BIBLIOGRAPHY

DAYAO, NORA A. MARCH 2008. Growth and Yield Response of Spoon Cabbage (*Brassica chinensis L.*) to Time of Liquid Bio-Fertilizer Application. Benguet State University, La Trinidad. Benguet.

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ABSTRACT

The study was conducted to assess the growth and yield of spoon cabbage applied with liquid bio-fertilizer (X-Tekh) at various time of the day; determine the best time of spraying the liquid bio-fertilizer and determine the profitability of spoon cabbage production applied with liquid bio-fertilizer at various time of the day.

The results of the study revealed that spoon cabbage applied with liquid bio-fertilizer at 3:00 o'clock in the afternoon had slightly higher weight of individual plant, marketable yield per plot, total yield per plot, computed yield per hectare, obtained the highest return on investment (519.63%) and had the lowest weight of non-marketable yield. On the other hand, plants applied at 9:00 o'clock in the morning produced longer leaf and higher number of leaves but ranked second in profitability of 490.37% ROI. Spoon cabbage applied at mid-day of bio-liquid fertilizer obtained 453.00% ROI while those plants applied at 6:00 o'clock in the morning or in the afternoon had the lowest of 440.19% and 432.67%, respectively.

There was no phytotoxicity observed in the use of the liquid bio-fertilizer at the various time of application and there was slight differences in the sugar content of the different plant samples. In soil pH, the use of liquid bio-fertilizer generally increased the soil pH every week.

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INTRODUCTION

Nature of the Study

Spoon cabbage (*Brassica chinensis L)* is one of the most nutritious leafy vegetables but not yet widely known in Benguet and Mountain Province. It is sometimes preceded by another name such as Pak choi, Bok-choi, Taisai and celery mustard. This plant contains 14 calories of food energy, 1.0 g protein, 2.73 g carbohydrates, 0.18 g total fat, and 0.84 g fiber (Kinoshita, 1972).

Under Benguet condition, most farmers produce leafy vegetables mainly for the fresh market. The continuous planting of crop results to the depletion of nutrient elements in the soil that requires replenishment. As a principle, the more is the yield removed the more is the nutrient elements consumed from the soil and the more fertilizer should be applied to replace the amount removed by plants. Applying organic and inorganic fertilizers in the form of dry or liquid fertilizers can be done to replace the nutrients in the soil.

In the application of liquid or foliar fertilizers, many farmers do not know the right time of the day when to apply foliar fertilizers. Although some brochures recommend early in the morning or late in the afternoon as the time to spray foliar fertilizers, there was no study yet on the time appropriate to apply foliar fertilizers under local condition. It is then a useful endeavor to conduct this proposed experiment.

Importance of the Study

At present, the demand for spoon cabbage in the local market is increasing especially that the number of foreign consumers like Japanese and Koreans in the locality are increasing in addition to the increasing population of the country. Farmers need to increase production to cope up with the increasing population.

Another problem is the destruction of the soil due to the application of dry fertilizers like urea, ammonium sulphate and complete that makes the soil acidic. If the application of foliar fertilizer can help in preventing the soil to become acidic, result of this study will be of help to the vegetable industry.

When the appropriate time to apply foliar fertilizer is determined in this study, it will be used to advice farmers avoid waste of their money due to the inappropriate time of application that cannot be used by plants.

With the trend of organic farming being advocated, the use of foliar fertilizers containing the macro and micro elements including beneficial microorganisms should be carefully evaluated not only the rates of application but also the time of application.

Moreover, there is a growing interest in foliar fertilizer application to crops in which the applied nutrients are immediately utilized by the plant through the leaves. This eliminates nutrient losses due to leaching and fixation, hence, lowering the cost of fertilizer materials.

Objectives of the Study

The study was conducted to:

1. assess the growth and yield of spoon cabbage applied with liquid bio-fertilizer (X-Tekh) at different time of the day;
2. determine the best time of spraying liquid bio-fertilizer that will enhanced growth and yield of spoon cabbage, and
3. to determine the profitability of spoon cabbage applied with liquid bio-fertilizer

at varying time of the day.

Place and time of the Study

The study was conducted at the Balili Experiment Area, Benguet State University, La Trinidad, Benguet from June to July 2007.

REVIEW OF LITERATURE

Description of Spoon Cabbage

Spoon cabbage is a leafy vegetable crop grown in all part of the world and has been used as food since antiquity, although it is not well popular in the Philippines (Tamayo, 1975).

The leaf petioles can be consumed raw as a whole or chopped and used in salads. It contains high amount of water and quickly becomes limpy upon cooking. Quick cooking at high temperature preserved leaf tenderness and crispness of the petioles. This crop is also used to flavor other dishes due to its good strong taste. Nutritionally, it is a good source of Vitamins and minerals (Thompson, 1931).

Spoon cabbage is succulent and mild in flavor, and maybe eaten either cooked or raw (McDonald, 1993).

Importance of the Crop

According to the Internet, this graceful vegetable with Chinese origins has spread throughout Asia and beyond, developing a wide range of varieties. The slight mustardy flavor of spoon cabbage makes it a delightful addition to stir-fries, soups, noodle and meat dishes, and salads, if the young leaves are used.   In China, the coarser leaves are often pickled. Some Chinese cooks also the leaves in boiling water and hang them out to dry in the sun for several days. Drying enables this highly perishable vegetable to be stored for winter months. Asian cooks use the entire plant at many stages of development.

Vitamin C and significant amounts of nitrogen compounds known as indoles, as well as fiber-both of which appear to lower the risk of various forms of cancer are in the crops. Spoon cabbage is also a good source of folate (folic acid) and with its deep green leaves, more beta-carotene can be obtained than other cabbages. It also supplies considerably more calcium. The stalks and leaves have quite different textures, so in culinary terms, it's like getting two vegetables for the price of one (Anonymous, 2007).

Climate and Soil Requirements

Tindal (1983), said that spoon cabbage is tolerant to a wide range of soil conditions, including pH, although excessively well-drained soils are unsuitable for this crop which matures rapidly. Normally grown at elevations up to 1,500 m above sea level although the leaves are liable to damage by winds in exposed situations, withstands periods of relatively high rainfall but requires full exposure to sun for optimum development. Flowering is reduced under high temperature condition but relatively low temperatures of less than 16ºC promote precocious flower production. High yielding, firm headed crops of the spoon cabbage are produced at high elevations during cool weather, at lower elevations heading is less likely to occur.

According to Prosea (1994), spoon cabbage withstands wet weather relatively well if not flooded. Fertile alluvial sandy to clayey loam with pH between 5.5-7 is preferred for cultivation. However, other soil types such as peat and latasols are also suitable if well provided with organic manure and fertilizers.

In addition, Swiader (2002), stated that spoon cabbage is better adapted to warmer growing conditions than pe-tsai. The plant requires a rich, well-drained and moist soil.

Foliar Fertilizer Application

Fertilizer chemicals applied as foliar sprays generally are much quickly absorbed and utilized by the leaves than when applied to the soil. To be most effective, spray application should be supplemented with soil application (McVickar, 1970).

As mentioned by Tisdale (1966), foliar spray provides for more rapid utilization and permits the correction of observed deficiencies in lesser time than would be required by soil treatments. He also forwarded than when problems of solid fixation of nutrients exist, foliar application constitute the most effective means of fertilizer.

Subido (1961) stated that among the different methods of fertilizer application, foliar fertilization particularly in the case of minor elements, has given marked increased in yield of some agricultural crops.

Collings (1962) mentioned that advantages of liquid fertilizers over dry fertilizers as follows. (1) less fertilizer is usually required; (2) the avoidance of injury to seedling roots from heavy application of dry fertilizer; (3) better distribution of small quantities of fertilizer is secured; (4) fertilizer of poor physical conditions can be utilized; (5) maximum crop response maybe obtained during dry weather; (6) light applications maybe applied according to the needs.

In the study of Poloc (1994), lettuce plants applied with different foliar fertilizers did not show any significant differences on the biological yield, average weight of individual head, weight of marketable heads, percentage of non-marketable head, total yield per plot and computed yield per hectare. The plants applied with chicken dung + 14-14-14 significantly promoted better growth and yield compared to any of the plants applied with 13 different commercial foliar fertilizers. The researcher mentioned not one of the 13 brands is recommended for use in lettuce for growth and yield were not enhanced.

Similarly, Balao (1996) reported that the application of crop Giant or Peter Special foliar fertilizers had no significant effect on the growth and yield of snap beans. The author said that application of the recommended rate of 50-120-50 kg N-P_2O_5 – K_2O/ ha or 75-50 and 25% of the recommended rate comparatively effected high marketable and total pod yield.

Moreover, the efficacy evaluation of 14-10-12 foliar fertilizer (Green Bee) on the growth and yield of lettuce produced the lowest leaf area and lowest ROI compared to the application of 14-14-14 at 14 sacks per hectare which significantly increased leaf area, percent heading and head. On the performance of carrot as affected by the foliar fertilizer (15-15-30 + micro elements) did not show significant difference on root sizes and yield although application once on six weeks after emergence had higher ROI at 77. 13% than without foliar application, which obtained an ROI of 65.89 % (Limoan, 2001).

X-Tekh Liquid Bio- fertilizer

According to the product brochure, X-Tekh new generation liquid bio-fertilizer microorganism is a revolutionary high technology compound fertilizer consisting a microbial, organic and non-organic minerals.

The action of microorganisms within X-Tekh new generation liquid bio-fertilizer help release the “locked-up’’ nutrients in the soil for ready plant uptake and utilization. The brochure mentioned the composition of X-Tekh new generation liquid bio-fertilizer microorganisms as follows: 1) Macro-nutrients; Nitrogen, Phosphorus, Potassium, Magnesium, Calcium and Sulfur 2) Micro-nutrients; Boron, Zinc, Manganese, Iron, Copper, Molybdenum and cobalt, 3) Organic Group; Humid Acid and amino acid, 4) Plant Growth Promoting Microorganisms, Nitrogen Fixing Microorganisms, Bacillus series, Lactobacillus series, Phosphorus Solubilizing Microorganisms, Fluorescent Pseudomonas series, Mycorrhiza, Yeast Group series, Actinomycete series and Trichoderma series.

It was explained in the brochure that X-tekh liquid bio-fertilizer microorganisms decreases fertilizer requirement, fungal attack, insect infestation and the salinity while increase root growth, nutrient uptake, quantity and the color of the soil structure. Meanwhile, this liquid bio-fertilizer optimizes maturity period, aids uniform crop establishment and modulates soil pH.

Moreover, the brochure enumerated the properties of X-tekh new generation liquid bio-fertilizer microorganism and function of each content as follows:

Macro-nutrients:

Nitrogen (8.0 %) – encourage vegetative growth.

Phosphorus (6.0 %) – promotes root development, help in flower and production.

Potassium (10.0%) – promotes crop maturation and uniformity.

Magnesium (1.5%) – aids in soil pH stabilization and stimulates bacterial activity in N-fixation.

Calcium (1.0%) – important in cell structure, cell division, enzymes, and as an enzyme activator.

Sulfur (2.0%) - part of protein amino acids, vitamins importance in respiration.

Micro-nutrients (B, Zn, Mn, Fe, Cu, Mo, Co)>4.05

Boron - important in sugar transport.

Zinc - promotes production of growth hormones, starch formation and the seed production.

Manganese - is involved in enzyme activity for photosynthesis and the nitrogen metabolism.

Iron - is necessary for photosynthesis and the chlorophyll formation.

Copper - important in protein and carbohydrates metabolism.

Molybdenum – promotes nitrogen fixation.

Cobalt – is the nitrogen fixation in legumes and root nodules.

Humid Acid (>10.0%) – release of nitrogen for organic nutrient.

Amino Acid (>35.0) – organic nutrient for plant.

Plant Growth Promoting Microorganisms

Nitrogen Fixing Microorganisms (NFM) $1.9x10^8$ (Azotobacter $6.8x\ 10^7$), Filamentous $6.8x10^7$, Rhizobia $6.8x10^7$) NFM can transform N_2 to ammonia by bilogical nitrogen fixation; NFM may increase the nitrogen uptake.

Lactobacillus series ($5.2x\ 10^6$). To create natural plant enzymes producing organic acid as a bio-regulator that can promote mineral elements for absorption of the crops

Phosphorus Solubilizing Microorganisms ($6.2\ x\ 10^7$). Breakdowns insoluble phosphate in the soil and transform them into phosphorus, iron and calcium fertilizer.

Mycorrhiza ($8.6x10^6$). Creates vitamins, growth hormones and decomposes organic material for strengthening antibiotics diseases.

Actinomycete Series ($6.6x10^7$). It secretes antibiotic material to help cure diseases.

Bacillus Series ($6.6\ x10^6$). Plant protection and bio-control.

Fluorescent Pseudomonas Series ($4.1x10^6$). It protects against pathogens.

Trichoderma Series ($2.8x10^6$). It decomposes organic materials stimulates mineral elements for absorption of crops.

MATERIALS AND METHODS

Materials

The materials used in the study were: seeds of spoon cabbage 'Chirokee', liquid bio-fertilizer (X-Tekh), garden tools, plant compost, measuring tape, and identifying tags.

Methods

Experimental design and treatments. The experiment were laid out in a Randomized Complete Block Design (RCBD). There were three replications and five treatments represented as follows:

Code	Time of Spraying
T_1	6:00 AM
T_2	9:00 AM
T_3	12:00 NOON
T_4	3:00 PM
T_5	6:00 PM

Land preparation. An area of 75 sq m was thoroughly prepared and divided into three blocks and each block were further subdivided into five experiment plots with a dimension of 1 m x 5 m. These plots were applied with 20 kg alnus compost each, mixed with the soil and leveled. On the leveled plot surface, 1 cm deep holes spaced at 15 cm were made by pushing the tip of a finger to mark where the seeds were planted. The 15 cm spacing accommodated 33 lines of plants across the plot and four rows of plants along the plot.

Planting seeds. Two seeds were directly seeded in the shallow holes made during land preparation and covered with thin soil. The plots were watered immediately after planting the seeds to promote seed germination and faster seedling establishment. After emergence, the seedlings were thinned to one plant per hill.

Foliar fertilizer application. One week after seedling emergence, the foliar fertilizer treatments were implemented following the time of application. The rates of application was 6.5 ml of x-tekh liquid bio-fertilizer per 3 liters of water. The intervals of application was every seven days for four applications or duration of one month.

Care and management. Watering the plants was done every three days up to harvest or a total of 11 irrigation frequencies for the duration of the study. Weeds were uprooted as soon as they emerge so they did not compete with the plants with nutrient elements, water, light and space.

Harvesting. All the plants were harvested by cutting the base with a sharp knife when they were 37 days from emergence and the data gathered were recorded.

Data Gathered

The data were gathered, tabulated, computed and subjected to variance analysis and mean separation test by the Duncan's Multiple Range test (DMRT) were as follows:

1. Leaf length (cm). Ten (10) plants from each treatment plot were used as sample plants for this data. With the use of a foot rule, the leaf lengths were measured from the based to the tip of the leaf, and the average leaf length was computed.

2. Number of leaves developed per plant. This was obtained from 10 sample plants at harvest by counting the number of leaves developed per plant.

3. Weight of individual plant (g). The weight of individual plant were obtained by dividing the yield per plot by the number of plants harvested per plot.

4. Marketable yield per plot (kg). This was the weight of plants harvested per plot without defect which were sold in the market.

5. Non-marketable yield per plot (kg). The plants infected with soft rot disease in each plot were weighed and recorded.

6. Total yield per plot (kg). This was the weight of marketable and non-marketable plants per plot.

7. Computed yield per hectare (tons). The total yield per plot was converted to tons per hectare by multiplying the yield per plot by 2000, which is the number of plots per hectare based on 1 m x 5 m plot used in the study and divided by 1000 which is the weight of one ton.

8. Soil analysis. Soil samples before planting and after harvesting the crop were taken and brought to the Soil Science Laboratory for analysis particularly for the soil pH, organic matter, phosphorus and potassium content.

9. Phytotoxicity. The plants in each plot were observed for burning effect, discoloration and other abnormalities as an effect of the foliar fertilizer applied.

10. Documentation in photograph. Any observation that cannot be measured were recorded in photographs during the conduct of the study.

RESULTS AND DISCUSSION

The study was conducted to assess the growth and yield of spoon cabbage applied with bio-fertilizer at different time of the day; determine the best time of spraying the liquid bio-fertilizer and determine the profitability of spoon cabbage applied with liquid bio-fertilizer at different time of the day. The results are presented and discussed in this section.

Leaf Length

The leaf length of spoon cabbage at harvest is presented in Table 1. There were no significant differences in leaf length among the spoon cabbage applied with liquid bio-fertilizer at different time of the day (see Fig. 1 crop stand before harvest). However, the plants applied at 9:00 o'clock in the morning had slightly longer leaves. It appears in the result that plants applied at 6:00 o'clock in the morning and afternoon had slightly shorter leaves.

Table 1. Leaf length as affected by time of liquid bio-fertilizer application

TIME OF SPRAYING	LEAF LENGTH (cm)
6 AM	25.44 [a]
9 AM	26.45 [a]
12 NOON	26.28 [a]
3 PM	26.39 [a]
6 PM	24.57 [a]

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

Figure. 1. Photograph of standing plants showing similar heights resulting to similar leaf length and marketable yield per plot

Number of Leaves Developed per Plant

The number of leaves developed per plant at harvest is presented in Table 2. There were no significant differences in leaves developed among the spoon cabbage applied with liquid bio-fertilizer at different time of the day. However, the plants applied at 6:00 o'clock is the morning and in the afternoon produced lower number of leaves developed per plant. This observation might suggest that nutrient absorption is more efficient from 9:00 o'clock in the morning to 3:00 o'clock in the afternoon than at 6:00 in the morning and in the afternoon. Stomatal opening in pak choi or spoon cabbage may happen from 9:00 a.m. to 3:00 p.m. Moreover, the wax in the cuticle may have melted and can allow the penetration of the foliar fertilizer.

Weight of Individual Plant

Table 3 shows the weight of individual plant as affected by the different time of liquid bio-fertilizer applications. Statistical analysis shows no significant differences in the weight of individual plant. However, the trend in the leaf length, number of leaves

Table 2. Number of leaves developed per plant

TIME OF SPRAYING	MEAN
6 AM	10.0 [a]
9 AM	11.0 [a]
12 NOON	11.0 [a]
3 PM	11.0 [a]
6 PM	10.0 [a]

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

developed per plant is consistent with the weight of individual plant where 6:00 o'clock in the morning and in the afternoon had slightly lighter weight than from 9:00 o'clock in the morning to 3:00 o'clock in the afternoon. It might be that the stomates are closed early in the morning and late in the afternoon and the wax of the cuticle hardened that there is slower foliar fertilizer absorption by the leaves than when there is bright sunlight from 9:00 to 3:00 PM.

Marketable Yield per Plot

Table 4 shows the marketable yield per plot from the different time of liquid bio-fertilizer application. There were no significant differences in the marketable yield of spoon cabbage per plot in the statistical analysis (see Fig. 2 of the similar sizes of plants). However, the trend is apparent in the marketable yield per plot, where lower yield of spoon cabbage was harvested from 6:00 o'clock application in the morning or afternoon. Fertilizer absorption and utilization may be more efficient from 9:00 o'clock in the morning to 3:00 o'clock in the afternoon.

Table 3. Weight of individual plant

TIME OF SPRAYING	MEAN (g)
6 AM	81.57 [a]
9 AM	89.14 [a]
12 NOON	85.13 [a]
3 PM	93.56 [a]
6 PM	80.43 [a]

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

Figure 2. Photograph of the harvested crop with obviously similar leaf length, and sizes of individual plant that resulted to similar marketable yield per plot. The roots also show similar length and color

Non-Marketable Yield per Plot

Statistical analysis showed that there were no significant differences in non-marketable yield per plot among the different treatments (Table 5). The non-marketable yield consisted of soft rot infected plants weighing from 50 to 230 grams.

Table 4. Marketable yield of spoon cabbage per plot

TIME OF SPRAYING	MEAN (kg)
6 AM	10.77 [a]
9 AM	11.77 [a]
12 NOON	11.02 [a]
3 PM	12.35 [a]
6 PM	10.62 [a]

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

Table 5. Non-marketable yield per plot

TIME OF SPRAYING	MEAN (kg)
6 AM	0.18 [a]
9 AM	0.22 [a]
12 NOON	0.18 [a]
3 PM	0.05 [a]
6 PM	0.23 [a]

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

Total Yield per Plot

The total yield per plot is presented in Table 6. There were no significant differences among the spoon cabbage applied with liquid bio-fertilizer at different time of the day. However, the plants applied at 3:00 o'clock in the afternoon had slightly higher total yield. It is consistent in the result that 6:00 o'clock in the morning and in the afternoon resulted in the slightly lower yield of about a kilo per plot.

Computed Yield per Hectare

As shown in Table 7, there were no significant differences in computed yield per hectare among the treatment means. However, the difference of 3.47 tons or 3,470 kilograms between the highest (3:00 PM) and the lowest (6:00 PM) computed yield will mean tremendous economic contribution to the farmer per hectare. With the selling price of Php 30.00 per kilo, 3,470 kilos will give the farmer Php 104,100.00 more when the foliar fertilizer is applied at 3:00 o'clock than when applied at 6:00 o'clock in the afternoon. Similarly, the plants applied with fertilizer at 9:00 o'clock had 2,000 kilos more yield compared to the 6:00 o'clock application that has a value of Php 60,000.00.

Table 6. Total yield per plot

TIME OF SPRAYING	MEAN (kg)
6 AM	10.95 [a]
9 AM	11.98 [a]
12 NOON	11.27 [a]
3 PM	12.40 [a]
6 PM	10.85 [a]

Means with the same level are not significantly different at 5% level by DMRT

<u>Cost and Return Analysis</u>

The cost and return analysis from the 75 sq m area is presented in Table 8. Spoon cabbage applied with liquid bio-fertilizer at 3:00 o'clock in the afternoon gave the highest return on investment of 519.63% or P 5.20 for every peso invested in the production. This was followed by plants applied at 9:00 o'clock in the morning, 12:00 noon, 6:00 o'clock in the morning and 6:00 o'clock in the afternoon with ROI of 490.37, 453.00, 440.19 and 432.67%, respectively. This result suggests that the plants applied at 3:00 o'clock in the afternoon is economically advantageous compared to the other time of applications. It was determined from this study that P 5.29 was spent to produce a kilogram of spoon cabbage.

Table 7. Computed yield per hectare

TIME OF SPRAYING	MEAN (ton)
6 AM	21.53 [a]
9 AM	23.53 [a]
12 NOON	22.03 [a]
3 PM	24.70 [a]
6 PM	21.23 [a]

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

Table 8. Cost and return analysis from 75 sq m area

ITEM	TIME OF APPLICATION				
	6 AM	9 AM	12 NOON	3 PM	6 PM
YIELD (kg)	32.30	35.30	33.05	37.05	31.85
SALES (Php)	969.00	1,059.00	991.50	1,111.50	955.50
Farm Inputs (Php)					
Seeds	4.16	4.16	4.16	4.16	4.16
X – tekh	24.00	24.00	24.00	24.00	24.00
Alnus compost	22.50	22.50	22.50	22.50	22.50
Regular gasoline	7.83	7.83	7.83	7.83	7.83
Labor					
Land preparation	13.76	13.76	13.76	13.76	13.76
Compost application and mixing	14.15	14.15	14.15	14.15	14.15
Measuring plots	13.80	13.80	13.80	13.80	13.80
Planting seeds	10.71	10.71	10.71	10.71	10.71
Irrigation	2.42	2.42	2.42	2.42	2.42
Spraying	2.50	2.50	2.50	2.50	2.50
Hilling-up	2.97	2.97	2.97	2.97	2.97
Harvesting	14.01	14.01	14.01	14.01	14.01
Greenhouse depreciation	46.57	46.57	46.57	46.57	46.57
EXPENSES (Php)	179.38	179.38	179.38	179.38	179.38
NET INCOME (Php)	789.62	879.62	812.12	932.12	776.12
ROI (%)	440.19	490.37	453.00	519.63	432.67

Note: Selling price = Php 30.00/kg

Soil Analysis

As presented in Table 9, the soil pH, organic matter and phosphorus content increased in the soil analysis after harvest, except the potassium that decreased. This indicates that the compost applied as base dress fertilizer and liquid bio-fertilizer contributed to the increase. Definitely, the compost contributed to the physical and chemical improvement. Additionally, the liquid bio-fertilizer may have contributed because according to its brochure it contain 10% humic acid and microorganisms that decompose organic materials and stimulates mineral element absorption by crops.

The different treatment plots were monitored every week to record the changes in soil pH with the use of portable pH meter and the results were presented in Table 10. Generally, the soil pH increased every week for the four weeks before the crop was harvested. As explained in the brochure of the liquid bio-fertilizer, the foliar fertilizer will not only aid in the uniform crop establishment but also modulates soil pH.

However, it is not clear in the result as the soil pH before planting was 6.34 and the pH one week after planting was lower. The alnus compost mixed with the soil as base dress fertilizer might have released organic acid that lowered the pH but immediately increased when the plants germinated and applied with the foliar fertilizer.

Table 9. Soil analysis before planting and after harvest

DETAILS	SOIL ANALYSIS			
	SOIL pH	OM	P (ppm)	K (ppm)
Before Planting	6.34	3.55%	140	1,510
After Harvest				
6 AM	6.66	4.5	245	1,220
9 AM	6.88	4.5	250	1,270
12 NOON	6.79	4.5	225	1,340
3 PM	6.90	4.0	250	1,060
6 PM	6.68	4.0	245	1,130

Note: The soil analysis was done at the DA Soils Laboratory, Baguio City.

Table 10. Weekly soil pH

TIME OF SPRAYING	WEEKLY SOIL PH			
	1st week	2nd week	3rd week	4th week
6 am	5.80	6.20	6.30	6.40
9 am	5.86	6.30	6.33	6.33
12 noon	5.80	6.36	6.36	6.50
3 pm	5.56	6.33	6.46	6.43
6 pm	5.53	6.26	6.30	6.33

Sugar Content

Table 11 shows the sugar content of spoon cabbage from the different treatments. Obviously, the sugar content did not indicate marked differences. This means that the different time of fertilizer application did not influence the sugar content.

Phytotoxicity

Table 12 shows the observation from the different time of application. This observation is similar to the observations made by Pingalo (2007) and Cat-ag (2007) wherein spoon cabbage did not exhibit burning effect unlike the romaine (Tocdangan, 2007) which show burning effect of liquid bio-fertilizer when applied exceeding the recommended rate of 3 tbsp per 16 liters of water. Fig 3 shows the harvested crop packed in the plastic crates and the class in Horticulture 108 examining all the plants without any sign of burning effect.

Table 11. Sugar content of leaf juice from the different treatments

TIME OF SPRAYING	MEAN (°B)
6 AM	2.33
9 AM	2.20
12 NOON	2.80
3 PM	2.53
6 PM	2.80

Figure 3. Photograph during harvest where the whole class in Horticulture 108 (Commercial Vegetable Production) helped in harvesting and examining the crops with no burning effect of the liquid bio-fertilizer

Table 12. Phytotoxicity

TIME OF SPRAYING	DESCRIPTION
6 AM	No burning effect
9 AM	No burning effect
12 NOON	No burning effect
3 PM	No burning effect
6 PM	No burning effect

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

This study was conducted at Balili Experiment Area of Benguet State University, La Trinidad, Benguet from June to July 2007, to assess the growth and yield of spoon cabbage applied with liquid bio-fertilizer at various time of the day; determine the best time of spraying liquid bio-fertilizer and to determine the profitability of spoon cabbage production.

Results showed that the application of liquid bio-fertilizer to spoon cabbage at 3:00 o'clock in the afternoon registered the highest weight of individual plant, marketable yield per plot, total yield per plot, computed yield per hectare and obtained the highest return on investment. In terms of average leaf length and number of leaves developed per plant, 9:00 o'clock in the morning application produced longer leaves and higher number of leaves. In non-marketable yield per plot, plants applied with liquid bio-fertilizer at 3:00 o'clock in the afternoon had the lowest weight However, statistical analysis indicated no significant differences among the different time of fertilizer applications.

The application of liquid bio-fertilizer (X-Tekh) to spoon cabbage at different time of the day did not influence the sugar content of the crop, no phytotoxicity indicated by burning effect on the leaves or other abnormalities and helped increase the soil pH after harvest and organic matter content of the soil also increased.

Economically, higher return on investment of 519.63% was obtained from plants applied with liquid bio-fertilizer at 3:00 o'clock followed by those plants applied at 9:00 o'clock in the morning with 490.37% ROI, 12:00 noon with 453.00%, 6:00 o'clock in the

morning with 440.19% ROI and the plants applied at 6;00 o'clock in the afternoon had the lowest of 432.67% ROI.

Conclusion

Based on the results presented and discussed, it is inferred that the spoon cabbage applied with liquid bio-fertilizer at 3:00 o'clock in the afternoon had slightly better growth and higher yield and that it could be the best time for spraying that will promote higher yield with higher return on investment. Early application of liquid bio-fertilizer at 6:00 o'clock in the morning and late at 6:00 in the afternoon had lower yield and return on investment.

Recommendation

It is therefore recommended that the time of applying the liquid bio-fertilizer to spoon cabbage should be at 3:00 o'clock in the afternoon to obtain the optimum economic benefit. It is also recommended that this result be verified using the same condition used in the study.

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APPENDICES

APPENDIX TABLE 1. Leaf length (cm)

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
6 am	26.87	26.41	23.04	76.32	25.44
9 am	27.98	26.54	24.84	79.36	26.45
12 noon	27.22	27.63	23.98	78.83	26.29
3 pm	27.23	27.2	24.73	79.16	26.39
6 pm	26.77	23.09	23.85	73.71	24.57
TOTAL	136.07	130.87	120.44	387.38	129.14

ANALYSIS OF VARIANCE

Source of Variance	Degrees of Freedom	Sum of Squares	Means of Squares	Computed F	Tabulated F	
					0.05	0.01
Block	2	25.34	12.67			
Treatment	4	7.91	1.98	1.98^{ns}	3.84	7.01
Error	8	8.01	1.00			
TOTAL	14	41.26	15.65			

ns – not significant

Coefficient of Variation = 3.87

APPENDIX TABLE 2. Number of leaves developed per plant

TREATMENT	BLOCK I	BLOCK II	BLOCK II	TOTAL	MEAN
6 am	9.5	9.7	11	30.2	10.07
9 am	10.1	11.8	11.1	33	11
12 noon	9.4	11.6	10.6	31.6	10.53
3 pm	10.4	10.8	11.3	32.5	10.83
6 pm	10.2	10.8	10.1	31.1	10.37
TOTAL	49.6	54.7	54.1	158.4	52.8

ANALYSIS OF VARIANCE

Source of Variance	Degrees of Freedom	Sum of Squares	Means of Squares	Computed F	Tabulated F 0.05	Tabulated F 0.01
Block	2	3.11	1.55			
Treatment	4	1.64	0.41	1.18^{ns}	3.84	7.01
Error	8	2.80	0.35			
TOTAL	14	7.56	2.31			

ns – not significant

Coefficient of Variation = 5.60

APPENDIX TABLE 3. Weight of individual plant (g)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
6 am	82.58	75.76	86.36	244.7	81.57
9 am	9.24	78.79	89.39	267.43	89.14
12 noon	103.41	83.33	63.64	250.38	83.46
3 pm	115.53	71.21	93.94	280.68	93.56
6 pm	93.56	62.88	84.85	241.29	80.42
TOTAL	494.32	371.97	418.18	1,284.48	428.15

ANALYSIS OF VARIANCE

Source of Variance	Degrees of Freedom	Sum of Squares	Means of Squares	Computed F	Tabulated F 0.05	Tabulated F 0.01
Block	2	1510.19	755.097			
Treatment	4	355.35	88.84	0.84^{ns}	3.84	7.01
Error	8	848.32	106.04			
TOTAL	14	2713.86	949.977			

ns – not significant

Coefficient of Variation = 11.98

APPENDIX TABLE 4. Marketable yield per plot (kg)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
6 am	10.9	10	11.4	32.3	10.77
9 am	13.1	10.4	11.8	35.3	11.77
12 noon	13.65	11	8.4	33.05	11.02
3 pm	11.25	9.4	12.4	37.05	12.35
6 pm	12.35	8.3	11.2	31.85	10.62
TOTAL	65.25	49.1	55.2	169.55	56.53

ANALYSIS OF VARIANCE

Source of Variance	Degrees of Freedom	Sum of Squares	Means of Squares	Computed F	Tabulated F 0.05	Tabulated F 0.01
Block	2	26.60	13.30			
Treatment	4	6.46	1.61	0.73^{ns}	3.84	7.01
Error	8	17.66	2.21			
TOTAL	14	50.72	17.12			

ns – not significant

Coefficient of Variation = 13.14

APPENDIX TABLE 5. Non-marketable yield per plot (kg)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
6 am	.20	.25	10	.55	.18
9 am	.35	.15	.15	.65	.22
12 noon	.35	.20	0	.55	.18
3 pm	0	0	.15	.15	.05
6 pm	.20	.15	.35	.7	.23
TOTAL	1.1	0.75	.75	2.6	0.86

ANALYSIS OF VARIANCE

Source of Variance	Degrees of Freedom	Sum of Squares	Means of Squares	Computed F	Tabulated F 0.05	0.01
Block	2	0.01	0.01			
Treatment	4	0.063	0.02	1.04^{ns}	3.84	7.01
Error	8	0.12	0.02			
TOTAL	14	0.20	0.05			

ns – not significant

Coefficient of Variation = 70.76

APPENDIX TABLE 6. Total yield per plot (kg)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
6 am	11.1	10.25	11.5	32.85	10.95
9 am	13.45	10.55	11.95	35.95	11.98
12 noon	14	11.4	8.4	33.8	11.27
3 pm	15.25	9.4	12.55	37.2	12.4
6 pm	12.55	8.45	11.55	32.55	10.85
TOTAL	66.35	50.05	55,95	172.35	57.45

ANALYSIS OF VARIANCE

Source of Variance	Degrees of Freedom	Sum of Squares	Means of Squares	Computed F	Tabulated F 0.05	0.01
Block	2	27.24	13.62			
Treatment	4	5.48	1.37	0.55^{ns}	3.84	7.01
Error	8	19.77	2.47			
TOTAL	14	52.48	17.46			

ns – not significant

Coefficient of Variation = 13.68

APPENDIX TABLE 7. Computed yield per hectare (tons)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN
6 am	21.8	20	22.18	64.6	21.53
9 am	26.2	20.8	23.6	70.6	23.53
12 noon	27.3	22	16.8	66.1	22.03
3 pm	30.5	18.8	24.8	74.3	24.77
6 pm	24.7	16.6	2.4	63.7	21.23
TOTAL	130.5	98.2	110.4	339.3	113.09

ANALYSIS OF VARIANCE

Source of Variance	Degrees of Freedom	Sum of Squares	Means of Squares	Computed F	Tabulated F	
					0.05	0.01
Block	2	106.41	53.20			
Treatment	4	25.82	6.46	0.73^{ns}	3.84	7.01
Error	8	70.64	8.83			
TOTAL	14	202.87	68.49			

ns – not significant

Coefficient of Variation = 13.14