and leguminous crops between mulberry rows could maximize the use of land particularly during pruning time. Several studies found that mulberry could be grown with other crops like corn, mungbeans, peanuts and bush beans and vegetable such as okra, pechay, sweet potato and sweet pepper as additional source of income while waiting for the mulberry leaf harvests Padilla et al. (1999). Layaoen et al. (1999) found that intercropping corn and peanut increased income of farmers due to combined value of cocoons and intercrops compared to monocropping. Though intercropping sweet potato was tried by some farmers for shoot cutting purposes, it was not yet fully explored particularly for root storage purposes. The need to identify short season varieties adapted to local conditions is imperative to synchronize harvesting of crops in the intercropping system.

On the other hand, balanced fertilization is imperative to provide good growth and development of sweet potato plants. Yeng et al. (2012) concluded that organic and inorganic input combinations for mineral supplementation in sweet potato production are a better option than either of organic and inorganic input applied singly. A combination of 150 kg inorganic fertilizer + 1.5 t poultry manure is preferred for higher sweet potato growth and marketable and total fresh root yield in the guinea savanna zone while 100 kg of inorganic fertilizer + 2 tons poultry manure per ha maybe preferred in zone for forest transition or similar environments. These combinations produced sweet potato growth and yield higher or comparable with inorganic fertilization alone as well as increased soil nutrients and physical properties.

Nowadays, in order to have sound growth and develop plants normally, fertilizer must be applied. The researcher used organic fertilizer (chicken compost) and inorganic fertilizer (urea) as recommended by Bureau of Soils (2018). The recommended rate for sweet potato was 60 + 0 + 0 kg NPK/ha, while the recommended rate of organic fertilizer (chicken compost) was three (3) tons per hectare (Otanes et al., 2018). For mulberry plants, the recommended rate of inorganic fertilizer NPK complete (14-14-14) was (300-120-120 kg NPK/ha) applied in 5 split doses throughout the year; first dose application was (60-60-60) as recommended by TSU Unit of SRDI (2019).

As supporting information for these two fertilizers, the organic fertilizer (chicken compost) and inorganic fertilizer N (urea) were applied to sweet potato varieties during the conduct of the study. Adeyeye et al. (2012), found out in their research on the evaluation and comparison on the effect of organic fertilizers such as chicken manure, cow dung, organic manure and inorganic fertilizers complete and urea on the growth and tuber yield of sweet potato that the number of leaves were significant in all the treatments. Application of urea fertilizer produced the highest number of tubers per plant, while tuber weight was not significantly affected. Chicken manure application had the higher mean value of 2.34 kg. In a field study conducted by Shinde et al. (2012) clearly indicated that T_3 (NPK) complete fertilizer showed highly significant leaf weight as compared with other treatments of fertilizers. Impact of N (urea) fertilizer on the productivity of mulberry *(Morus alba* L.*)* showed positive results.

In the Philippines and other countries of the world, no studies have been conducted about varietal performance of sweet potato (*Ipomoea batatas* L.) as affected by two fertilization strategies using chicken compost as organic fertilizer and urea as inorganic fertilizer intercrop in mulberry *(Morus alba* L.*)* trees applied with complete fertilizer NPK (14-14-14), hence, this research.

II. OBJECTIVES OF THE STUDY

This study aimed to assess the varietal performance of sweet potato to fertilization strategies as intercrop in mulberry trees. Specifically, the study determined the following: *first*, the most favorable variety that gave the best growth and yield of sweet potato intercrop in mulberry trees; *second* the most appropriate fertilization strategy to sweet potato as intercrop in mulberry trees; *third*, the interaction effect between sweet potato varieties and fertilization strategies on the growth and yield of sweet potato; *fourth*, the response of mulberry trees in intercropping different sweet potato varieties applied with different fertilization strategies; *fifth*, the effect of climatological data during the conduct of the study; and *sixth*, the changes on soil properties after the conduct of the study.

III. METHODOLOGY

❖ *Research Design*

The study was laid out following the 4 x 4 split plot technique in Randomized Complete Block Design (RCBD) replicated three times (Figure 1). The sweet potato varieties were the main plot and the fertilization strategies were the subplot. Each subplot measured 2 m by 1.25 m and per main plot measured 8 m by 5 m (Figures 2 and 3).

The treatments used were as follows:

Main plot: Sweet potato varieties (V) Subplot: Fertilization Strategies (F)
V_1 - Seven Flores
F_0 - No Fertilizer Application (control)
V_2 - Seri Kenya F_1 - Organic Fertilizer (RR 100% Chicken
V_3 - Immitlog (Check Variety) Compost - 3t/ha)
V_4- Violeta
F_2 – Inorganic Fertilizer (RR 100% Urea
- 60 kg/ha)
F_3 – 50% RR Chicken Compost + 50% RR Urea

❖ *Materials and Procedures*

The materials used were sharp bolo, pruning shear and pruning saw, rice sacks, water pump, garden hose, sweet potato varieties, chicken compost, urea and complete fertilizers, carabao drawn plow, meter stick and tape measure, paints, bamboo sticks, hand trowel, weighing scale, vernier caliper, knife, spading pork, wheel borrow, and strainer, shredder, net bags, preserving cloth, pail, basin, plastic tray, and office supplies.

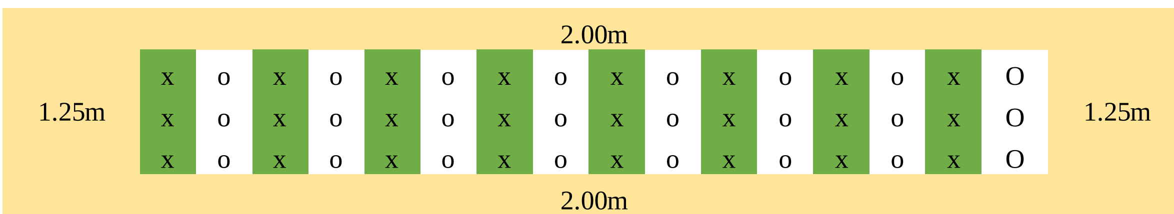

Fig. 1:- Experimental Layout of the Study

Legend:
X = Mulberry Trees
O = Sweet potato

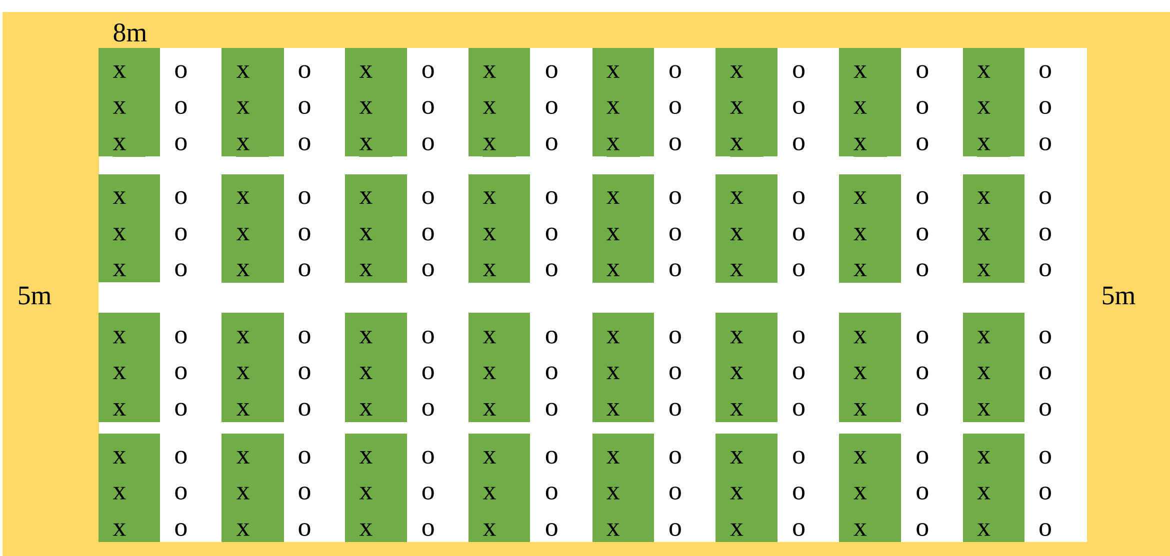

Fig. 2:- Layout per Subplot

Legend:
X = Mulberry trees
O = Sweet potato

BLOCK

I	II	III
$V_1 F_2$	$V_4 F_1$	$V_2 F_1$
$V_1 F_0$	$V_4 F_0$	$V_2 F_2$
$V_1 F_3$	$V_4 F_3$	$V_2 F_3$
$V_1 F_1$	$V_4 F_2$	$V_2 F_0$
$V_4 F_1$	$V_2 F_3$	$V_4 F_3$
$V_4 F_0$	$V_2 F_2$	$V_4 F_2$
$V_4 F_2$	$V_2 F_0$	$V_4 F_0$
$V_4 F_3$	$V_2 F_1$	$V_4 F_1$
$V_2 F_0$	$V_3 F_2$	$V_3 F_3$
$V_2 F_2$	$V_3 F_3$	$V_3 F_1$
$V_2 F_3$	$V_3 F_1$	$V_3 F_0$
$V_2 F_1$	$V_3 F_0$	$V_3 F_2$
$V_3 F_2$	$V_1 F_1$	$V_1 F_2$
$V_3 F_0$	$V_1 F_3$	$V_1 F_0$
$V_3 F_3$	$V_1 F_2$	$V_1 F_3$
$V_3 F_1$	$V_1 F_0$	$V_1 F_1$

Fig. 3:- Layout per Main Plot

Legend:
Main plot - (Sweetpotato varieties) Subplot - (Fertilization Strategies)
V_1: Seven Flores F_0: No Fertilizer application (control)
V_2: Seri Kenya F_1: Organic Fertilizer (RR 100% Chicken Compost)
V_3: Immitlog (Check Variety) F_2: Inorganic Fertilizer (RR 100% Urea)
V_4: Violeta F_3: 50% RR Chicken Compost + 50% RR Urea
Size per subplot: 2.00 m x 1.25 m = 10 m^2
Size per main plot: 8.0 m x 5.0 m = 40 m^2

Seven Flores and Seri Kenya sweet potato varieties were procured from P1 Upper Libas Tagana-an, Surigao del Norte, while Immitlog and Violeta varieties were procured from the College of Agriculture Research Farm of DMMMSU-NLUC, Bacnotan, La Union.

Chicken compost was procured from the College of Agriculture Manure Processing Center, DMMMSU-NLUC, Bacnotan, La Union. The chemical fertilizers (14-14-14 and urea), rice sacks and hand trowels were bought from the agricultural supply in Bacnotan, La Union. Other tools and materials such as bolo, pruning saw and pruning shear, rake, pail, water pumps and garden hoses, tractor, plow and carabao, meter sticks, tape measure, weighing scale, wheel borrow, basin, plastic tray, spading pork and net bags were borrowed from the Sericulture Research and Development Institute (SRDI) of DMMMSU.

A total land area of 480 sq m mulberry plantation was prepared by removing all the weeds and undesirable vegetation with the use of a spading fork and bolo. Mulberry trees were pruned at thirty five (35) cm from the ground. Prior to land preparation, the area was flooded to make the soil soft and provide moisture before it was cultivated twice using tractor rotavator to loosen the soil. Furrows were constructed between rows of mulberry trees with the use of a carabao drawn plow at 25 cm deep.

Chicken composts were applied in furrows following the basal method at 2.4 kg/subplot for RR organic fertilizer; 106.66 g/subplot for RR inorganic fertilizer and 1.2 kg chicken compost and 53.33 g urea for ½ RR organic and ½ RR inorganic urea, respectively. After basal fertilizer application, irrigation was done to dilute the fertilizers for an easy absorption of nutrients by the crops. The second fertilizer application was done twenty five (25) days after planting sweet potato. This was done by two point drill method with a distance of twenty (20) cm per plant to avoid burning the root system. Irrigation followed after fertilizer application.

Two hundred eighty eight (288) sweet potato cuttings per variety were prepared. These cuttings were matured, 30 cm long and with 5 nodes/cuttings as recommended by DA et al. (2011) and Abidin et al. (2017). The cuttings were put in rice sacks and placed in a pail filled with water and stored in a cool place before they were planted.

Planting of cuttings was done at 30 cm between hills and 50 cm between rows of mulberry trees. Half of the length of cutting with 3 nodes was buried to the ground using a hand trowel. There were 24 plants/sub plot.

Irrigation was done just after planting and every other two weeks thereafter to facilitate the development of the roots and stems of sweet potato varieties and mulberry trees until the termination of the study to maintain the moisture of the soil.

Replanting was done a week after planting sweet potato varieties. The cuttings that died were immediately replaced so that the yield of sweet potato varieties will not be affected. Weeding was done two weeks after planting by hand weeding to avoid disturbing the development of storage root of the sweet potato varieties.

Hilling-up of sweet potato plants was done fifteen (15) days from planting as suggested by Schlueter (2015) to fully cover the root systems with soil (Plate 6). Hilling- up of sweet potato tubers would minimize direct sunlight exposure thus, preventing tubers to become green and not fit for consumption. In fact, green potatoes can carry toxins and become poisonous.

Weekly pest surveillance was done after planting to monitor the presence of insect pests, disease incidence and degree of damage. According to Okonya et al. (2014), insect pests are among the most limiting constraints in sweet potato production.

Harvesting of shoots and leaves of mulberry trees was done sixty days (60) from pruning in time for silkworm rearing activities. The collected shoots and leaves were wrapped in a cloth to avoid wilting and were placed in the storage room building of SRDI for data gathering and eventually used for feeding silkworms. Other pruned and cut stems with leaves were given to SRDI staff as feed for silkworms (Plate 8).

Harvesting of sweet potato was done 90 days after planting using spading fork. The spading fork was inserted below the ridges of the plants and turned upright to expose the storage roots. The vines with storage roots were uprooted and the tubers were handpicked and placed in net bags. The harvested vines were transported to SRDI storage room building using the wheel borrow for data collection. After data gathering, the tubers were sorted and classified into damaged, large, medium and small sizes (Plate 9) as recommended by Abidin et al. (2017) and Sweet Potato Production Guide (2018). The harvested tubers were marketed at the DMMMSU-NLUC compound. Regardless of size, the price per kg was P30.00 based on the average prevailing market price in the locality.

❖ *Data Gathered*

A. Growth and Yield of Sweet potato Varieties

➢ *Percent Survival 30 Days after Planting (DAP).*

This was determined by dividing the number of cuttings that survived to the total number of cuttings planted multiplied by x 100. This was computed using this formula:

$$S\ (\%) = \frac{NSC}{TNCP} \times 100$$

Where S - Percentage Survival
NSC - Number of Survived Cuttings
TNCP - Total Number of Cuttings Planted

➢ *Number of secondary vines per plant.*

This was gathered by counting the number of secondary vines that were attached to the main vine per plant.

➢ *Length of the main vine per plant (cm).*

This was gathered by measuring the shoots of the main vine from the base to the tip of the plant using a tape measure.

➢ *Length of the longest secondary vine per plant (cm).*

This was measured from the base to the tip of shoot of the longest secondary vine per plant using meter stick.

➢ *Diameter of main vine per plant (mm).*

This was gathered by measuring the stem 20 cm from the base of the main stem per plant using a digital vernier caliper.

➢ *Number of storage roots per plant.*

This was taken by counting the number of storage roots per plant.

➢ *Fresh weight of storage roots per plant (kg).*

This was gathered by weighing the storage roots per plant with the use of a weighing balance.

➢ *Weight* of *storage roots per subplot (kg).*

This was gathered by weighing the harvested storage roots per subplot with the use of a weighing scale.

➢ *Yield per hectare (kg/h).*

The yield per hectare was determined through ratio and proportion from the subplot basis. This was calculated by following this formula:

Yield per sub plot (area occupied by sweet potato per ha)

Yield per ha (kg) =

Area per subplot

B. Growth of Mulberry Trees.

This was taken sixty (60) days from pruning of mulberry trees. The data were taken from ten (10) sample plants randomly selected from twenty four (24) population per subplot.

- *Number of developed leaves per plant.*

This was gathered by counting all the developed leaves per plant.

- *Number of shoots per plant.*

This was gathered by counting the shoots that developed per plant.

- *Length of the longest shoot per plant (cm).*

This was gathered by measuring from the base up to the tip of shoot of the longest vine with the use of a meter stick.

- *Diameter of the longest shoot per plant (cm).*

This was gathered by measuring the diameter 20 cm from the base of the stem with the use of a digital vernier caliper.

C. Soil Analysis.

Soil samples were taken from the experimental area before and after the conduct of the study and submitted for soil analysis at the DA Regional Soils Laboratory Office in San Fernando City, La Union.

- *Fresh weight biomass per sweet potato (g).*

This was gathered from all plant parts with the use of weighing balance.

D. Climatological Data.

Data on temperature (°C), rainfall (mm) and relative humidity (%) were taken at the AGROMET Weather Station of DMMMSU-NLUC, Bacnotan, La Union.

E. Data Analysis

All the data gathered were summarized, presented and subjected for analysis of variance (ANOVA) in RCBD split plot design. Treatment means were compared using the Least Significant Difference Test (LSD).

IV. RESULTS AND DISCUSSION

A. Growth and Yield of Sweet Potato Varieties

- *Percent Survival (%) Effect of Varieties.*

Table 1 and Figure 4 present the effect of sweet potato varieties on the percentage survival (%) 30 DAP. The highest percentage survival were the plants under Immitlog variety (Check Variety) with a mean of (97. 22%), followed by Seven Flores variety with a mean of (95.49%), Seri Kenya variety with a mean of (93.40%) and the lowest were the plants under Violeta variety with a mean of (60.38%).

Significant result was indicated (Appendix Table 1b). Comparison among means revealed that varieties of Seven Flores, Seri Kenya and Immitlog were comparable with each other and significantly higher percentage survival over the Violeta variety. This might due to some immature cuttings that were planted because of the shortage of matured cuttings of the Violeta variety during the conduct of the study.

Sweet Potato Varieties	Mean*
V_1 - Seven Flores	95.49^a
V_2 - Seri Kenya	93.40^a
V_3 - Immitlog	97.22^a
V_4 - Violeta	60.38^b

Table 1:- Percentage Survival (%) of Sweet potato as affected by Sweet potato Varieties 30 DAP
*Means with the same letter are not significantly different at 0.05 (LSD)

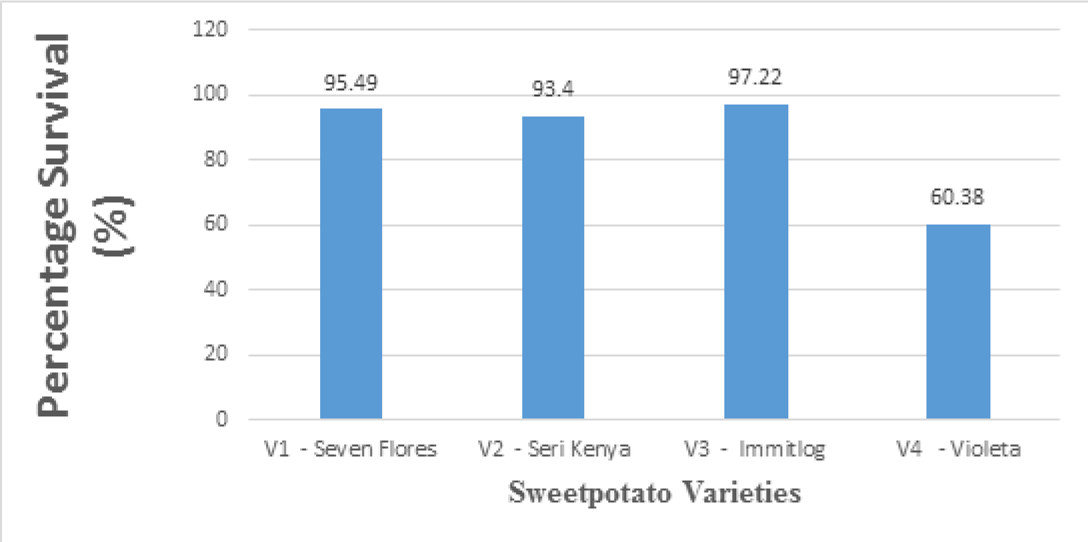

Fig. 4:- Percentage Survival (%) of Sweet Potato as affected by Sweet Potato Varieties 30 DAP

➢ *Effect of Fertilization Strategies.*

Table 1a presents the effect of fertilization strategies on the percentage survival (%) of sweet potato varieties 30 DAP. The percent survival ranged from 85.72% to 88.19%.

Fertilization Strategies	Mean
F_0 – (Control) No Fertilizer Application	88.19
F_1 – Organic Fertilizer (RR 100% Chicken Compost - 3t/ha)	87.15
F_2 – Inorganic Fertilizer (RR 100% Urea – 60 kg/ha)	85.72
F_3 – 50% RR Chicken Compost + 50% Urea	85.42

Table 1a:- Percentage Survival (%) of Sweet Potato as affected by Fertilization Strategies 30 DAP

No significant result was shown (Appendix Table 1b). This implies that the different fertilization strategies did not influence the survival percentage of sweet potato varieties 30 DAP.

➢ *Interaction Effect.*

There was no significant interaction effect between the sweet potato varieties x fertilization strategies on the percentage survival 30 DAP (Appendix Table 1b).

❖ *Main Vine*

➢ *Effect of Varieties.*

Table 2 and Figure 5 present the effect of sweet potato varieties on the length (cm) and diameter (mm) of the main vine of sweet potato. The longest length was produced by the Seri Kenya variety with a mean of 347.67 cm followed by Seven Flores variety with a mean of 257.50 cm and Immitlog variety with a mean of 191.83 cm, while the shortest length was produced by the Violeta variety with a mean of 162.25 cm. In terms of diameter of the main vine, it ranged from 1.13 mm to 1.42 mm.

Highly significant result was indicated on the length of the main vine while no significant difference was observed on the diameter of the main vine (Appendix Tables 3b and 5b). On the comparison among treatment means, Seri Kenya variety produced significantly longest length of main vine followed by the Seven Flores variety. Immitlog Variety and Violeta variety were comparable with each other and also produced the lowest length of main vine as compared to Seri Kenya and Seven Flores varieties. Results on the significant difference of the length of the main vine and an insignificant difference on the diameter of the main vine were due to the inherent genetic make-up of the sweet potato per variety.

Sweet Potato Varieties	Mean*	
	Length	Diameter
V_1 - Seven Flores	257.50[b]	1.30
V_2 - Seri Kenya	347.67[a]	1.13
V_3 - Immitlog	191.83[c]	1.24
V_4 - Violeta	162.25[c]	1.42

Table 2:- Length (cm) and Diameter (mm) of the Main Vine of Sweet Potato as affected by Varieties 90 DAP
*Means with the same letter are not significantly different at 0.05 (LSD)

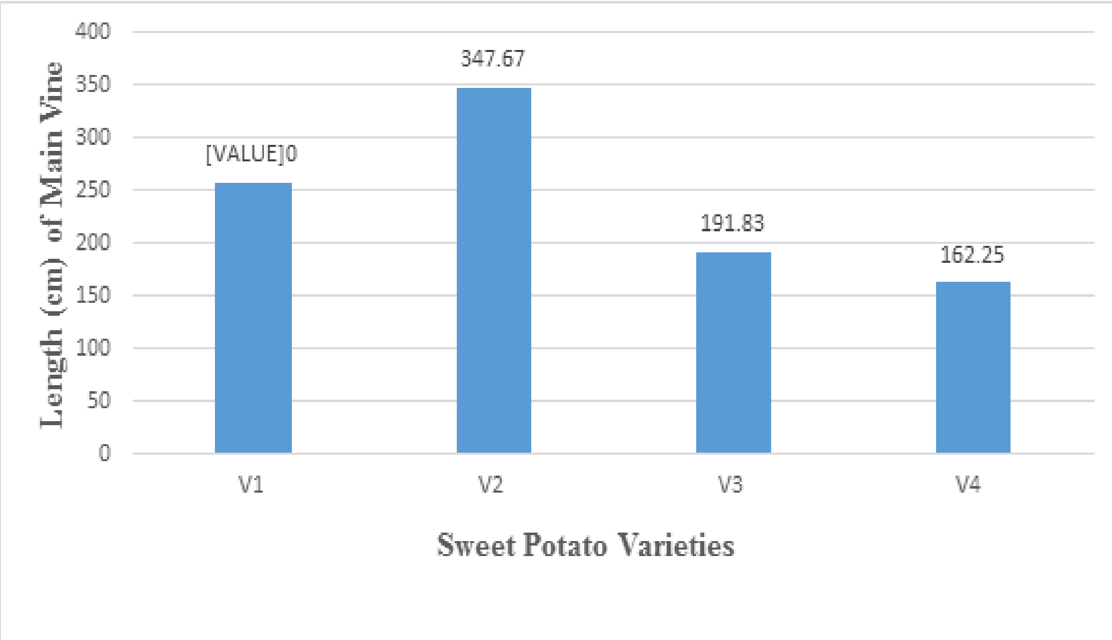

Fig. 5:- Length (cm) of the Main Vine of Sweet Potato as affected by Sweet Potato Varieties 90 DAP

➢ *Effect of Fertilization Strategies.*

Table 2a and Figure 6 present the length (cm) and diameter (mm) of the main vine of sweet potato varieties as affected by fertilization strategies 90 DAP. The longest length of the main vine that registered a mean of 259.92 cm with the largest diameter of 1.76 mm were the sweet potato varieties applied with 50% RR chicken compost + 50% RR urea, followed by the sweet potato varieties applied with 100% RR chicken compost with a mean of 248.34 cm (length of main vine) and sweet potato varieties applied with 100% RR urea with a mean of 1.50 mm (diameter of main vine). The shortest length with the smallest diameter (main vine) were the sweet potato varieties with no fertilizer application.

Highly significant result was indicated on the length and diameter of the main vine per cutting of sweet potato (Appendix Tables 3b and 5b). Comparison among treatment means on the length (cm) and diameter (mm) of the main vine were the sweet potato plants applied with organic fertilizer (RR 100% chicken compost – 3t/ha), inorganic fertilizer (100% RR urea – 60 kg/ha) and 50% RR chicken compost + 50% RR urea showed comparable results and significantly higher length and diameter (main vine) over the sweet potato plants with no fertilizer application. This implies that the fertilization strategies favored the growth and development of the length and diameter of the main vine per sweet potato variety used in the study.

Fertilization Strategies	Mean*	
	Length	Diameter
F_0 – No Fertilizer Application (Control)	205.50[b]	0.37[b]
F_1 – Organic Fertilizer (RR 100% Chicken Compost - 3t/ha)	248.34[a]	1.47[a]
F_2 – Inorganic Fertilizer (RR 100% Urea - 60 kg/ha)	245.50[a]	1.50[a]
F_3 – 50% RR Chicken Compost + 50% Urea	259.92[a]	1.76[a]

Table 2a:- Length (cm) and Diameter (mm) of Main Vine of Sweet Potato as affected by Fertilization Strategies 90 DAP
*Means with the same letter are not significantly different at 0.05 (LSD)

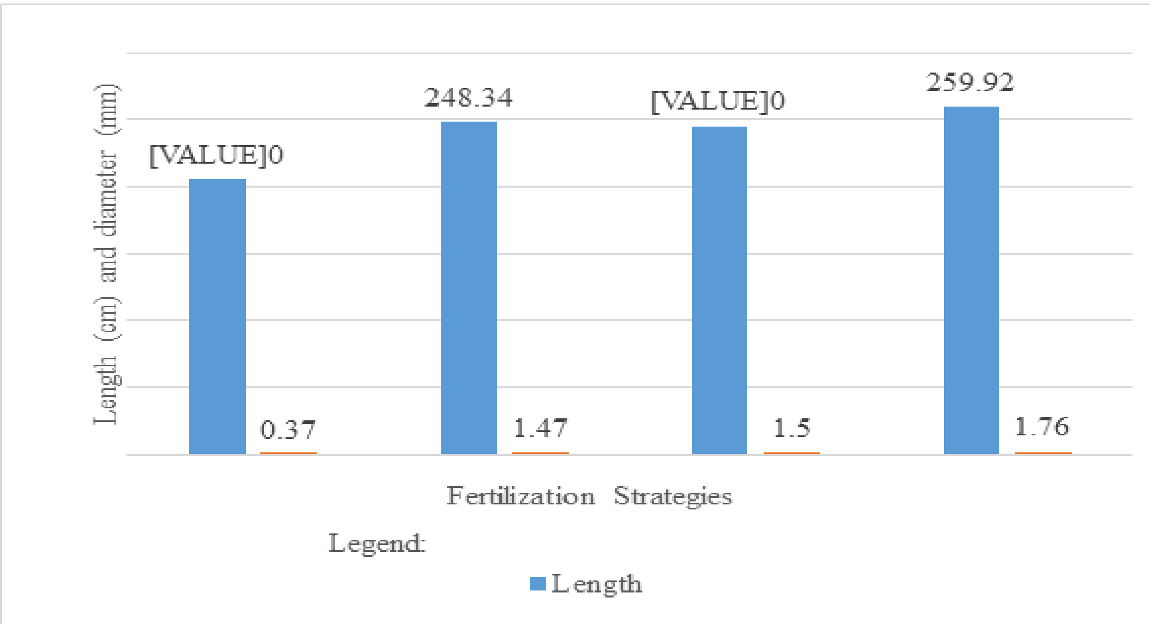

Fig. 6:- Length (cm) and Diameter (mm) of the Main Vine of Sweet Potato as affected by Fertilization Strategies 90 DAP

➢ *Interaction Effects.*

No significant interaction effect was indicated between the sweet potato varieties x fertilization strategies on the length (cm) and diameter of the main vine (mm) (Appendix Tables 3b and 5b).

❖ *Secondary Vines*

➢ *Effect of Varieties.*

Table 3 and Figure 7 present the number and length of secondary vines of sweet potato as affected by varieties 90 DAP. The highest number of secondary vine was obtained by the Violeta variety with a mean of 30.92 followed by the Seri Kenya variety with a mean of 19.67 and variety Immitlog with a mean of 16.17, while the lowest was the Seven Flores variety with a mean of 15.84. On the other hand, the highest length of secondary vine was the Seri Kenya variety with a mean of 246.75 cm followed by Seven Flores variety with a mean of 147.33 cm and Immitlog Variety with a mean of 93.17 cm while the lowest length was the Violeta variety with a mean of 84. 42 cm.

Highly significant result (Appendix Tables 2b and 4b) was observed. Comparison among treatment means showed that the Violeta variety was significantly highest on the number of secondary vines while Seri Kenya produced significantly the longest length of secondary vines. Moreover, the Seven Flores and Immitlog varieties were comparable and significantly lowest on the number of vines compared to Violeta and Seri Kenya varieties. Immitlog and Violeta varieties were comparable and significantly had the lowest length of secondary vines compared to Seri Kenya and Seven Flores varieties. The highly significant effect on the number and length of secondary vines was due to the inherent genetic make – up per sweet potato variety used in the study.

Sweet Potato Varieties	Mean*	
	Number	Length
V_1 - Seven Flores	15.84[c]	147.33[b]
V_2 - Seri Kenya	19.67[b]	246.75[a]
V_3 - Immitlog	16.17[c]	93.17[c]
V_4 - Violeta	30.92[a]	84.42[c]

Table 3:- Number and Length (cm) of Secondary Vines of Sweet Potato as affected by Sweet Potato Varieties 90 DAP
*Means with the same letter are not significantly different at 0.05 (LSD)

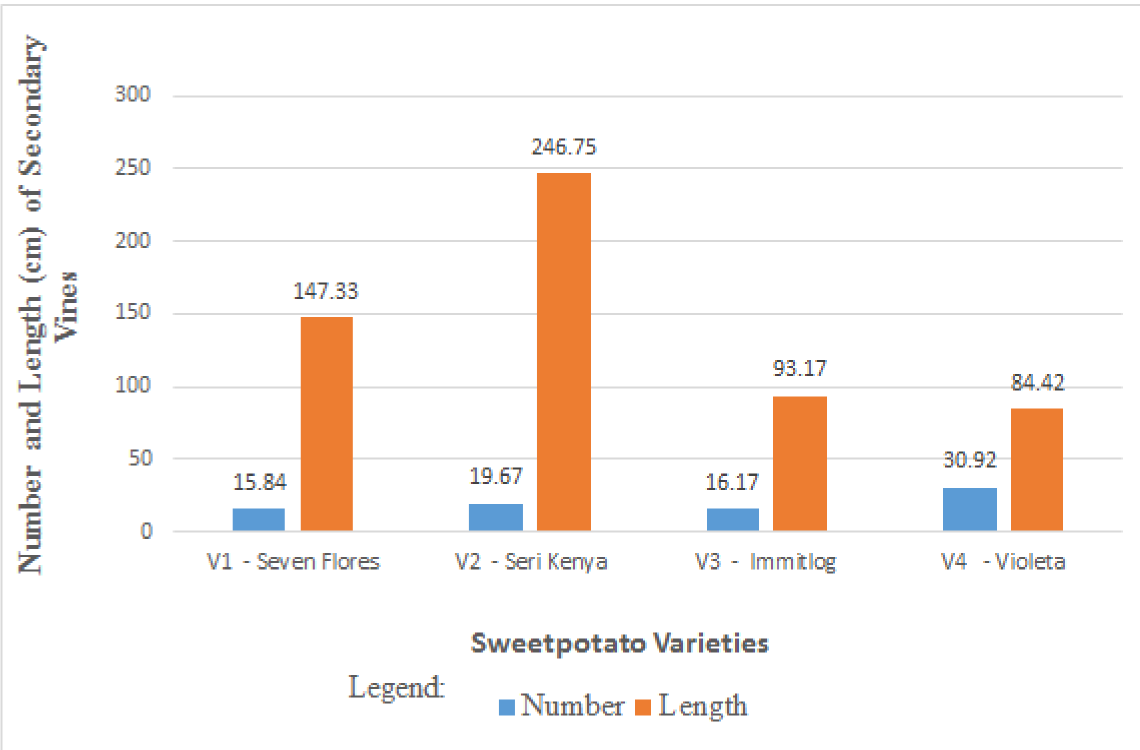

Fig. 7:- Number and Length (cm) of Secondary Vines of Sweet Potato as affected by Varieties 90 DAP

➢ *Effect of Fertilization Strategies.*

Table 3a and Figure 8 present the number and length of secondary vines of sweet potato varieties as affected by fertilization strategies 90 DAP. The highest mean on the number of secondary vines were the plants applied with inorganic fertilizer (100% RR urea) with a mean of 22. 75 followed by the plants applied with organic fertilizer 100% RR chicken compost with a mean of 22.50 and the plants applied with 50% RR urea + 50% RR chicken compost with a mean of 21.50, while the plants with no fertilizer application showed the lowest number of secondary vines with a mean of 15.83. On the other hand, the plants applied with 50% RR urea + 50% RR chicken compost showed the highest mean of 154.42 cm (length of longest secondary vine) followed by the plants applied with inorganic fertilizer (100% RR urea – 60 kg/ha with a mean of 150.83 cm and organic fertilizer (100% RR chicken compost – 3t/ha) with a mean of 142.42 cm. The unfertilized plants produced the shortest length with a mean of 124.00 cm.

Highly significant results were indicated (Appendix Tables 2b and 4b). Planta applied with inorganic fertilizer (100% RR urea – 60 kg/ha), and organic fertilizer (100% RR chicken compost - RR 3t/ha) and 50% RR chicken compost + 50% urea were comparable with higher number and length of secondary vines over the unfertilized plants. This implies that fertilizer with 50% RR chicken compost + 50% urea and inorganic fertilizer (100% RR urea – 60 kg/ha) and organic fertilizer (100% RR chicken compost - RR 3t/ha) were beneficial that influenced the production and development of the secondary vines of sweet potato varieties.

Fertilization Strategies	Mean*	
	Number	Length
F_0 – (Control) No Fertilizer Application	15.83[b]	124.00[b]
F_1 – Organic Fertilizer (RR 100% Chicken Compost - 3t/ha)	22.50[a]	142.42[a]
F_2 – Inorganic Fertilizer (RR 100% Urea - kg/ha)	22.75[a]	150.83[a]
F_3 – 50% RR Chicken Compost + 50% Urea	21.50[a]	154.42[a]

Table 3a. Number and Length (cm) of Secondary Vines of Sweet Potato as affected by Fertilization Strategies 90 DAP
*Means with the same letter are not significantly different at 0.05 (LSD)

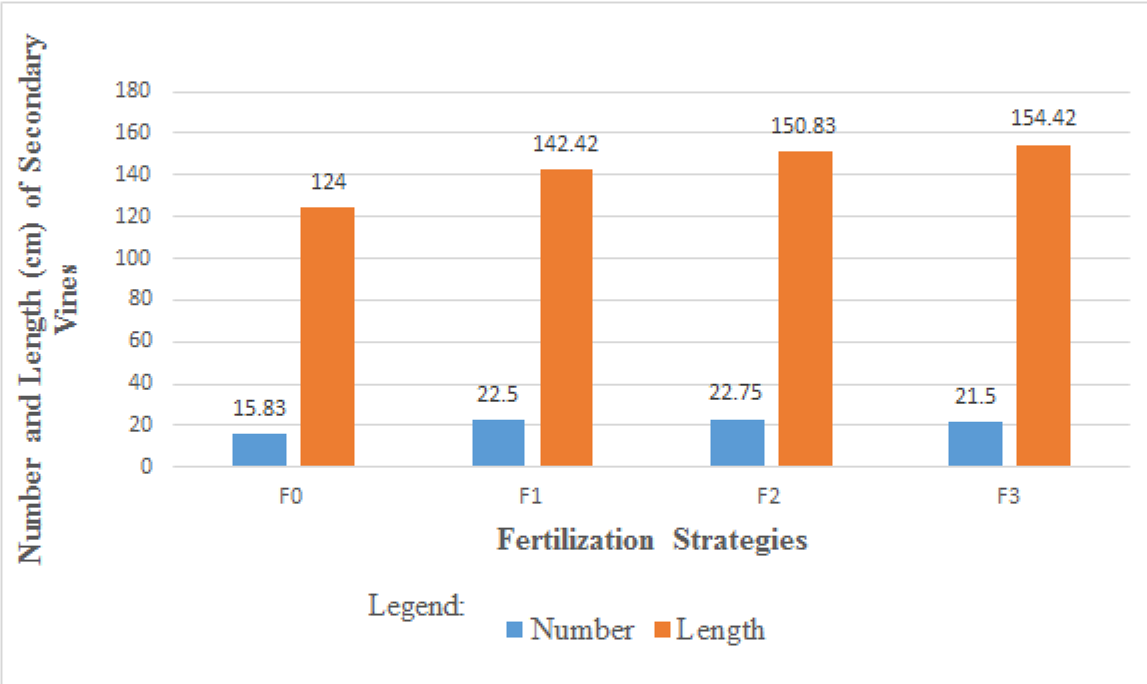

Fig. 8:- Number and Length (cm) of Secondary Vines of Sweet Potato as affected by Fertilization Strategies 90 DAP

➢ *Interaction Effects.*

The interaction effect of varieties x fertilization strategies on the number and length of secondary vines 90 DAP showed no significant differences (Appendix Tables 2b and 4b). This implies that both varieties and fertilization strategies did not inhibit the production and development of the secondary vines of sweet potato varieties.

❖ *Storage Roots*

➢ *Effect of Varieties.*

Table 4 presents the number and fresh weight of storage roots of sweet potato as affected by varieties 90 DAP. The number of storage roots per sweet potato cutting ranged from 13.00 tubers to 16.67 while the fresh weight ranged from 0.14 to 0.26 kg.

Sweet Potato Varieties	Mean	
	Number	Weight (kg)
V_1 - Seven Flores	13.00	0.16
V_2 - Seri Kenya	14.66	0.14
V_3 - Immitlog	16.67	0.24
V_4 - Violeta	15.50	0.26

Table 4:- Number and Weight (kg) of Storage Roots per Sweet Potato Cutting as affected by Sweet Potato Varieties 90 DAP

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No significant difference was observed among the sweet potato varieties used (Appendix Tables 6b and 7b). This implies that sweet potato varieties had comparable effect on the number and fresh weight of storage roots per sweet potato cuttings.

➢ *Effect of Fertilization Strategies.*

Table 4a and Figure 9 present the number and fresh weight (kg) of storage roots per sweet potato cutting as affected by fertilization strategies 90 DAP. The highest number of storage roots were the sweet potato cuttings applied with organic fertilizer (100% RR chicken compost – 3t/ha) with a mean of 17.42 tubers followed by the sweet potato cuttings applied with 50% RR chicken compost + 50% urea with a mean of 16.58 tubers and cuttings applied with inorganic fertilizer (100% RR urea) with a mean of 15. 67 tubers. The least tubers were produced by the unfertilized sweet potato cuttings.

As per fresh weight of storage roots, the heaviest storage roots were produced by the sweet potato cuttings applied with 50% RR chicken compost + 50% urea with a mean of 0.24 kg followed by the sweet potato cuttings applied with inorganic fertilizer (100% RR urea – 60 kg/ha) with a mean of 0.22 kg and sweet potato cuttings applied with organic fertilizer (100% RR chicken compost – 3t/ha) with a mean of 0.20 kg, while the lowest weight of storage roots were the unfertilized sweet potato cuttings with a mean of 0.14 kg. Highly significant result was observed as shown in Appendix Tables 6b and 7b. Comparison among treatment means revealed that sweet potato cuttings applied with fertilizers were comparable and significantly produced the heaviest storage roots over the unfertilized sweet potato cuttings. Result implies that fertilization strategies enhanced the production of heaviest storage roots compared to the unfertilized sweet potato cuttings.

Fertilization Strategies	Mean*	
	Number	Weight
F_0 – (Control) No Fertilizer Application	10.17^b	0.14^b
F_1 – Organic Fertilizer (RR 100% Chicken Compost - 3t/ha)	17.42^a	0.20^{ab}
F_2 – Inorganic Fertilizer (RR 100% Urea - 60 kg/ha)	15.67^a	0.22^a
F_3 – 50% RR Chicken Compost + 50% Urea	16.58^a	0.24^a

Table 4a:- Number and Weight (kg) of Storage Roots per Sweet Potato Cutting as Affected by Fertilization Strategies 90 DAP

*Means with the same letter are not significantly different at 0.05 (LSD)

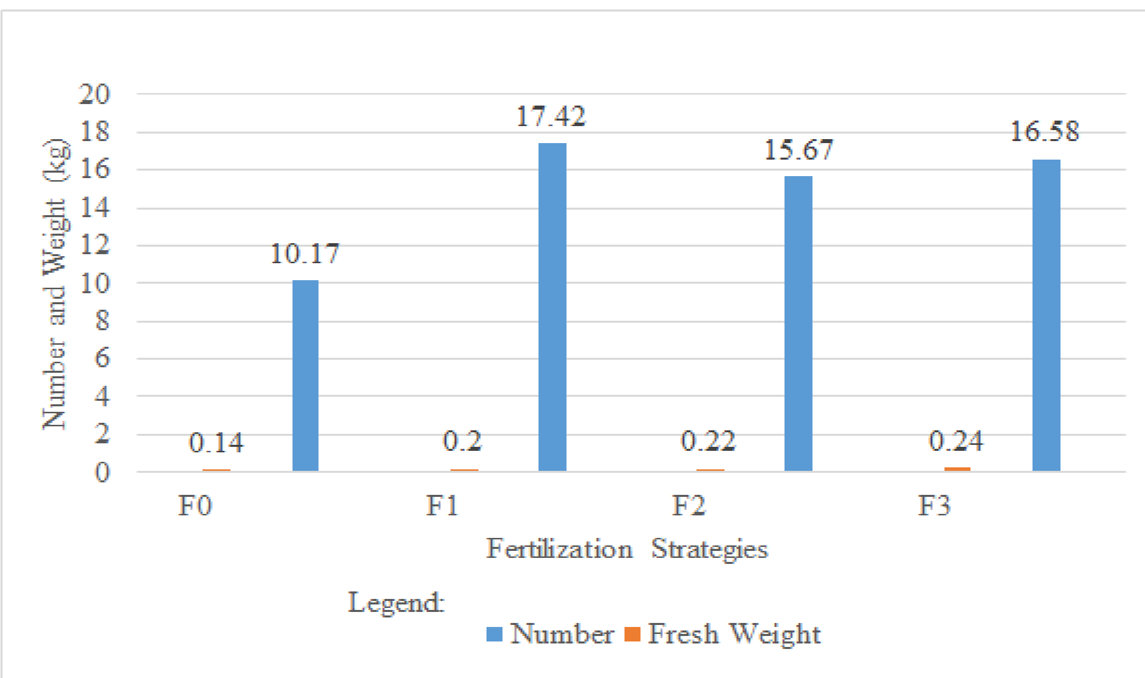

Fig. 9:- Number and Weight (kg) of Storage Roots per Sweet Potato as affected by Fertilization Strategies 90 DAP

➢ *Interaction Effects.*

The interaction effect of varieties x fertilization strategies on the number and fresh weight of storage roots per plant is presented in Appendix Tables 6 and 7. The number of storage roots ranged from 9.33 to 21. 33 and 0.09 kg to 0.30 kg fresh weight of storage roots.

No significant interaction effect was indicated (Appendix Tables 6b and 7b).This implies that both sweet potato varieties and fertilization strategies did not influence the production and on the heaviest storage roots per sweet potato variety.

❖ *Yield*

➢ *Effect of Varieties.*

Table 5 and Figure 10 present the yield per subplot (kg) and computed yield per hectare (kg) as affected by sweet potato varieties. The highest yield per subplot was the Immitlog variety with a mean of 6.97 kg and 55,766.67 kg per hectare followed by the Seven Flores variety with a mean of 5.76 kg per subplot and 46,100 kg per hectare. The lowest was the Violeta variety with a mean of 3.60 kg per subplot and 28,800 kg per hectare.

Significant effect was indicated on the yield per subplot and hectare (Appendix Tables 8b and 9b). Comparison among treatment means revealed that Immitlog and Seven Flores varieties were comparable with significant highest yield (kg) per subplot and hectare. Seri Kenya and Violeta varieties were comparable and showed significant lowest yield compared to Immitlog and Seven Flores varieties per subplot and hectare. This result may be attributed to the inherent genetic characteristics per variety used in the study.

Sweet Potato Varieties	Mean*	
	Subplot	Hectare
V_1 - Seven Flores	5.76^a	46100.00^{ab}
V_2 - Seri Kenya	3.20^b	25566.67^c
V_3 - Immitlog	6.97^a	55766.67^a
V_4 - Violeta	$3.60a^b$	28800.00^{bc}

Table 5:- Yield per Subplot (kg) and Computed Yield per Hectare (kg) of Sweet Potato as affected by Varieties 90 DAP
*Means with the same letter are not significantly different at 0.05 (LSD)

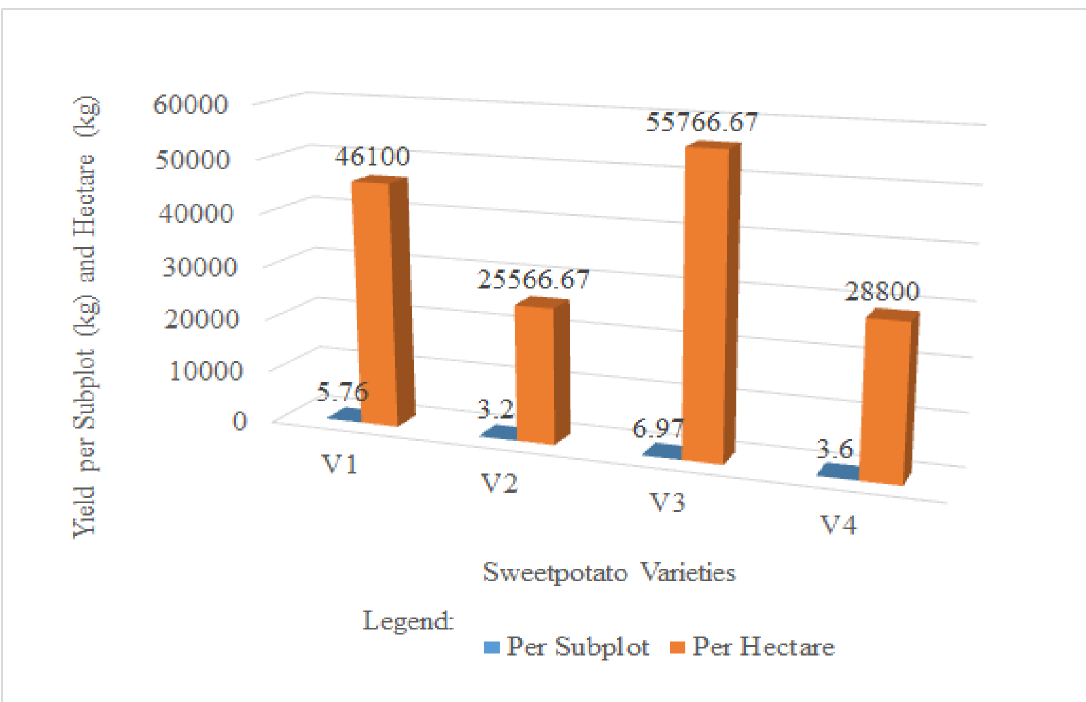

Fig. 10. Yield per Subplot (kg) and Computed Yield per Hectare (kg) of Sweet Potato as affected by Varieties 90 DAP

➢ *Effect of Fertilization Strategies.*

Table 5a and Figure 11 present the yield per subplot and computed yield per hectare of sweet potato as affected by fertilization strategies 90 DAP. The highest yield per subplot were the plants applied with 50% RR chicken compost + 50% RR urea with a mean of 5.97 kg followed by the plants applied with inorganic fertilizer (100% RR urea - 60 kg/ha) with a mean of 4.95 kg. The highest yield/ha were the plants applied with 50% RR chicken compost + 50% RR urea with a mean 47, 766.67 kg followed by the plants applied with inorganic fertilizer (100% RR urea – 60 kg/ha) with a mean of 4.95 kg per subplot and 39, 566.67 kg per hectare. The least yield per subplot and per hectare were the plants applied with organic fertilizer (100% RR % chicken compost – 3t/ha) with a mean of 4.23 kg per subplot and 33,833.33 kg per hectare. Inorganic Fertilizer (100% RR urea - 60 kg/ha)

Significant result was indicated as shown on Appendix Tables 8b and 9b. Comparison among means revealed that plants applied with 50% RR chicken compost + 50% urea produced significant highest yield of storage roots per subplot and hectare over the plants applied with other fertilization strategies indicating comparable and significant lowest yield over the plants applied with 50% RR chicken compost + 50% urea. This implies that the application of 50% RR chicken compost + 50% RR urea was the best fertilization strategy for sweet potato plants in producing the heaviest yield per subplot and per hectare.

Fertilization Strategies	Mean*	
	Subplot	Hectare
F_0 – (Control) No Fertilizer Application	4.38^{b}	35066.67^{bc}
F_1 – Organic Fertilizer (RR 100% Chicken Compost - 3t/ha)	4.23^{b}	33833.33^{c}
F_2 – Inorganic Fertilizer (RR 100% Urea - 60 kg/ha)	4.95^{a}	39566.67^{ab}
F_3 – 50% RR Chicken Compost + 50% Urea	5.97^{a}	47766.67^{a}

Table 5a:- Yield per Subplot (kg) and Computed Yield per Ha (kg) of Sweet Potato as affected by Fertilization Strategies 90 DAP

*Means with the same letter are not significantly different at 0.05 (LSD)

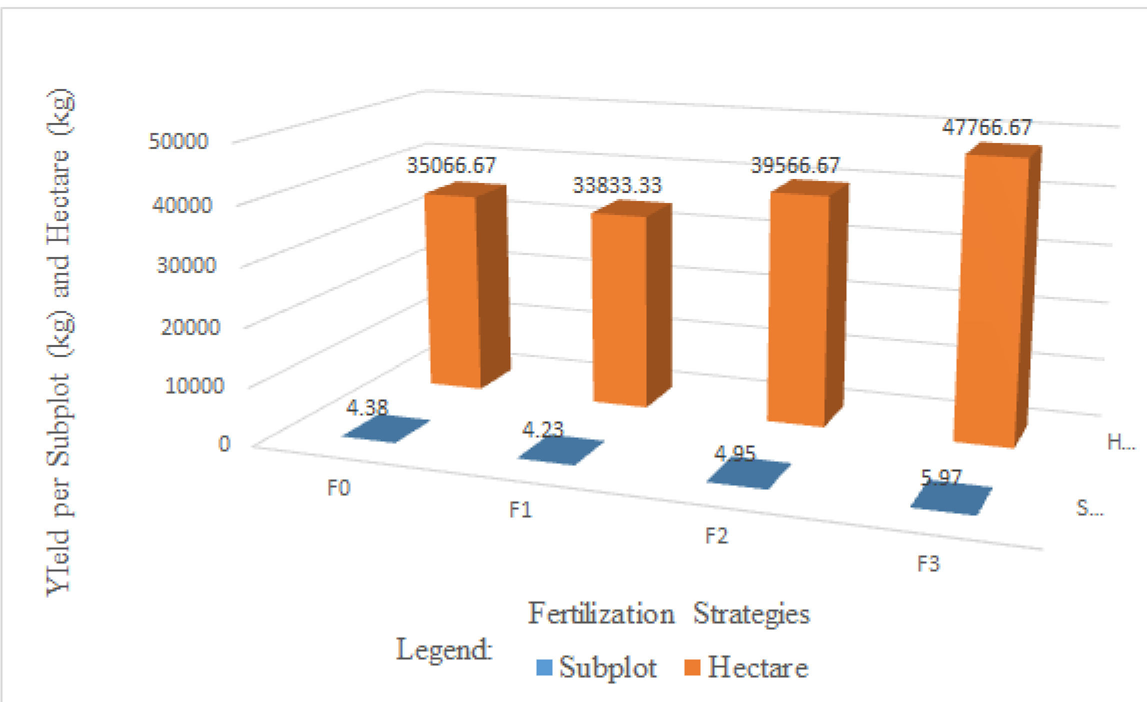

Fig. 11:- Yield per Subplot (kg) and Computed Yield per Hectare (kg) of Sweet Potato as affected by Fertilization Strategies 90 DAP,

➢ *Interaction Effects.*

The interaction effect of varieties x fertilization strategies on the yield per subplot (kg) ranged from 2.93 kg – 9.00 kg and computed yield per hectare (kg) that ranged from 23,466.67 kg – 72,000.00 kg (Appendix Tables 8 and 9).

No significant interaction effect was indicated between the sweet potato varieties and fertilization strategies (Tables 8b and 9b). This implies that both sweet potato varieties and fertilization strategies did not favor the production of heaviest weight of storage roots.

❖ *Biomass*

➢ *Effect of Varieties.*

Table 6 presents the fresh weight biomass yield (g) per plant as affected by sweet potato varieties. Result showed that fresh weight biomass yield ranged from 1101.67 g to 1589.08 g.

Sweet Potato Varieties	Mean
V_1 - Seven Flores	1101.67
V_2 - Seri Kenya	1589.08
V_3 - Immitlog	1279.58
V_4 - Violeta	1138.33

Table 6:- Biomass Yield (g) of Sweet Potato as affected by Sweet Potato Varieties 90 DAP

No significant effect was shown on the sweet potato varieties used in the study to the biomass yield per sweet potato cutting (Table 10b). This implies that the fresh weight biomass was not influenced by the sweet potato varieties as intercrop in mulberry trees.

➢ *Effect of Fertilization Strategies.*

Table 6a and Figure 12 present the fresh weight biomass yield (g) of sweet potato as affected by fertilization strategies 90 DAP. The heaviest biomass yield were the plants applied with 50% RR chicken compost + 50% urea with a mean of 1, 598. 58 g, followed by the plants applied with organic fertilizer (100% RR chicken compost – 3t/ha) with a mean of 1, 323.33 g while the lowest biomass yield were the unfertilized plants with a mean 884. 58 g.

Highly significant effect was revealed on the biomass yield per plant of sweet potato (Appendix Table 10b). Comparison among means showed that plants applied with 50% RR chicken compost + 50% urea produced significantly the highest biomass over the plants applied with organic fertilizer (100% RR chicken compost) and inorganic fertilizer applied with 100% RR urea - 60kg/ha but were significantly comparable with the highest yield biomass compared to the unfertilized plants. This indicates that fertilization strategies are beneficial on the yield performance of sweet potato plants.

Fertilization Strategies	Mean*
F_0 – (Control) No Fertilizer Application	884.58^c
F_1 – Organic Fertilizer (RR 100% Chicken Compost - 3t/ha)	1323.33^b
F_2 – Inorganic Fertilizer (RR 100% Urea - 60kg/ha)	1302.17^b
F_3 – 50% RR Chicken Compost + 50% Urea	1598.58^a

Table 6a:- Biomass Yield (g) of Sweet Potato as affected by Fertilization Strategies 90 DAP

*Means with the same letter are not significantly different at 0.05 (LSD)

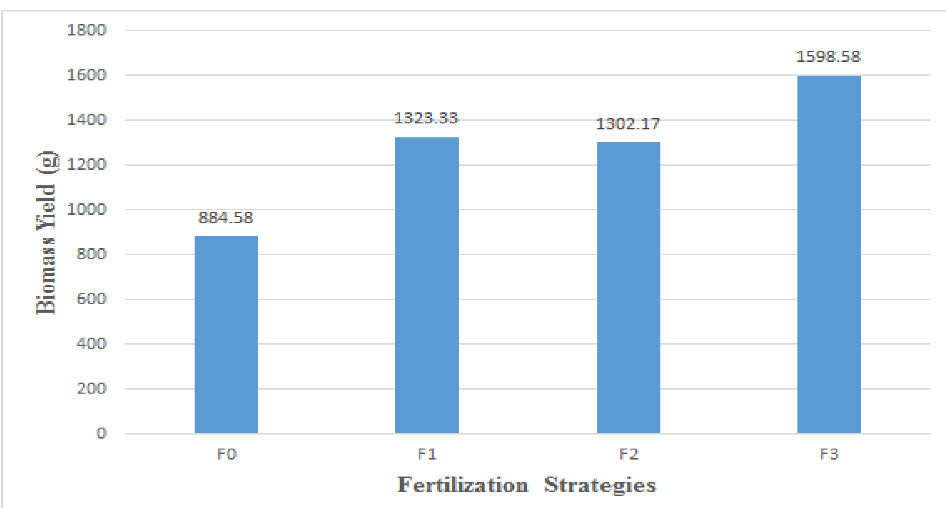

Fig. 12:- Biomass Yield (g) of Sweet Potato as affected by Fertilization Strategies 90 DAP

➢ *Interaction Effects.*

No interaction effect (Appendix Table 10b) between sweet potato varieties x fertilization strategies on the fresh weight biomass yield per sweet potato 90 DAP.

B. Growth of Mulberry Trees

➢ *Leaves and Shoots*

Table 7 presents the number of leaves, number of shoots, length (cm) of the longest shoots and diameter (mm) of the longest shoot per mulberry tree during the conduct of the study 60 DAP. Results showed that the number of developed leaves ranged from 50.37 to 130.67 while on the number of shoots, it ranged from 2.47 to 8.63. On the length (cm) of the longest shoots, it ranged from 57.17 cm to 253.17 cm and the diameter (mm) of the longest shoots ranged from 0.8 mm to 5.14 mm.

Treatments	Number of Developed Leaves	Number of Shoots	Length of the Longest Shoot (cm)	Diameter of the Longest Shoot (mm)
$V_1 F_0$	69.30	2.53	65.00	2.59
$V_1 F_1$	95.20	6.73	154.17	5.13
$V_1 F_2$	99.70	7.47	135.17	3.66
$V_1 F_3$	126.13	8.63	153.50	4.12
$V_2 F_0$	62.40	2.47	57.17	1.45
$V_2 F_1$	123.83	7.17	183.00	5.14
$V_2 F_2$	116.20	7.13	199.83	4.04
$V_2 F_3$	116.27	6.63	169.33	3.51
$V_3 F_0$	50.37	2.50	147.00	0.80
$V_3 F_1$	126.97	7.07	253.17	2.77
$V_3 F_2$	87.23	5.03	245.67	3.46
$V_3 F_3$	103.47	5.70	218.83	3.02
$V_4 F_0$	70.23	2.50	84.67	1.20
$V_4 F_1$	130.67	7.97	214.50	2.15
$V_4 F_2$	114.93	6.80	169.70	3.06
$V_4 F_3$	130.30	7.97	232.17	3.21

Table 7:- Number of Leaves, Number of Shoots, Length (cm) of the Longest Shoots and Diameter (mm) of Longest Shoots of Mulberry Trees

Mulberry trees favored the growth and yield of sweet potato varieties during the conduct of the study.

C. Soil analysis

Table 8 presents the available soil pH, OM, P and K before and after the conduct of the study. Initially, soil pH ranged from 0 – 5.7. After 3 months of experimentation, soil pH increased to 6.8 - 6.9 in sweet potato plants with no fertilizer application, RR urea and RR chicken compost and for plants fertilized with ½ RR organic and ½ RR inorganic fertilizer. Though it increased tremendously in all plots, it is still within the optimum range required for sweet potato yields (Figure 13). According to Brandenberger et al. (2014), soil pH requirement for sweet potato production ranges from 5.5 to 6.8.

Treatment	Before				After			
	pH	OM	P	K	pH	OM	P	K
		%	ppm	ppm		%	ppm	ppm
F_0 – (Control) No Fertilizer Application	5.70	1.21	23.15	226.85	6.90	2.00	7.00	76.00
F_1 – Organic Fertilizer (RR 100% Chicken Compost - 3t/ha)	5.70	1.21	23.15	226.85	6.80	2.50	7.00	76.00
F_2 – Inorganic Fertilizer (RR 100% Urea - 60kg/ha)	5.70	1.21	23.15	226.85	6.80	2.20	6.00	76.00
F_3 – 50% RR Chicken Compost + 50% Urea	5.70	1.21	23.15	226.85	6.80	3.00	6.00	76.00

Table 8:- Soil Analysis before and after the Conduct of the Study
Source: Region 1 Soils Laboratory Office, Department of Agriculture, San Fernando City, La Union.

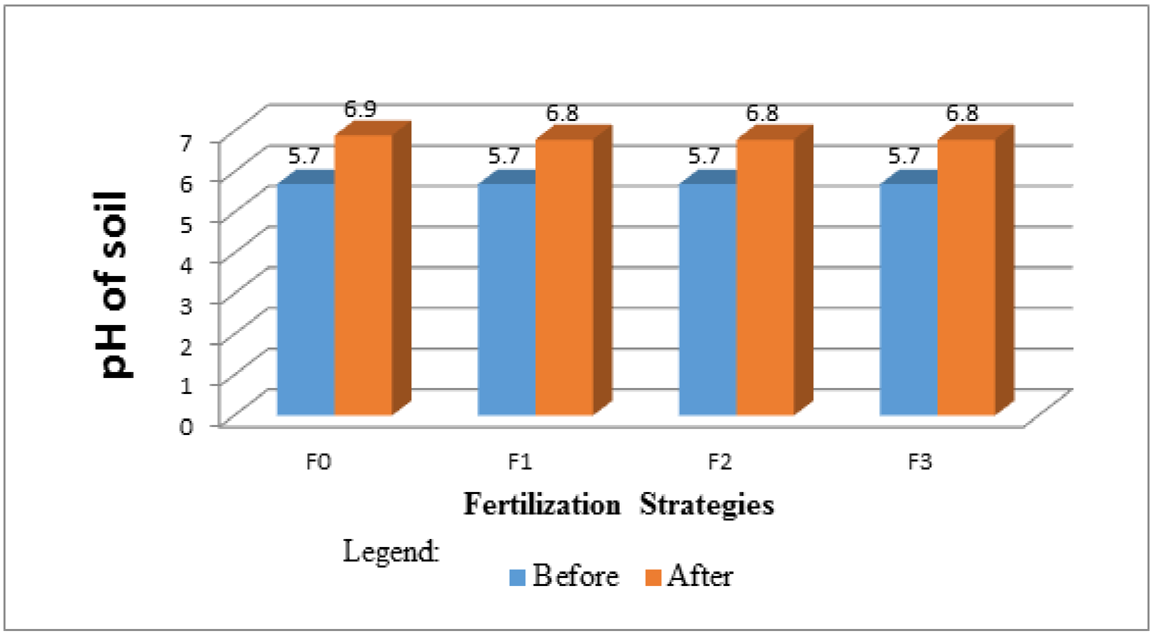

Fig. 13:- Soil pH Content of Soil before and after the Conduct of the Study

➢ ***Soil Organic Matter (%)***.

The initial soil analysis revealed that the soil contained about 1.21 % OM. After 3 months from planting, organic matter content of soil increased to 2.0%, 2.20%, 2.50% and 3.00% for sweet potato plants not applied with fertilizer, plants applied with RR organic fertilizer, and plants applied with inorganic fertilizer and plants applied with a combination of ½ RR organic + ½ RR inorganic fertilizer. The increased of OM in the soil could be due to the application of different fertilization strategies in every subplot that led to the higher production in treatment plots. An increased in OM in unfertilized plots could be also be due to presence of debris around the plots that have decomposed that provided the source of OM. These results conformed to the conclusion of Zewide et al. (2012) and Vosawai et al. (2015) that the different rates of nitrogen (N), phosphorus (P) and potassium (K) in their interaction have sound and promising impact on the growth and on marketable tuber yield of sweet potato (Figure 14).

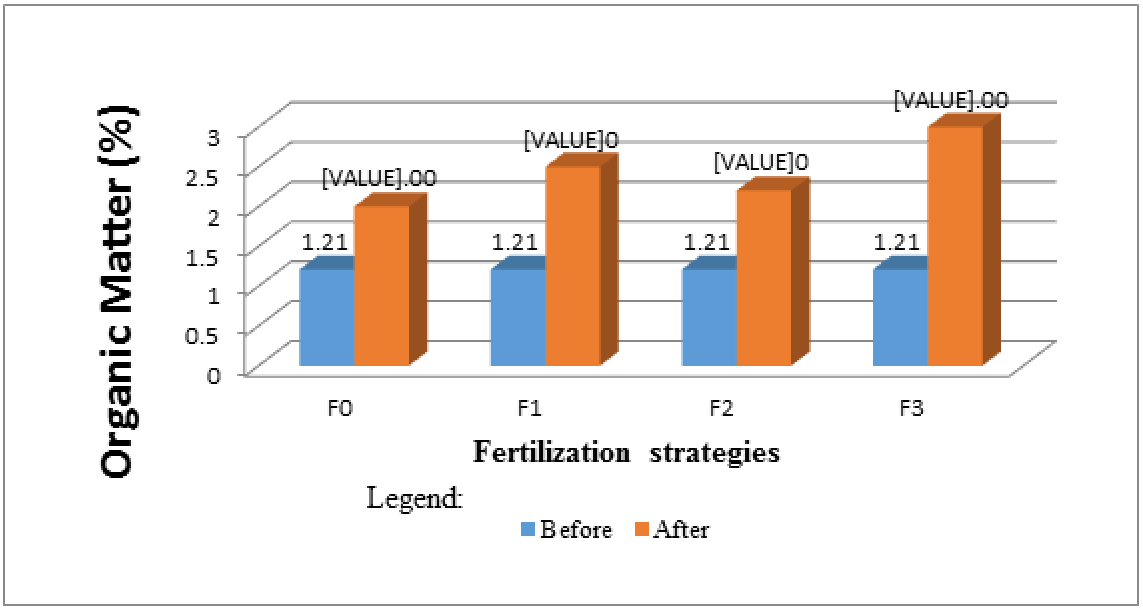

Fig 14:- Organic Matter before and after the Conduct of the Study

Available P in the soil was high at 23.15 ppm but after the conduct of the study, available P in the soil tremendously decreased to 7 ppm on sweet potato plants with no fertilizer application and plants supplied with RR organic fertilizer, while it decreased to 6 ppm in sweet potato plants applied with RR inorganic fertilizer and ½ RR organic + ½ RR inorganic fertilizer. This could be due to the plants that utilized the nutrients for its growth and development as it was not supplied with P during the developmental stage (Figure 15).

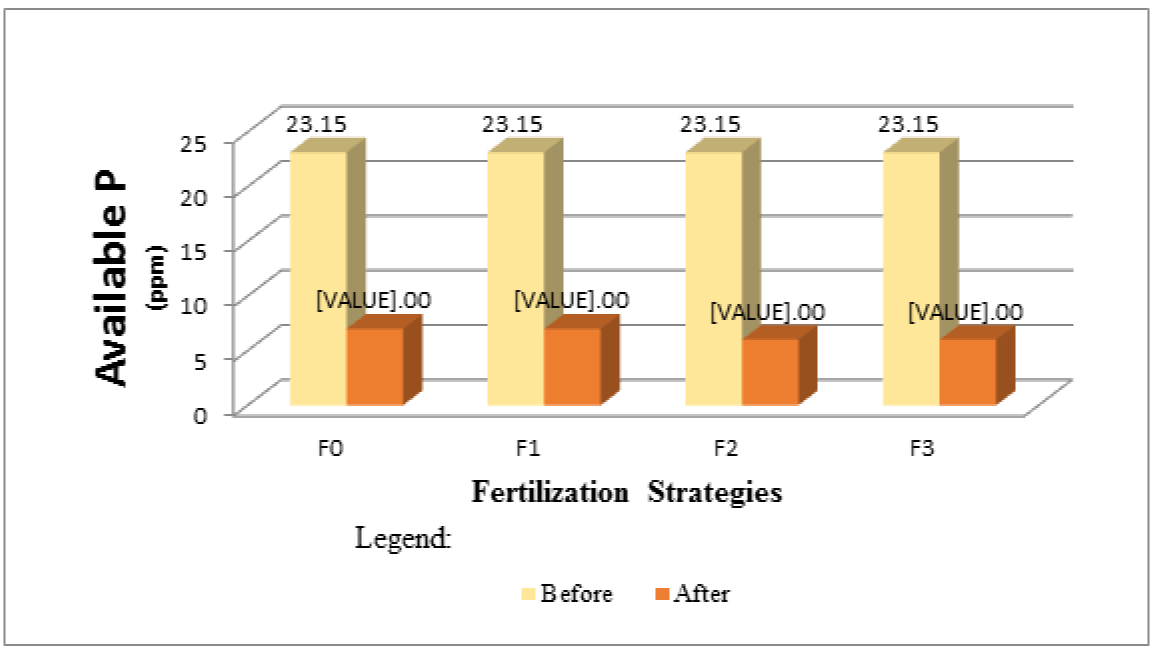

Fig 15:- Available P Present in the Soil before and after the Conduct of the Study

Available K was high at initial stage at 226.85 ppm but dropped to 76 ppm in all fertilization strategies after the conduct of the study. This could be due to the nutrient that was used by the plants in its growth and development as it was not supplied with such nutrient at the start of the experiment (Figure 16).

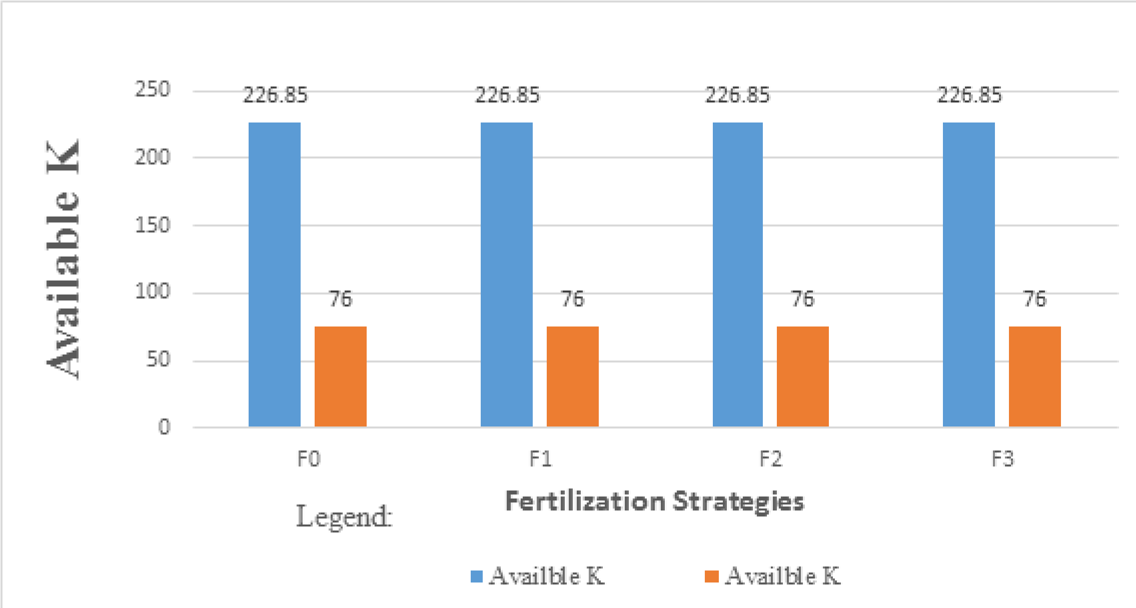

Fig 16:- Available K Present in the Soil before and after the Conduct of the Study

D. Climatological Data

Table 9 presents the monthly temperature (ºC), rainfall (mm) and relative humidity (%). Monthly temperature ranged from 22.40 ºC to 31.64 ºC. The temperature was within the optimum range of 24 ºC to 30 ºC required by sweet potato. Sweet potato is a warm loving plant needing relatively high temperature during the growing period (LGU, 2017).

The total average rainfall that occurred in the whole duration of the study was 0.00 millimeter. There were no rainfall that occurred during the conduct of the study. Hence, the area was regularly irrigated throughout the growing season (LGU 2017) to supply the water requirement of growing sweet potato from 750 mm to 1000 mm per annum with about 500 mm falling during the growing season.

The mean (RH) relative humidity ranged from 76.19% to 87.69%. This indicates a warm environment during the growth of the plants. Being a sun-loving crop, it grows best in humid environment. Despite being intercropped between mulberry trees, the growth of sweet potato was favored as mulberries were pruned to provide enough space for the growing of sweet potato plants. At the flowering stage of sweet potato, the mulberry branches were again pruned to give way for sweet potato storage roots to develop. Thus, the synchronized pruning activities in mulberries provided opportunity for sweet potato to grow and develope storage roots.

Months	**Temperature (ºC)**	**Rainfall (mm)**	**Relative Humidity (%)**
January	31.64 (ºC)	0.00	88.69%
February	27.00 (ºC)	0.00	77.45%
March	22.40 (ºC)	0.00	76.19%

Table 9:- Temperature (ºC), Rainfall (mm) and Relative Humidity (%) during the Conduct of the Study
Source: AGROMET Weather Station, DMMMSU-NLUC, Bacnotan, La Union.

V. CONCLUSIONS

1. Any of the varieties of sweet potato could be intercropped in mulberry trees. However, for higher survival, Seven Flores, Immitlog and Seri Kenya could be used.
2. No interaction between variety x fertilization in all growth and yield parameters of sweet potato varieties.
3. Mulberry trees were favored to the growth and yield of sweet potato varieties during the conduct of the study.
4. The climatological data (temperature range, relative humidity and warm environment) that prevailed during the growing seasons were favorable for the growth of sweet potato varieties except for the rainfall.
5. Soil pH increased, organic matter increased, while available P and K decreased after the growing period of sweet potato varieties applied with different fertilization strategies.

RECOMMENDATIONS

Based on the above findings, the following recommendations were derived: Intercropping of Immitlog variety and Seven Flores variety in mulberry trees could be adopted due to the production of highest storage roots per subplot and hectare and consequently highest income. The fertilizer application of ½ RR organic and ½ RR inorganic and RR inorganic N alone were the two systems that produced the highest yield of storage roots and consequently highest income.

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