BIBLIOGRAPHY

CAT-AG, JENNIFER S. DECEMBER 2007. Growth and Yield Response of Spoon Cabbage to Different Frequency of Liquid Bio-Fertilizer Application. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted from June to July 2007 at the Experiment area of Benguet State University to determine the growth and yield of spoon cabbage applied with liquid bio- fertilizer at varying frequencies and the profitability of the frequency of application.

Results of the soil analysis before planting shows that the area has 6.34 pH, 3.5% organic matter, 140 ppm phosphorus and 1,510 ppm potassium and this fertility level produced spoon cabbage with slightly longer leaves, heavier individual plant, heavier marketable plant per plot and computed yield per hectare, and the highest return on investment of 458.09% or PhP 4.58 for every peso invested in the production. On the other hand, supplementing the native fertility level of the soil with 8.75 ml of liquid bio- fertilizer per gallon of water on the plot before planting then one week after seedling emergence closely followed the growth and yield performance of spoon cabbage not applied with fertilizer. Application of liquid bio-fertilizer every seven days after seedling emergence for three weeks had ROI of 367.44 %, and the farmer's practice of applying chicken dung as base dress then side dressing with 14-14-14 had the shortest leaves, lowest number of fully expanded leaves, lowest weight of individual plant, yield per plot and computed yield per hectare giving the lowest return on investment of 205.50 % or P2.26 for

every peso invested in the production. Slight differences were observed in the incidence of pest and disease, sugar content, and no burning effect or phytoxicity was observed.

INTRODUCTION

Despite the many problems of the vegetable industry, farming can never be abandoned. More than 76,000 families in the province of Benguet are dependent on agriculture as their main source of income. Agriculture and mining are the two major industries in Benguet (Sagapan, 2006).

There are several kinds of fertilizer such as traditional inorganic and organic commercial fertilizers which farmers use and apply. However, several brands of foliar fertilizers that contain the macro and micro-nutrients are introduced in the market and recently with the inclusion of beneficial microorganisms.

The use of foliar fertilizers is claimed to be more effective than using dry fertilizers because they prevent the problems encountered in soil application such as leaching and denitrification. In addition, Subido (1961) cited that foliar fertilization was the best among the different methods of fertilizer application particularly in the case of micro-elements, and it increases the yield of some agricultural crops.

Foliar application is a method in which fertilizer nutrients are applied to the plants through the leaves and stem. Nutrients soluble in water will penetrate the cuticles of the leaves or absorbed to the stomata then enter to the cell. It is also the best treatment to prevent soil fixation or nutrient deficiency.

Knott and Deanon (1967) stated that foliar application has been found effective to plants because it contain very small quantity of the chemicals that have to be absorbed. Liquid fertilizers are superior to solid fertilizers since they contain an appreciable amount of water soluble phosphorus.

Furthermore, Abadilla (1982) mentioned that foliar fertilizers were applied to correct a deficiency of some essentials elements in a relatively short time and to supply raw materials which are when applied to the soil become unavailable to the crop. High yield will be attained when using supplementary fertilizers due to the presence of calcium and other micronutrients, which have important role in plant growth and development.

However, there were no data yet in the frequency of foliar fertilizer application to plants that is or most effective thus; this study was proposed.

Foliar fertilizer is expensive and fertilizer application should be based on the requirement of the crop and what is already present in the soil. This will minimize waste of resources, destruction of soil and increasing profit. If this study can obtain good results from this experiment, it will be useful to farmers who will produce early maturing plant like spoon cabbage. Researchers will be guided also in conducting similar studies on other crops.

This study was conducted at Benguet State University Experiment Area, Balili, La Trinidad, Benguet from June to July 2007 to determine the growth and yield of spoon cabbage applied with liquid bio-fertilizer at varying frequencies, determine the best frequency or frequencies of liquid bio-fertilizer application to spoon cabbage that will enhance growth and assess the profitability of liquid bio-fertilizer to spoon cabbage production at varying frequencies of application.

REVIEW OF LITERATURE

Description of Spoon Cabbage

One of the leafy vegetables that provide nutrition to human is spoon cabbage (*Brassica cheninses* L.). Common variations for spoon cabbage include Bok chio, pak chio, taisai, celery mustard and Chinese mustard. In addition, spoon cabbage is botanically turnip. Unlike Chinese cabbage, it has thick glossy leaves and thus not forms 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 fifth 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 tender. Both parts are edible and use frequently in stir-fries.Bok-Choy stalks can be 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 tendr and stalks stay crisp. Bok-Choy grows well with the flavor of soy sauce, hot peppers 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 is similar to cabbage and texture is tender-crisp.

Importance of Spoon Cabbage

At present, the demand of spoon cabbage in the local market is quite good due to its nutrients content. It contains 14 calories food energy, 1.0 g protein, 2.73 g carbohydrate, 0.84 g fiber and 0.18 g total fat.

To the farmers, a specifically grower of spoon cabbage serve as their source of livelihood.

Soil and Climatic Requirement
of Spoon Cabbage

Bok-Choy is a cool season crop. Temperature ranging from 15 to 20^0F is favorable to its growth. However, spoon cabbage or Bok-Choy with temperature of 75^0F can cause trip burn prolonged temperature 55^0F can initiate flowering and premature bolting (McDonald, 1993). Furthermore, the same author stated that Bok-Choy grows well in a well-drained soil with good water retention. In Arizona, Spoon Cabbage grows in a sandy loam to clay loam soil with a ph 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 induce flowering while short day promote vegetative growth.

Advantages and Disadvantages
of Foliar Fertilizer

Foliar fertilizers are fertilizers with ease of handling. It is also known to enhance the growth and development of plants. They are commercially available and applied by farmers on their green leafy vegetables (Subido, 1961).

In addition, the same author stated that foliar fertilizers were utilized by farmers to supplement NPK requirement of crops, improve the plants resistance to pest and diseases, enhance vigor and increase yield.

Neuman (1988), observed that on the field studies of soybeans and oats, foliar that is being applied on seeds has the greatest effect. On the other hand, it has the tendency to alter seed and seed size. If applied during flowering, it is possible that changes in chemical component may be due to incomplete development.

Fertilizer chemicals applied as foliar sprays are easily absorbed and utilized by the leaves while fertilizers applied on the soil are not (Mc Vickar, 1970). In similar report Salisbury and Ross (1969), reported that fertilizer application on leaf has been primarily used in plants that are requiring recovery from a nutrient deficiency.

Application of foliar fertilizers is to supplement a normal pre-plant fertilizer that can boost the plant requirements during critical stages of growth, provide nutrients that are safe, available in form for rapid and efficient utilization, for maximum absorption of nutrients by foliage and reduce the effects of critical stress periods. Foliar fertilizer should be compatible with the pesticides and protected from alkaline hydrolysis (Perry, 1985).

Successively for the application of urea, NPK, Mg or various deciduous fruit trees and herbaceous species. In addition, Donahue (1990) mentioned that leaves and stem of the plants easily absorb most of the elements for plant growth when they are sprayed to the particular parts. Absorption takes place on the upper part and lower surfaces of the leaves. The rate of movement may be upward to the leaves or downward to the roots.

Collings (1962) stated that the advantage of dry fertilizers over liquid fertilizers are as follows: (1) fertilizers are poor physical condition can be utilized; (2) it prevent injury to seedlings root from heavy application of dry fertilizers; (3) there is secured and better distribution of small quantities of fertilizers; (4) less fertilizer is usually required; and (5) maximum crop response may be obtained during dry season.

Furthermore, foliar fertilizer can be a big relief to farmers in terms of lower production cost and can supplement major elements in addition to micro-nutrients (Kramer, 1996).

However, nutritional sprays are not always expected to replace soil application. Instead, they are recommended as best treatment to overcome acute deficiency (Muksheje and de Rajat, 1969).

Liquid Bio-fertilizer Microorganisms

The composition of X-Tekh liquid bio-fertilizer indicated on the container label registered to the Fertilizer and Pesticides Authority are:

Macronutrients: Nitrogen - 5.0 %; Phosphorus - 7.0 %; Potassium - 8.0 %; Magnesium - 0.73 %; Calcium - 0.68 %, Sulfur - 2.0 %.

Micronutrients: Boron - 4382 mg/kg; Zinc - 3362 mg/kg; Manganese - 1742 mg/kg; Iron - 1324 mg/kg; Copper; Molybdenum - 324 mg/kg and Cobalt. Humic acid - 10.0 %; Amino acid - 35.0 %.

Plant Growth Promoting Microorganisms: Nitrogen Fixing Microorganisms (NFM) - 1.9×10^{8}; Lactobacillus Series - 5.2×10^{6}; Phosphorus Solubilizing Microorganisms (PSM) - 6.2×10^{7}; Mycorrhiza - 8.6×10^{6}; Yeast Group Series - 1.9×10^{8}; Actinomycete Series - 1.4×10^{7}; Bacillus Series - 6.6×10^{6}; Fluorescent Pseudomonas Series - 4.1×10^{6} and Trichoderma Series - 2.8×10^{6}.

MATERIALS AND METHODS

Materials

The materials used were spoon cabbage seeds, liquid bio-fertilizer (X-Tekh), identifying tags, measuring tape, weighing scale, garden tools, knapsack sprayer, alnus compost and chicken dung.

Methods

Experimental design and treatments. The experiment was laid out in a randomized complete block design (RCBD) with five treatments replicated three times. The treatments were as follows:

Treatment Code	Frequency of Application
T_1	No liquid bio-fertilizer application
T_2	Farmer's practice of applying chicken dung basally and side dressing 357.1429 14-14-14 + 21.7391 urea
T_3	Liquid bio-fertilizer sprayed on the plot before planting then one week after seedling emergence
T_4	Liquid bio-fertilizer applied every four days after seedling emergence for two weeks
T_5	Liquid bio-fertilizer applied every seven days after seedling emergence for three weeks

Land preparation. An area of 75 m2 was prepared for the study. The area was prepared into 15 plots measuring 1m x 5m and these plots were grouped into three to represent the three blocks or replications and each block contained 5 plots to represent the treatments. Each plot except farmer's practice was applied with ½ can (16 li capacity) alnus compost and mixed thoroughly with the soil before planting. Farmer's practice was applied with ½ can (16 li capacity) of chicken dung and mixed thoroughly with the soil. After mixing the chicken dung and alnus compost with the soil, the plant spacing were marked by pressing the tip of finger on the plot surface at a distance of 15 cm. There were four rows of plants and 33 rows across the plot or a total of 132 plants per plot.

Planting the seeds. Two seeds of spoon cabbage var. Chirokee were dropped into the shallow holes made during the land preparation then covered with thin soil (about 1 cm thick). Immediately after planting the seeds, the plots were watered to field capacity.

Care and management. Irrigation was done after every three days up to harvest. Thinning the plants one week after emergence was done by leaving one seedling in each hill. Weeds were removed as they emerge on the plots.

Foliar fertilizer application. The rate of foliar fertilizer application was 8.75 ml per gallon based on the recommended 35 ml per 16 li of water. The frequency of application specified in the treatments was strictly followed.

Harvesting. The plants were harvested by cutting them below the base of petioles when they were 40 days after emergence. All marketable plants were bundled into ½ kg each while those infected with soft rot were weighed and recorded as non-marketable. Data gathered. The data gathered, tabulated, computed and subjected to variance analysis and mean separation test by the Duncan's Multiple Range Test (DMRT) were:

1. Leaf length (cm). Ten plants from each treatment plot were used in this data where the leaf length was measured from the based to the tip of the leaf, and the average leaf length was computed.

2. Number of fully expanded leaves. This was taken from ten sample plants by counting the number of leaves develop per plant.

3. Soil analysis. Before planting, composite soil sample were collected then brought to the soil laboratory for the analysis of organic matter, phosphorus and potassium content. The soil pH monitored weekly by using pH meter before planting up to harvesting.

4. Weight of individual plant (g). This was computed by dividing the total weight of plants per plot by the number of plants harvested per plot.

5. Weight of marketable plants (kg). This was the weight of plants with out any defect that were sold in the market.

6. Weight of non-marketable plants (kg). This was the weight of plants with defects such as diseased and malformed.

7. Yield per plot (kg). This was the total weight of marketable and non-marketable plants per plot.

8. Computed yield per hectare (ton). The marketable yield per plot was converted to yield per hectare by multiplying the yield per plot by 2000 then dividing by 1000. Two thousand is the number of plots per hectare based on 1m x 5m plot used in the study while 1000 is the weight per ton.

9. Incidence of insect pest and diseases

a. Disease incidence. This was evaluated on a per plot basis using the following scale:

Rating	Description
1	No disease
2	Slight incidence (1-19%)
3	Moderate incidence (20-39%)
4	Severe incidence (40% or more)

This was done when plants reached their harvesting stage.

b. Insect pest infestation. This was evaluated on a per plot basis using the following scale:

Rating Description

1 No infestation

2 Slight infestation (1-19%)

3 Moderate infestation (20-39%)

4 Severe infestation (40% or more)

Evaluation was done 40 days after planting the seeds.

10. Sugar content (ºBrix). One sample plant from each plot was taken and squeezed and the juice was placed on a hand refractometer. The reading of the sugar content was recorded.

11. Phytoxicity. The plants in each plot were observed if there were burning effects, discoloration and other abnormalities. This was documented in photographs and rated as follows:

Rating Description

1 No burning effect

2 Slight burning effect (visible browning on leaf edges)

3 Moderate burning effect (browning on leaf edges or below)

4 Severe burning effect (browning of all leaves)

12. Return on investment (%). All the cost of inputs were recorded then deducted from the sales to compute for the net income and ROI. The formula used in computing the ROI was:

$$\text{ROI (\%)} = \frac{\text{Total Sales per Treatment} - \text{Total Expenses per Treatment}}{\text{Total Expenses per Treatment}} \times 100$$

RESULTS AND DISCUSSION

The study was conducted to determine the growth and development of spoon cabbage applied with liquid bio-fertilizer at varying frequencies and the profitability of spoon cabbage at the varying frequencies of application from June to July 2007 with the following results and discussion:

Leaf Length

The plants not applied with liquid bio-fertilizer, plants applied every seven days after seedling emergence for three weeks, every four days after seedling emergence for two weeks and plots sprayed with liquid bio-fertilizer before planting then one week after seedling emergence had numerically longer leaves over the farmer's practice of applying chicken manure as base-dress then side dressed with 14-14-14 followed by hilling-up (Table 1).

This result suggests that even if the differences are not significant, foliar application had slight advantage in enhancing growth of the spoon cabbage than applying the dry

Table 1. Leaf length of spoon cabbage at harvest

TREATMENT	MEAN (cm)
No fertilizer application (control)	27.56[a]
Farmer's practice	24.29[a]
Sprayed on plot before planting the one week after seedling emergence	26.45[a]
Every four days after seedling emergence for two weeks	26.49[a]
Every seven days after seedling emergence for three weeks	27.19[a]

Means with a common letter are not significantly different at 5% level of DMRT

fertilizer according to Collings (1962). Similarly, Donahue (1990) mentioned that the leaves and stem of the plants easily absorb most of the elements for plant growth when they are sprayed to the particular parts.

Number of Fully Expanded
Leaves at Harvest

As presented in Table 2, there were no significant differences among the treatments on the number of fully expanded leaves at harvest. However, the farmer's practice of applying fertilizer had the least number of fully expanded leaves at harvest.

The result of soil analysis (Table 3) shows that the farmer's practice has the highest phosphorus and potassium after harvest, but still the least in fully expanded leaves at harvest. This may demonstrate the advantage of foliar fertilizer for the plant to easily absorb most of the elements for plant growth and that absorption takes place on the upper part and lower surfaces of the leaves according to Donahue (1990). The author also explained that the rate of the movement may be upward to the leaves or downward to the roots which explain the

Table 2. Number of fully expanded leaves at harvest

TREATMENT	MEAN
No fertilizer application (control)	10.0[a]
Farmer's practice	9.0[a]
Sprayed on plot before planting the one week after seedling emergence	10.0[a]
Every four days after seedling emergence for two weeks	10.0[a]
Every seven days after seedling emergence for three weeks	10.0[a]

Means with a common letter are not significantly different at 5% level of DMRT

Table 3. Soil analysis of the experiment area before planting and after harvestingdone at the Department of Agriculture, Soils Laboratory, Baguio City

BEFORE APPLICATION	SOIL pH	OM (%)	N (%)	P (ppm)	K (ppm)
	6.34	3.5	0.175	140	1510
AFTER HARVEST					
No fertilizer application (control)	6.39	4.5	0.225	215	1300
Farmer's practice	6.16	4.5	0.225	260	1360
Sprayed on plot before planting the one week after seedling emergence	6.18	4.5	0.225	185	1080
Every four days after seedling emergence for two weeks	6.45	3.5	0.175	185	1000
Every seven days after seedling emergence for three weeks	6.47	4.5	0.225	235	1080

slightly lower count of leaves from the plants harvested following the farmer's practice.

Weight of Individual Plant

Although the statistical analysis indicated slight differences among the treatments in terms of weight of individual plant, the plants not applied with fertilizer had the heaviest weight of individual plant, followed by plants applied with liquid bio-fertilizer every seven days after seedling emergence for three weeks (Table 4).

The slightly lower weight of individual plant at harvest from the farmer's practice may be due to the observation that it had the least number of fully expanded leaves as shown in Table 2. As mentioned by Kramer (1996), foliar fertilizer can supplement major elements in addition to micro-elements.

Table 4. Weight of individual plant at harvest

TREATMENT	MEAN (g)
No fertilizer application (control)	83.00[a]
Farmer's practice	66.51[a]
Sprayed on plot before planting the one week after seedling emergence	70.33[a]
Every four days after seedling emergence for two weeks	72.41[a]
Every seven days after seedling emergence for three weeks	80.26[a]

Means with a common letter are not significantly different at 5% level of DMRT

Weight of Marketable Plants

Table 5 shows that plants not applied with fertilizer produced the heaviest weight of marketable plants, followed by plants applied in every seven days after seedling emergence for three weeks. However, all the treatments means are not significantly different. The results may be explained by the other data gathered where there were no significant differences on leaf length, number of fully expanded leaves and weight of individual plants. As mentioned, the nutrient content of the soil before planting (Table 3) may be enough for spoon cabbage.

Weight of Non- marketable Plants

There were no significant differences among the weights of non-marketable plants per plot as shows in Table 6. This means that the different treatments in the study did not influence the weight of non- marketable plants.

Table 5. Weight of marketable plant at harvest

TREATMENT	MEAN (kg)
No fertilizer application (control)	10.60[a]
Farmer's practice	7.60[a]
Sprayed on plot before planting the one week after seedling emergence	8.73[a]
Every four days after seedling emergence for two weeks	8.73[a]
Every seven days after seedling emergence for three weeks	10.00[a]

Means with a common letter are not significantly different at 5% level of DMRT

Table 6. Weight of non-marketable plant at harvest

TREATMENT	MEAN (kg)
No fertilizer application (control)	0.19[a]
Farmer's practice	0.17[a]
Sprayed on plot before planting the one week after seedling emergence	0.28[a]
Every four days after seedling emergence for two weeks	0.28[a]
Every seven days after seedling emergence for three weeks	0.23[a]

Means with a common letter are not significantly different at 5% level of DMRT

These results may be due to the observation that the farmer's practice had the least weight of individual plant at harvest. According to Perry (1985), critical stress period can be reduced by application of foliar fertilizer and it can supplement a normal pre-plant fertilizer that can boost the plant requirement.

Yield per Plot

Total yield per plot is consistent with the result of leaf length, number of fully expanded leaves, weight of individual plant, weight of marketable plants and non- marketable plants where there were no significant differences among the treatments. (Table 7). The slightly lower yield form the farmer's practice was due to plant mortality (Figure 1).

The result suggests that when soil has 3.5% organic matter content, 140 ppm phosphorus, 1,510 potassium and 6.34 pH (Table 3) the application of liquid bio-fertilizer does not make significant increase in yield of spoon cabbage.

Computed Yield per Hectare

Result in the computed yield per hectare (Table 8) shows that the differences are not significant in all the treatments. Statistically, the differences may not be significant, but

Table 7. Total yield per plot at harvest

TREATMENT	MEAN (kg)
No fertilizer application (control)	10.79[a]
Farmer's practice	8.31[a]
Sprayed on plot before planting the one week after seedling emergence	9.01[a]
Every four days after seedling emergence for two weeks	9.01[a]
Every seven days after seedling emergence for three weeks	10.23[a]

Means with a common letter are not significantly different at 5% level of DMRT

Table 8. Computed yield per hectare at harvest

TREATMENT	MEAN (t)
No fertilizer application (control)	21.20[a]
Farmer's practice	15.33[a]
Sprayed on plot before planting the one week after seedling emergence	17.47[a]
Every four days after seedling emergence for two weeks	17.47[a]
Every seven days after seedling emergence for three weeks	20.00[a]

Means with a common letter are not significantly different at 5% level of DMRT

economically the difference of 5.87 tons between the no fertilizer applications over the farmer's practice, which when translated to pesos based on the selling price of P 30.00 per kilo is P 176,100.00. This amount is a significant income for the farmer.

Incidence of Insect Pest and Diseases

It was observed that all the plants have slight incidence of insect damage and disease as indicated by the slight damage and infection (Table 9, see photograph in Fig.1). Flea beetle was observed during the seedling stage while soft rot was the disease that infected few plants. The slight damage might be due to the method of growing where it was done inside a greenhouse and the time of planting which was rainy season. The population of insect pest is lesser during the rainy season. Moreover, the plants were harvested in 40 days.

Sugar Content

Table 10 shows similar refractive index of crop juice from the different treatment studied. According to Price (2004) fruit and vegetable quality correlates to the amount of Table 9.

Incidence of insect pest and diseases to spoon cabbage plants

TREATMENT	INSECT	DISEASES
No fertilizer application (control)	Slight	Slight
Farmer's practice	Slight	Slight
Sprayed on plot before planting the one week after seedling emergence	Slight	Slight
Every four days after seedling emergence for two weeks	Slight	Slight
Every seven days after seedling emergence for three weeks	Slight	Slight

Table 10. Sugar content at harvest

TREATMENT	MEAN (^{0}Brix)
No fertilizer application (control)	2.27
Farmer's practice	2.27
Sprayed on plot before planting the one week after seedling emergence	2.80
Every four days after seedling emergence for two weeks	2.27
Every seven days after seedling emergence for three weeks	2.27

dissolved solids in plant sap (fresh juice). High Brix produce adamantly resists rotting in storage, only high quality produce dehydrates. However, the quality charts did not include spoon cabbage or pak choi to compare the measured sugar content.

Phytoxicity

There was no phytoxicity or burning effect on the leaves of spoon cabbage observed from the study (Table 11). This suggest that spoon cabbage or pak choi does not exhibit phytoxicity when 8.75 ml of the x-tekh liquid bio-fertilizer per gallon of water is applied every seven days intervals. Figure 1 shows no burning effect on plant leaves.

Return on Investment

The different total yield and the cost of farm inputs had resulted to the differences in net income and return on investment from the different frequency of liquid bio- fertilizer application (Table 12). The plants not applied with fertilizer obtained the highest return on investment of 458.09% or P 4.58 for every peso spent in the production. This was followed by spraying the liquid bio-fertilizer on the plot before planting then one week after seedling emergence, every seven days after seedling emergence for three weeks, every four days after seedling emergence for two weeks and the farmer's practice with ROI of 371.36 %, 367.44 % 317.44 % and 205.50 5, respectively.

Table 11. Phytoxicity to spoon cabbage plants

TREATMENT	DESCRIPTION
No fertilizer application (control)	No burning effect
Farmer's practice	No burning effect
Sprayed on plot before planting the one week after seedling emergence	No burning effect
Every four days after seedling emergence for two weeks	No burning effect
Every seven days after seedling emergence for three weeks	No burning effect

Table 12. Cost and return analysis from 15 m^2 area

	FREQUENCY OF FOLIAR FERTILIZER APPLICATION				
ITEM	T_1	T_2	T_3	T_4	T_5
Yield (kg)	31.80	22.80	26.20	18.45	30.00
Sales (PhP)	954.00	684.00	768.00	768.00	900.00
Farm inputs (PhP)					
Seeds	7.71	7.71	7.71	7.71	7.71
46-0-0 (21.739 g)	-	1.08	-	-	-
14-14-14 (357.429 g)	-	14.49	-	-	-
Foliar fertilizer	-	-	11.40	11.40	11.40
Alnus compost	15.00	15.00	15.00	15.00	15.00
Chicken manure	-	26.67	-	-	-
Labor					
Land preparation	8.75	8.75	8.75	8.75	8.75
Planting	1.67	1.67	1.67	1.67	1.67
Irrigation	13.33	13.33	13.33	13.33	13.33
Thinning	2.91	2.91	2.91	2.91	2.91
Fertilizer application	-	-	1.67	1.67	1.67
Hilling-up	-	3.75	-	-	-
Harvesting	75.00	75.00	75.00	75.00	75.00
Depreciation cost	46.57	46.57	46.57	46.57	46.57

Expenses (PhP)	170.94	271.35	184.01	184.08	192.54
Net income (PhP)	783.06	446.65	583.99	583.99	707.46
ROI (%)	458.09	205.50	371.36	317.37	367.44

Note: Selling price = PhP 30.00/kg

As mentioned earlier, the differences in yield did not significantly differed among the treatments, but this return on investment indicated the differences where every centavo counts. The application of fertilizer will increase the cost of production and lower the net income. In this study, when the soil contains 3.5% organic matter, 140 ppm phosphorus, 1,510 ppm potassium and soil pH of 6.34, higher profit is obtained by not applying fertilizer anymore as implied in this study.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at Benguet State University Experiment area, Balili, La Trinidad, Benguet from June to July 2007 to determine the growth and yield response of spoon cabbage applied with liquid bio- fertilizer at varying frequencies, to determine the best frequency of liquid bio- fertilizer applications and to assess the profitability of spoon cabbage production applied with liquid bio- fertilizer at varying frequency.

Results of the study showed slight differences among the treatments on all the data gathered from the spoon cabbage subjected to the different frequency of fertilizer application from soil fertility level of 6.34 pH, 3.5% organic matter, 140 ppm phosphorus, and 1,510 ppm potassium. This provided the plants not applied with fertilizer higher net income and 458.09% return on investment, followed by applying liquid bio-fertilizer on the plot before planting then one week after emergence with 371.36 % ROI, every seven days after seedling emergence for three weeks with 367.44 %, every four days after emergence for two weeks with 317.36 %, and the farmer's practice had the lowest ROI of 205.50%.

Conclusion

Based on the result presented and discussed, the application of liquid bio-fertilizer to spoon cabbage or pak choi is not needed when the soil has pH of 6.34, organic matter of 3.5%, 140 ppm phosphorus and 1,510 ppm potassium.

Recommendation

It is therefore recommended not to apply liquid bio-fertilizer to spoon cabbage when the soil fertilizer level is similar to the soil used in the study. It is also recommended that farmers must have their garden be soil- sampled and analyzed to avoid unnecessary expenses in fertilizer inputs. Moreover, the result of the study will be verified in a different area that has different soil fertility level.

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APPENDICES

Appendix Table 1. Leaf length of spoon cabbage at harvest (cm)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	27.58	27.98	26.22	81.78	27.26
T_2	24.09	24.01	24.77	72.07	24.29
T_3	27.88	27.52	23.93	79.33	26.44
T_4	26.65	25.70	27.13	79.48	26.49
T_5	28.03	27.13	26.40	81.56	27.19

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	2	3.48	1.74			
Treatment	4	17.40	4.35	3.31^{ns}	3.84	7.01
Error	8	10.53	1.32			
Total	14	31.41				

ns = Not significant Coefficient of variation = 4.36%

Appendix Table 2. Number of fully expanded leaves at harvest

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	10.00	11.00	10.00	31.00	10.00
T_2	10.00	9.00	9.00	28.00	9.00
T_3	10.00	10.00	9.00	29.00	10.00
T_4	10.00	10.00	10.00	30.00	10.00
T_5	10.00	9.00	10.00	29.00	10.00

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	0.40	0.20			
Treatment	4	1.73	0.43	1.53^{ns}	3.84	7.01
Error	8	2.27	0.28			
Total	14	4.40				

ns = Not significant Coefficient of variation = 5.53%

Appendix Table 3. Weight of individual plant at harvest (g)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	72.02	102.69	74.29	249.00	86.00
T_2	72.00	64.03	61.49	199.52	66.51
T_3	79.37	95.35	36.93	210.98	70.33
T_4	77.27	65.35	74.60	217.22	72.41
T_5	90.70	80.47	69.60	240.77	80.26

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	910.46	455.23			
Treatment	4	573.24	143.31	0.61^{ns}	3.84	7.01
Error	8	1888.49	236.06			
Total	14	3342.19				

ns = Not significant Coefficient of variation = 20.62%

Appendix Table 4. Weight of marketable plants at harvest (kg)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T_1	9.40	13.20	9.20	31.80	10.60
T_2	7.00	7.80	8.00	22.80	7.60
T_3	9.60	12.20	4.40	26.20	8.70
T_4	9.00	7.80	9.40	26.20	8.70
T_5	11.50	9.80	8.70	30.00	10.00

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	12.53	6.26			
Treatment	4	16.72	4.18	0.95^{ns}	3.84	7.01
Error	8	35.10	4.39			
Total	14	64.35				

ns = Not significant Coefficient of variation = 22.94%

Appendix Table 5. Weight of non-marketable plants at harvest (kg)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	0.25	0.15	0.16	0.56	0.19
T_2	2.00	0.14	0.00	2.14	0.71
T_3	0.40	0.10	0.35	0.85	0.28
T_4	0.35	0.50	0.00	0.85	0.28
T_5	3.20	0.50	0.00	0.70	0.23

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	2	0.75	0.38			
Treatment	4	0.54	0.14	0.53^{ns}	3.84	7.01
Error	8	2.06	0.26			
Total	14	3.35				

ns = Not significant Coefficient of variation = 22.94%

Appendix Table 6. Computed yield per hectare (ton)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
T_1	18.80	26.40	18.40	63.60	21.20
T_2	14.40	15.60	16.00	45.60	15.20
T_3	19.20	24.40	8.80	52.40	17.47
T_4	18.00	15.60	18.80	52.40	17.47
T_5	23.00	19.60	17.40	60.00	20.00

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	2	50.41	25.20			
Treatment	4	64.47	16.12	0.93^{ns}	3.84	7.01
Error	8	139.27	17.41			
Total	14	254.15				

ns = Not significant Coefficient of variation = 22.81%