YIELD & SUGAR PERFORMANCE OF SWEET POTATO (Ipomoea batatas L.) VARIETIES TO FERTILIZATION STRATEGIES AS INTERCROPPED IN MULBERRY TREES

1Marjohn V. Anislag, 2Ludy G. Alsong, 3EdilmarP. Masuhay,

1, 2 & 3Surigao State College of Technology, Magpayang, Mainit,
Surigao Del Norte Philippines

IJASR 2020
VOLUME 3
ISSUE 1 JANUARY - FEBRUARY **ISSN: 2581-7876**

Abstract – Agroforestry is the combination of agriculture and forestry practices within a farming system. It involves the combination of trees and crops that increase the environmental and economic value of land while sustaining food security. Among the agroforestry systems that would be an effective tool to solve land degradation, poverty and malnutrition is intercropping. Intercropping is a sustainable practice to increase diversity and productivity in farming system. High value agricultural crops like sweet potato and trees like mulberry applied with different fertilization strategies is an efficient intercropping system. This study was laid out in a 4 x 4 following the split plot RCB factorial design replicated three times. The following factors were tested: main plot (V1 – Seven Flores, V2 – Seri Kenya, V3 – Immitlog and V4 - Violeta) and subplot (F0 – No fertilizer application, F1 – RR 100% chicken compost, F2 – RR 100% urea and F3 – 50% RR chicken compost + 50% Urea).

Results of the study revealed that as to the effect of sweet potato varieties, Immitlog variety had the highest yield of 6.97 kg per subplot and 55,766.67 kg per hectare. On the effect of fertilization strategies sweet potato plants applied with 50% RR chicken compost + 50% urea had produced the highest yield per subplot of 5.97 kg and 47,766.67 kg per hectare. There was no significant effect in between sweet potato varieties and fertilization strategies on yield of sweet potato as intercropped in mulberry trees. And the plants applied with 100% RR Urea and 100% RR Chicken Compost significantly influenced on the sugar content of the sweet potato tubers as intercropped in mulberry trees.

Keywords: Sweet Potato Varieties, Mulberry, Fertilization Strategies, Yield and Performance

I. INTRODUCTION

People in 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). In the Philippines widespread poverty continues to be a big problem (De Guzman, et al., 2015). This study was conducted to help the poor people in the Philippines likewise the poor people in the world how to solve the poverty and malnutrition status they faced. The information of this study would give awareness of the people in the world about sustainable agriculture like the intercropping of high-value agricultural crop like sweet potato and tree like mulberry is the best measure to solve malnutrition and poverty (Padilla et al., 1999). Nowadays, in order to have sound growth and develop plants normally, fertilizer must be applied. This study was used organic fertilizer (chicken compost) and inorganic fertilizer (urea) as recommended by the (Bureau of Soils, 2018). The recommended rate for sweet potato was 60+0+0 kg NPK/ha while the recommended rate organic fertilizer (chicken compost) was three (3) tons per hectare (Otanes, et al., 2018).

Mousavi et al., (2011) stated that intercropping is among the ways to increase diversity in an agricultural ecosystem. Crops yield increases with intercropping due to higher growth rate, reduction of weeds pests and diseases and more effective use of resources. Sweet potato and mulberry trees could be intercropped with other crops & their role is a key source of income for small scale farmers (Abidin et al., 2017) and (Islam, et al., 2014). Ezin, et al., (2018) mentioned that sweet potato plays and important role of ensuring food security and incomes for local community. 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. According to Ghost, 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. Mulberry silk contributes around 90% of the total 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 food stuff. The mulberry bark and wood are also useful for manufacturing of paper and sports good items. 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, complete and urea on the growth and tuber yield of sweet potato revealed that number of leaves were significantly in all treatments. Application of Urea fertilizer produced the highest number of tuber per plant while tuber weight was not significantly affected. Chicken manure application had the higher mean value of 2.34 kg.

In the Philippines and other countries of the world, have no studies been conducted about yield performance of sweet potato (Ipomoea batatas L.) to fertilization strategies (100% RR chicken compost, 100% RR urea and 50% RR chicken compost + 50% RR urea) as intercropped within mulberry trees.

Hence, this study on yield performance of sweet potato (Ipomoea batatas L.) to fertilization strategies as intercropped within mulberry trees was conducted.

II. OBJECTIVES

1. Determined the sweet potato variety that gave the best yield as intercropped in mulberry trees;
2. Determined the appropriate fertilization strategy to sweet potato as intercrop in mulberry trees;
3. Determined the interaction effect between sweet potato varieties and fertilization strategies on the yield of sweet potato; &
4. Determined the sugar content of sweet potato tubers applied with different fertilization strategies as intercropped in mulberry trees.

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. The treatments used were as follows:

Main plot: Sweet potato varieties (V), Subplot: Fertilization Strategies (F)

Main Plot	Subplot
V_1 - Seven Flores	F_0 - No Fertilizer Application (control)
V_2 - Seri Kenya	F_1 - Organic Fertilizer (RR 100% Chicken Compost - 3t/ha)
V_3 - Immitlog (Check Variety)	F_2 – Inorganic Fertilizer (RR 100% Urea – 60kg/ha
V_4- Violeta	F_3 – 50% RR Chicken Compost + 50% RR urea

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. 1. Experimental Lay out

Legend:
Main plot - (Sweet potato varieties)   Subplot - (Fertilization Strategies)
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

Experimental Procedure

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 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 of 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. 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 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 as recommended by (Abidin et al., 2017) and (Sweet Potato Production Guide, 2018).

Collection of sweet potato tubers juice per variety was done through extracting & got 10 ml as sample to be analyzed and read using the brix meter as sugar content measuring tool.

Data Gathered

A. Percent Survival 30 Days after Planting (DAP). This was determined by dividing the number of cuttings planted multiplied by x 100. This was computed using this formula:

S (%) = NSC x100

TNCP

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

B. Yield per Subplot and Hectare. This was gathered by weighing the storage roots per plant with the use of a weighing balance.

C. Interaction Effect bet. Sweet potato varieties and Fertilization Strategies. This was done by means of analyzing the collected to data using the RCBD ANOVA in split plot design.

D. Sugar Content. This was done by means of analyzing the extracted juice of sweet potato tubers by the use of brix meter in ml.

IV. Results and Discussion

Table 1 presents the yield of sweet potato as affected by sweet potato varieties per subplot and hectare as intercropped in mulberry trees. The highest yield per subplot and hectare observed from the variety of Immitlogwith a mean of 6.97 kg per subplot and 55,566.67 kg per hectare. While the lowest yield observed from the Seri Kenya variety with a mean of 3.20 kg per subplot and 25,566.67 kg per hectare. Comparison among treatment means Seven Flores and Immitlog variety were significant higher over Seri Kenya and Violeta variety. The significant effect of sweet potato varieties on the yield per subplot and hectare of sweet potato is the same with the result of the study conducted by (Zewide et al., 2012). This implies that the Seven Flores and Immitlog variety are the best sweet potato varieties could be intercropped in mulberry trees.

Table 1. Yield of sweet potato as affected by the sweet potato varieties as intercropped in mulberry trees.

Sweet Potato Varieties	**Yield** Sub.(kg)	Ha. (kg)
V_1 - Seven Flores	5.76a	46100.00ab
V_2 - Seri Kenya	3.20b	25566.67c
V_3 - Immitlog	6.97a	55766.67a
V_4 - Violeta	3.60b	28800.00bc

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

Table 2 presents the yield of sweet potato varieties as affected by the fertilization strategies per subplot and hectare. The highest yield per subplot and hectare were observed from the plants applied with 50% RR Chicken Compost + 50% RR Urea with a mean of (5.97 kg) per subplot and (47,766.67 kg) per hectare while the lowest yield were observed from the plants without fertilizer application with a mean of 4. 23 kg per subplot and 33,833.33 kg per hectare.

Fertilizers were used in the study significantly influenced the yield of sweet potato tubers per subplot and hectare. Comparison among the treatment means revealed that the plants applied with 50% RR Chicken Compost + 50% RR Urea and 100% RR Urea werecomparable with each other and significant higher yield of tubers per subplot and hectare over the plants with no fertilizer application and the plants applied with 100% Chicken Compost.

This implies that the 50% RR Chicken Compost + 50% RR Urea and 100% RR Urea were the best fertilization strategies favored to the growth and production of heaviest tubers of sweet potato varieties.

Table 2. Yield of sweet potato varieties as affected by the fertilization strategies as intercropped in mulberry trees.

Fertilization Strategies	**Yield** S(kg)	H (kg)
F_0	4.23 b	33833.33 c
F_1	4.38 b	35066.67 bc
F_2	4.95 a	39566.67 ab
F_3	5.97 a	47766.67 a

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

INTERACTION EFFECT

Table 3 presents the interaction effect in between sweet potato varieties and fertilization strategies.Statistical analysis revealed that there is no significant effect in between the sweet potato varieties and fertilization strategies on the yield performance of sweet potato as intercropped in mulberry trees. This is because the mulberry trees were bottom pruned 50 cm from the ground 60 DAP to avoid shed on the growing sweet varieties.

Table 3. Presents the interaction effect in between sweet potato varieties and fertilization strategies.

SOURCE	**Yield**	
VXF	Yield Per Subplot (KG)	Yield Per Hectare (KG)
TAB. F. VAL. 0.05 0.01	F. VALUE	

2.30	3.25	1.11 ns	1.34 ns

Table 4 presents the effect of fertilization strategies on the sugar content of sweet potato tubers as intercropped in mulberry trees.The highest level of sugar content of sweet potato tubers were observed from the plants applied with 100% RR urea while the lowest level of sugar content of sweet potato tubers were observed from the plants with no fertilizer application.

Statistical analysis revealed that the fertilization strategies were used in the study significantly influenced on the sugar content of sweet potato tubers. Comparison among the treatment means showed that 100 % RR chicken compost & 100 % RR urea were comparable with each other and significant higher influenced on the sugar content of sweet potato tubers over the plants applied with 50% RR Chicken Compost + 50% RR Urea and the plants with no fertilizer application. This result is the same result of the study conducted by (Enzin et al., 2018).

This implies that the 100% RR Chicken Compost and 100% RR Urea are the fertilization strategies improved the sugar content sweet potato tubers as intercropped in mulberry trees.

Table 4. Effect of fertilization strategies on the sugar content of sweet potato tubers as intercropped in mulberry trees.

Fertilization Strategies	Sugar Content of Sweet Potato (ml)
F_0	9.98 b
F_1	10.24 a
F_2	10.25 a
F_3	9.78 b

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

CONCLUSION

This study is concluded that Immitlog and Seven Flores are the best sweet potato varieties could be intercropped in mulberry trees due higher yields and consequently higher income. 50% RR Chicken Compost + 50% Urea fertilization strategy is the best fertilizer that the sweet potato varieties produced heaviest tubers per plant. There is no significant effect sweet potato varieties and fertilization strategies on the yield performance of sweet potato as intercropped in mulberry trees. And 100% RR Chicken Compost and 100% RR Urea help to improve the sugar content of sweet potato tubers as intercropped in mulberry trees.

RECOMMENDATION

Based on the above findings the following recommendations were derived: Immitlog and Seven Flores sweet potato varieties are the best to be intercropped in mulberry trees due higher yields and consequently higher income. As to the fertilization strategy 50% RR Chicken Compost + 50% RR Urea is the best fertilizer to be applied of growing sweet potato varieties as intercropped in mulberry trees. This fertilizer helps to develop and produce heaviest tubers of sweet potato. There is no significant effect of sweet potato varieties and fertilization strategies on the yield of sweet potato as intercropped in mulberry trees. However, Immitlog and Seven Flores sweet potato varieties applied with 50% RR Chicken Compost + 50% RR Urea and 100% RR Urea produced heaviest tubers per subplot and hectare.

If the concern of the future research is to produce sweetest tubers of sweet potato application of 100% RR Chicken Compost and 100% RR Urea are highly recommended.

REFERENCES:

1. Abidin, P. E, Carey, E. Mallubhotla, S. &Sones, K. (2017). Sweetpotato Cropping Guide. Retrieved on February 02, 2019 from File:///C:/Users/Dell/Downloads/Ashc-English-Sweet-Potato-A5-Colour-Highres.Pdf;
2. Adeyeye, A. S, Akanbi, W.B, Sobola, O.O, Lamidi, W.A & Olalekan, K.K. (2016). Comparative Effect of Organic and In-Organic Fertilizer Treatment on the Growth and Tuber Yeild of Sweet Potato (Ipomea batatas L). Retrieved on September 02, 2018 from Http://Www.Conscientiabeam.Com/Pdf-Files/Agr/70/Ijsar-2016-3(3)-54-57.Pdf;
3. Bureau of Soils (2018). Department of Agriculture Region 1, San Fernando City, La Union, Philippines;
4. Deguzman, L. E. P & Zamora, O. B. & Bernardo, D. F. H. (2015). Diversified and Integrated Farming Systems (Difs): Philippine Experiences for Improved Livelihood and Nutrition. Retrieved on February 02, 2019 From Https://Www.Researchgate.Net/Publication/281430256_Diversified_and_Integrated_Farming_Systems_Difs_Philippine_Experiences_For_Improved_Livelihood_And_Nutrition;
5. Enzin, V., Quenum, F., Bodjrenou, R. H., Kpanougo, C. M. I., Kochori, E. M. G., Chabi, B. I., &Ahanchede, A. (2018). Assessment of Production and Marketing Constraints and Value Chain of Sweet Potato in the Municipalities of Dangbo and Bonou. Retrieved on September 02, 2018 from Https://Agricultureandfoodsecurity.Biomedcentral.Com/Articles/10.1186/S40066-018-0164-6;
6. FAO, (2018). Food Security & Nutrition around the World. Retrieved on January 28, 2019 From Http://Www.Fao.Org/State-Of-Food-Security-Nutrition/En/;
7. Ghosh, A., Gangopadhyay, D. B. & Chowdhury, T. (2017). Economical and Environmental Importance of Mulberry: A Review. Retrieved on September 03, 2018 from Https://Www.Researchgate.Net/Publication/321926579_Economical_and_Environmental_Importance_of_Mulberry_A_Review;
8. Islam, M. N., Akhteruzzaman, M., Alom, M. S., &Salim, M. (2014). Hybrid Maize and Sweet Potato Intercropping: A Technology to Increase Productivity and Profitability for Poor Hill Farmers in Bangladesh. Retrieved on September 03, 2018 from File:///C:/Users/Dell/Downloads/21922-78548-1-Pb%20(1).Pdf;
9. Mousavi, S. R. & Eskandari, H. (2011). A General Overview on Intercropping and Its Advantages in Sustainable Agriculture. Retrieved on October 23, 2018 from File:///C:/Users/Dell/Downloads/J.Appl.Environ.Biol.Sci.111482-4862011.Pdf;
10. Okonya, J. S., Mwanga, R. O., Syndikus, K., & Krochel, J. et al. (2014). Insect Pests of Sweet Potato in Uganda: Farmers' Perceptions of their Importance and Control Practices. Retrieved on February 2, 2019 from Https://Www.Ncbi.Nlm.Nih.Gov/Pmc/Articles/Pmc4169129/;
11. Otanes, M. J. & Picazo, M. O. (2018). Republic of the Philippines, Office of the Provincial Agriculturist, Province of La Union;
12. Padilla, E. F. Caccam, MM, Dacayanan GP and RD Supsup. 1999. Improved Productivity and Profitability in Sericulture Through Cropping Systems. Paper Presented to the ILLARRDEC Regional Symposium on R and D Highlights. August 9-11, 2002. Mariano Marcos Memorial State University, Batac, Ilocos Norte.Schlueter, C. (2015). Hilling Potatoes: Why It's Important. Retrieved on February 2, 2019 from Http://Www.Herald-Journal.Com/Farmhorizons/2015-Farm/Hilling-Potatoes.Html;
13. Sweet Potato Production Guide. (2018). Plant Industry Production Guide on Sweet Potato, Bpi Sweet Potato Commodity Profile Da-Eastern Visayas Integrated Agricultural Research Center. Retrieved on September 02, 2018 from Https://Businessdiary.Com.Ph/4609/Sweet-Potato-Production-Guide/;
14. Zannou, A., Gbaguidi, M. A., &Dahouenon, E. A. (2017). Synthesis of Research on Sweet Potato (Ipomoea Batatas L.) with a View to Its Valorization: A Review. Retrieved on September 02, 2018 From File:///C:/Users/Dell/Downloads/1-1-50-499.Pdf;
15. Zewide, I., Mohammed, A. & Tulu S. (2012). Effect of Different Rates of Nitrogen and Phosphorus on Yield and Yield Components of Potato (Solanum Tuberosum L.) at Masha District, Southwestern Ethiopia. Retrieved on April 25, 2019 Https://Scialert.Net/Archivedetails.Php?Issn=1816-4978&Issueno=28