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GROWTH AND YIELD PERORMANCE OF SWEET CORN (*Zea mays* L.) INTERCROPPED WITH SWEET POTATO (*Ipomoea batatas* L.) APPLIED WITH MUSHROOM SPENT AND RICE ASH

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ABSTRACT: *The study was conducted to evaluate the growth and yield performance of sweet corn (Zea mays L.) intercropped with sweet potato (Ipomoea batatas L.) and applied with mushroom spent, rice ash as organic fertilizer, and inorganic or commercial fertilizer. It was laid out following the procedures of 3 x 3 factorial Randomized Complete Block Design (RCBD) with three, equal replications. Factors compared were the spatial arrangement of corn and sweet potato as factor A (mono sweet corn, mono sweet potato and intercropped sweet corn with sweet potato), and type of fertilizers such as mushroom spent, rice ash, and inorganic fertilizers as factor B. Production and yield data gathered and compared were the height of corn, days to form tassels, days to form silks, number of corn ears per plant, length of diameter of corn ear, total weight of corn ears (kg), marketable and non-marketable tubers (kg), total weight of tubers produced (kg), and biomass were collected, weighted and compared each treatment of sweet potato. The economics of employing the spatial arrangement and applied fertilizers in the experimental crops were used to determine production costs and return of investment as well as the Land Equivalent Ratio (LER). Application of different fertilizer sources on sweet corn had no significant results on its height, number of ears, length and diameter of ears, total years, marketable and non-marketable ears. Its biomass however varied significantly. Growth and yield performance of corn applied to mushroom spent (organic) and inorganic fertilizer were significantly different. While sweet potato intercropped with sweet corn did not show significant result on the length of vines, marketable and non-marketable tubers and biomass. Sweet potato applied with different fertilizer sources show significant result on length of vines but no significant result on the marketable and non-marketable tubers and biomass. Results of LER of intercropping sweet corn and sweet potato showed a complementary effect with each other.*

Key words: Factor A and B, tubers, biomass

1. INTRODUCTION

Intercropping offers farmers the opportunity to engage nature principles of crop diversity. It can be more productive than growing crops in pure stands. Spatial arrangement of plants, planting rates, and maturity dates are some consideration in intercropping. Crop production in general is attributed to the factors: the size of the area to be cultivated should be extensive; the potential yield of the crop must be increased through breeding, and the last is multiple cropping [7,15].

Corn (Zea mays L.) is a member of family Gramineae. This type of crop is cultivated by Filipino farmers in mono or solo type of cropping system which is very prone to soil erosion and causes depletion of farm land nutrients especially in hilly land beyond 150 elevation. If this type of dangerous system of farming is changed into multiple cropping like intercropping of sweet corn with sweet potato, soil erosion will be minimized and production of crops per unit area will be increased. Sweet corn is grown mainly for human consumption. In the Philippines, 100% of our sweet corn production is used as food. The sweet corn stover left was used as animal feed and the rest for the various types. The rapidly increasing population and the expansion of livestock industry will lead to the great demand for sweet corn in our local markets. The yield of sweet potato varies greatly due to different factors. This crop is also grown mostly in mono or solo type of cropping system by the Filipino farmers but in the recent time there are few local who used this crop in mixed cropping system. Sweet potato was not among the strong competitors of corn in terms of light interception and utilization of other environmental resources available [1] this is because of the creeping growth habit of sweet potato, its ability to grow in poor soils and tolerance to drought. The yield of crops depends on the availability of soil nutrients. Soil that is rich in organic matter is said to be productive. These organic matters are sources of plants nutrients. The source of organic matter can be in the form of animal manure or dung, crop residues including mushroom production wastes. These mushroom wastes are composed of the following materials: the mushroom spent, the waste material from the medium of oyster mushroom after one cropping season and the rice ash which is from rice hulls used in sterilization of medium-bags before the inoculation of the mother spawn to the bag substrates. The most common practice in increasing crop productivity is the use of inorganic fertilizer. The continuous use of this material results to soil acidity and to some extent it requires a large amount of inputs in which local farmers could not meet the recommended amount to be applied per hectare because of financial constraint. As an alternative to reduce the cost of farm inputs, the use of the farm wastes is more appropriate as source of plant nutrients. One strategy is the use of locally available materials as sources of organic fertilizers such as mushroom spent and rice ash. These materials are found to have essential nutrients that can contribute to the growth and yield of the crops. In addition, using organic matter as source of plant nutrients has contribution to soil condition, it maintains the good soil texture and provides aeration making the soil more suitable for the plant growth and development. Organic matter in the soil varies greatly according to the availability of soil elements and types of cultivation practices employed. Generally, organic matter balance is negative in cultivated soil and organic matter content declines at about 2% per year in most tropical ferruginous soils and by some 4% in every soil under continuous cropping (14). The continuous increase in human population and conversion of agricultural lands into subdivisions are the main reasons why farmers need to change their farming system. One strategy to maximize the use of their land resources is to shift from mono cropping to multiple cropping or intercropping. This is the most appropriate practice to increase production yield without expanding the land area to sustain the food demand of mankind. One of the reasons in growing two or more crops together is the increase in productivity per unit area of land. Assessing intercrop performance as compared to pure stand or monoculture is higher in terms of income per unit area of land. Intercropping of sweet corn with sweet potato applied with mushroom spent and rice ash as an organic fertilizer and commercial or inorganic fertilizer are some of the types of multiple cropping where farmers will increase their production expanding without their farm area to answer the problem in food shortage in the near future.

This study was aimed to increase the productivity of agricultural land without expanding the farm area using corn (Zea mays L) intercropped with sweet potato (Ipomoea batatas L) applied with mushroom spent and rice ash as organic fertilizer and commercial or inorganic fertilizer. This is to maximize the use of limited land with optimum yield through intercropping and reducing farm inputs by recycling of agricultural wastes materials and minimized the use of inorganic fertilizer for good physical condition of the soil.

2. MATERIALS AND METHODS

Location and duration of the study

The experiment was conducted at the research area of the Plant Science Department, College of Agriculture, Mindanao State University, Marawi City from August 1, 2005 to December 30, 2005, for a period of four months.

Materials used

Mushroom spent and rice ash are available in the College of Agriculture, MSU, Marawi City. The inorganic/ commercial fertilizer is available in the local markets. Other materials used for this study were bought from the local market. These are the following: Sweet Corn Seeds (Major crop) and Sweet potato Cuttings (Minor crop). The seeds used in the study were secured from the near local markets.

Experimental design used

A three by three (3 x 3) factorial experiment laid out in Randomized Complete Block Design (RCBD) was used in the study. In factor A, there were three (3) treatments and in factor B, three (3) treatments were also tested. There were nine (9) treatments combinations used in the study. Each treatment was replicated three times.

The experimental area was divided into three (3) blocks that correspond to the number of replications. Each block was divided into nine (9) experimental plots for the nine treatment combinations. Randomization was done through drawing of lots for all the twenty-seven plots.

The Experimental field lay-out is shown in figure 1. Each plot was measured 3.0 meters wide and 6 meters long. The distance between replications was 2 meters and 1.5 meters between plots.

The results that showing significant difference were compared using the Duncan Multiple Range Test (DMRT).

Treatments

Factor A (Intercropping) A1–Sweet corn intercropped with sweet potato in 1:1 ratio, A2–Mono sweet corn, A3–Mono sweet potato,

Factor B (Fertilization), B1–purely rice ash organic fertilizer, B2–purely mushroom spent as organic fertilizer, B3– purely commercial as inorganic fertilizer. The following treatment combinations: T1-A1, T4-A2B1, T7-A3B1, T2-A1B2, T5-A2B2, T8-A3B2, T3-A1B3, T6A2B3 and T9-A3B3.

Cultural practices and management

Sampling was done to determine the recommended ratio of fertilizer to be applied in the experimental area in both sweet corn and sweet potato. The area was prepared thoroughly by plowing and harrowing; done two times using the animal drawn plow and alternate harrowing to ensure that the field was properly pulverized. Furrowing was done on the day of planting. Mushroom spent and rice ash as organic fertilizer (20 tons/ha, half dry) in basal application were done two weeks before planting. Incorporation of the mushroom spent and rice ash was done at the last harrowing. Commercial fertilizer was applied in split application, half of the recommended fertilizer was applied during planting and the other half was applied at the 40th days after planting, for sweet corn only following the recommendation based on the soil analysis [6].

Planting

Planting of sweet corn and potato was done simultaneously. For sweet corn, two seeds were sown at a distance of 25 cm between hills and 75 cm between rows. Intercropped sweet corn with sweet potato was done between the furrows of sweet corn. For sweet potato,as the minor crop, the distance of planting was 75 cm between furrows and 25 cm between hills, using one cutting per hill.

Care and maintenance

Seven days after emergence sweet corn was thinned to one plant per hill, living one vigorous seedling per hill. Manual weeding was done regularly Thirty days after planting, hilling up was done manually.

Control of Pests and Diseases

At the early stage of sweet corn, seedling maggots were expected to attack the young sweet corn and this was controlled by the use of furadan.

Harvesting

Sweet corn was harvested at 75 days after planting, while sweet potato was harvested 120 days after planting in manual basis.

3. DATA GATHERED

Data gathered were the following:

for sweet corn (Major crop)

A.1. Plant Height (cm). This was measured from the base of the sweetcorn plant up to the tip of last leaf. This was taken by measuring ten (10) representative sample plants per treatment in each replication at harvest time excluding the tassel.

A.2. Number of days to tassel. This was done by counting the number of days from sowing up to the first appearance of the tassel. Taken from ten (10) sample plants.

A.3. Number of days to silk. This was done by counting the number of days from sowing of sweet corn up to the first emergence of silk. Taken from ten (10) sample plants.

A.4. Number of ears per plant. This was taken from ten (10) sample plants on each replication of all the treatments by counting the number of developed ears per plant.

A.5. Length of ears (cm). This was taken from ten (10) sample plants on each replication of all the treatments by measuring the length of corn ear from the base to tip the ear.

A.6. Land Equivalent Ratio (LER). This was calculated using the formula below;

$$LER = \frac{Yield\ of\ intercropped\ S.corn}{Yield\ of\ Sweet\ corn\ (mono)} + \frac{Yield\ of\ intercropped\ S.potato}{Yield\ of\ Sweet\ potato\ (mono)}$$

A.7. Weight dehusked corn ears. This was done by weighing the dehusked 10 samples plants corn ears per treatment in kilogram (kg).

For sweet potato (Minor crop)

B.1. Vine length (cm).This was done by measuring the length of vine of ten (10) sample plants from each treatment, taken from the base to the tip of the longest vine per plant.

B.2. Weight of marketable and non-marketable tubers (kg). This was done by weighing the marketable tubers and the non-marketable (small, diseased and deformed tubers) tubers.

B.3 Yield of harvested tubers (kg).This was done by getting the average weight of tubers per plot times the number of plot per hectare divided by 1,000 kilograms per ton.

B.4. Land Equivalent Ratio (LER). This was calculated using the formula below;

$$LER = \frac{Yield\ of\ intercropped\ S.corn}{Yield\ of\ Sweet\ corn\ (mono)} + \frac{Yield\ of\ intercropped\ S.potato}{Yield\ of\ Sweet\ potato\ (mono)}$$

Economic analysis

Economic analyses were made for the intercropped sweet corn and sweet potato and monocropped sweet corn and sweet potato.

Computation of Net Income = Gross Income – Cost of Production

$$ROI = \frac{net\ income}{Cost\ of\ production}\ x\ 100$$

Data were analyzed statistically using Analysis of Variance (ANOVA) Randomized Complete Block Design (RCBD) for 3 x 3 factorial experiments. Significant differences between treatment means were compared using Duncan's Multiple Range Test (DMRT).

4. RESULTS AND DISCUSSIONS

Table 1. The height, number of days to tassel and silk, number of ears, length of ears, diameter of ears, biomass and marketable and non-marketable ears of mono-cropped corn applied with mushroom spent, rice ash and inorganic fertilizers did not differ significantly. This showed that growth and yield of mono-cropped sweet corn applied with mushroom spent, rice ash were similar with that applied with inorganic fertilizer.

Height of corn plant (cm)

Table 1 showed that the tallest sweet corn was obtained in mono-cropping with a height of 154.91 cm. while sweet corn intercropped with sweet potato had a mean height of 149.67 cm. The results did not show significant difference with regards the height of sweet corn plants under the two different cropping systems. This result indicated that sweet potato, as an intercrop, did not affect the height of sweet corn. It confirmed the observation that sweet potato was not a strong competitor for sweet corn in terms of light interception and utilization of other environmental resources available [1]. Results on the different cropping systems and different fertilizer sources showed that T1 intercropped with sweet corn was the tallest with a mean of 173.63 cm., followed by T4 (mono-crop), T5 (mono-crop), T6 (mono-crop), T3 (intercrop), and T2 (intercrop) with means of 166.20 cm, 153.37 cm, 145.17 cm, 140.20 cm, and 135.17cm respectively, as shown in Table 1. There is no significant result on the length of plant as affected by the interaction of cropping systems applied with different sources of fertilizer.

There was no significant result on the height of corn plant as affected by different fertilizer sources. The result showed that different fertilizer sources did not have significant difference on the plant height of sweet corn because organic matter content is a sensitive indicator of the state of soil fertility (14).

The result of different cropping systems and fertilizer sources did not affect the plant height of sweet corn whether intercrop or mono-crop systems.

Number of Days to Tassel Table 1 showed that in the number of days to tassel for sweet corn plants as affected by two different cropping systems, the earlier number of days to tassel was recorded from sweet corn plants intercropped with sweet potato with a mean of 51.11 days compared to mono-cropped sweet corn with a mean of 51.22 days. There was no significant result on the effects of different cropping systems on the number of days to tassel.

Table 1, showed that the number of days to silk the sweet corn plant as affected by different cropping systems. It was observed that silk was produced ahead than those plants applied with the other treatments. It obtained a mean of 53.78 no. of days. Followed by the corn plants intercropped with sweet potato which obtained a mean of 55.11 no. of days. The results revealed that there is no significant result on the number of days to silk at different cropping systems.

Table 1. Growth And Yield Performance Of Sweet Corn Mono-Cropped And Intercropped With Sweet Potato Applied With Organic (Mushroom Spent And Rice Ash) And Inorganic Fertilizers

Growth Parameters	Intercrop				Mono-cropped			
	Mushroom Spent	Rice Ash	Inorganic Fertilizer	Mean	Mushroom Spent	Rice Ash	Inorganic Fertilizer	Mean
1.Height of Corn	173.63	135.17	140.20	149.67	166.20	153.37	145.17	154.91
2.No. of Days to tassel	48.00	51.00	54.33	51.11	48.00	54.33	51.33	51.22
3. No. Days to silk	48.00	57.33	60.00	55.11	50.33	54.33	56.67	53.78
4. No. of corn ears	1.95	1.21	1.08	1.41	1.50	1.61	1.40	1.50
5. Length of corn ears (cm)	16.1	12.27	11.40	13.26	14.29	16.18	12.49	14.32
6. Diameter of corn ears (cm)	4.85	3.73	3.54	4.04	4.60	4.60	3.77	4.32
7. Total Corn ears (cm)	1.95	1.21	1.08	1.41	1.50	1.61	1.40	1.50
8. Marketable corn ears (kg.)	1.74	1.01	0.87	1.21	1.07	1.37	0.99	1.14
9. Non-Marketable corn ears (kg.)	0.21	0.20	0.21	0.20	0.43	0.25	0.41	0.36
10. Biomass (kg.)	4.57	6.73	4.30	5.20	6.53	7.60	7.57	7.23

This result implies that the soil organic matter is important as stated by [14] which is; the higher the nutrient content of the soil is, the better is the growth performance of the crop. Likewise, [8] in his article "Bio-Intensive Gardening" said that maximum use of spaced is achieved through companion planting, crop rotation, and multi-stored cropping. Close spacing is recommended. It also promotes biological activity in the soil, as well as a favorable nutrient exchange capacity, water balance, organic matter content, and soil structure. In this way it helps protect the plants against drought, while in clay soils; it helps to add porosity to the soil and helps the soil to drain more easily, so that it does not stay waterlogged and does not dry out into a bricklike substance; ultimately improve plant growth and yield. The favorable effect in the cropping system might have changing the cycle of plant nutrients primarily in the so-called biological cycling instead of geographical [12].Interactions results on the different cropping systems and different fertilizer sources showed that T1 (48.00 days) were earlier to silk. This was followed by T4 (50.33 days), T5 (54.33 days), T6 (56.67 days), T2 (57.33 days), and T3 (60 days) to silk as shown in Table 1.There is no significant result on the number of days to silk as affected by different cropping systems and different sources of fertilizer.

Intercropping system was more stable than single cropping with any of the component crops [5]. Some agronomists are convinced that if soil organic matter is important, then the higher the composition of these matters, the better [14]

Table 1 showed that the intercropped sweet corn treated with rice ash (B1) has a mean of 1.21. Sweet corn plants treated with mushroom spent (B2) has a mean of 1.95, and a mean of 1.08 for the plants treated with inorganic fertilizers (B3). There is no significant result on the number of sweet corn ears per plant at different cropping systems.

In mono-cropped sweet corn, variations in mean data were also revealed, Sweet corn treated with rice ash (B1) has a mean of 1.61, mushroom spent (B2) has a mean of 1.50, commercial fertilizers (B3) has a mean of 1.40 (Table 5). There was no significant result on the application of different sources of fertilizers on sweet corn.

The result on treatment means in intercropping and mono-cropping vary slightly. However, these results indicates that different sources of fertilizer for sweet corn either under intercropping or mono-cropping patterns has no effect on the number sweet corn ears per plant based on statistical results, this was because, the most important reason to grow two or more crops together is the increase in productivity per unit of land[15].

Table 1 showed that the longest length of sweet corn ears was obtained from mono-crop with a mean of 14.32 cm and the shortest was from sweet corn intercropped with sweet potato with a mean of 13.26 cm. There was no significant difference on the length of sweet corn ears as affected by cropping systems.

The length of intercropping sweet corn ears did not differ significantly from the mono-cropping system. It was assumed that intercropped sweet potato did not affect the length of sweet corn ears because sweet potato was not a strong competitor for corn in terms of light interception and utilization of other environmental resources available [1].

Results on the different fertilizers sources revealed that the corn plants applied with mushroom spent (B2) showed the longest sweet corn ears with a mean of 16.10 cm., this was followed by sweet corn applied with rice ash (B1) and inorganic fertilizers (B3) with a mean of 12.27 cm and 11.40 cm, respectively as shown in Table 1. There was no significant result on the application of different sources of fertilizers on the length of sweet corn ears. It has been stated that adequate supply of energy and mineral nutrients are essential for proper growth and development of roots. Initially, it comes from seed, but later, it must come from soil and foliage[7].

Interaction results on the different cropping systems and different fertilizer sources showed that the longest length of sweet corn ears was obtained by T5 (16.18 cm), followed by T1 (16.10 cm), T4 (14.29 cm), T6 (12.49 cm), T2 (12.27 cm), and T3 (11.40 cm) respectively. There was no significant result on the application of different sources of fertilizers on sweet corn at different cropping systems.

Table 1 showed that the biggest diameter of corn ear was obtained from mono-cropped sweet corn with a mean of 4.32 cm, compared to sweet corn intercropped with sweet potato with a mean of 4.04 cm. There was no significant result on the diameter of sweet corn ears as affected by cropping systems. Result on the different fertilizer sources revealed that the sweet corn plants applied with mushroom spent (B2) showed the biggest sweet corn ear diameter with a mean of 4.85 cm, this was followed by sweet corn applied with rice ash (B1) and inorganic fertilizers (B3) with a mean of 3.73 cm, and 3.54 cm, respectively. There was no significant result on the application of different sources of fertilizers on the length of sweet corn ears.

Interaction results on the different cropping systems and different fertilizer sources showed that the biggest sweet corn ear diameter was obtained by T2 (4.85 cm), this was followed by T5 andT4 (4.60cm), T6 (3.77 cm), T1 (3.73 cm), and T3 (3.54 cm). There was no significant difference on the application different sources of fertilizers on diameter of sweet corn ear as affected by cropping systems and different fertilizer sources. The inadequate utilization of applied nutrients by the corn plant would result to poor corn kernel development [14] said that the field with high or perhaps more correctly not too low organic contents always give the best yield of crops.

Table 1 showed the most number of total sweet corn ears was obtained from mono-cropped sweet corn with a mean of 1.50 cm., while sweet corn intercropped with sweet potato obtained a mean of 1.41 cm. There was no significant result on the total number of sweet corn ears as affected by the two different cropping systems.

Intercropping sweet corn was not enough to affect mutual shading and increase the number of barren stalk. This was because the population density used in this study was maximized.

Result on the different fertilizers sources revealed that the sweet corn plants applied with mushroom spent (B2) showed the most number of sweet corn ears with a mean of 1.95. The sweet corn plants applied with rice ash (B1) and inorganic fertilizers (B3) obtained a mean of 1.21 cm. and 1.08 cm. respectively. There was no significant result on the application of different sources of fertilizers on the sweet corn ears.

Interaction results on the different cropping systems and different fertilizer sources showed that the highest number of sweet corn ears was obtained from T1 (1.95 cm). This was followed by T5 (1.61 cm), T4 (1.50 cm), T6 (1.40 cm), T2 (1.21 cm), and T3 (1.08 cm) ears. There was no significant result on the application different sources of fertilizers on the total number of sweet corn as affected by different cropping systems and different fertilizer sources and treatments. This was because of the three fundamental functions of organic matter wherein the yield of sweet corn and sweet potato applied with mushroom spent and rice ash, produced almost the same with sweet corn and sweet potato applied with inorganic or commercial fertilizers. The three fundamental functions mentioned are as follows: promotion of root development, stabilization of the soil structure and mineralization; and the nitrogen cycle which directly affects plants nutrition and soil physical properties like exchange capacity total sweet corn ears as affected and acidity of the soil [14].

Table 1 showed that the highest weight of marketable sweet corn ears was obtained from sweet corn intercropped with sweet potato with a mean of 1.21 kg., while mono-cropped sweet corn has 1.14 kg. There was no significant result on the marketable sweet corn ears as affected by cropping systems.

Intercropping sweet potato with sweet corn does not cause significant reduction in the amount of photosynthesis produced due to the growth habit of sweet potato that is\
creeping and this does not affect much of the photosynthetic activity of the plants [7].

On the other hand, results on the different fertilizer sources revealed that the sweet corn plants applied with mushroom spent (B2) showed the heaviest weight marketable ears with a mean of 1.74 kg. This was followed by sweet corn applied with rice ash (B1) and inorganic fertilizers (B3) with a mean of 1.01 kg. and 0.87 kg., respectively. There was no significant result on the application of different sources of fertilizers on the marketable sweet corn ears. The application of different fertilizer sources did not affect the weight of marketable sweet corn ears. This is supported by [2] that fertilizers are either organic or inorganic compounds that are added to the soil to supplement the plants with the nutrients that the soil is incapable of supplying. It is likewise important to realize that plants did not recognize the difference between organic and inorganic fertilizers as long as it has adequate supply of energy and mineral nutrients essential for proper growth and development. Interaction results on the different cropping systems and different fertilizer sources showed that the heaviest weight of marketable sweet corn ears was obtained in T1 (1.74 kg.). followed by T5 (1.37 kg.), T4 (1.07 kg.), T2 (1.01 kg.), T6 (0.99 kg.), and T3 (0.87 kg.). There was no significant result on the application of different sources of fertilizers on the weight of the marketable sweet corn ears as affected by different cropping systems and different fertilizer sources.

Table 1 showed the non-marketable sweet corn ears (kg.) as affected cropping systems. The heaviest weight of non-marketable sweet corn ears was obtained from sweet corn under the mono-cropping system with a mean of 0.36 kg., while sweet corn intercropped with sweet potato has 0.20 kg. There was no significant result on the non-marketable sweet corn ears as affected by cropping systems.

Result on the different fertilizers sources showed the heaviest weight of non-marketable ears with a mean of 0.21 kg. Sweet corn plants applied with rice ash (B1) had a mean of 0.20 kg. There was no significant result on the application of different sources of fertilizers on the sweet corn ears.

Interaction results on the different cropping systems and different fertilizer sources showed that the heaviest weight of non-marketable sweet corn ears was obtained from T4 with a mean of 0.43 kg. This was followed by T6 (0.41 kg.), T5 (0.25 kg.), T3 and T1 (0.21 kg.), and T2 (0.21 kg.). There was no significant result on the application of different sources of fertilizers on the weight of non-marketable sweet corn ears as affected by different cropping systems and different fertilizer sources.

Table 1 showed that heaviest biomass weight obtained in mono-cropped sweet corn with a mean of 7.23 kg., while sweet corn intercropped with sweet potato has 5.20 kg. There was no significant result on the non-market sweet corn ears as affected by cropping systems. The presence of sweet potato did not hinder the growth and development of sweet corn plant since the population density of sweet corn and sweet potato in this study was maximized for intercropping which did not significantly contribute competition of crops. Sweet potato was not a strong competitor for sweet corn in terms of light interception and utilization of other environmental resources available [1]. Result on the different fertilizers sources revealed that the sweet corn plants applied with rice ash (B1) showed the greatest biomass weight with a mean of 6.73 kg. Followed by corn applied with mushroom spent (B2) and inorganic fertilizer (B3) with means of 4.57 kg and 4.30 kg, respectively. There was no significant result on the application of different sources of fertilizers on the biomass yield of sweet corn. Interaction results on the different cropping systems and different fertilizer sources showed that the heaviest biomass weight of sweet corn was obtained from T5 (7.60 kg.), followed by T6 (7.57 kg.), T2 (6.73 kg.), T4 (6.53 kg.), T1 (4.57 kg.), and T3 (4.30 kg.) respectively. There was no significant result on the application of different sources of fertilizers on the biomass weight of sweet corn as affected by different cropping systems and different fertilizer sources.

Table 2 showed that the longest length of vines was obtained in intercropped sweet potato and sweet corn with a mean of 158.44 cm, while mono-cropping sweet potato has a mean of 144.00 cm only. There was no significant result on the length of vine as affected by different cropping systems. This indicates that sweet potato did not affected by the presence of sweet corn. The possibility of using sweet potato as animal feed, its ability to grow in poor soils, and its drought tolerance characteristics are the reasons why it was included in the research. Result on the different fertilizers sources revealed that vine length applied with mushroom spent (B2) showed the longest with a mean of 177.67cm., followed by sweet corn applied with inorganic fertilizer (B3) and rice ash (B1) with a mean of 140.33 cm. and 135.67 cm. respectively. There was no significant result on the length of vines as affected by different fertilizer sources. The application of mushroom spent (B2) and inorganic fertilizer (B3) did not differed from each other, but significantly different from application of rice ash (B1). The application of different organic soil amendments to soil has significant effect on the length of foliage. This result corroborated with the report of [8] who stated that green manure and composted organic materials provide plant nutrients, alleviate the aluminum toxicity and render phosphorus more available to crops. Results on the different cropping systems and different fertilizer sources showed that T1 was the tallest with a mean of 183.67 cm, was followed by T7 (171.67 cm),

T3 (148.33 cm), T2 (143.33 cm), T9 (132.33 cm) and T8 (128.00 cm). There is a significant result on the length of plant as affected by interaction effect of cropping systems applied with different sources of fertilizer.

Table 2 showed that the heaviest weight of sweet potato was obtained from intercropping sweet corn with a mean of 10.02 kg, while mono-cropped sweet potato has a mean of 9.13 kg. There is no significant result on the non-marketable ears as affected by cropping systems.

Result on the different fertilizers sources revealed that the plants applied with mushroom spent (B2) showed the highest biomass weight with a mean of 11.57kg, this was followed by plants applied with rice ash (B1) and organic fertilizers (B3) with a mean of 9.57 kg and 7.59 kg, respectively (Table 13). There is no significant result on the application of different sources of fertilizers on the biomass yield of sweet potato.

Table 2. Data On Different Parameters Of Sweet Potato (10 Plants/Treatment) As Affected By The Interaction Of Different Cropping Systems And Different Fertilize Sources

Treatments	Length of Vines (cm)	Marketable Tubers (kg.)	Non-Marketable Tubers	Biomass (kg)
INTERCROP				
T2 – Rice Ash	143.33	0.53	0.24	11.58
T1 – Mushroom Spent	183.67	1.00	0.58	10.68
T3 – Inorganic Fertilizer	148.33	0.85	0.25	7.80
MEAN	158.44	0.79	0.36	10.02
MONOCROP				
T8 – Rice Ash	128.00	1.08	0.38	7.55
T7 – Mushroom Spent	171.67	1.35	0.75	12.45
T9 – Inorganic Fertilizer	132.33	2.03	0.73	7.38
MEAN	144.00	1.49	0.62	9.13

Interaction results on the different cropping systems and different fertilizers sources showed that the highest biomass weight of sweet potato was potato as affected by different cropping systems and different fertilizers sources.

Table 3 showed that the heavier weight of marketable tubers was obtained from mono-cropping of sweet potato which gave a mean of 1.49 kg, while intercropping sweet potato with sweet corn had a mean of 0.79 kg only. There was no significant result on the marketable tubers as affected by cropping systems. Result of the different fertilizers sources revealed that the marketable tubers of sweet potato applied with inorganic fertilizer (B3) obtained the heaviest weight with a mean of 1.44 kg, followed by (B2) and rice ash (B1) with a mean of 1.18 kg and 0.81 kg, respectively.

There was no significant result on the application of different sources of fertilizers on the sweet corn ears. Interaction results on the different cropping systems and different fertilizers sources showed that the highest weight of marketable tuber was obtained T9 (2.03 kg.) This was followed by T7 (1.35 kg.), T8 (1.08 kg.), T1 (1.00 kg.), T3 (0.85 kg.), and T2 (0.53kg.). There is no significant result on the application of different sources of fertilizers on t weight of marketable tubers as affected by different cropping systems and different fertilizer sources.

Table 3. Mean Data On The Different Parameters Of Sweet Potato (10 Hills/Treatment) As Affected By The interaction Of Different Cropping Systems And Different Fertilizer Sources

Parameters	Treatments		
	Rice Ash (B1)	Mushroom Spent (B2)	Inorganic Fertilizers (B3)
Length of Vine (cm)	135.67	177.67 [a]	140.33 [a]
Marketable Tubers (kg.)	0.81	1.18	1.44
Non-Marketable Tubers (kg)	0.31	0.67	.49
Biomass (kg)	9.57	11.57	7.59

Table 3 showed that the heaviest weight of non-marketable tubers were obtained from mono-cropped sweet potato with a mean of 0.62 kg, while sweet potato intercropped with corn has a mean of 0.36 kg. There was no significant result on the nonmarketable sweet corn ears as affected by cropping systems.

Result on the different fertilizers sources revealed that the sweet potato plants applied to nmarketable sweet corn ears with a mean of 0.67 kg, this was followed by plants applied with inorganic fertilizer (B3) and rice ash (B1) with a mean of 0.49 kg and 0.31 kg, respectively. There is no significant result o the application of different sources of fertilizers on the total sweet corn ears. Interaction results on the different cropping systems and different fertilizers sources showed that the heaviest weight of non-marketable tuber was obtained from T7 (0.75 kg.), this was followed by T9 (0.73 kg.), T1 (0.58 kg.), T8 (0.38 kg.), T3 (0.25 kg.), and T2 (0.24 kg.). There is no significant result on the application of different sources of fertilizers on weight of non-marketable tubers as affected by different cropping systems and different fertilizers sources.

Table 4 shows the profitability analysis of intercropped sweet corn and sweet potato applied to mushroom spent, rice ash and inorganic fertilizers. The highest net income and ROI were obtained in T2 with an amount of P 90,160.00 and ROI value of 500.88%. This was followed by T9 with ROI value of 403.63%, T4 (301.86%), T8 (281.81%), T3 (234.88%),T1 (234.44%),T5 (213.86%),T6 (190.40%), and T7 (167.27%). The net return in intercropping was slightly higher compared to monocropping even though the yields of sweet corn were not significantly different. The monetary return from sweet potato and the low cost of organic fertilizers would constitute and added income in these combinations. Hence, intercropping schemes (T1, T2 and T3) may considered a better system compared to sole cropping. On the other hand, application of organic fertilizers as supported by Fuller (1951) as cited by [3] stated that the continued productivity of soil depends largely upon the replenishments and maintenance of soil

Table 4. Cost And Return Analysis Of Sweet Corn Intercropped With Sweet Potato For The Computation Of Return Of Investment (ROI).

Treatment	S. Corn Yield (T)	S. Potato Yield (T)	Total Cost of Prod'n (Php)	Net Income (Php)	ROI (%)	Gross Income (Php)
T1 (Rice Ash)	4.04	3.08	18,000	41,840	232.44	59,840.00
T2(Mushroom Spent)	6.96	6.32	18,000	90,160	500.88	108,160.00
T3 (Inorganic)	3.48	4.40	18,000	42,280	234.88	60,280.00
T4 (Rice Ash)	5.48		15,000	45,280	301.86	60,280.00
T5(Mushroom Spent)	4.28		15,000	32,080	213.86	47,080.00
T6 (Inorganic)	3.96		15,000	28,560	190.40	43,560.00
T7 (Rice Ash)		5.88	11,000	18,400	167.27	29,400.00
T8(Mushroom Spent)		8.40	11,000	31,000	281.81	42,000.00
T9 (Inorganic)		11.08	11,000	44,400	403.63	55,400.00

Table 5. Yield of Marketable Sweet Corn Ears and Sweet Potato Tubers in Tons per Hectare.

Treatment Code	**Sweet Corn Yield (T)**	**Sweet Potato Yield (T)**
T1 (Rice Ash)	4.04	3.08
T2 (Mushroom Spent)	6.96	6.32
T3 (Inorganic)	3.48	4.40
T4 (Rice Ash)	5.48	
T5 (Mushroom Spent)	4.28	
T6 (Inorganic)	3.96	
T7 (Rice Ash)		5.88
T8 (Mushroom Spent)		8.40
T9 (Inorganic)		11.08

organic constituents. Applying organic matter is the only way of making some soils economically productive.

Table 5 shows the different yields of sweet corn intercropped with sweet potato applied to mushroom spent, rice ash and commercial/inorganic fertilizers. The highest yield in sweet corn was obtained from T2 intercropped with sweet potato applied with mushroom spent with 6.96 T. This was followed by T4 (5.48 T), T5 (4.28 T), T1 (4.04 T), T6 (3.96 T), and T3 (3.48 T). The highest yield for sweet potato was in T9 mono-cropped with 11.08 T. This was followed by T8 (8.40 T), T2 (6.32 T), T7 (5.88 T), T3 (4.40 T), and T1 (3.08 T) respectively.

The Land Equivalent Ratio (LER) for sweet corn was shown in Table 6. The highest LER was obtained from T2 with a value of 2.37, followed by T3 andT1 with a means of 1.26 and 1.25, respectively. All intercropped combinations showed LER values of greater than 1, which means that sweet corn and sweet potato complements each other under the intercropping system, which manifested a yield advantage of intercropping than monoculture. When the LERs measures 1.0, there was no advantage to intercropping over pure stands; when LERs is above 1.0, it showed an advantage of intercropping over pure stands; and when LERs is below 1.0, it showed disadvantage of intercropping over pure stands.

Table 6. Land Equivalent Ratio (LER) of intercropped Sweet Corn and Sweet Potato.

Treatment Code	Sweet Corn Yield (T)	Sweet Potato Yield (T)	Land Equivalent Ratio (LER)		
			Sweet Corn	Sweet Potato	Combination
T1 (Rice Ash)	4.04	3.08	0.74	0.52	1.25
T2 (Mushroom Spent)	6.96	6.32	1.62	0.75	2.37
T3 (Inorganic)	3.48	4.40	0.87	0.39	1.26

5. CONCLUSION

Therefore, one of the alternative of using inorganic fertilizer to reduce the cost of farm inputs is by the use of farm waste materials like mushroom spent and rice ash the ideal organic fertilizer to achieve sustainable agriculture and as appropriate source of plant nutrients. These materials were found out to contribute the growth and yield of sweet corn and sweet potato both mono cropping and intercropping systems. In addition, using organic fertilizer as source of plant nutrients has contribution to soil condition since it maintains the good soil texture and provides aeration, making the soil more suitable for the growth and development of the crops.

The study was showed increase of productivity in agricultural land without expanding the farm area by using sweet corn (Zea mays L.) intercropped with sweet potato (Ipomoea batatas L.) applied with mushroom spent and rice ash as organic fertilizer and commercial or inorganic fertilizer to maximize the use of limited land resources with optimum yield through intercropping and minimizing farm inputs through recycling of agricultural waste materials and minimizing the use of inorganic fertilizer for good physical condition of the soil.

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