BIBLIOGRAPHY

CABADING, MELVER S. APRIL 2010. Yield and Profitability of Chinese Spinach, Spoon Cabbage and Romaine Lettuce in Three Successive Croppings. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

This study was conducted in greenhouse condition at Balili, La Trinidad, Benguet from October 2009 to march 2010 to evaluate the yield of Chinese spinach, spoon cabbage, and romaine lettuce in a three successive planting, to asses auto toxicity among the three crops and to determine the profitability of Chinese spinach, spoon cabbage and romaine lettuce after the three successive cropping.

The succession of spoon cabbage-spinach-romaine lettuce produced high yield that obtained 344% return on investment or Php 3.44 for every peso invested in the production. But did not differ from romaine lettuce or spoon cabbage successively planted three times on the same plot that obtained 365% ROI and 226% ROI respectively. Meanwhile, romaine lettuce-spinach-spoon cabbage and spinach-romaine lettuce-spoon cabbage succession croppings obtained 269% ROI and 226% ROI which showed slight difference in yield compared to either romaine lettuce or spoon cabbage in three successive croppings. On the other hand, spinach planted successively planted three times on the same plot obtained 208% ROI or Php 2.08 for every peso invested in the production.

Spoon cabbage seeds watered with romaine lettuce, spinach and spoon cabbage compost tea had similar germination percentage with the control (water) which did not also differ from romaine lettuce irrigated with spinach compost tea. Romaine lettuce seeds watered with spoon cabbage compost tea had the lowest germination percentage which was similar to romaine lettuce seeds watered with romaine lettuce compost tea, and the spinach seeds watered with compost tea of romaine lettuce, spinach and spoon cabbage. This controlled germination study supports the tremendous reduction in growth and yield of spinach successively planted three times.

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INTRODUCTION

Succession cropping refers to the planting of a crop one after another on the same piece of land. The main objective is to optimize the use of land for better productivity.

Philippine is an agricultural country but at this time, land availability of crop production is getting smaller. In order to increase profit from crop production, proper cropping systems, intensified use of land and efficient labor management become a matter of necessity. Relatively, majority of the people in the Cordillera are engaged in vegetable production but there is a limited area for expansion.

Recent studies showed that the profitability of crop production is determined by cropping system employed by the farmers. Although, these systems are influence by several factors such as environmental, biological, some old practices like relay cropping or succession cropping are common to most farmers. However, such practices are usually done regardless of the compatibilities of the crops being planted.

Succession planting is common in rain fed rice lands where vegetables are grown as second crop and in the farms growing selected high value crops such as tomatoes, cucumber, melons and beans. Planting may be done every month or every 2-4 months depending on the crops and the varieties used.

Many farmers nowadays, succession cropping is common to them but there are some problems in the plants planted after the first crop. This is because there are some plants that are not compatible when it is successively planted. This study will help the farmers select crop that are compatible to increase productivity. This will not benefit the farmers only but also extension workers, researchers and the following generation who will be involved in vegetable production.

The objectives of the study were:

1. to evaluate the yield of Chinese spinach, spoon cabbage and romaine lettuce in a three successive planting.

2. to assess auto toxicity among the three crops.

3. to determine the profitability of Chinese spinach, spoon cabbage and romaine lettuce after the three successive cropping.

This study was conducted at Balili, La Trinidad, Benguet from October 2009 to March 2010.

REVIEW OF LITERATURE

Description of the Crops

Romaine. According to Groman (1997), there are three main kinds of lettuce: (1) head, (2) leaf, and (3) romaine. Head lettuce has leaves that curl around the center of the plant forming a ball-shaped head. Crisp head lettuce or ice berg lettuce has tight head and brittle, juicy leaves. Leaf lettuce forms dense, leafy dumps instead of head. Gardeners grow more of it than any kind. Most leaf lettuce has a tight green leaves but a few red varieties have been developed for their taste and for the attractive color they give to salads. The waxy, crinkled leaves vary in shape among the various type of leaf lettuce. On the other hand, romaine lettuce grows long and upright and its leaves are inward. Romaine lettuce is most nutritious among the lettuce crops.

Chinese spinach. Spinach (*Spinacia oleracea*), as stated by Lorenz (1994), is annual herb that belongs to the goosefoot family(Chenopdiaceae), which is grown for its nutritious green leaves and is extensively cultivated throughout the world. Spinach is considered to be native to Southwestern Asia. It was introduce to Europe during the Middle Ages. Price (1991) mentioned that it was a special dish in Europe. The Persians used it as medicine.

There are four main type of spinach: savoy, semi-savoy, flat-leaf, and baby spinach. Savoy spinach has crinky, dark green and curly leave. Flat-leaf/ smooth-leaf spinach is uncrinkled and have spade-shaped leaves that are easier to clean than the curly types. Semi-savoy is a combination of savoy and flat-leaf. Baby spinach is a flat-leaf variety and usually longer than three inches. It is often used in salads, but can also be lightly cooked (Lumioan, 2006).

Spoon cabbage. One of the leafy vegetables that provide nutrition to human is spoon cabbage (*Brassica chinensis L.*). Common variations for spoon cabbage include Bok-Choy, Pakchoi, Taisai, celery mustard and Chinese mustard. In addition, spoon cabbage is botanically turnip. Unlike Chinese cabbage, it has thick glossy leaves and does not form a true head. It is a small fast growing rosette-shaped, often upright (similar to celery) crisp stemmed, annual with cup-shaped tender leaves.

Bok-Choy or spoon cabbage is an Asian vegetable which is being cultivated in China since fifty century and member of the cabbage family. The smooth, wide stalks are crunchy like celery, although they do not have string fibers and the long full leaves are dark and consumed raw with dip or chopped and included in salads. Bok-Choy has high water content and becomes limp very quickly upon cooking. It should be cooked very quickly over high temperature so that the leaves become tender and stalks stay crisp. Bok-Choy grows well with the flavor of soy sauce, hot pepper and toasted sesame oil. Bok-Choy has a long, crisp, white meaty stalk that supports its dark green leaves. Stalks should be firm, have fresh cooking leaves and range from 12-16 inches in length. Bok-Choy's mild flavor similar to cabbage and texture is tender-crisp.

Soil and Climatic Requirements

Chinese spinach. Spinach does not grow well unless it has an abundance of moisture. It should be therefore planted in moist soil at a time when rainfall is abundant or where artificial watering can be given. In wet seasons and cold weather ,it makes a luxuriant growth of almost perfect foliage, but when the weather is hot and dry, it is not only stunted by the unfavorable weather conditions but also seems more subject to insect attacks. It is thus almost impossible to produce good spinach when the weather is hot and

dry (Lloyd, 1935). This crop matures within 6-10 weeks depending on climatic conditions. A pH of 5.6 is favorable3 for spinach production (McColumn and Ware, 1975).

Romaine. According to McColumn (1942), lettuce can be grown in a wise variety of soil, including muck and sandy or silty loam. Lettuce prefers a moist but well-drained soil type, rich in organic matter, sandy loam or loam with pH ranging from 6.5-7.5.

Temperate requirements, Groman (1997) wrote that most kinds of commercial lettuce grow well at 21-24 ^{o}C. In contrast, Wallace (1969) mentioned that the optimum (high) temperature for lettuce is 10 to 15 ^{o}C with a day temperature of 15-20 ^{o}C. Seeds germinate in 6 to 10 days and can be directly planted.

Spoon cabbage. Spoon cabbage is a cool season crop. Temperature ranging from 15 to 20 ^{o}F is favorable to its growth. However, spoon cabbage with temperature of 75 ^{o}F can cause trip burn prolonged temperature 55 ^{o}F can initiate flowering and premature bolting (McDonald, 1993). Furthermore, the same author stated that spoon cabbage grows well in a well-drained soil with good water retention. In Arizona, spoon cabbage grows in sandy loam to clay loam soil with a pH ranging from 7.5 to 8.0. It is also being grown in the fall and winter. From time of weeding, spoon cabbage requires 40 to 80 days to reach maturity. In addition, spoon cabbage flowering is photoperiod sensitive where in long days include flowering while short day promote vegetative growth.

Importance of the Crops

Chinese spinach. As food, spinach began a medicine used for its mildly laxative effects, likely because of the oxalic acid. The oxalic acid binds calcium into an insoluble salt (Calcium oxalate), which cannot be absorbed by the body. Spinach has extraordinary

vitamin C content and rich in riboflavin. It also contains a very high level of vitamin A, folate, magnesium, potassium, as well as vitamin E, B_6 and Thiamine. Despite of its unusual iron and calcium content, it is rich in other important minerals, proteins, and vitamins. Of all the vegetable juices, spinach juice is most the potent for the prevention of cancer cell formation. Research has shown that those who eat spinach daily are not likely to develop lung cancer (Lumioan, 2006).

Romaine. Ensminger et al. (1986) said that romaine lettuce is guaranteed to be packed with nutrients. The vitamin and minerals found in romaine lettuce are especially good for alleviation or prevention of many health complaints due to its extremely low calorie amount and high water volume. Romaine lettuce while often over-cooked in the nutrition world is actually a very nutritive food based on its nutrient density. The ranking system qualified. It is source of vitamin A and C and folute manganese. Good source of dietary fibers. The fiber adds another plus in its collism of heart healthy effects. Folic acid (vitamin B), is needed by the body to covert a damaging chemical called "homocytene" into another benign substances. In addition romaine lettuce is a very good source of potassium, which is in lowering high blood pressure.

Spoon cabbage. Spoon cabbage is one of the most important leafy vegetables produced and eaten in all parts of the world. It is a crop commercially grown in the highland areas particularly Benguet and some parts of Mountain Province and considered as a source of income for the people. Spoon cabbage can provide nutrition to humans since it contains 14 calories of food energy, 1.0 protein, 2.37 grams carbohydrates, 0.18 grams total fat, and 0.84 grams fiber (Kinoshita, 1972).

Succession Cropping

Earlier, Thatcher (1923) stated that in succession cropping, the first crops affect the yield of the following crops either beneficial or deleterious. Moreover, Sabbarth (1970) stated that a plant may enhance the growth and yield of another by adding nutrients to the soil.

Relatively, Delorit (1959) stated that a well-planned crop rotation conserves, improves and increases the productivity of the soil rather than depleting the fertility over a period of time.

Furthermore, Cevallos (1933) stated that planting of different crops in succession cropping on a piece of land merely prevent the exhaustion of any particular plant food from the soil. He also indicated that when successive crops of one kind grown on the same area, those elements which are more consumed become exhausted; hence the land becomes weak and sticky.

A reduction in both crop yield and quality often occurs when the same crops or its related species are cultivated on the same soil successively. This phenomenon is called soil sickness. It is a complicated natural phenomenon and the causes are not fully known. Various factors such as the buildup of pests in the soil, disorder in physico-chemical properties of the soil, auto toxicity (special kind of allelopathy) and other unknown factors are believed to be involved in soil sickness (Narwal, 1999).

MATERIALS AND METHODS

Materials

The materials used in the study were spinach seeds, romaine lettuce seeds, spoon cabbage seeds, watering cans and organic fertilizers (such as compost), garden equipment, peg, weighing scale and record book.

Methods

Experimental design and treatments. The experimental layout followed the Randomized Complete Block Design (RCBD) with 3 replications.

The treatments were as follows:

Code		Description
C_1	=	Spinach- Spinach- Spinach
C_2	=	Spoon cabbage-Spoon cabbage-Spoon cabbage
C_3	=	Romaine lettuce-Romaine lettuce-Romaine lettuce
C_4	=	Spinach-Romaine lettuce-Spoon cabbage
C_5	=	Romaine lettuce-Spinach-Spoon cabbage
C_6	=	Spoon cabbage-Spinach-Romaine lettuce

Land preparation. Eighteen plots measuring 1m x 5m were prepared for the study. The plots were applied with compost mixtures of grasses, animal manures, and sunflower as base dress. No synthetic fertilizer was used as the greenhouse area is under organic system of production.

Seedling production. Seeds of romaine lettuce were sown in a seedling trays filled with sterilized soil media. The seedlings were transplanted 3 weeks from

emergence. On the other hand, spoon cabbage and Chinese spinach seeds were planted directly to their assigned plots.

Crop maintenance. Irrigation was done after planting and was done twice a week up to harvesting. Weeds were uprooted as they emerged on the plots in order not to compete with the crops. There were larvae of insects, but they were collected and crushed. All other cultural practices in growing the crops to ensure optimum growth and yield were done.

Harvesting. The crops were harvested when they reach 30 to 35 days after planting. The produced were packed and sold to the BSU organic market and to the LaTOP stall in the La Trinidad public market.

Figure 1 shows a documentation during the planting time, irrigation and data gathering.

Data Gathered

The data gathered, tabulated, and subjected to mean separation test using Duncan's Multiple Range Test (DMRT) were:

1. Plant height at harvest (cm). Ten sample plants from each plot were selected at random and measured during harvest from the base of the leaf petioles to the tip of the longest leaf.

2. Total yield per plot (kg). This was the weight of marketable and non-marketable plant harvested from each treatment plot.

3. Weight of marketable plants (kg). This was the weight of plants from each treatment plot without defect which were sold in the market.

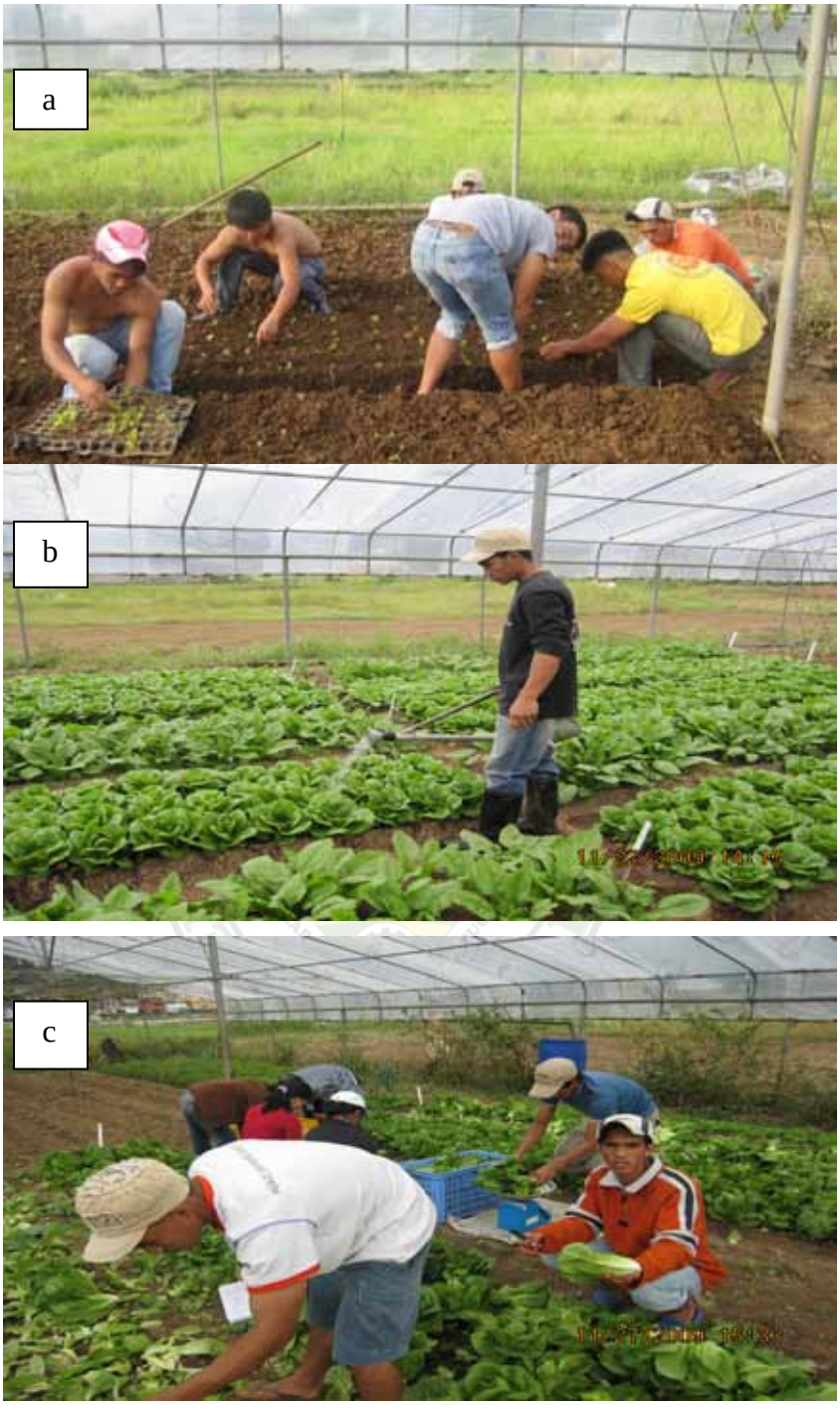

Figure 1. Photographs during the planting time (a), irrigation of the crops (b) and during harvest to gather yield data (c).

4. Weight of non-marketable plants (kg). This was the weight of plants with defect such as stunted, rotten; insect-damaged that were not be sold in the market.

5. Weight of individual plants (g). The weight of ten plants picked at random from each treatment plot was divided by 10 to get the weight of each plant.

6. Number of leaves per plant. This was obtained from ten plants per plot by counting the number of leaves then divided by 10 to get the number of leaves per plant.

7. Germination percentage (%). One hundred seeds from each test crop were sown in a seedling trays replicated three times and the water where the plants were soaked for two weeks was utilized for irrigating the seedling trays.

8. Return on investment (ROI). This was taken by using the formula:

$$\text{ROI (\%)} = \frac{\text{Gross sales- Total Expenses per Plot}}{\text{Total Expenses per Plot}} \times 100$$

9. Documentation through photographs. Observations that cannot be measured like color of leaves was recorded in a photograph during the gathering of data. Figure 2 shows the different succession crops planted.

10. Other observations.

a. Occurrence of insect pests and diseases- Insect pests and diseases attacking the crops during the cropping period was recorded and identified.

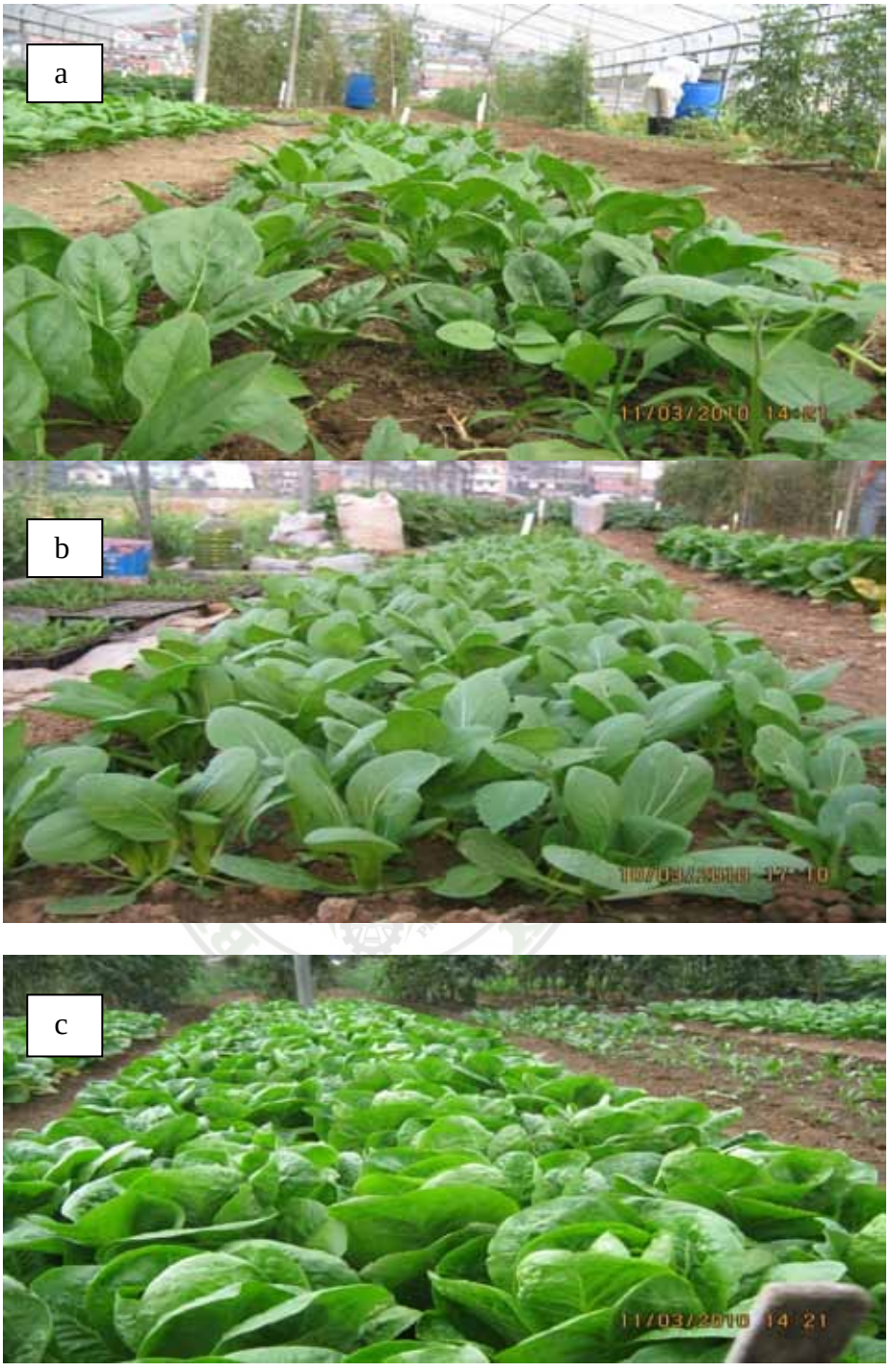

Figure 2. The different succession crops planted: (a) spinach, (b) spoon cabbage, and (c) romaine lettuce.

RESULTS AND DISCUSSION

Plant Height at Harvest

Presented in Table 1 is the final height of crops at harvest. Statistically, spinach significantly surpassed spoon cabbage and romaine lettuce in height. However, this difference in height may not be due to the succession cropping but a crop characteristic. In the succession of crops planted on the plots, there were reduction in height of plants but this might be due to the insufficient irrigation water during the succession cropping. There was also severe infestation of flea beetles and mole crickets during the second and third croppings especially flea beetles which were prevalent during dry season.

Weight of Marketable Plants

As presented in Table 2, there were slight differences among the spinach, romaine lettuce and spoon cabbage from the first cropping. During the second cropping, romaine

Table 1. Plant height at harvest

TREATMENT	HEIGHT (cm)		
	1st CROP	2nd CROP	3rd CROP
Spinach-Spinach-Spinach	34.60[a]	32.83[a]	29.57[a]
Spoon cabbage-Spoon cabbage-Spoon cabbage	22.43[b]	19.40[b]	19.47[c]
Romaine lettuce-Romaine lettuce-Romaine lettuce	23.23[b]	20.33[b]	20.30[c]
Spinach-Romaine lettuce-Spoon cabbage	34.37[a]	21.70[b]	19.47[c]
Romaine lettuce-Spinach-Spoon cabbage	23.80[b]	32.03[a]	20.03[c]
Spoon cabbage-Spinach-Romaine lettuce	23.37[b]	32.53[a]	22.90[b]

Means in a column with the same letter are not significantly different at 5% level by DMRT

lettuce had significantly higher marketable plants compared to spinach and spoon cabbage in the succession. This result is due to the nature of spinach which are naturally slender and light and the building auto-toxicity shown in reduced germination (Table 7) in addition to severe infestation of flea beetle that affected the growth of spoon cabbage.

On the third succession crops, romaine lettuce had significantly heavier yield while spoon cabbage reduced in weight of marketable plants particularly the spinach where the weight decreased from the second to third croppings. This might indicate that planting spinach on the same plot for more than twice has allelophatic interaction effect as shown by the stunted plants (Figure 3) and the controlled germination percentage (Table 7).

Table 2. Weight of marketable plants

TREATMENTS	WEIGHT (kg)		
	1st Crop	2nd Crop	3rd Crop
Spinach-Spinach-Spinach	6.25[b]	5.42[b]	3.42[c]
Spoon cabbage-Spoon cabbage-Spoon cabbage	15.33[a]	5.50[b]	7.00[b]
Romaine lettuce-Romaine lettuce-Romaine lettuce	11.08[ab]	7.75[a]	11.50[a]
Spinach-Romaine lettuce-Spoon cabbage	6.08[b]	9.08[a]	7.67[b]
Romaine lettuce-Spinach-Spoon cabbage	11.00[ab]	4.33[b]	7.67[b]
Spoon cabbage-Spinach-Romaine lettuce	13.00[a]	4.03[b]	11.17[a]

Means in a column with the same letter are not significantly different at 5% level by DMRT

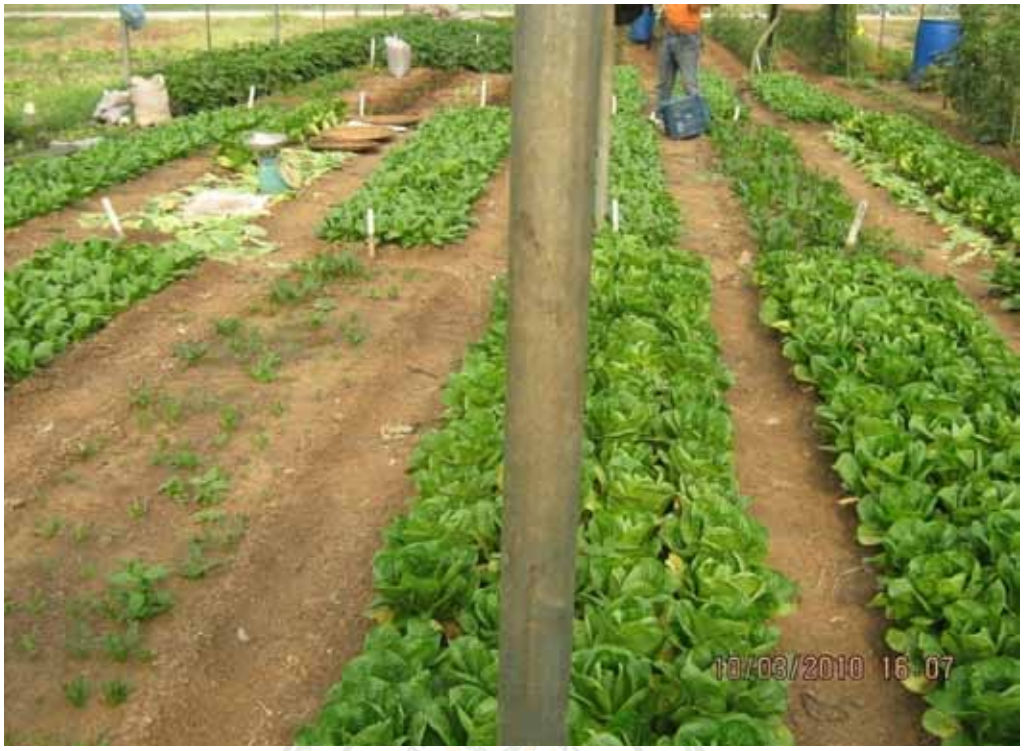

Figure 3. Overview of the experimental area inside the greenhouse showing the stunted growth of spinach (polonsai) and low percentage of survival.

Weight of Non-Marketable Plants

There were no significant differences among the croppings on the non-marketable plants during the first and second cropping (Table 3). Except the romaine lettuce that had significantly higher non-marketable plants in the third cropping, the rest of the cropping systems had lesser non-marketable plants than the first and second cropping. The higher weight of non-marketable plants in romaine lettuce was due to infestation of insect and rotting as the plants were not sprayed with pesticide. Although, the non-marketable plant were just in grams, the significant differences among the succession croppings might reflect the allelophatic interaction effect.

Table 3. Weight of non-marketable plants

TREATMENT	WEIGHT (kg)		
	1st CROP	2nd CROP	3rd CROP
Spinach-Spinach-Spinach	0.17[a]	0.08[a]	0.17[c]
Spoon cabbage-Spoon cabbage-Spoon cabbage	0.28[a]	0.15[a]	0.09[d]
Romaine lettuce-Romaine lettuce-Romaine lettuce	0.23[a]	0.13[a]	0.35[a]
Spinach-Romaine lettuce-Spoon cabbage	0.19[a]	0.15[a]	0.08[d]
Romaine lettuce-Spinach-Spoon cabbage	0.30[a]	0.17[a]	0.09[d]
Spoon cabbage-Spinach-Romaine lettuce	0.30[a]	0.14[a]	0.20[b]

Means in a column with the same letter are not significantly different at 5% level by DMRT

Weight of Individual Plant

Table 4 shows the weight of individual plant obtained from the three succession crops evaluated. Romaine lettuce and spoon cabbage were significantly heavier than spinach which is obviously a crop characteristic. Although romaine lettuce and spoon cabbage have similar weight of individual plant during the first cropping, spoon cabbage was outweighed by romaine lettuce during the second and third cropping due maybe to allelophaty and the severe flea beetle infestation. Besides, the third cropping which was replanted twice and was harvested earlier to catch up with the deadline of thesis defense.

Table 4. Weight of individual plant

TREATMENT	WEIGHT (g)		
	1st CROP	2nd CROP	3rd CROP
Spinach-Spinach-Spinach	75.17[b]	60.03[b]	57.00[c]
Spoon cabbage-Spoon cabbage-Spoon cabbage	162.00[a]	84.00[b]	79.00[b]
Romaine lettuce-Romaine lettuce-Romaine lettuce	190.67[a]	163.17[a]	154.00[a]
Spinach-Romaine lettuce-Spoon cabbage	68.50[b]	165.00[a]	72.73[b]
Romaine lettuce-Spinach-Spoon cabbage	177.83[a]	53.50[b]	78.33[b]
Spoon cabbage-Spinach-Romaine lettuce	160.17[a]	45.17[b]	156.17[a]

Means in a column with the same letter are not significantly different at 5% level by DMRT

Number of Leaves per Plant

As presented in Table 5, romaine lettuce has significantly more leaves compared to spoon cabbage and spinach which is observed to be crop characteristic differences and not being affected by the successive cropping. The leaf counts in spinach at harvest is similar in the study of Dulatre (2008) while spoon cabbage was the same with the study of Dayao (2008) and Pingalo (2008).

Table 5. Number of leaves per plant

TREATMENT	NUMBER OF LEAVES		
	1st CROP	2nd CROP	3rd CROP
Spinach-Spinach-Spinach	13.87[b]	13.10[b]	13.83[b]
Spoon cabbage-Spoon cabbage-Spoon cabbage	11.93[b]	11.83[b]	10.20[c]
Romaine lettuce-Romaine lettuce-Romaine lettuce	21.53[a]	20.20[a]	21.20[a]
Spinach-Romaine lettuce-Spoon cabbage	14.27[b]	20.23[a]	10.10[c]
Romaine lettuce-Spinach-Spoon cabbage	21.13[a]	14.47[b]	10.40[c]
Spoon cabbage-Spinach-Romaine lettuce	11.30[b]	14.17[b]	19.80[a]

Means in a column with the same letter are not significantly different at 5% level by DMRT

Total Yield from the Succession Croppings

As presented in Table 6, the succession of spoon cabbage-spinach-romaine lettuce did not differ from romaine lettuce or spoon cabbage successively planted three times on the same plots which produced significantly higher yield compared to planting spinach three times successively. Meanwhile, romaine lettuce-spinach-spoon cabbage and yield compared to either romaine or spoon cabbage in three successive croppings.

Obviously, the height and weight of spinach was reduced particularly on the third cropping which may imply that there is bad effect of planting spinach continuously on the same plot. Narwal (1999) reported that various factors such as the buildup of pests in the soil, disorder in physico-chemical properties of the soil, auto-toxicity (special kind of allelopathy) and other unknown factors are believed to be involved in soil sickness.

Table 6. Total yield from the succession croppings of spinach, spoon cabbage and romaine lettuce

TREATMENT	TOTAL YIELD (kg)
Spinach-Spinach-Spinach	15.52[c]
Spoon cabbage-Spoon cabbage-Spoon cabbage	29.47[ab]
Romaine lettuce-Romaine lettuce-Romaine lettuce	29.83[ab]
Spinach-Romaine lettuce-Spoon cabbage	23.26[b]
Romaine lettuce-Spinach-Spoon cabbage	23.76[b]
Spoon cabbage-Spinach-Romaine lettuce	31.84[a]

Means in a column with the same letter are not significantly different at 5% level by DMRT

Germination Percentage

As presented in Table 7, spoon cabbage seeds watered with romaine lettuce, spinach and spoon cabbage compost tea had similar germination percentage with the control (water) which did not also differ from romaine lettuce irrigated with spinach compost tea. Romaine lettuce seeds watered with spoon cabbage compost tea had the lowest germination percentage which was similar to romaine lettuce seeds watered with romaine lettuce compost tea, and the spinach seeds watered with compost tea of romaine lettuce, spinach and spoon cabbage. This controlled germination study supports the tremendous reduction in growth and yield of spinach successively planted three times.

Table 7.Germination percentage (%) from spinach, romaine lettuce and spoon cabbage seeds watered by its compost tea under controlled experiment

TREATMENT	PERCENTAGE (%)
Spinach-Spinach	75.00^{de}
Spinach-Spoon cabbage	78.00^{cde}
Spinach-Romaine lettuce	74.00^{de}
Spinach-water	82.67^{bcd}
Romaine lettuce-Romaine lettuce	77.00^{de}
Romaine lettuce-Spinach	84.00^{bcd}
Romaine lettuce- Spoon cabbage	70.33^{e}
Romaine lettuce-water	84.00^{bcd}
Spoon cabbage- Spoon cabbage	88.00^{abc}
Spoon cabbage-Spinach	90.00^{ab}
Spoon cabbage-Romaine lettuce	95.00^{a}
Spoon cabbage-water	91.33^{ab}

Means in a column with the same letter are not significantly different at 5% level by DMRT

Return on Investment

Table 8 shows the profitability of spinach, spoon cabbage and romaine lettuce in succession croppings. The three successive croppings of romaine lettuce obtained the highest net income with 365% ROI or Php 3.65 for every peso invested in the production. In descending order, this was followed by the spoon cabbage-spinach-romaine lettuce successions, romaine lettuce-spinach-spoon cabbage succession, spinach-romaine lettuce-

spoon cabbage, spoon cabbage-spoon cabbage-spoon cabbage and spinach-spinach-spinach on the same plot.

Table 8. Return on investments

ITEMS	TREATMENT					
	T1	T2	T3	T4	T5	T6
Marketable Yield(kg)	45.05	86.00	91.00	68.00	69.00	93.60
A.Sales(Php)	4525.00	5160.00	9100.00	5930.00	5980.00	7430.00
B.Expenses(Php)						
Inputs						
1. Seeds	35.65	54.45	58.95	49.68	49.68	49.68
2. Compost	270.00	270.00	270.00	270.00	270.00	270.00
3. Packing materials	200.00	299.00	400.00	251.00	253.00	306.00
Labor costs						
4. Land preparation	58.74	58.74	58.74	58.74	58.74	58.74
5. Sowing	-	-	264.39	88.13	88.13	88.13
6. Planting	117.51	117.51	117.51	117.51	117.51	117.51
7. Irrigation	220.32	220.32	220.32	220.32	220.32	220.32
8. Harvesting	235.00	235.00	235.00	235.00	235.00	235.00
9. Land rent	149.85	149.85	149.85	149.85	149.85	149.85
10. Depreciation cost	180.06	180.06	180.06	180.06	180.06	180.06
Total Expenses(Php)	1467.00	1585.00	1955.00	1620.00	1622.00	1675.00
Net Profit (Php)	3058.00	3575.00	7145.00	4310.00	4358.00	5755.00
ROI(%)	208	226	365	266	269	344
Rank	6	5	1	4	3	2

Note: The selling price of spinach during harvest was Php 100.00 per kilo, spoon cabbage was Php 60.00 per kilo and romaine lettuce was sold at Php 100.00/kg.

Other Observations.

The severe infestation of flea beetles on the spoon cabbage especially the third cropping resulted to replanting the treatment plots twice. This was due to the observation that the period (dry season) coincide to the prevalence of flea beetles. Mole cricket, on the other hand, surfaced and bulldozed the plots when irrigated destroying the emerging seedlings. On romaine lettuce, insect damaged the inside leaves and at the same time, soft rot was observed. Soft rot was also observed in spoon cabbage.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The study was conducted at Balili area from October 2009 to March 2010 to evaluate the yield of Chinese spinach, spoon cabbage, and romaine lettuce in a three successive planting, to asses auto toxicity among the three crops and to determine the profitability of Chinese spinach, spoon cabbage and romaine lettuce in the three succession croppings.

Results in the study show that romaine lettuce successively planted three times had obtained high marketable yield, heavier weight of individual plant, highest number of leaves counted resulting to heavier total yield. Spinach significantly surpassed spoon cabbage and romaine lettuce in height, but slightly reduced in height during the second and third cropping which also decreased in marketable yield during the second and third cropping that resulted to lowest total yield clearly indicating that planting spinach on the same plot more than twice has allelophatic interaction effect. Spoon cabbage seeds watered with spinach and spoon cabbage compost tea had the highest germination percentage compared to the romaine lettuce watered by the spoon cabbage tea. However, on the second and third cropping, there was prevalence of flea beetles that attacked the plant resulting to low marketable yield.

The economic analysis shows that romaine lettuce successively planted three times obtained the highest net income with 365% return on investment or Php 3.65 for every peso invested in the production followed by spoon cabbage-spinach-romaine lettuce croppings, romaine lettuce-spinach-spoon cabbage, spinach-romaine lettuce-spoon

cabbage, spoon cabbage- spoon cabbage- spoon cabbage and the three cropping of spinach on the same plot.

Conclusions

Based on the results, it is inferred that planting romaine lettuce successively for three times have high yield and return on investment and there was no marked allelophatic interaction effects while planting spinach successively on the same plot results to poor growth and yield resulting to low ROI.

Recommendations

It is therefore recommended, that romaine lettuce can be planted for three times on the same plot to obtain higher yield and higher profit and to avoid planting spinach on the same plot in succession.

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APPENDICES

Appendix Table 1. Plant height at harvest (cm), first cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	30.40	36.40	37.00	103.8	34.60
T_2	23.40	21.60	22.30	67.30	22.43
T_3	22.90	22.40	24.40	69.70	23.23
T_4	37.50	36.20	31.20	103.1	34.27
T_5	23.00	24.30	24.10	71.40	23.80
T_6	22.80	23.60	23.70	70.10	23.37

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	3.510	1.755			
Treatments	5	511.513	102.303	23.4765**	3.33	5.64
Error	10	43.577	4.358			
Total	17	558.600				

** = highly significant Coefficient of variation 7.74 %

Appendix Table 2. Plant height at harvest (cm), second cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	32.10	35.30	31.10	98.50	32.83
T_2	20.30	20.30	17.60	58.20	19.40
T_3	20.90	19.80	20.30	61.00	20.33
T_4	22.00	19.80	23.30	65.10	21.70
T_5	30.50	34.10	31.50	96.10	32.03
T_6	32.70	34.70	30.2	97.60	32.53

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	8.361	4.181			
Treatments	5	655.809	131.162	43.6253**	3.33	5.64
Error	10	30.066	3.007			
Total	17	694.236				

** = highly significant

Coefficient of variation = 5.55 %

Appendix Table 3. Plant height at harvest (cm), third cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	30.20	30.80	27.70	88.70	29.57
T_2	19.40	19.10	19.90	58.40	19.47
T_3	19.90	21.10	19.90	60.90	20.30
T_4	19.20	19.60	19.60	58.40	19.47
T_5	20.30	20.10	19.70	60.10	20.03
T_6	24.50	21.10	23.10	68.70	22.90

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	1.081	0.541			
Treatments	5	232.938	46.488	39.6640**	3.33	5.64
Error	10	11.746	1.175			
Total	17	254.7764				

** = highly significant

Coefficient of variation = 4.94 %

Appendix Table 4. Weight of marketable plants (kg), first cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	3.25	6.25	9.25	18.75	6.25
T_2	18.50	11.00	16.50	46.00	15.33
T_3	11.00	11.25	11.00	33.25	11.08
T_4	7.75	7.25	3.25	18.25	6.08
T_5	10.50	11.25	11.25	33.00	11.00
T_6	19.00	12.50	16.50	48.00	16.00

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	6.438	3.219			
Treatments	5	203.281	40.656	5.3627*	3.33	5.64
Error	10	75.813	7.581			
Total	17	285.531				

* = significant

Coefficient of variation = 26.33 %

Appendix Table 5. Weight of marketable plants (kg), second cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	4.00	5.50	6.75	16.25	5.42
T_2	6.50	8.00	5.00	19.50	6.50
T_3	8.75	8.25	6.25	23.25	7.75
T_4	9.50	8.75	9.00	27.25	9.08
T_5	3.25	5.50	4.25	13.00	4.33
T_6	3.60	4.75	3.75	12.10	4.03

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	0.697	0.348			
Treatments	5	59.409	11.882	10.1470**	3.33	5.64
Error	10	11.710	1.171			
Total	17	71.816				

** = highly significant

Coefficient of variation = 17.98 %

Appendix Table 6. Weight of marketable plants (kg), third cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	5.25	4.00	1.00	10.25	3.42
T_2	6.50	5.00	9.50	20.50	6.83
T_3	10.00	13.50	11.00	34.50	11.50
T_4	8.00	8.00	7.00	23.00	7.67
T_5	8.00	8.00	11.00	23.00	7.67
T_6	12.5	11.25	9.75	33.50	11.17

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	2.528	1.264			
Treatments	5	133.434	26.687	9.1585**	3.33	5.64
Error	10	29.139	2.914			
Total	17	165.101				

** = significant

Coefficient of variation = 21.15 %

Appendix Table 7. Weight of non-marketable plants (kg), first cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	0.15	0.20	0.15	0.50	0.17
T_2	0.19	0.15	0.50	0.84	0.28
T_3	0.60	0.55	0.45	1.60	0.53
T_4	0.15	0.18	0.25	0.58	0.19
T_5	1.00	0.65	0.15	1.65	0.55
T_6	0.25	0.20	0.45	0.90	0.30

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	0.018	0.009			
Treatments	5	0.485	0.097	2.04^{ns}	3.33	5.64
Error	10	0.474	0.047			
Total	17	0.977				

^{ns} = Not significant Coefficient of variation = 33.02 %

Appendix Table 8. Weight of non-marketable plants (kg), second cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	0.10	0.05	0.10	0.25	0.08
T_2	0.15	0.15	0.15	0.45	0.15
T_3	0.15	0.08	0.15	0.38	0.13
T_4	0.23	0.12	0.10	0.45	0.15
T_5	0.08	0.08	0.10	0.26	0.09
T_6	0.12	0.10	0.20	0.42	0.14

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	0.115	0.058			
Treatments	5	0.374	0.035	2.23^{ns}	3.33	5.64
Error	10	0.469	0.047			
Total	17	0.911				

^{ns} = Not significant Coefficient of variation = 25.39 %

Appendix Table 9. Weight of non-marketable plants (kg), third cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	0.18	0.16	0.18	0.52	0.17
T_2	0.10	0.10	0.08	1.00	0.33
T_3	0.25	0.20	0.21	0.66	0.22
T_4	0.08	0.10	0.06	0.24	0.08
T_5	0.10	0.06	0.10	0.25	0.09
T_6	0.22	0.18	0.19	0.59	0.20

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	0.002	0.001			
Treatments	5	0.058	0.012	38.2308**	3.33	5.64
Error	10	0.003	0.000			
Total	17	0.063				

** = highly significant

Coefficient of variation = 12.29 %

Appendix Table 10. Weight of individual plant (g), first cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	66.00	72,00	87.50	225.50	75.17
T_2	181.51	133.00	171.50	486.00	162.00
T_3	214.00	159.00	199.00	572.00	190.67
T_4	74.00	84.50	47.00	205.50	68.50
T_5	175.00	172.50	186.00	533.50	177.83
T_6	178.50	319.00	187.00	684.50	228.17

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	364.778	182.389			
Treatments	5	62771.611	12554.322	7.8106**	3.33	5.64
Error	10	16073.389	1607.339			
Total	17	79209.778				

** = highly significant

Coefficient of variation = 26.66 %

Appendix Table 11. Weight of individual plant (g), second cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	50.10	64.00	66.00	180.10	60.03
T_2	77.50	104.50	72.00	254.00	84.67
T_3	139.00	148.50	172.50	459.00	153.00
T_4	159.00	143.00	193.00	495.00	165.00
T_5	37.50	70.00	53.00	160.50	53.50
T_6	58.50	63.00	47.00	168.50	56.17

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	469.818	234.909			
Treatments	5	41456.211	8291.242	19.7715**	3.33	5.64
Error	10	4193.522	419.352			
Total	17	46119.551				

** = highly significant

Coefficient of variation = 21.91 %

Appendix Table 12. Weight of individual plant (g), third cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	65.50	62.50	43.00	171.00	57.00
T_2	82.50	79.00	75.50	237.00	79.00
T_3	161.00	144.50	156.50	462.00	154.00
T_4	78.00	77.00	63.50	218.50	72.83
T_5	79.50	79.00	76.50	235.00	78.33
T_6	155.50	154.00	159.00	468.50	156.17

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Replication	2	192.444	96.222			
Factor A	5	28700.944	5740.189	134.8869**	3.33	5.64
Error	10	425.556	42.556			
Total	17	29318.944				

** = highly significant Coefficient of variation = 6.55 %

Appendix Table 13. Number of leaves per plant, first cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	13.70	13.80	14.10	41.60	13.87
T_2	13.00	11.50	11.30	35.80	11.93
T_3	24.30	21.80	18.50	64.60	21.53
T_4	15.00	16.40	11.40	42.80	14.27
T_5	21.10	22.80	18.50	63.40	21.13
T_6	10.80	10.80	12.30	33.90	11.30

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	16.004	8.002			
Treatments	5	307.523	61.505	21.8187**	3.33	5.64
Error	10	28.189	2.819			
Total	17	351.716				

** = highly significant Coefficient of variation = 10.71 %

Appendix Table 14. Number of leaves per plant, second cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	12.30	14.20	12.80	39.30	13.10
T_2	12.30	12.60	10.60	35.50	11.83
T_3	23.50	20.20	16.90	60.60	20.20
T_4	23.90	19.30	17.50	60.70	20.23
T_5	14.90	16.20	12.30	43.40	14.47
T_6	12.50	17.40	12.60	42.50	14.17

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	31.943	15.972			
Treatments	5	199.133	39.827	10.0921**	3.33	5.64
Error	10	39.463	3.946			
Total	17	270.540				

** = highly significant

Coefficient of variation = 12.68 %

Appendix Table 15. Number of leaves per plant, third cropping

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	14.30	14.30	12.90	41.50	13.83
T_2	10.00	10.10	10.50	30.60	10.20
T_3	20.80	21.90	20.90	63.60	21.20
T_4	10.40	9.60	10.30	30.30	10.10
T_5	10.10	10.20	10.90	31.20	10.40
T_6	16.70	22.20	20.50	59.40	18.80

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	3.054	1.527			
Treatments	5	383.178	76.636	48.6506**	3.33	5.64
Error	10	15.752	1.575			
Total	17	401.572				

** = highly significant

Coefficient of variation = 8.80 %

Appendix Table 16. Total yield from the succession cropping (kg)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	12.98	16.16	17.43	46.57	15.52
T_2	31.94	24.75	31.73	88.42	88.42
T_3	30.75	33.83	24.91	89.49	89.49
T_4	25.71	24.40	19.66	69.77	69.77
T_5	22.93	25.54	22.85	71.28	71.28
T_6	35.69	28.98	30.84	95.51	95.51

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	13.189	6.594			
Treatments	5	546.620	109.324	9.0598**	3.33	5.64
Error	10	120.669	12.067			
Total	17	680.477				

** = highly significant

Coefficient of variation = 13.56 %

Appendix Table 17. Germination percentage (%) from spinach, romaine lettuce and spoon cabbage seeds watered by its compost tea under controlled experiment

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	72	82	71	225.00	75.00
T_2	75	77	82	234.00	78.00
T_3	77	76	69	222.00	74.00
T_4	85	82	81	248.00	82.67
T_5	86	74	71	231.00	77.00
T_6	84	87	81	252.00	84.00
T_7	68	63	80	21.00	70.33
T_8	88	82	82	252.00	84.00
T_9	92	80	92	264.00	88.00
T_{10}	95	79	96	270.00	90.00
T_{11}	96	93	96	285.00	95.00
T_{12}	95	85	94	274.00	91.33

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	121.056	60.528			
Treatments	5	1956.889	177.899	5.6644**	3.33	5.64
Error	10	690.944	31.407			
Total	17					

** = highly significant Coefficient of variation = 16.80 %