BIBLIOGRAPHY

QUIRANTE, MARGIE A. MAY 2011. Growth, Yield, Shelf-life and Glucosinolates Content of 'Broccoli Lucky Miracle' Applied with Organic Fertilizers. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

This study was conducted in greenhouse condition at Balili, La Trinidad, Benguet from July to November 2010 to evaluate the growth and yield of broccoli as affected by the different fertilizer treatments, determine the shelf-life of broccoli curds harvested from the different fertilizer treatments, determine the concentration of glucosinolates in broccoli applied with the different fertilizers and determine the economics of using the different fertilizers.

Results revealed that that broccoli applied with alnus compost alone had significantly shorter plants, stem and curd diameter resulting to slightly higher yield. Similarly, plants applied with chicken manure + 14 – 14 – 14 had comparable stem diameter with those plants applied with alnus compost alone, however, the rest of the data on growth, yield and shelf-life were statistically similar.

The curd samples from the different treatments showed five peaks of glucosinolate compounds from the chromatogram where the glucosinolate number 4 has ranged from 513.0 to 1,598.0 milli amphere units and the glucosinolate number 5 showed that the application of alnus compost + liquid bio-fertilizer had the highest peak of 13,307.0 milli amphere units.

In terms of profitability, the highest return on expenses was computed from the application of alnus compost alone with P 1.34 for every peso spent, followed by the application of alnus compost + liquid bio-fertilizer (P 1.22) and no application of fertilizer (P 1.17).

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INTRODUCTION

According to Chen (2007), President of the Association of Taiwan Organic Agriculture Promotion, only after the last river has been poisoned, only after the last tree has been cut down, only after the last fish has been caught, only after then will you learn that money cannot be eaten. This statement correctly describes the traditional or chemical agriculture which is oriented towards profit, but pollute the environment.

The continuous application of synthetic fertilizer such as urea, 14-14-14, 21-0-0, 16-16-16, 16-20-0, etc., without any soil analysis as basis of the amount to apply did not only make the soil extremely acidic, but also pollute the underground water and deplete organic matter in the soil. The clear evidences are the findings of Laurean and Badayos (2009) when they recorded a pH of 3.96 and 2.19% organic matter in Ngano-an, Bokod Benguet, 4.54 pH and 4.44% OM in Ballay, Kabayan Benguet, 3.72 pH and 0.99% OM in Guinaoang, Mankayan Benguet, 4.17 pH and 0.96% OM in Nangalisan, Tuba, Benguet and 5.08 pH and 2.60% OM in Magmagaling, Buguias, Benguet.

At present, it appears that most farmers do not like to shift to the more sustainable crop production practices. Advantages in using natural inputs obtained from scientific studies are much wanted.

The nutritional benefits of organic vegetables reviewed by Chen (1999) shows that the snap bean, cabbage, lettuce, tomatoes and spinach have 87% more minerals and trace elements than the commercially grown vegetables. This report is supportive to the advocacy of the university to follow organic farming practices. However, there are very few studies conducted in the university to establish the benefits derived from the practice. It is then a worthwhile endeavor to conduct studies on the benefits of using natural/organic fertilizers to the soil and to the crop. Findings from this study will add to science, provide information to vegetable consumers and producers alike, including researchers for further study and the extension workers to disseminate to the public.

The study was conducted to:

1. evaluate the growth and yield of broccoli as affected by the different fertilizer treatments.

2. determine the shelf-life of broccoli curds harvested from the different fertilizer treatments, and

3. determine the concentration of glucosinolates in broccoli applied with the different fertilizer brands.

4. determine the economics of using different fertilizer treatments in brocolli production.

The study was conducted inside the greenhouse at Balili, La Trinidad, Benguet from July to November 2010.

REVIEW OF LITERATURE

Description of Broccoli

According to Groman (1997), broccoli is a nutritious garden vegetable closely related to cauliflower which originally came from southern Europe. The crop has thick clusters of flower buds that form edible ”heads” which are green and are more branched and open than the tight, round, white heads of cauliflower. The author also mentioned that broccoli can be grown from seeds in 100 to 120 days and that it belongs to the mustard family, cruciferae (Brassicaceae).

A biennial, normally grown as annuals, the edible part of broccoli is the un opened flower cluster (curd) and it's subtending fleshy stems at the terminal of the main axis from two to four feet tall and of the auxiliary branches (Benton, 1970; Tindall, 1983). The curd consists of a mass of abortious flowers on thick hypertrophied branches which are produced at the top of the short, thick stem. Leaves are long and elliptical (Tindall, 1983) and grow about two to three feet tall (Burpee, 1984).

Importance of Broccoli

In terms of food value, broccoli is rich in protein, minerals, and vitamins A and C. People cook broccoli or use it as a green, raw snack vegetable and the buds and fleshy stems are eaten (Groman, 1997).

Broccoli is the earliest and requires the least vernalization of vegetable coles grown in the United States. It thrives under cool condition and a hot period of two to three weeks before market stage will result in a loose head with puffy buds and unacceptable quality. There is a need for heat tolerance in broccoli, but most of the commercial crops are grown in the cool coastal areas of California. Consumption of broccoli had grown rapidly each year since the 1950's. It is high in nutritional value, vitamins, minerals, and roughage, but it is low in carbohydrates (Becnan, 2005).

Soil and Climatic Requirements

Groman (1997) wrote that broccoli grows best in cool weather and in moist, fertile soil. According to Comila 2008, the requirements of broccoli are similar to those of cauliflower but generally less sensitive to high temperature, optimum temperature are in the range of 18-24 degrees Celsius. High temperature may accelerate maturity and induce early flowering. Broccoli also has a lower requirement than cauliflower for a cool period of flowering. The period taken to reach maturity is generally similar to that required by cauliflower; the crop maybe harvested 80-140 days from transplanting. The heads are harvested with 15-25 cm of stem attached, immediately prior to opening of the flowers. After the terminal head has been harvested, several lateral buds developed, to be harvested successionally over a period of several weeks.

Concentrated Mineral Drops (Amazing Harvest)

According to the company, Amazing Integrated Marketing International, the Concentrated Mineral Drops (Amazing Harvest) is a natural active occurring ionic mineral which can easily be assimilated and can be fully absorbed by animals and plants, and helps in enhancing natural defenses that prevents disease and other attacks from destroying elements. It is also claimed that the product has natural balance, complete and stable. It is complete in essential minerals and trace minerals that can work synergistically with living things like plants to create a dynamic equilibrium to bring back lost fertility and nutrients needed by living things. Moreover, the product does not cause toxicity and acidity like chemically base products instead it creates a symbiotic relationship between plants, animals and man (AIM, 1992).

Based on the certificate of analysis on 2 February 2009, the minerals and amounts are the following: Chloride-249 mg/ml; magnesium-81.9 mg/ml; Sulfate-26.6 mg/ml; Sodium-11.6 mg/ml; potassium-14 mg/ml; Lithium-0.544 mg/ml; Boron-0.406 mg/ml; Calcium-0.0947 mg/ml and pH-6.41. Mineral Resources International, Inc. (MRI) the laboratory in Ogden, Utah that conducted the mineral analysis included heavy metals, other contaminants, and microbiological profile of the product, which are all found to be in the specification standards.

As to the rate of application, fruits/leafy vegetables such as tomato, eggplant, cabbage, cauliflower, sweet pepper, pechay, celery, lettuce, cucumber, ampalaya, and squash seeds are soaked for 8 hours in a solution prepared from 8 ml concentrated mineral drops and 16 liters of water then spray the plants with the same solution every 10 days from emergence/transplanting to a day before harvesting.

Plantmate Organic Fertilizer

In the study of Debso (2007), broccoli applied with varying rates of plantmate did not produce significant differences in term of growth and yield parameters which were comparable to the farmer's practice of applying chicken dung basally and side dressing with complete fertilizer three weeks after transplanting. However, the application 2.0 kg of plantmate organic fertilizer obtained the highest return of P1.23 for every peso spent in the production. Recently, Pang-ot (2010) in his experiment on seed yield of French beans and Puyao (2010) in his study on romaine lettuce did not recommend the use of plantmate when the fertility level contain 126 ppm phosphorous, 366 ppm potassium, 2% organic matter and 6.6 pH.

Liquid Bio-fertilizer

In 2007, Tocdangan reported that the application of liquid bio-fertilizer to romaine 'Xanadu' significantly increase the weight of marketable plants compared to the application of chicken dung and 14-14-14. The author, however, recommended that the rate of application is 1.5ml per liter of water and not to exceed for it has burning effect to romaine lettuce, and if the soil has 3.5% organic matter, 140 ppm phosphorous, and 1,510 ppm potassium, high profit can be obtained even without fertilizer application. Similarly, Cat-ag (2007) recommended not to apply liquid bio-fertilizer to spoon cabbage or pak choi when the soil has 6.34 pH, organic matter of 3.5%, 140 ppm phosphorous, and 1,510 ppm potassium as the experiment area of the study

As to the time of application, Dayao (2008) found that spoon cabbage applied with liquid bio-fertilizer at 3:00 o'clock in the afternoon had slightly better growth and 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 o'clock in the afternoon had lower yield and return on investment.

Importance of Organic Fertilizer

Dagoon and Cadiz (1985) stated that the decomposition of organic material by the action of soil microorganisms yield valuable nutrients, which are essential for plant growth. The product of decay enrich the soil to the benefit of plants which in turn cause the microorganism to work continuously, thus breaking the complex compound of the decaying organic material into simple forms, which can be readily used by the plants.

Similarly, PCARRD (1979) pointed out that organic matter improves soil structure, thus increasing the capacity of the soil to hold water and provide aeration. They stimulate the microorganism decomposing residues and aid in the extraction of plant nutrients from minerals in the soil.

Bautista, *et al*. (1983) cited several functions of organic matter in the soil. By forming complexes with the nutrient elements, organic matter prevents loss of nutrient. It facilitates entrance and percolation of water into and through the soil. It improves the penetration of roots through the soil good structure brought by its decomposition. Organic matter also contributes nutrient elements, thus favoring the high yield and growth of plants.

Organic matter opens up non-porous clays to improve drainage and admit the air necessary for good root growth. It is also needed in very porous soils to retain moisture and proper light penetration and in sandy soils to prevent leak of precious rain water and nutrient (Crockett, 1987).

Importance of Glucosinolates

Bones and Rossiter (1996) stated that glucosinolates are substances occurring widely in plants of the genus brassica which includes (broccoli, brussel sprout, and cabbage). It is useful anti- cancer activity since they increase the rate at which a variety of potentially toxic and carcinogenic compound are conjugated and excreted. Aside from that it is also anti- microbial induction of detoxifying enzyme systems. The present compound component of glucosinolates is a class of organic compound that contain sulfur and nitrogen and are derived from glucose and amino acid.

MATERIALS AND METHODS

Materials

The materials used in the study were seeds of broccoli 'Lucky Miracle', organic fertilizers (plantmate, liquid bio-fertilizer, concentrated mineral drops, and chicken dung), 14-14-14, garden tools, weighing scale, refractomer, tape measure, record book and pegs.

Methods

Experimental design and treatments. The experiment was laid out in a Randomized Complete Block Design (RCBD). The treatments which were replicated three times were the following:

Treatment Code	Description
T_1	No application of fertilizer (control)
T_2	5 kg of plantmate per plot of 1m x 5m
T_3	1 can alnus leaves compost + 1.875 ml liquid bio- fertilizer per liter of water
T_4	1 can alnus leaves compost + 0.94 ml of Concentrated mineral drop per liter of water
T_5	Farmer's practice (chicken dung +14-14-14 + insecticide)
T_6	1 can alnus leaves compost alone

Sowing the seeds. Seeds of broccoli 'Lucky Miracle' were sown in seedling trays. The media used in filling the holes of the seedling trays was a mixture of 1:1:1 part by volume of garden soil, plant compost and sand. This mixture was sterilized to kill the soil pathogens and weed seeds. One seed of broccoli was sown in each hole of the seedling tray and was irrigated every after three days when the seedlings were transplanted to the plant beds.

Land preparation. Before preparing the plots, soil sample for N, P, K analysis was taken. Fifteen plots measuring 1m x 5m were prepared for the study. Each plot was applied with one can (16 liters capacity) of alnus compost and mixed with the soil except the plots for farmer's practice where one-half kerosene can of chicken dung per plot was used as base dress fertilizer. After mixing the fertilizer base dress, the distance of planting the seedlings were measured on the plot and marked with sticks at 35 cm x 35 cm.

Transplanting the seedlings. The broccoli seedlings were transplanted to the prepared plots when they reach three weeks (21days) from seedling emergence. The seedlings were taken out from the seedling trays by pushing the outside bottom then transplanting them to the previously prepared plots at a distance of 35 cm x35 cm. With the distance of planting, there were 14 seedlings transplanted per row or 28 seedlings per plot of double rows. The plots were irrigated immediately after transplanting the seedlings (Figure 1).

Hilling- up. Three weeks after transplanting the seedlings, 428.57g of 14-14-14 was side dressed on the plot for farmer's practice then hill-up to cover the fertilizer. Hilling-up of the other treatment plots was also done to control weed growth, put more soil to anchor the plants and to fix the plots so that irrigation water does not over flow to the canals between plots.

Foliar fertilizer application. The application of the liquid bio-fertilizer (X-Tekh Micro) and concentrated mineral drops (Amazing Harvest) started one week after

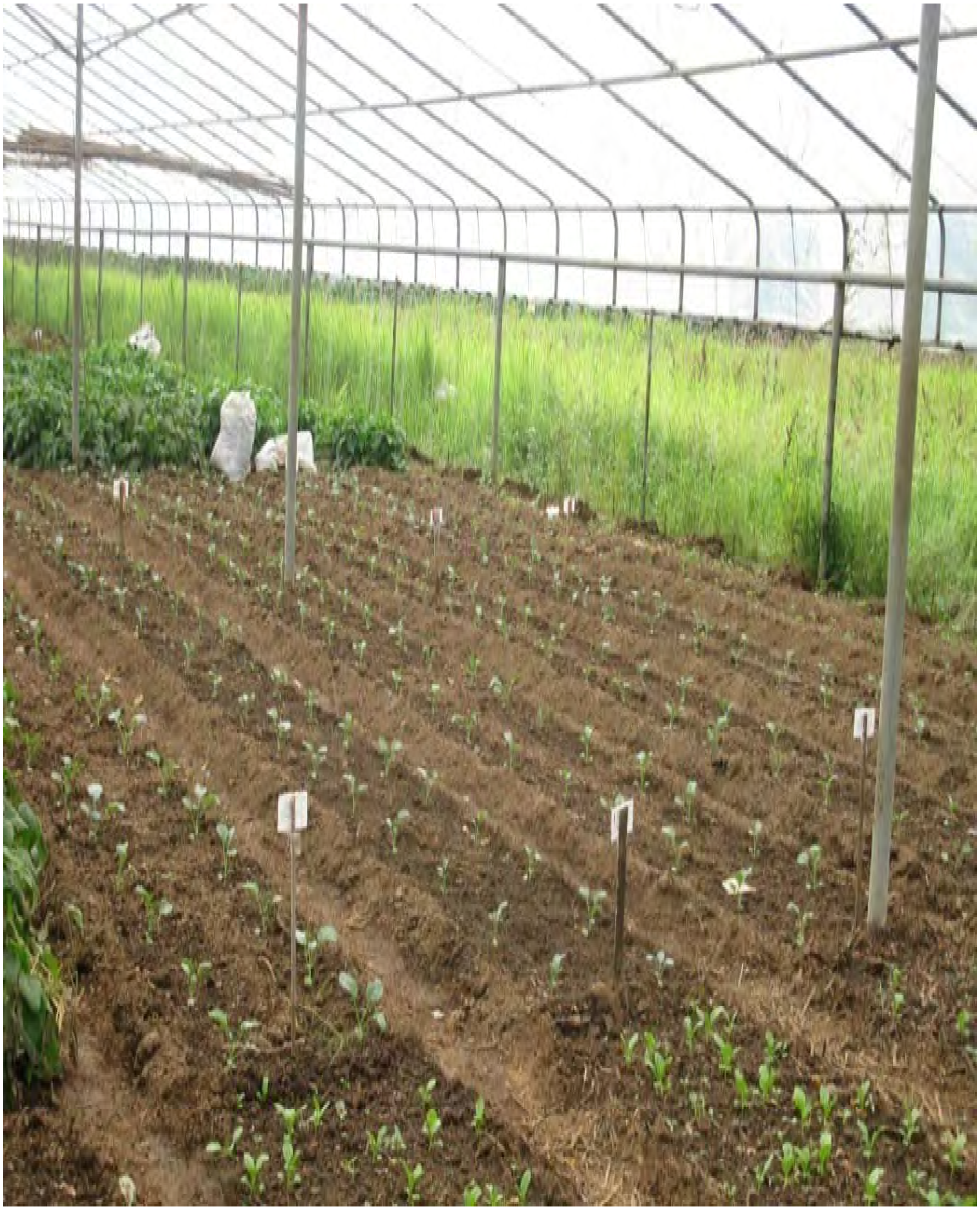

Figure 1. Overview of the experimental area inside the greenhouse showing the transplanted seedlings of broccoli

transplanting the seedlings and every 10 days interval thereafter until before harvest, following the rate of application in the treatments.

Crop maintenance. Two watering cans (32 liters) of water per plot were applied every three days up to the day the plants were ready to be harvested. The plots assigned to the farmer's practice were sprayed with biological insecticide (Xentari) when diamond- back moth larvae were observed infesting the plants. Except this treatment plot, the rest of the treatment plots were taken cared without synthetic chemical use.

Harvesting. The plants were harvested when the curds are green and the florets are still tight. The curds are cut from the plants with 8 to 10 cm stem below the curds and the leaves were removed.

The data gathered were the following:

1. Plant height at harvest (cm). Ten sample plants per plot were measured with tape measure at random from the base of the plant to the surface of the curd. The sum of the measurements was divided by 10 to get the average height of plants.

2. Curd diameter (cm). Ten sample curds were measured from edge to edge crossing the middle during harvest.

3. Stem diameter (cm). Ten sample plants were used by measuring the stem with a Venier caliper during harvest.

4. Total yield per plot (kg). The weights of all the harvested curds per plot were added and recorded which include the marketable and non-marketable.

5. Weight of marketable curds (kg). This was the weight of curds that do not have any defect such as malformed, rotten, too small and severely damaged by insects.

6. Weight of non-marketable curds (kg). This was the weight of curds having defects mentioned above which were not sold in the market.

7. Weight of individual curd (g). The total yield per plot was divided by the number of curds harvested per plot.

8. Sugar content (Brix). This was obtained with the use of refractomer. Curd samples were crushed and the juice placed on the main prism of the refractomer covered with the daylight plate and the reading was recorded.

9. Shelf-life. One-fourth kilo of curds from each plot were taken during harvest and set-up in the horticulture laboratory room to observe the shelf-life. The number of days from the day it was set-up to the day the curds were not fit for consumption due to florets yellowing, was recorded as the shelf life of curds.

10. Glucosinolates concentration. One- fourth kilo of curds from each plot were packed in plastic bag and sent to De la Salle University for the analysis of glucosinolates content under the care of Prof. Mel Garcia.

11. Return on Expenses (ROE). This was taken by using the formula:

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

Data Analysis

The data gathered were tabulated and the means were subjected to separation test using the Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Plant Height

Table 1 shows that plants base- dressed with alnus compost alone had significantly shorter plant heights compared to the rest of the treatments. Except the plants applied with alnus compost, plants applied with chicken dung +14-14-14, concentrated mineral drops, liquid bio-fertilizer and plantmate did not differ in height, together with the plants that were not applied with fertilizer. The slight differences among these treatments might be due to the presence of adequate nutrient elements in the soil prior to planting as shown by the soil analysis where the organic matter content is 10.00, the phosphorous is 380 ppm and the potassium was 1,100 ppm. On the other hand, the application of alnus compost seem to shorten plant height but enhanced bigger stem diameter and curd size as shown in the results. It might be that the function of compost in improving the soil structure made the stem bigger rather than taller as measured from these plants applied with fertilizer materials containing mineral elements and beneficial microorganisms.

Curd Diameter

As presented in Table 1, plants applied with alnus compost alone significantly surpassed the diameter of curds produced from the rest of the treatments with similar curd diameters. Except the plants applied with alnus compost, the rest of the treatments produced curds with almost similar diameter. As explained earlier, broccoli base- dressed with alnus compost had dwarfing effect, but enhanced the growth of curds and stems which was shown in the result. It was also observed by Pilpiling (2010) in pakchoi planted under pine tree stand applied with alnus compost to obtain good yield.This

Table 1. Plant height and curd diameter of broccoli applied with organic fertilizers

TREATMENT	PLANT HEIGHT (cm)	CURD DIAMETER (cm)
No application of fertilizer (control)	38.57^{a}	16.69^{b}
5kg of plantmate per 1m x 5m plot	38.03^{a}	16.47^{b}
1 can alnus leaves compost + 1.875 ml liquid bio-fertilizer per liter of water	37.27^{a}	15.57^{b}
1 can alnus leaves compost + 0.94 ml of concentrated mineral drop per liter of water	38.10^{a}	16.19^{b}
Farmer's practice (chicken dung +14-14-14 + insecticide)	37.07^{a}	16.47^{b}
1 can alnus leaves compost alone	35.27^{b}	19.57^{a}

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

observation in the effect of alnus compost is not fully understood at the moment except that the acidity can be minimized by alnus compost application according to Pilpiling (2010).

Stem Diameter

Table 2 shows that the different organic fertilizer treatments had promoted significant differences in the stem diameter of broccoli plants. The application of alnus compost alone and the farmers practice promoted the production of similar stem diameter that significantly bigger compared to the rest of the treatments. This was followed by plants applied with alnus compost+ liquid bio-fertilizer which significantly produced bigger stem diameter compared to those without fertilizer application, concentrated mineral drops and the plantmate fertilizer having similar stem diameter.

Table 2. Stem diameter of broccoli applied with different organic fertilizers

TREATMENT	MEAN (cm)
No application of fertilizer (control)	3.85^{c}
5kg of plantmate per 1m x 5m plot	3.78^{c}
1 can alnus leaves compost + 1.875 ml liquid bio-fertilizer per liter of water	3.99^{b}
1 can alnus leaves compost + 0.94 ml of concentrated mineral drop per liter of water	3.83^{c}
Farmer's practice (chicken dung +14-14-14 + insecticide)	4.07^{a}
1 can alnus leaves compost alone	4.25^{a}

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

The significantly shorter plants, bigger curd and stem diameter of broccoli applied with alnus compost alone seem to be a consistent result from this treatment (Figure 2). However, the application of chicken dung and 14-14-14 enhanced similar stem diameter in broccoli due to higher nutrient content that promoted growth. The same reason may be explaination with the use of liquid bio-fertilizer; although it was significantly lower stem diameter compared to the plants applied with alnus compost alone and the farmers practice; but had significantly bigger stem compared to those applied with CMD, plantmate and the control. However, these differences in stem diameter did not influence the data on all the weights of curds.

Figure 2 Curds and stem diameter of harvested broccoli applied with different organic fertilizers at harvest

Total Yield per Plot

There were no significant differences on the total yield harvested from the broccoli applied with different organic fertilizer materials as presented in Table 3.This result may be due to the presence of high nutrient elements in the soil before planting as shown by the soil analysis wherein the organic matter content was 10.00%, phosphorous of 380 ppm and the potassium was 1,100 ppm. It is interesting to obtain a slight difference in total yield from an area which was high in organic matter, phosphorous and potassium as a result of eight years of applying compost alnus leaves, cow/horse manure and weeds. The application of different organic fertilizers did not show significant results in yield as the soil contains sufficient nutrients for the plant, for normal growth

Table 3. Total yield of broccoli harvested from 5 sq. m plot

TREATMENT	TOTAL YIELD (kg)
No application of fertilizer (control)	6.34[a]
5kg of plantmate per 1m x 5m plot	5.45[a]
1 can alnus leaves compost + 1.875 ml liquid bio-fertilizer per liter of water	6.66[a]
1 can alnus leaves compost + 0.94 ml of concentrated mineral drop per liter of water	5.13[a]
Farmer's practice (chicken dung +14-14-14 + insecticide)	5.54[a]
1 can alnus leaves compost alone	6.64[a]

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

Weight of Marketable Curds

Plants applied with alnus compost alone produced higher marketable curds followed by those applied with alnus compost + liquid bio- fertilizer, no application of fertilizer, farmers practice, plantmate and the lowest was harvested from plants applied with alnus compost+ concentrated mineral drops, however, the differences were not significant (Table 4).

As presented earlier, plant height, stem diameter and curd diameter showed significant differences, but the yield data did not obtain significant differences, which may imply that sufficient nutrient elements is present in the soil as shown in the analysis of sample before conducting the experiment.

Table 4. Weight of marketable and non marketable curds from plants applied with the different organic fertilizers

TREATMENT	MARKETABLE (kg)	NON-MARKETABLE (kg)
No application of fertilizer (control)	5.60[a]	0.74[a]
5kg of plantmate per 1m x 5m plot	5.18[a]	0.28[a]
1 can alnus leaves compost + 1.875 ml liquid bio-fertilizer per liter of water	6.35[a]	0.32[a]
1 can alnus leaves compost + 0.94 ml of concentrated mineral drop per liter of water	4.81[a]	0.32[a]
Farmer's practice (chicken dung +14-14-14 + insecticide)	5.23[a]	0.31[a]
1 can alnus leaves compost alone	6.54[a]	0.10[a]

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

Weight of Non-Marketable Curds

There were no significant differences obtained on the weight of non marketable curds from the different treatments studied as shown in Table 4. However, plants that were not applied with fertilizer (control) had slightly heavier non-marketable curds due to abnormalities, and plants applied with alnus compost alone yielded the lowest non-marketable curds.

Weight of Individual Curds

Table 5 shows that there were no significant differences among the treatments in terms of the weight of individual curd. However, curds from plants applied with liquid bio-fertilizer weighed heavier followed by the application of alnus compost alone, no fer-

Table 5. Weight of individual curd from plants applied different organic fertilizers

TREATMENT	WEIGHT (g)
No application of fertilizer (control)	226.43[a]
5kg of plantmate per 1m x 5m plot	194.76[a]
1 can alnus leaves compost + 1.875 ml liquid bio-fertilizer per liter of water	238.12[a]
1 can alnus leaves compost + 0.94 ml of concentrated mineral drop per liter of water	183.10[a]
Farmer's practice (chicken dung +14-14-14 + insecticide)	197.76[a]
1 can alnus leaves compost alone	237.25[a]

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

ilizer application, farmers practice, plantmate and the lowest weight of curd was produced from plants applied with concentrated mineral drops.

Refractive Index

As shown in Table 6, there were no significant differences among the treatments in terms of sugar contents measured in ^{0}Brix. The extracted juices were measured with the use of refractometer and the ^{0}Brix of 4 is described as poor which means that the quality of the broccoli produced in the experimental plots was poor. Average quality should have a reading of 8, good is 10 and an excellent quality is 12, according to Price in 2004.

Table 6. Refractive index of broccoli juice in ^{0}Brix

TREATMENT	MEAN
No application of fertilizer (control)	4.17[a]
5kg of plantmate per 1m x 5m plot	3.27[a]
1 can alnus leaves compost + 1.875 ml liquid bio-fertilizer per liter of water	3.93[a]
1 can alnus leaves compost + 0.94 ml of concentrated mineral drop per liter of water	3.60[a]
Farmer's practice (chicken dung +14-14-14 + insecticide)	4.33[a]
1 can alnus leaves compost alone	4.53[a]

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

Shelf life

Shelf-life of curds from the broccoli applied with different organic fertilizers is presented in Table 7 and Figure 3. Plants applied with concentrated mineral drops attained longer shelf-life but was not significantly different from the rest of the treatments. It was explained by Price (2004) that high quality produced dehydrates. Sugar content firmly resist rotting in storage of broccoli.

As mentioned under refractive index (Table 6), the data obtained from the different treatments is considered poor and did not show any significant differences. It follows that the shelf-life of curds was the same at four days except the plants applied with CMD which had a means of 4.67 days was slightly longer, than the other treatment

Table 7. Shelf-life of curds from plants applied with different organic fertilizers

TREATMENT	SHELF-LIFE (days)
No application of fertilizer (control)	4.33[a]
5kg of plantmate per 1m x 5m plot	4.33[a]
1 can alnus leaves compost + 1.875 ml liquid bio-fertilizer per liter of water	4.00[a]
1 can alnus leaves compost + 0.94 ml of concentrated mineral drop per liter of water	4.67[a]
Farmer's practice (chicken dung +14-14-14 + insecticide)	4.00[a]
1 can alnus leaves compost alone	4.00[a]

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

Figure 3. Shelf-life of broccoli curds from the different treatments at the end of four days

Glucosinolates Concentration

As shown in Table 8, the samples of curd from the different treatments studied have five peaks of glucosinolates concentrations obtained from the chromatogram. This means that there are five kinds of glucosinolate compounds in the broccoli analysis and that plants applied with alnus compost alone had the highest peaks in GI_1 and GI_2 and had the lowest peaks in GI_3, GI_4 and GI_5. In contrast, plants applied with alnus compost then supplemented with liquid bio-fertilizer (X-Tekh) produced the curds with the highest concentration of glucosinolates in GI_5. Glucosinolate 5 shows that all the treatments have the highest peaks in the chromatogram analysis followed by GI_4.

Table 8. Peak area (in MAU) of five glucosinolate compounds observed from the Chromatogram of different curd samples applied with different organic fertilizers.

TREATMENT	GI_1	GI_2	GI_3	GI_4	GI_5
			(Milli amphere)		
No application of fertilizer(control)	303.5	695.0	379.0	1,255.5	9,632.0
5kg of plantmate per 1m x 5m plot	341.0	797.5	375.5	1,337.5	8,707.5
1 can alnus leaves compost + 1.875 ml liquid bio-fertilizer per liter of water	401.5	910.5	351.5	1,481.5	13,307.0
1 can alnus leaves compost + 0.94 ml of concentrated mineral drop per liter of water	412.5	935.0	348.0	1,168.0	9,721.5
Farmer's practice (chicken dung + 14-14-14 + insecticide)	340.0	692.5	343.5	1,598.0	11,453.0
1 can alnus leaves compost alone	617.5	1,797.0	327.5	513.0	3,001.0

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

Economic Analysis

Table 9 shows that the application of liquid bio-fertilizer (X-Tekh) obtained the highest net income with a computed return on expenses of 142.82 % or Php. 1.43 for every peso spent in the production. This was followed by the application of alnus compost alone (133.66%), no fertilizer application (117.35%), farmer's practice (83.19%) plantmate (87.65%) and the plants applied with concentrated mineral drops obtained the lowest net income and return on expenses (71.64%).

Obviously, the profitability of each treatment is the function of the marketable yield and the expenses, wherein if the yield is high and the expenses is low, then a higher net profit is obtained. On the other hand, if the yield is low and the expenses is high then the net income is low.

The very slight differences in the marketable yield between the plants applied with alnus compost alone and with the application of alnus compost plus the supplements of bio-liquid fertilizer of 0.19 kg per plot when projected to hectare basis would amount to 380 kg more yield or P 38,000.00 more sales, but the application of alnus compost then supplemented with bio-liquid fertilizer will still earn net income of P 13,200.00 due to lower expenses in fertilizer. Similarly, the plants without fertilizer application had lower yield of 0.75 kg per plot or 150 kg per hectare but ranked third due to the absence of expenses in fertilizers.

Table 9. Economic analysis of the different treatments from 15 sq. m area

ITEMS	TREATMENT T1	T2	T3	T4	T5	T6
Marketable Yield(kg)	16.81	15.53	19.04	14.42	15.70	19.63
A. Sales(Php)	2,017.20	1,863.60	2,284.80	1,730.40	1,884.00	2,355.60
B. Expenses(Php)						
1. Seeds	25.20	25.20	25.20	25.20	25.20	25.20
2. 14-14-14	-	-	-	-	12.50	-
3. Foliar Fertilizer	-	-	22.80	90.00	-	-
4. Chicken Dung	-	-	-	-	90.00	-
5. Pesticide	-	-	-	-	7.80	-
6. Plantmate	-	75.00	-	-	-	-
7. Alnus compost	-	-	90.00	90.00	-	90.00
8. Land preparation	39.17	39.17	39.17	39.17	39.17	39.17
9. Sowing	29.38	29.38	29.38	29.38	29.38	29.38
10. Transplanting	39.17	39.17	39.17	39.17	39.17	39.17
11. Irrigation	220.32	220.32	220.32	220.32	220.32	220.32
12. Harvesting	235.00	235.00	235.00	235.00	235.00	235.00
13. Land rent	149.85	149.85	149.85	149.85	149.85	149.85
14. Depreciation Cost	180.06	180.06	180.06	180.06	180.06	180.06
Total Expenses(Php)	928.15	993.15	1,030.95	1,090.15	1,028.45	1,008.15
Net Profit (Php)	1,089.05	870.45	1,253.85	640.25	855.25	1,347.45
ROE(%)	117.35	87.65	121.82	58.73	83.19	133.66
Rank	3	4	2	6	5	1

Note: The selling price of broccoli during harvest was Php 100.00 per kilo.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at Balili area from July to September 2010 to evaluate the growth, yield, shelf-life and the glucosinolates content of broccoli as affected by the different fertilizer treatments. Results of the study show the following:

1. the application of alnus compost alone had promoted the production of significantly shorter plants at harvest, wider curd diameter, wider stem diameter and slightly heavier yield per plot.

2. the farmer's practice of applying chicken dung as base- dress and 14-14-14 as side-dress slightly differ from those applied with alnus compost, both of which had significantly wider stem diameter than those of the other treatments, how ever except for the stem diameter, the rest of the data were statistically comparable.

3. there are five peak areas of glucosinolate compounds obtained from the Chromatogram analysis where plants applied with alnus compost and supplemented with liqui bio-fertilizer had the highest milli Amphere unit in the glucosinolate No. 5 at 13,307.0 while the plants applied with alnus compost alone had the lowest peak of 3,001.0. Glucosinolate 4 shows almost similar peak areas on all the treatment samples except from plants applied with alnus compost alone which had a peak area of less than half of the other treatments;

4. Shelf-life of curds applied with concentrated mineral drops was slightly longer than the other treatments which had a mean of 4.0 which was considered of poor quality in the refractive index of similar results;

5. In the terms of profitability, the application of alnus compost + liquid bio-fertilizer obtained the highest return on expenses of P1.43 for every peso spent followed by the application of alnus compost alone and without fertilizer application.

Conclusion

Based on the results presented and discussed, it is inferred that among the treatments, the application of alnus compost alone promotes shorter plants with wider diameter of stems and curds resulting to slightly higher yield with return on expenses of P1.34 for every peso spent compared to the second rank where plants were applied with alnus compost supplemented with liquid bio-fertilizer of P1.22 which contain the highest glucosinolate compound.

Recommendation

It is then recommended that when the soil contain 10% organic matter, 380ppm phosphorous and 1,100 ppm potassium, alnus compost alone would be sufficient. Alternatively, the application of alnus compost supplemented with liquid bio-fertilizer provides higher return on expenses too with the highest content of glucosinolate compounds.

LITERATURE CITED

AMAZING INTEGRATED MARKETING. 1992. Amazing Integrated Marketing International Product Manual. 10 Pp.

BAUTISTA, O. K., H. V. VALMAYOR., P. C. TABORA Jr.p and R. R. C. ESPINO. 1983. Introduction to Tropical Horticulture. UP Los Baños, Laguna. P. 100.

BECNAN, J. A. 2005. Yield performance of seven broccoli varieties under Bayoyo, Buguias, Benguet Condition. BS Thesis. BSU, La Trinidad, Benguet. P 3.

BENTON, W. 1970. Broccoli. World Book Encyclopedia. London: World Book Inc. P. 541.

BONES, A. M and J. T. ROSSITER. 1996. The Myrosinae- Glucosinolates System- An innate defense system in Plantarum 97(1). Pp. 194-208.

BURPEE, D. 1984. New Book of Knowledge. Dunburg, Connecticutt: Groiler Inc. P. 289.

CAT-AG, J. S. 2007. Growth and yield response of spoon cabbage to different frequency of liquid bio-fertilizer application. BS Thesis. BSU, La Trinidad, Benguet. 34 Pp.

CHEN, J. F. 1999. Plant foods and nutritional immunology: A scientific approach. In: Organic Matters. 1 (1): 22-23.

CHEN, S. 2007. Association of Taiwan Organic Agriculture Promotion flyer. 369 Wen-Hua Rd., Pestoow, Chang Hua, Taiwan.

COMILA, J. G. 2008. Performance of broccoli (*Brassica oleraceae L. italica*) as affected by frequency of irrigation. BS Thesis. BSU, La Trinidad, Benguet. P. 1.

CROCKETT, J. V. 1987. Flowering shrubs. Hongkong: Lippincott, Inc. P. 41.

DAGOON, J. D and T. G. CADIZ. 1985. Soils, Fertility, and Plants. Rex Book Store. Manila. Pp. 1-50.

DAYAO, N. A. 2008. Growth and yield response of spoon cabbage (*Brassica chinensis*) to time of liquid bio-fertilizer application. BS Thesis. BSU, La Trinidad, Benguet. 38 Pp.

DEBSO, P. D. 2007. Growth and yield performance of broccoli applied with different rates of plantmate (organic fertilizer). BS Thesis. BSU, La Trinidad, Benguet. 42 Pp.

GROMAN, J. 1997. The World Book Encyclopedia. London. World Book Inc. 2: 583-584.

PANG-OT, L. V. 2010. Seed development of French bean (*Phaseolus vulgaris spp*.) and seed yield as affected by rates of Plantmate organic fertilizer. BS Thesis. BSU, La Trinidad, Benguet. 53 Pp.

PCARRD. 1979. The Philippine Recommends for Soil Fertility Management. Pp. 63-68
.

PILPILING,J.E.2010. Growth and Yield of Pakchoi 'Cherokee' Grown on Soil with and without Pine needle litters. BS Thesis. BSU, La Trinidad, Benguet. 32 Pp

PRICE, W. 2004. Nutrition and Physical Degeneration. brixman@wietern.com.

PUYAO, J. B. 2010. Growth and yield of romaine lettuce 'Xanadu' based-dressed with varying rates of plantmate organic fertilizer. BS Thesis. BSU, La Trinidad, Benguet. 31 Pp.

TINDALL, H. D. 1983. Vegetable Crops in the Tropics. London: McMillan Education Co., Inc. P. 533.

TOCDANGAN, M. L. C. L. 2007. Growth and yield performance of romaine lettuce 'Xanadu' applied with varying rates of liquid bio-fertilizer. BS Thesis. BSU, La Trinidad, Benguet. 37 Pp.

APPENDICES

Appendix Table 1. Plant height at harvest (cm)

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
T_1	38.80	38.10	38.80	115.70	38.57
T_2	39.60	37.80	36.70	114.10	38.03
T_3	37.10	36.90	37.80	111.80	37.27
T_4	37.40	38.50	38.40	114.30	38.10
T_5	37.60	35.10	38.50	111.20	37.07
T_6	35.90	34.60	35.30	105.80	35.27

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	2.790	1.395			
Treatments	5	20.792	4.158	4.13*	3.33	5.64
Error	10	10.063	1.006			
Total	17	33.645				

* = highly significant

Coefficient of variation 2.68 %

Appendix Table 2. Curd diameter (cm)

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
T_1	17.20	16.70	16.18	50.08	16.69
T_2	18.10	15.80	15.50	49.40	16.47
T_3	15.60	14.80	16.30	46.70	15.57
T_4	16.41	15.35	16.80	48.56	16.19
T_5	16.20	16.80	16.40	49.40	16.47
T_6	19.80	20.10	18.80	58.70	19.57

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	1.412	0.706			
Treatments	5	29.345	5.869	9.00^{**}	3.33	5.64
Error	10	6.521	0.652			
Total	17	37.278				

** = highly significant Coefficient of variation 4.80 %

Appendix Table 3. Stem diameter (cm)

TREATMENT	BLOCK I	BLOCK II	BLOCK III	TOTAL	MEAN
T_1	4.02	3.79	3.73	11.54	3.85
T_2	3.81	3.87	3.71	11.39	3.80
T_3	4.07	3.97	3.94	11.98	3.99
T_4	4.06	3.66	3.76	11.48	3.83
T_5	3.96	4.05	4.20	12.21	4.07
T_6	4.38	4.10	4.28	12.76	4.25

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	0.069	0.034			
Treatments	5	0.469	0.094	5.98*	3.33	5.64
Error	10	0.157	0.016			
Total	17	0.695				

** = highly significant

Coefficient of variation 3.16 %

Appendix Table 4. Total yield per plot (kg)

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
T_1	6.29	6.84	5.89	19.02	3.85
T_2	4.40	5.57	6.39	16.36	3.80
T_3	5.89	7.63	6.47	19.99	3.99
T_4	4.66	5.15	5.57	15.38	3.83
T_5	4.70	5.47	6.45	16.62	4.07
T_6	7.41	6.62	5.90	19.93	4.25

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	1.491	0.746			
Treatments	5	6.701	1.340	2.38^{ns}	3.33	5.64
Error	10	5.629	0.563			
Total	17	13.820				

ns = not significant

Coefficient of variation 12.59 %

Appendix Table 5. Weight of marketable curds (kg)

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
T_1	5.27	5.65	5.89	16.81	5.60
T_2	4.25	4.89	6.39	15.53	5.18
T_3	5.15	7.40	6.49	19.04	6.35
T_4	4.16	4.84	5.42	14.42	4.81
T_5	3.90	5.35	6.45	15.70	5.23
T_6	7.11	6.62	5.90	19.63	6.54

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	4.011	2.006			
Treatments	5	7.165	1.433	2.40^{ns}	3.33	5.64
Error	10	5.967	0.597			
Total	17	17.144				

ns = not significant Coefficient of variation 13.75%

Appendix Table 6. Weight of non-marketable curds (kg)

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
T_1	1.03	1.19	0.00	2.22	0.74
T_2	0.15	0.68	0.00	0.83	0.28
T_3	0.74	0.23	0.00	0.97	0.32
T_4	0.50	0.31	0.15	0.96	0.32
T_5	0.80	0.12	0.00	0.92	0.46
T_6	0.30	0.00	0.00	0.30	0.10

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	1.000	0.5000			
Treatments	5	0.670	0.134	1.54^{ns}	3.33	5.64
Error	10	0.870	0.087			
Total	17	2.540				

ns = not significant Coefficient of variation 16.42%

Appendix Table 7. Weight of individual curds (g)

TREATMENT	BLOCK I	BLOCK II	BLOCK III	TOTAL	MEAN
T_1	224.64	244.29	210.36	679.29	226.43
T_2	157.14	198.93	228.21	584.28	194.76
T_3	210.36	272.39	231.61	714.36	238.12
T_4	166.43	183.93	198.93	549.29	183.10
T_5	167.86	195.25	230.18	593.29	197.76
T_6	264.64	236.43	210.68	711.75	237.25

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	1901.710	950.855			
Treatments	5	8575.348	1717.070	2.40^{ns}	3.33	5.64
Error	10	7155.089	715.509			
Total	17	17632.148				

ns = not significant

Coefficient of variation 12.56%

Appendix Table 8. Refractive index (^{0}brix)

TREATMENT	BLOCK I	BLOCK II	BLOCK III	TOTAL	MEAN
T_1	4.50	3.20	4.80	12.50	4.17
T_2	2.80	3.00	4.00	9.80	3.27
T_3	4.00	3.00	4.80	11.80	3.93
T_4	3.20	2.60	5.00	10.80	3.60
T_5	4.00	5.00	4.00	13.00	4.33
T_6	4.00	5.20	4.40	13.60	4.53

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	2.528	1.264			
Treatments	5	3.363	0.673	1.14^{ns}	3.33	5.64
Error	10	5.906	0.591			
Total	17	11.796				

ns = not significant

Coefficient of variation 19.35%

Appendix Table 9. Shelf-life (days)

TREATMENT	BLOCK I	BLOCK II	BLOCK III	TOTAL	MEAN
T_1	4	4	5	13	4.33
T_2	5	4	4	13	4.33
T_3	4	4	4	12	4.00
T_4	5	4	5	14	4.67
T_5	4	4	4	12	4.00
T_6	4	4	4	12	4.00

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	0.444	0.222			
Treatments	5	1.111	0.222	1.43^{ns}	3.33	5.64
Error	10	1.556	0.156			
Total	17	3.111				

ns = not significant

Coefficient of variation 9.34%

Appendix Table 10. Weight loss (g) in 4 days

TREATMENT	BLOCK I	BLOCK II	BLOCK III	TOTAL	MEAN
T_1	71.95	64.60	49.75	186.30	62.10
T_2	64.80	69.95	60.00	194.75	64.92
T_3	75.08	85.61	79.85	240.54	80.18
T_4	64.90	65.15	60.53	190.58	63.53
T_5	59.75	74.75	69.90	204.40	68.13
T_6	69.85	65.30	65.25	200.40	66.80

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	133.981	66.990			
Treatments	5	639.668	127.934	3.44*	3.33	5.64
Error	10	371.578	37.158			
Total	17	1145.226				

* = significant

Coefficient of variation 9.02%