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Fertilization strategies on Mulberry (*Morus alba* L. var. Alfonso) plants under sweet potato-based agroforestry system

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Key words: Mulberry, Growth yield performance, Sweet potato varieties, Fertilization strategies, Intercropping scheme

Abstract

This study aimed to determine the growth yield performance per plant of mulberry (*M. alba* L. var. Alfonso) in terms of fresh weight biomass yield (g), number of shoots, weight of shoots, length of the longest shoot (cm), diameter of the longest shoot (mm), number of leaves and weight of leaves as influenced by fertilization strategies intercropped with sweet potato (*Ipomea batatas* L.) varieties. Results of the study revealed that the plants applied with RR 100% Chicken Compost, RR 100% Urea & RR 50% Chicken Compost + RR 50% Urea were comparable with each other and significantly favored on the fresh weight biomass yield (g), number of shoots, weight of shoots (g), length of the longest shoot (cm), diameter of the longest shoot (mm), number of leaves and weight of leaves (g) per mulberry (*M. alba* var. Alfonso) plant intercropped with sweet potato varieties over the plants with no fertilizer application. Consequently, the fertilization strategies prominently favored on the growth yield performance of mulberry (*M. alba* var. Alfonso) plant. This intercropping scheme as agroforestry practice provides additional income, increase carbon stocks in soil and woody biomass and maintain the most soil fertility properties. It further contributes to climate change mitigation through reforestation and carbon sequestration. The use of RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea is recommended to mulberry (M. alba var. Alfonso) tree plantations intercropped with high value agricultural crops like sweet potato.

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Introduction

There is existing challenge at present in terms of malnutrition status and food shortage not only in the Philippines but to other parts of the world as well. The call now for research and development 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, 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) one of the agroforestry systems such as intercropping can be used to increase crop yields through resource partitioning and facilitation in addition to achieve greater productivity. And in addition to that, 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.

An agricultural crop, sweet potato, *Ipomea batatas* L. can be used to intercrop with other crops. *I. batatas* L. is an important food crop for humans and animals due to its desirable starch, sugar, protein and vitamin content (Ozturk *et al.*, 2012). According to Serenje & Mwala, (2010), the nutritional significance of sweet potato has increased along with its role as a key source of income for small-scale farmers. 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 monocropping. 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).

In the Philippines, common characteristics of sweet potato are long and tapward tuberous root with a 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). 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).

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 into mulberry (*Morus alba L.* var. Alfonso) trees. *M. alba L.* var. Alfonso variety 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, and being used for many other purposes also. 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 manufacturing of paper and sports goods items.

On the other hand, balanced fertilization is imperative to provide good growth and development to both mulberry and sweet potato plants. Yeng *et. al.* (2012) concluded that organic and inorganic input combinations for mineral supplementation in sweet potato production is a better option than either of organic and in-organic input applied singly. A combination of 150kg 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 100kg 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.

The recommended rate for sweet potato was 60-0-0kg NPK/ha while the recommended rate organic fertilizer (chicken compost) was three (3) tons per hectare by Otanes, *et al.,* (2018). For mulberry plants, the recommended rate of inorganic fertilizer NPK complete (14-14-14) was (300-120-120kg NPK/ha) applied in 5 split doses throughout the year; first dose application was (60-60-60) as recommended by the Technical Services Unit of SRDI by Apilado *et al.* (2018).

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 numbers of leaves were significant in all the 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 2.34kg. In a field study conducted by Shinde, *et al.* (2012) clearly indicated that T3 (NPK) complete fertilizer showed highly significant leaf weight as compared with other treatment of fertilizers. Impact of N (Urea) fertilizer on the productivity of mulberry *(Morus alba* L.*)* showed positive results.

In this study, the researcher investigated the growth yield performance of mulberry (*M. alba* var. Alfonso) trees intercropped with varieties of sweet potatoes utilizing combination of organic (chicken compost) fertilizer and inorganic fertilizer (Urea).

Materials and methods

Research Design

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

Sweet Potato Varieties	Fertilization strategies
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

Research Procedures

Land preparation

A total of 480 sq m of land was prepared by removing all unwanted plants and materials by the use of sharp bolo, sacks, baskets and wheelbarrows.

Pruning

Three-year old mulberry (*M. alba* var. Alfonso) trees planted at the experimental area of the Sericulture Research and Development Institute of Don Mariano Marcos Memorial State University North La Union Campus, Sapilang, Bacnotan, La Union, Philippines were bottom pruned 30cm from the ground by the use of pruning shear and saw.

Irrigation

Two days before land cultivation the mulberry (*M. alba* var. Alfonso) trees were flood irrigated to make the soil soft and provide moisture content. Second irrigation was done two weeks from pruning and consecutive irrigation was done two weeks interval until the termination of the study to facilitate the growth of shoots and leaves.

Land Cultivation

Two days after irrigation the strips of mulberry plantation were cultivated by the use of farm tractors. Furrowing. Furrows were constructed in between the strips of the mulberry (*M. alba* var. Alfonso) trees plantation with the use of the carabao-drawn plow 25cm deep and 20cm wide.

Fertilizer application

Recommended rate fertilizers based on the soil analysis result from Department of Agriculture Bureau of Soils in Region 1, Philippines were basally applied & buried in between the constructed furrows then were covered by the soil right after the application. Second application was done 25 days after the first application utilizing the various treatments indicated for investigation.

Hilling up management

This was done 15 days after the first fertilizer application to cover the root systems of mulberry (*M. alba* var. Alfonso) trees.

Weeding

This was done every last week of the month to control the growth of unwanted plants.

Harvesting

This was done 60 days after pruning (DAP). The shoots and leaves were harvested by the use of pruning shear and placed in a cloth bag to avoid wilting and were placed in a cool storage room building for data gathering procedure. Harvesting of sweet potato was done 90 days after planting. The vines with storage roots were then uprooted and the tubers were handpicked and placed in net bags for data gathering.

Data Gathered

Fresh weight biomass yield (g) per plant. This was done by weighing the harvested leaves and shoots per plant. Number of shoots per plant. This was done by counting the number of shoots developed per plant. Weight of shoots (g) per plant. This was done by removing all the leaves attached to the shoots per plant then the shoots were weighed using the electronic weighing scale. Length of the longest shoot (cm) per plant. This was done by measuring the length of the longest shoot per plant using the meter stick. Diameter of the longest shoot (mm) per plant. This was done by measuring the diameter of the longest shoot with the use of a digital tree caliper.

Number of leaves per plant.

This was done by counting all the leaves attached per plant shoot.

Weight of leaves (g) per plant

This was done by weighing the leaves using the electronic weighing scale. Yield of sweet potato tubers. Tubers of the sweet potato varieties were sorted and weighed using the electronic weighing scale.

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 (LSD) test.

The economic analysis was determined through net income production considering the inputs and outputs generated in the intercropping systems which were gathered and recorded as basis of computing the net returns.

Production (material and labor) inputs were quantified and computed with the prevailing market prices. Outputs concentrated in two major products as storage roots for sweet potato and leaves for mulberry. These were quantified and computed using the prevailing market prices. Net income or net returns was estimated as Gross income – total production cost (material, labor and fixed cost and contingency cost).

Results and discussion

Growth Yield Performance of Mulberry (M. alba var. Alfonso) Plant

Fresh weight biomass yield (g)

Table 1 and Fig. 1 present the fresh weight biomass yield (g) per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by fertilization strategies 60 DAP. The highest fresh weight biomass yield was observed from the plants applied RR 50% Chicken Compost + RR 50% Urea with a mean of 370.96g followed by the plants applied RR 100% Chicken Compost with a mean of 366.96g and the plants applied RR 100% Urea with a mean of 339.25g while the lowest fresh weight biomass yield were observed from the plants with no fertilizer application with a mean of 93.69g.

Table 1. Fresh Weight Biomass Yield (g) per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Fertilization Strategies	Fresh Weight Biomass Yield (g)
F_0 - No Fertilizer Application (control)	93.69 b
F_1 - RR 100% Chicken Compost	366.96 a
F_2 - RR 100% Urea	339.25 a
F_3 - RR 50% Chicken Compost + 50% Urea	370.96 a

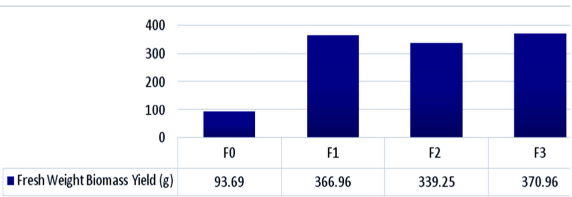

Fig. 1. Fresh Weight Biomass Yield (g) per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Statistical analysis showed that there was a significant effect of fertilization strategies on the fresh weight biomass yield (g) of mulberry (*M. alba* L. var. Alfonso) tree. Comparison among means revealed that the plants applied RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea were comparable with each other and significantly higher over the plants with no fertilizer applications. This result implies that RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea favored on the fresh weight biomass yield (g) of mulberry (*M. alba* L. var. Alfonso) tree.

Number of shoots

Table 2 and Fig. 2 present the number of shoots per plant of the mulberry (*M. alba* L. var. Alfonso) tree as influenced by fertilization strategies 60 DAP. The highest number of shoots were observed from the plants applied RR 50% Chicken Compost + RR 50% Urea with a mean of 8.00 followed by the plants applied RR 100% Chicken Compost with a mean of 7.00 and the plants applied RR 100% Urea with a mean of 6.00. The lowest number of shoots observed from the plants with no fertilizer application had a mean of 3.00. Statistical analysis revealed that there was a significant effect of fertilization strategies on the number of shoots of mulberry (*M. alba* L. var. Alfonso) tree.

Table 2. Number of Shoots per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Fertilization Strategies	Number of Shoots per Plant
F_0 - No Fertilizer Application (control)	3.00 b
F_1 - RR 100% Chicken Compost	7.00 a
F_2 - RR 100% Urea	6.00 a
F_3 - RR 50% Chicken Compost + 50% Urea	8.00 a

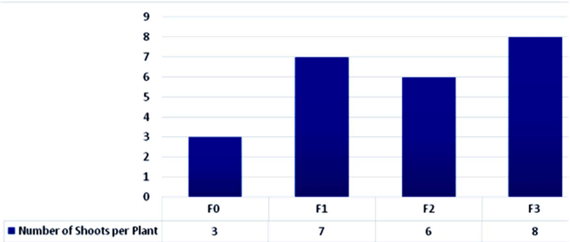

Fig. 2. Number of Shoots per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Comparison among means showed that the plants applied RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea were comparable with each other and significantly higher over the plants with no fertilizer applications. This result implies that RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea favored on the production of shoots of mulberry (*M. alba* L. var. Alfonso) tree.

Weight of shoots (g)

Table 3 and Fig. 3 present the weight of shoots per plant mulberry (*M. alba* L. var. Alfonso) tree as influenced by fertilization strategies 60 DAP. Heaviest shoots were observed from the plants applied RR 100% Urea with a mean of 103.92g followed by the plants applied RR 50% Chicken Compost + 50% RR Urea with a mean of 102.96g and the plants applied RR 100% Chicken Compost with a mean of 101. 33g while the least weight of shoots were observed from the plants with no fertilizer application had a mean of 22.50g.

Table 3. Weight of Shoots (g) per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Fertilization Strategies	Weight of Shoots (g)
F_0 - No Fertilizer Application (control)	22.50 b
F_1 - RR 100% Chicken Compost	101.33 a
F_2 - RR 100% Urea	103.92 a
F_3 - RR 50% Chicken Compost + 50% Urea	102.96 a

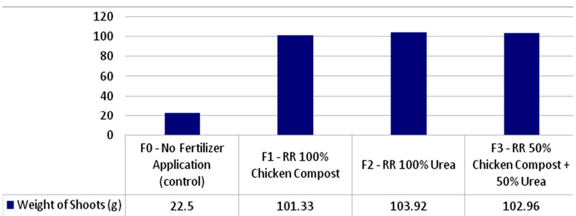

Fig. 3. Weight of Shoots (g) per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Statistical analysis showed that there was a significant effect of fertilization strategies to the weight of shoots of mulberry (*M. alba* L. var. Alfonso) tree. Comparison among means revealed that the plants applied RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea were comparable with each other and significantly higher over the plants with no fertilizer applications. This result implies that RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea were favored on the weight of shoots of mulberry (*M. alba* L. var. Alfonso) tree.

Length of the longest shoot (cm)

Table 4 and Fig. 4 present the length of the longest shoot (cm) per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by fertilization strategies 60 DAP. The longest length of shoot were observed from the plants applied RR 100% Urea with a mean of 98.55cm followed by the plants applied RR 100% Chicken Compost with a mean of 97.07cm and the plants applied RR 50% Chicken Compost + 50% Urea with a mean of 96.96cm while the shortest length of shoot were observed from the plants with no fertilizer application had a mean of 85.53cm.

Table 4. Length of the Longest Shoot (cm) per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Fertilization Strategies	Length of the Longest Shoot (cm)
F_0 - No Fertilizer Application (control)	85.53 b
F_1 - RR 100% Chicken Compost	97.07 a
F_2 - RR 100% Urea	98.55 a
F_3 - RR 50% Chicken Compost + 50% Urea	96.96 a

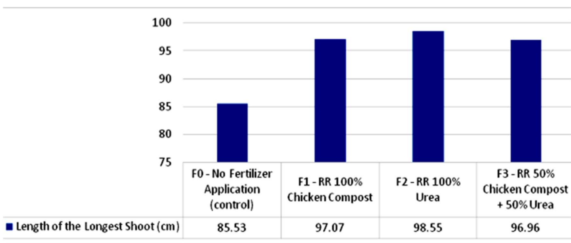

Fig. 4. Length of the Longest Shoot (cm) per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Statistical analysis showed that there was a significant effect of fertilization strategies on the length of the longest shoot of mulberry (*M. alba* L. var. Alfonso) tree.

Comparison among means revealed that the plants applied RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea were comparable with each other and significantly higher over the plants with no fertilizer applications. This result implies that RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea were favored on the development & growth of shoots of mulberry (*M. alba* L. var. Alfonso) tree.

Diameter of the longest shoot (mm)

Table 5 and Fig. 5 present the diameter of the longest shoot per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

The highest diameter of the longest shoot of mulberry (*M. alba* L. var. Alfonso) tree were observed from the plants applied RR 100% Chicken Compost with a mean of 3.80mm followed by the plants applied RR 100% Urea with a mean of 3.56mm and the plants applied RR 50% Chicken Compost + RR 50% Urea with a mean of 3.46mm while the lowest diameter of the longest shoot were observed from the plants with no fertilizer application with a mean of 1.51mm.

Table 5. Diameter of the Longest Shoot (mm) per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Fertilization Strategies	Diameter of the Longest Shoot (mm)
F_0 - No Fertilizer Application (control)	1.51 b
F_1 - RR 100% Chicken Compost	3.80 a
F_2 - RR 100% Urea	3.56 a
F_3 - RR 50% Chicken Compost + 50% Urea	3.46 a

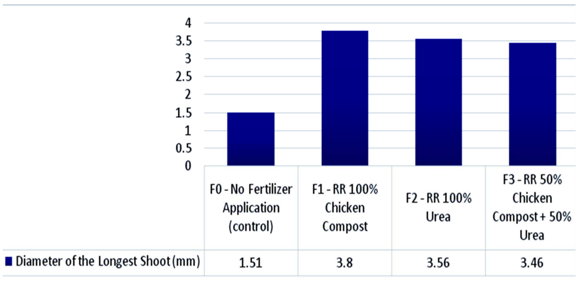

Fig. 5. Diameter of the Longest Shoot (mm) per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Statistical analysis showed that there was a significant effect of the fertilization strategies on the diameter of the longest shoot (mm) of mulberry (*M. alba* L. var. Alfonso) tree. Comparison among means revealed that the plants applied with RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea were comparable with each other and significantly higher over the plants with no fertilizer applications. This result implies that RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea were favored on the increment of the diameter of mulberry (*M. alba* L. var. Alfonso) tree.

Number of leaves

Table 6 and Fig. 6 present the number of leaves per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP. The highest number of leaves were observed from the plants applied RR 100% Chicken Compost with a mean of 119.17 followed by the plants applied RR 50% Chicken Compost + RR 50% Urea with a mean of 119.04 and the plants applied RR 100% Urea with a mean of 104.52 and the lowest number of leaves were observed from the plants with no fertilizer application had a mean of 63.08.

Table 6. Number of Leaves per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Fertilization Strategies	Number of Leaves
F_0 - No Fertilizer Application (control)	63.08 b
F_1 - RR 100% Chicken Compost	119.17 a
F_2 - RR 100% Urea	104.52 a
F_3 - RR 50% Chicken Compost + 50% Urea	119.04 a

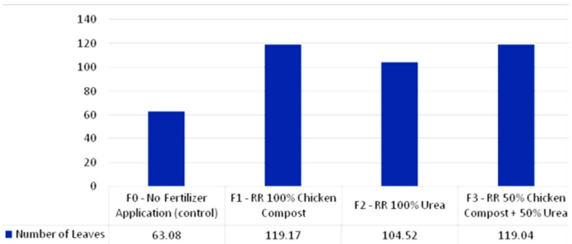

Fig. 6. Number of Leaves per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Statistical analysis showed that there was a significant effect of fertilization strategies on the number of leaves of the mulberry (*M. alba* L. var. Alfonso) tree. Comparison among means revealed that the plants applied with RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea were comparable with each other and significantly higher over the plants with no fertilizer applications. This result implies that RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea were favored on the production of the most number of leaves of the mulberry (*M. alba* L. var. Alfonso) tree.

Weight of Leaves (g)

Table 7 and Fig. 7 present the weight of leaves (g) per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP. The heaviest weight of leaves were observed from the plants applied RR 50% Chicken Compost + RR 50% Urea with a mean of 209.46g followed by the plants applied RR 100% Chicken Compost with a mean of 201.33g and the plants applied RR 100% Urea with a mean of 183.01g. Least weight of leaves observed from the plants with no fertilizer application had a mean of 47.63g.

Table 7. Weight of Leaves (g) per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Fertilization Strategies	Weight of Leaves (g)
F_0 - No Fertilizer Application (control)	47.63 b
F_1 - RR 100% Chicken Compost	201.33 a
F_2 - RR 100% Urea	183.01 a
F_3 - RR 50% Chicken Compost + 50% Urea	209.46 a

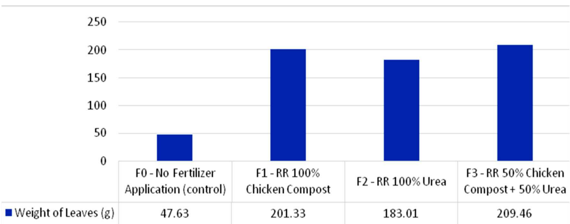

Fig. 7. Weight of Leaves (g) per plant of mulberry (*M. alba* L. var. Alfonso) tree as influenced by Fertilization Strategies 60 DAP.

Statistical analysis showed that there was a significant effect of fertilization strategies on the weight of leaves of the mulberry (*M. alba* L. var. Alfonso) tree. Comparison among means revealed that the plants applied RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea were comparable with each other and significantly higher over the plants with no fertilizer applications. This result implies that RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea were favored on the production of heaviest leaves of the mulberry (*M. alba* L. var. Alfonso) tree.

It can be noted that the use of organic fertilizer and the combination of organic and inorganic fertilizers as fertilization strategies contributed to the high yields of mulberry (*M. alba* var. Alfonso) plant in terms of weight biomass yield (g), number and weight of shoots, length of the longest root (cm), diameter of the longest shoot (mm), number and weight of leaves per mulberry (*M. alba* var. Alfonso) plant.

The robust growth and development of the mulberry (*M. alba* var. Alfonso) plant dispenses attributes of the plant's role in reforestation and carbon sequestration which was manifested to strengthen the review of Gulab Khan Rohela, *et al.* (2020) on mulberry (Morus spp.) as an ideal plant for sustainable development.

Reforestation with mulberry plantation facilitates restoration of soil carbon, preservation of water holding capacity of soils, enhancing soil nutrients, nurturing of soil micro flora, and upgrading air quality (Zhang, *et al.*, 1997; Lu *et al.*, 2004; Lin *et al.*, 2008 as cited by Gulab Khan Rohela, *et al.*, 2020).

Furthermore, Lu *et al.* 2004; Ghosh *et al.* 2017 as cited by Gulab Khan Rohela, *et al.* (2020) corroborated that the leaves of mulberry plants have strong ability to absorb air pollutants like carbon dioxide, carbon monoxide, hydrogen fluoride, sulfur dioxide and chlorine from atmosphere. The large mulberry roots in terms of diameter near the stem portion and then decreases rapidly in size; a long rope like structure with secondary and tertiary roots along with root hairs to form fibrous mat-like structure which enables them to uptake high concentrations of carbon pollutants from the soil (Bunger and Thomson. 1938; Farrar, 1995 as cited by Gulab Khan Rohela, *et al.*, 2020).

Economics of Sweet potato Varieties intercropped in Mulberry (M. alba var. *Alfonso) Plant*

The net returns derived in using different fertilization strategies in sweet potato production intercropped in between mulberry trees is shown in Fig. 8.

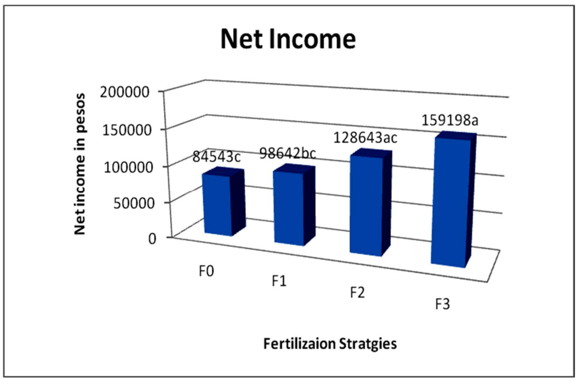

Fig. 8. Net income derived from production system of the varieties of sweet potatoes affected by fertilization strategies.

Net return was highly significantly highest in sweet potato plants applied with ½ RR compost and ½ RR N but comparable to sweet potato plants applied with RR Urea alone that ranked second.

The lowest net income was recorded in unfertilized sweet potato plants followed by plants fertilized by RR chicken compost. The results of this investigation reinforced of that of Rajegowda, *et al.* (2020), describing that in India, most sericulture farmers have small land holdings solely dependent on family labor and limited, simple tools and opted to diversify crops by growing other short-duration crops such as pulses to get additional benefits or income. Similar findings that of Palb, (2013) who found out that intercropping of legumes on mulberry (*Morus alba* L.) trees recorded significantly higher net returns (Rs.26086.1/ha/crop) and B:C ratio (3.2) which was on far from other intercropping systems.

Locally, farmers and researchers of the Sericulture Research and Development Institute (SRDI), Bacnotan, La Union, Philippines which tried intercropping legumes, cereals and other crops yielded promising results. Intercropping cereals and leguminous crops in between mulberry rows could maximize the use of the land particularly during pruning time. Layaoen *et al.* (1999) as cited by Caccam, (2019) found that intercropping corn and peanut increased income of farmers due to combined value of cocoons and intercrops compared to monocropping.

Conclusions

This study concluded that RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea fertilization strategies were prominently favored on the growth yield performance of mulberry (*M. alba* L. var. Alfonso) tree. This intercropping scheme as agroforestry practice can help to increase the income of the farmers, increase carbon stocks in soil and woody biomass and maintain most soil fertility properties. Moreover, this study can contribute to climate change mitigation and adaptation by reducing threats and enhancing agricultural landscape resiliency, facilitating species movement to more favorable conditions, sequestering carbon and reducing greenhouse gas emissions.

Recommendations

This study recommends RR 100% Chicken Compost, RR 100% Urea and RR 50% Chicken Compost + RR 50% Urea to apply the mulberry (*M. alba* L. var. Alfonso) tree plantations as intercrop with high value agricultural crops like sweet potato and other high value crops. In addition, this this study is worth extending to other parts of the Philippines and the world as well, add parameters to be gathered and extend the duration of the study into 90 days and more.

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