BIBLIOGRAPHY

FIANZA, MICHAEL JORDAN V. APRIL 2012. Growth and Yield of Potato(*Solanumtuberosum L.*) applied with soil enhancers under Paoay, Atok, Benguet condition.Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted atPaoay, Atok, Benguet;determine the growth and yield performance of potato seed tuber as affected by soil enhancers; determine the best soil enhancers for potato production; and compare the profitability of potato stem cuttings and seed tuber using soil enhancers through return on cash expenditures (ROCE).

Based on the results, plants applied withVitazyme + 0.60kg (T-14) performed the best in terms of its growth, survival, vigorousness, and canopy cover at 30 DAP, 45 DAP, and 60DAP, it also produced the highest and heaviest tubers and was the highest yield.

Based on the result of the study, Vitazyme was the best soil enhancer out of the 3 soil enhancers that were used in the study.

On the return on cash expenses, all the soil enhancers had positive income but quite low ranging only from 11.5 (Nitromax + 0.60kg T-14) to 18.7 (Vitazyme + 0.60kg T-14). The effect of the soil enhancers could be better appreciated though during the succeeding planting.

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INTRODUCTION

Potato (*Solanumtuberosum L.*) was a crop introduced in the highlands of the Cordillera between 1930's to 1940's by the Americans, who established the Camp John Hay Recreational Base in Baguio City. Beginning at this time, potato production created big business opportunities for the Cordillera farmers (Aquino, 2009).

Currently, potato is the fourth largest source of food in the world after rice, wheat, and corn. Every year, 350 million tons of potatoes are produced and 52 percent of these are in developing countries (Tacio, 2011).

In many potato producing areas, Benguet included, one of the major constraints in potato production is the poor quality of planting material (Khatri, 1995) and soil degradation due to continuous cropping.

In traditional potato production, the success and failure of commercial production depends principally on the quality of tubers planted. However, to further increase profit, other planting materials such as rooted stem cuttings should be considered. Rooted stem cuttings are available at 8-15 days as compared to seed tubers with dormancy period of 8-15 months (Tacio, 2011).

The relatively new technology of using potato stem cuttings for production is still not widely practiced. Farmers still prefer potato tubers as planting material which they save from their previous operations. However, even with the presence of both stem cuttings and seed tubers, a continuous supply of quality planting materials, which is the basic input in crop production, is not guaranteed (Bryan, 1984).

New products like soil enhancers are coming out to help in bringing back the soil nutrients that are lost due to continuous cropping. The product promises greater yield,

higher profit, lesser cost of production and better protection to the environment. If such products are proven effective, this study could be very meaningful in increasing potato production, profit and environmental care.

The objectives of the study were as follows:

1. to determine the growth and yield performance of potato seed tuber as affected by soil enhancers;

2. to determine the best soil enhancers for potato production; and

3. to compare the profitability of potato stem cuttings and seed tuber using soil enhancers through return on cash expenditures (ROCE).

The research was conducted from November, 2011 until January, 2012 at Paoay, Atok, Benguet.

REVIEW OF LITERATURE

At present, most farmers in Benguet grow the Granola cultivar. The farmers prefer this variety because it is adapted to the wet and dry cropping seasons as well as warm and cold weather condition. This variety has been with the farmers for almost 15 cropping generations (Ayangdan, 1998). New selections, I-1085 (Po_4) and LBR 1-5 (BSU Po_3) are recommended for the highlands. I-1085 is resistant to late blight and suitable for French fries processing. The selection LBR 1-5 is the first highland potato variety entirely developed through hybridization and selection in the Philippines.

One of the major constrains to potato production in the Philippine highlands is the occurrence of *Phythopthorainfestans*, commonly known as late blight. Highland farmers spray 20 times per season making fungicide application about 50% of the total cost of production. The use of resistant varieties is the best and most economical control against this major destructive disease. (Nisperos*et al*., 1984)

Use of Stem Cuttings and Seed Tubers

Cole and Wright (1957), as cited by Bryan (1984) stated that the utilization of cuttings as planting materials was the first alternative to seed tubers. It was shown that eight plants from one tuber could produce 5000 rooted cuttings in six months by cloning and re cloning. The first practical use of stem cutting seems to be more related to removal of non systematic disease such as *ervina* and *phoma spp*.

Ba-a (2002) noted that seed tubers as a planting material for three varieties granola, Igorota and Raniag gave higher yield than stem cuttings for potato production in Abiang, Atok Benguet. Among the three varieties evaluated, Igorota produced the highest

yield and has the highest return as investment. Seed tuber as planting materials was proven to be better than the stem cuttings.

On the other hand, rooted stem cuttings serve not only as low cost planting materials but also as a source for clean and healthy planting materials. Vander Zaag et al. (1988) reported that under optimal management, stem cuttings give high competitive yields with tuber seeds with over 20 tons per hectare. Plant survival varied with genotypes but tuber size was generally similar to that from seed tuber grown.

Soil Enhancers Defined

Soil enhancer could be a mixture of quality organic materials and beneficial micro- organisms that have a reviving action on the natural environment. Most of the organisms are used in the food processing industry and in the field of probiotic medicine. The fermentation process converts sugars and proteins, which are easily decomposed into organic acids and amino acids. Unlike the decomposition process, fermentation of organic matter conserves much of the energy in the constituent components of Soil Enhancer. This means that there still is a lot of energy available in the Soil Enhancer which is available to give to the soil and the plants and organisms in it. All materials used in Soil Enhancer are of organic origin. Soil Enhancer supplies many nutrients to the soil it is not intended to be a replacement for a standard fertilizer regime. (Bokashi, 2011)

Effect of Soil Enhancers

Soil treated with soil enhancer has shown increased fertility by increasing the soil organic matter content and available nutrients, providing nutrients and stimulatory compounds to growing plants, improving the soil porosity and permeability and increasing the micro-biomass of the soil.

The stimulation of microbial activity means the soil is able to degrade more plant residues more rapidly releasing nutrients and improving soil organic matter quality (Bokashi, 2011).

Benefits of Using Soil Enhancer

Using Soil enhancer regularly Releases nutrients from the soil, Increase soil microbial activity, Improve soil structure and water holding capacity. Increase photosynthetic capacity of plants, Suppress soil borne pathogens and pests, Improve plant growth. Soil Enhancer is environmental friendly and easy to use, it is non-toxic and GE free (Agricultural Biotech Inc. 2000).

Besides improving the growth of the plant, it also benefits soil characteristics. Soil structure may markedly improve over time because of, increased root growth, and thus more root channels, Greater polysaccharide production by microbes to glue clay platelets together; only 0.2% more polysaccharide can markedly improve structure, improved mycorrhizal activity, creating sac-like structures. (Agricultural Biotech Inc. 2000)

Improvement of soil structure, mean cleavage planes and burrows creating channels to promote readily exchange of air and water because of greater earthworm activity. Increased water infiltration, and consequently decrease in soil erosion and soil runoff. Reduced soil compaction for better soil absorption of nutrients and water for greater yield (Agricultural Biotech Inc. 2000).

Results of Some Studies on the Different soil Enhancers

Fingh (2008) recorded the effect of vitazyme on potato growth, yield, and income. Results showed that the seed and in-furrow treatments, plus a foliar-soil application,

hastened emergence and early growth. At harvest, the vitazyme treatments greatly increased tuber number, by 79% for the seed treatments and by 52% for the in-furrow treatment. The valuable 28 to 55 mm tuber size was much greater for the vitazyme applications: 24% for the seed treatment and 14% for the in-furrow treatment. The yield increases for vitazyme treatments presented in the report were small, 5% for the seed treatment but based upon much greater tuber numbers and considerably higher percentage of 28 to 55 mm tubers for both vitazyme treatments, these two yields should have been much higher than reported. Likewise, the modest income improvements with vitazyme should be higher than the above chart shows. It is apparent from this study that vitazyme does indeed improve potato production and profits in India.

Fisher (2011) found in his study that nirtromax can stimulate growth and biomass in potatoes. Results have shown 25% increase in yield, better plant growth and bigger size of potato tubers. It was further noted that the stimulatory activity in potato could be seen at concentrations as low as 1%.

Flickr (2010) Stated that Organic farmers place a high value of dolomite, both for its capacity to “sweeten” the soil by lowering its acidity and for its tendency to act as a secondary fertilizer and neutralizes soil acidity to increases activity of soil bacteria, especially for tomatoes and related plants and just by using lime it actually gives more profit for farmers because it increases there yield. But even many veteran horticulturalists have little idea of what dolomite actually is, except that in general it’s a mineral.

MATERIALS AND METHODS

An area of 250 ms was thoroughly prepared and divided into two sets with three blocks for each set and later subdivided to 25 plots measuring 1m x 5m (Figures). The potato seed tubers and stem cuttings were planted in double row plots at a distance of 30cmx30cm between hills and rows.

The experiment was laid-out using randomized complete block design (RCBD). Treatments were the following:

T_0- Control (no fertilizer)

T_1- 0.60 kg (T-14)

T_2- vitazyme + 0.60 kg (T-14)

T_3- vitazyme + 0.30 kg (T-14)

T_4- Nitromax + 0.60 kg (T-14)

T_5- Nitromax + 0.30 kg (T-14)

T_6- Dolomite + 0.30 kg (T-14)

T_7-Dolomite + 0.60 kg (T-14)

Fertilizer Application

Three weeks after planting, the plants were side-dressed with complete fertilizers (14-14-14) at a rate of 80-80-80 NPK kg per hectare. Hilling up was done to cover the side-dressed fertilizer.

Soil Enhancer's Active Ingredients
And Methods of Application

Soil enhancers	Active ingredient	Method of application
Vitazyme	Potassium (k_2O)-0.80% Iron (Fe) as Cu EDTA–0.07% Zn (Zn) as Zn EDTA-0.06% Water (H_2O)- 100% Brassinosteroids Triacontanol Glycosids B vitamins	Vitazyme was applied to seed tubers before planting. Vitazyme was applied as a foliar spray, or via drip or sprinkler irrigation to plants every 30, 45, 60 days.
Nitromax	Nitrogen (N)% 0.24 Phosphorus (P_2O_5)% 0.002 Potassium (K_2O)% 0.74 Protein% 0.56 Zinc (Zn), ppm 6.05 Copper (Cu), ppm 2.42 Manganese (Mn), ppm 10.28 Iron (Fe), ppm 52.62 Bacillus species	One liter ofnitromax was Mixed to 100 parts water then it was allowed to stand in a closed plastic container. It was not exposed to daylight for 36 hours at 24 ^{0}C or higher to activate. Application It was Applied at seedling stage at the rate of 1:100 liter per hectare then it was alternately applied to freshly plowed moist soil 3 days before planting, and sprayed every after 7 days.
Dolomite	CaO-39.6% MgO-15.9%	Dolomite was applied to the soil to give time for the dolomite to work with the soil and the next day it was mixed with the soil before planting.

Figure 1. Overview of the experimental area at 60, 75, 90 days after planting and just after harvesting

Data Gathered

1.Meteorological data. The temperature, relative humidity, rainfall and sunshine duration were taken from the municipality of Sayangan, Atok, Benguet (LGU- PAG-ASA).

2. Soil chemical properties. Soil samples were taken before planting and after harvesting. Soil pH, organic matter, nitrogen, phosphorus and potassium were analyzed by theDepartment of Agriculture, Regional Field Unit 1, San Fernando City, La Union.

3. Growth Parameter

a. Plant survival (%). This was the number of plants that survived taken 30 days after planting.

$$\% \text{ Survival} = \frac{\text{Number of Transplanted seedling that Survived}}{\text{Total Number of Plants Transplanted}} \times 100$$

b. Plant vigor. This was gathered 30, 45 and 60 days after transplanting using the CIP rating scale:

Scale	Description	Remarks
1	Plants are weak with few stems and leaves; very pale.	Poor vigor
2	Plants are weak with few thin stems and leaves; pale	Less vigorous
3	Better than less vigorous	Vigorous
4	Plants are moderately strong with robust stems and leaves; leaves are light green in color.	Moderately vigorous
5	Plants are strong with robust stems and leaves; Leaves are light to dark green in color.	Highly vigorous

c. Initial height (cm). This was measured using five random sample plants per plot, ten days after planting.

d. Final height (cm). This was measured using five random sample plants used in getting the initial height 15 days before harvesting. Plants were measured from the base up to the tip of the tallest shoot.

e. Canopy cover. This was gathered at 45, 60 and 75 days using a wooden frame measuring 120 cm x 6 cm and having equally sized grids of 12 cm x 6 cm. Having the grid over the foliage of two representatives previously marked plants, grids covered with effective leaves were counted.

4. Maturity

a. Number of days from planting to emergence. This was recorded by counting the days starting from planting the stem cuttings to emergence.

b. Number of days from emergence to harvesting. This was recorded by counting the number of days from emergence to harvesting (Figure 2).

5. Yield Component

a. Number of marketable and weight of marketable tubers. All tubers of marketable quality were counted and weighed at harvest and were classified into XL, large, medium and marble sizes.

b. Number and weight of non- marketable tubers. This was obtained by counting and weighing all tubers with malformedations, damaged by pest and diseases and had more than 10% greening.

c. Total yield per plot (kg). This is the sum of the marketable and non-marketable tubers that were counted and weighed.

d. Computed yield (tons/ha). Yield was computed using the formula:

$$\text{Yield (t/ha)} = \frac{\text{Total marketable yield/plot x } 10{,}000\text{m}^2}{10\text{m}^2 \text{ x } 1000}$$

6. Pest and Disease Incidence

a. Leaf miner. The reaction was recorded at 30 and 40 DAP using the following rating scale (CIP, 2001):

Scale	Description	Remarks
1	Less than 20% of plants per plot is infested	Highly resistant
2	21-40% of the plants per plot infested	Moderately resistant
3	41-60% of the plants per plot infested	Susceptible
4	61-80% of the plants per plot Infested	Moderately susceptible
5	81-100% of the plants per plot infested	Very susceptible

b. Late blight. This was gathered at 30, 45, 60 DAP using the CIP scale (Henfling, 1987).

Blight (%)	CIP Scale	Description
1	1	No blight to be seen
01-1	1	Very few plants in larger plots with a lesion. Not more than 2 lesions per 10m or row (+ 30 plants).
1.1-2	2	Up to 10 small lesions per plants
3.1-10	3	Up to 30 small lesions per plant, or up to 1 in each 20 leaflets attacked.
10.1-24	4	Most plants are visibly attacked and 1 in 3 leaflets infected. Few multiple infections per leaflet.

Blight (%)	CIP Scale	Description
25-49	5	Nearly every leaflet with lesions. Multiple infections per leaflet are common. Filed plot looks green, but all plants in plot are blighted.
50-74	6	Every plant blighted and half the leaf area destroyed by blight. Plots look green- flecked and brown; blight is very obvious.
75-90	7	As previous, but ¾ of each plant blighted. Lower branches may be overwhelmingly killed off, and the only green leaves, if any, are spindly due to extensive foliage loss. Plot looks neither brown nor green.
91-97	8	Some leaves and stems are green, Plot looks brown with some green patches.
97.1-99.9	9	Few green leaves, almost all with blight lesions, remain. Many stem lesions. Plot looks brown.
100	9	All leaves and stems dead.

Remarks: 1 – highly resistant; 2-3 resistant; 4-5 moderately resistant; 6-7 moderately susceptible; 8-9 susceptible.

7. Other Data

a. Return on cash expenses. This was computed using the formula:

$$\text{ROCE} = \frac{\text{Gross income – production cost}}{\text{Production cost}} \times 100$$

Analysis of Data

All quantitative data were analyzed through the analysis of variance (ANOVA) for Randomized Complete Block Design (RCBD) with three replications. Significance of differences among the treatment means was tested using the Duncan's Multiple Range Test (DMRT).

T_0-Control (no fertilizer)

T_1-0.60 kg (T-14)

T_2-vitazyme + 0.60kg (T-14)

T_3- vitazyme + 0.30 kg (T-14)

T_4- Nitromax + 0.60 kg (T-14)

T_5- Nitromax + 0.30 kg (T-14)

T_6- Dolomite + 0.30 kg (T-14)

T_7-Dolomite + 0.60 kg (T-14)

Figure 2. Potato Plants at 90 days before harvesting

RESULTS AND DISCUSSION

Meteorological Data During the Study Period

Table 1 shows the air temperature, relative humidity, rainfall and total sunshine duration during the study period. Maximum daytime air temperature ranged from 23.5 to 19.2^{o}C while the minimum air temperature ranged from 10.1 to 11.6^{o}C with an air temperature mean of 15.86^{o}C. Relative humidity was 73.66% and rainfall amount is 1.6 mm. Total sunshine duration in minute ranged from 381.4 to 377.00 with a mean of 375.

Potato grows best in areas with temperatures ranging from 17^{o}C to 22^{o}C with a mean of 19^{o}C and average relative humidity of 86% (NPRCRTC, n.d.). The temperature that prevailed during the study period somehow depressed the potato growth especially during the months of December and January.

Table 1. Meteorological data during the study period (November, 2011 – January, 2012)

MONTH	AIR TEMPERATURE (^{O}C)			RELATIVE HUMIDITY (%)	RAINFALL AMOUNT (mm)	SUNSHINE DURATION (min)
	MIN	MAX	MEAN			
November	15.2	23.5	19.35	76	2.5	381.40
December	11.6	19.2	15.4	72	2.3	377.00
January	10.1	15.6	12.85	73	0	366.60
MEAN	12.3	19.43	15.86	73.66	1.6	375

Source: Sayangan, Atok, Benguet (LGU- PAG-ASA)

Soil Chemical Properties

Soil chemical properties of the farm before planting is shown in Table 2. It was observed that the soil pH is slightly acidic. The average soil pH for potato production should range from 5.6 to 6.5 with high organic matter (NPRCRTC n.d.).

Nitrogen, phosphorus and potassium were observed to be low, since the organic matter is also low. Parnes (1986) stated that organic matter is the principal source of nitrogen, phosphorus and sulfur nutrients which organisms require. A typical agricultural soil may contain 1.5% organic matter in the top 15 cm of the soil surface.The greater the amounts of organic matter in the soil the better are the physical properties of the soil (Alam et al., 20010).

Nitrogen is needed for vegetative growth. However, application of high amount of nitrogen may prolong the maturity of the crop. Total nitrogen content of the top 25cm of most soils ranges from 0.03 to 0.4%. About 0.95 % or more of total nitrogen in the soil in organic forms (e.g. Proteins, amino acids, amino sugar and other complex N compounds), may not be available directly to growing plants.

Phosphorus contributed to the early development of the crop and early tuberization. It may increase the number of tuber production per plant. Although organic

Table 2. Chemical properties of the soil before planting and after harvest

	pH	OM(%)	N(%)	P(ppm)	K(ppm)
Before planting	6.68	3.0	0.15	81	310
After harvest	6.0	3.5	0.19	98	315

Analyzed by: Department of Agriculture, Regional Field Unit 1, San Fernando City, La Union

source of phosphorus are slowly available, they are very important since organic phosphorus may account for up to 90% of the total soil phosphorous. Organic phosphorus can be supplied to the soil by the addition of manure, municipal waste and the accumulation of microbial and plant residues.

Potassium increases the dry matter content and helps prevent black spot damage and blue discoloration after cooking. It also improves the storage quality of potato. Potassium is regarded as one of the most important nutrients for plant because it plays an important role in water transportation, photosynthesis and other metabolic activities throughout the plant growth and development (Motavalli, 2005).

Number of Days from Planting to Emergence and Harvesting

Table 3 shows the number of days from planting to emergence and to harvesting of potato as affected by the treatments. Statistical analysis shows highly significant differences among treatments. It showsthat Vitazyme + 0.30 kg (T-14) garnered the

Table 3. Number of days from planting to emergence and harvesting of potato applied with soil enhancer

TREATMENT	DAYS TO	
	EMERGENCE	HARVESTING
Control (no fertilizer)	14.00[a]	76.00[e]
0.60 kg (T-14)	14.00[a]	76.00[e]
Vitazyme + 0.60kg(T-14)	10.00[de]	80.00[ab]
Vitazyme + 0.30 kg (T-14)	10.00[e]	80.00[a]
Nitromax + 0.60 kg (T-14)	11.00[cd]	79.00[bc]
Nitromax + 0.30 kg (T-14)	11.00[c]	79.00[c]
Dolomite + 0.30 kg (T-14)	13.00[b]	77.00[d]
Dolomite + 0.60 kg (T-14)	12.00[b]	78.00[d]
CV (%)	4.64	0.71

Means followed by the same letter are not significantly different at 5% level of significance, DMRT

earliest days from planting to emergence (10.00), while control plants emerged the latest (14.00 days) and harvested the latest (73.00 days). Plants under the different treatments emerged and harvested at the same time.

Plant Survival

The percentage plant survival at 30 days after planting (DAP) varied statistically.Table 2 shows that plants applied with Vitazyme + 0.60 kg T-14 and Vitazyme +0.30 kg T-14 obtained the highest percentage survival but not significantly different with the other treatments. The results reveal that the soil enhancers used did not affect the plant survival.

Plant Vigor

Plant vigor of potato applied with soil enhancer is shown in table 5. Plant vigor was evaluated based on the stand of plants. It was observed that most of the treatments were moderately vigorous while others were less vigorous.

Table 4. Plant survival of potato at 30 DAP of potato tubers applied with soil Enhancer

TREATMENT	PLANT SURVIVAL (%)
Control (no fertilizer)	95.73
0.60 kg (T-14)	96.93
Vitazyme + 0.60kg (T-14)	100.00
Vitazyme + 0.30 kg (T-14)	100.00
Nitromax + 0.60 kg (T-14)	97.30
Nitromax + 0.30 kg (T-14)	96.97
Dolomite + 0.30 kg (T-14)	92.43
Dolomite + 0.60 kg (T-14)	98.47

Means followed by the same letter are not significantly different at 5% level of significance, DMRT

Plant Height at 30 and 90 DAP

Plant height of potato plants at 30 and 90 DAP of the different treatment is presented in Table 6. At 30 DAP, plants applied with Vitazyme + 0.60 kg T-14 and Vitazyme + 0.30 kg T-14 significantly registered the tallest plants with heights of 6.48 cm and 6.15 cm, respectively, but comparable with the other treatments. Control (no fertilizers) plants were the shortest (4.60 cm).

Table 5. Plant vigor at 30, 45 and 60 days after planting (DAP) of potato applied with soil enhancers.

TREATMENT	PLANT VIGOR		
	30 DAP	45 DAP	60 DAP
Control(no fertilizer)	Less vigorous	Less vigorous	Less Vigorous
0.60 kg (T-14)	Less vigorous	Vigorous	Vigorous
Vitazyme + 0.60kg (T-14)	Moderately Vigorous	Moderately Vigorous	Moderately Vigorous
Vitazyme + 0.30 kg (T-14)	Moderately Vigorous	Vigorous	Vigorous
Nitromax + 0.60 kg (T-14)	Moderately Vigorous	Moderately Vigorous	Moderately Vigorous
Nitromax + 0.30 kg (T-14)	Vigorous	Vigorous	Vigorous
Dolomite + 0.30 kg (T-14)	Vigorous	Vigorous	Moderately Vigorous
Dolomite + 0.60 kg (T-14)	Moderately Vigorous	Moderately vigorous	Moderately Vigorous

Means followed by the same letter are no significantly different at 5% level of significance, DMRT

Table 6. Height of potato plants at 30 and 90 DAP applied with soil enhancer

TREATMENT	PLANT HEIGHT (cm)	
	30DAP	90DAP
Control (no fertilizer)	4.60[b]	14.07[d]
0.60 kg (T-14)	5.65[d]	17.40[c]
Vitazyme + 0.60kg (T-14)	6.48[a]	26.00[a]
Vitazyme + 0.30 kg (T-14)	6.15[b]	24.40[a]
Nitromax + 0.60 kg (T-14)	5.93[c]	20.13[b]
Nitromax + 0.30 kg (T-14)	5.90[c]	19.80[b]
Dolomite + 0.30 kg (T-14)	5.78[cd]	21.60[b]
Dolomite + 0.60 kg (T-14)	5.47[e]	20.80[b]
CV (%)	1.78	5.11

Means followed by the same letter are not significantly different at 5% level of significance, DMRT

Canopy Cover at 30, 45 and 60 Days after Planting

Table 7 shows the canopy cover of the potato plants at 3 stages. At 30 DAP,plants applied with Vitazyme + 0.60 kg T-14 exhibited the widest canopy of 4.19 followed by Vitazyme + 0.30 kg T-14 with the mean of 4.14, while un fertilized plants had the narrowest canopy cover of 4.61.

At 45 DAP, canopy cover of all treatments increased with Plants applied withVitazyme + 0.60 kg T-14 and 0.30 kg T-14 again having the widest canopy cover of 6.05. This was followed by plants applied withNitromax + 0.60 kg (T-14) with a mean of 5.853 while unfertilized plants had the narrowest canopy of 4.61.

At 60 DAP, plants applied withVitazyme + 0.60 kg T-14 still had the significantly widest canopy cover with 9.53.Unfertilized plants (Control) were observed to have narrow canopy cover of 6.98.

The two treatments w/ Vitazyme had more than 30% canopy cover than the control at both 45 and 60 DAP. Those applied w/ Nitromax or Dolomite had 22% with less canopy cover than the other treatments. Obviously, Vitazyme possesses materials that can enhance potato vegetative growth. To a lesser extent, both Nitromax and Dolomite exhibited the same trait. It was observed that all the treatments with high canopy covers were resistant to late blight infection.

Number and Weight of Marketable Tubers

The average number and weight of marketable tubers is shown in Table 8. Statistical analysis showed significant differences among treatments. Plants applied with Vitazyme + 0.60 kg T-14 had increased its number and weight of marketable tubers by 32-38% and unfertilized plants(control)had 22% with less number and weight of marketable tubers than the other treatments. This result indicates that Vitazyme has contents that can enhance tuber production, while both Nitromax and Dolomite has the same effect.

Table 7. Canopy cover of potato tubers using soil enhancer

TREATMENT	CANOPY COVER		
	30 DAP	45 DAP	60 DAP
Control(no fertilizer)	3.513^{d}	4.607^{d}	6.980^{d}
0.60 kg (T-14)	3.767^{c}	5.467^{c}	7.547^{c}
vitazyme + 0.60kg (T-14)	4.193^{ab}	6.047^{a}	9.533^{a}
vitazyme + 0.30 kg (T-14)	4.143^{b}	6.047^{a}	9.107^{a}
Nitromax + 0.60 kg (T-14)	4.107^{b}	5.853^{ab}	8.487^{b}
Nitromax + 0.30 kg (T-14)	4.067^{b}	5.713^{abc}	8.297^{b}
Dolomite + 0.30 kg (T-14)	4.047^{b}	5.720^{abc}	8.320^{b}
Dolomite + 0.60 kg (T-14)	4.133^{b}	5.660^{abc}	8.167^{b}
CV (%)	3.65	3.35	3.70

Means followed by the same letter are not significantly different at 5% level of significance, DMRT

The results reveal that the soil enhancers used did affect the number and weight of tubers. Basically, number and weight of tubers is controlled or influenced by environmental factors.However, there are also other factors that affect the number and weight of tubers such as pest, diseases, nutrient and water availability which should be taken into account.

Number and Weight of Non Marketable Tubers

Table 9 shows the average number and weight of non-marketable tubers. Statistical analysis showed no significant variations in terms of the number of tubers but highly significant differences among treatments were observed in terms of the weight.Unfertilized plants (Control) had more number of tubers (69.67) and weight (1.57 kg) and plants applied with Dolomite + 0.60 kg T-14 had the least number of tubers (44.33) but had weighed more than a kilo.

Table 8. Number and weight of marketable tubers applied with soil enhancer

TREATMENT	MARKETABLE TUBERS	
	NUMBER (per plot/ $5m^2$)	WEIGHT ($kg/5m^2$)
Control(no fertilizer)	56.67^{c}	2.50^{f}
0.60 kg (T-14)	67.67^{bc}	3.23^{ef}
Vitazyme + 0.60kg (T-14)	69.00^{bc}	6.60^{a}
Vitazyme + 0.30 kg (T-14)	87.67^{a}	6.23^{ab}
Nitromax + 0.60 kg (T-14)	81.33^{ab}	5.33^{bc}
Nitromax + 0.30 kg (T-14)	80.67^{ab}	5.60^{ab}
Dolomite + 0.30 kg (T-14)	67.00^{bc}	4.17^{de}
Dolomite + 0.60 kg (T-14)	80.33^{ab}	4.50^{cd}
CV%	11.31	12.07

Means followed by the same letter are not significantly different at 5% level of significance, DMRT

This result validates the findings that the soil enhancers used really affect the number and weight of tubers.

Total Yield per Plot and Computed Yield per Hectare

The yield per plot and computed yield per hectare as affected by the different treatments are shown in Table 10 and Figure 3. The results show that plants fertilized with the combination of Vitazyme + 0.60 kg T-14 fertilizer had the highest yield of 7.23 kg per plot and 14.48 tons/ha. This was followed by the plants fertilized with Vitazyme + 80-80-80kg/ha T-14, and Nitromax + 0.60kg T-14 with means of 6.57 per plot and 13.73 tons/ha. There were highly significant differences observed among the treatments.

Table 9. Number and weight of non marketable tubers applied with soil enhancers

TREATMENT	NON- MARKETABLE	
	NUMBER OF TUBERS (per plot/ $5m^2$)	WEIGHT OF TUBER ($kg/5m^2$)
Control(no fertilizer)	69.67	1.57
0.60 kg (T-14)	71.67	1.40
Vitazyme + 0.60kg (T-14)	55.33	0.90
Vitazyme + 0.30 kg(T-14)	54.00	0.63
Nitromax + 0.60 kg(T-14)	63.67	1.03
Nitromax + 0.30 kg(T-14)	60.33	0.97
Dolomite + 0.30 kg (T-14)	49.00	1.13
Dolomite + 0.60 kg (T-14)	44.33	1.20
CV%	8.48	15.73

Means followed by the same letter are not significantly different at 5% level of significance, DMRT

Table 10. Total yield per plot and computed yield tons per hectare of potato tubers applied with soil enhancer

TREATMENT	COMPUTED YIELD	
	Total yield (kg/5m^2)	t/ha
Control (no fertilizer)	4.07^{e}	8.13^{e}
0.60 kg (T-14)	4.63^{de}	9.27^{de}
Vitazyme + 0.60kg (T-14)	7.23^{a}	14.47^{a}
Vitazyme + 0.30 kg (T-14)	7.13^{a}	14.27^{a}
Nitromax + 0.60 kg (T-14)	6.57^{abc}	13.73^{abc}
Nitromax + 0.30 kg (T-14)	6.37^{ab}	12.13^{ab}
Dolomite + 0.30 kg (T-14)	5.30^{cd}	10.60^{cd}
Dolomite + 0.60 kg (T-14)	5.70^{bcd}	11.40^{bcd}
CV (%)	1.78	5.11

Means followed by the same letter are not significantly different at 5% level of significance, DMRT

Late Blight Occurrence

Table 11 shows the late blight infection at 30, 45 and 60 DAP of the eight treatments. Most of the treatments had shown consistent trend in relation to late blight occurrence. Plants applied with Vitazyme + 0.60kg (T-14) were consistently resistant to late blight infection at 30, 45 and 60 DAP. Most of the treatments were observed to be moderately resistant and resistant except for plants applied with vitazyme + 0.60kg T-14, Nitromax + 0.60kg T-14, Dolomite + 0.60kg T-14, and control which were observed to be moderately resistant.

Increase of late blight infection from 30 to 60 DAP could be due to the scattered rain showers during the period.

T_0-Control(no fertilizer) T_1-0.60 kg (T-14) T_2- Vitazyme + 0.60kg (T-14)

T_3- Vitazyme + 0.30 kg (T-14) T_4- Nitromax + 0.30 kg (T-14) T_5- Nitromax + 0.30 kg (T-14)

T_6- Dolomite + 0.30 kg (T-14) T_7- Dolomite + 0.60 kg (T-14)

Figure 3. Harvested potato tubers at 90 days after planting

Leaf Miner incidence

Visual rating for leaf miner incidence was done at 30 to 45 DAP. It was observed that most of the treatments were highly resistant at 30 and 45 DAP except for control (no fertilizer), 0.60 kgT-14 and Dolomite + 0.60kg T-14 which is moderately resistant (Table 12).

Low leaf miner incidence could be due to the crop diversity practiced in the study area.

Table 11. Late blight infection of potato plants applied with soil enhancer

TREATMENT	LATE BLIGHT		
	30 DAP	45 DAP	60 DAP
Control(no fertilizer)	Moderately Resistant	Moderately Resistant	Moderately Resistant
0.60 kg (T-14)	Resistant	Resistant	Resistant
Vitazyme + 0.60kg (T-14)	Highly Resistant	Resistant	Resistant
Vitazyme + 0.30 kg (T-14)	Resistant	Resistant	Moderately Resistant
Nitromax + 0.60 kg (T-14)	Highly Resistant	Moderately Resistant	Moderately Resistant
Nitromax + 0.30 kg (T-14)	Resistant	Moderately Resistant	Moderately Resistant
Dolomite + 0.30 kg (T-14)	Resistant	Moderately Resistant	Moderately Resistant
Dolomite + 0.60 kg (T-14)	Highly Resistant	Resistant	Resistant

Means followed by the same letter are not significantly different at 5% level of significance, DMRT

Table 12. Leaf miner incidence of potato plants applied with soil enhancers

TREATMENT	LEAF MINER	
	30 DAP	45 DAP
Control (no fertilizer)	Moderately Resistant	Moderately Resistant
0.60 kg (T-14)	Moderately Resistant	Moderately Resistant
Vitazyme + 0.60kg (T-14)	Highly Resistant	Highly Resistant
Vitazyme + 0.30 kg (T-14)	Highly Resistant	Highly Resistant
Nitromax + 0.60 kg (T-14)	Highly Resistant	Highly Resistant
Nitromax + 0.30 kg (T-14)	Highly Resistant	Highly Resistant
Dolomite + 0.30 kg (T-14)	Highly Resistant	Highly Resistant
Dolomite + 0.60 kg (T-14)	Moderately Resistant	Moderately Resistant

Means followed by the same letter are not significantly different at 5% level of significance, DMRT

Return on Cash Expense

Table 13 shows the cost and return analysis on potato production using different soil enhancers. Computation shows that plants applied with Vitazyme + 0.60kg T-14 had the highest computed ROCE fallowed by Vitazyme + 0.30kg T-14.

Table 13.Return on Cash Expenses (ROCE) of potato applied with soil enhancer

PARTICULARS	SOIL ENHANCER TREATMENT							
	Control(no fertilizer)	0.60 kg Farmers Practice	vitazyme + 0.60kg Farmers Practice	vitazyme + 0.30 kg Farmers Practice	Nitromax + 0.60 kg Farmers Practice	Nitromax + 0.30 kg Farmers Practice	Dolomite + 0.30 kg Farmers Practice	Dolomite + 0.60 kg Farmers Practice
Marketable tubers	2.50	3.23	6.60	6.23	5.33	2.50	2.50	2.50
Expenses								
Fertilizer		14.50	14.50	7.50	14.50	7.50	7.50	14.50
Chemicals	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00
Labors	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Soil enhancer			83.00	83.00	83.00	83.00	60.00	60.00
Total expenses	156.00	170.50	253.50	196.50	247.50	246.50	223.50	230.50
Gross sales	975.00	126.10	257.40	243.10	208.00	168.00	162.50	175.50
Net income	-58.00	-44.90	39.00	46.60	37.00	25.00	24.00	23.00
ROCE	-6.50	-8.70	18.70	17.60	11.50	11.90	11.50	14.90

*The harvested tubers were sold at Php 13 per kilogram.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at Sayangan, Paoay, Atok Benguet from November 2011 to January 2012. The objectives of the study were to determine the growth and yield performance of potato seed tubers as affected by soil enhancers; identify the best soil enhancers for potato production; and compare the profitability of potato productionapplied with soil enhancers through return on cash expenditures (ROCE).

Significant differences were observed in the growth and yield performance of potato applied with soil enhancers. Plants applied withVitazyme + 0.60kg T-14 and Vitazyme + 0.30kg T-14 had the highest percentage plant survival. Some of the treatments were rated moderately vigorous, others were vigorous and control was rated less vigorous as with farmers practice but not significantly different with the other treatments. Applied ofVitazyme + 0.60kg T-14 produced the tallest plants and control was recorded to be the shortest plant. At 30, 45 and 60 DAP, plants applied withVitazyme + 0.60kg T-14 produced the tallest plants and control was recorded to be the shortest plant. At 30, 45 and 60 DAP, plants applied with Vitazyme + 0.60kg T-14 had greater canopy cover than the other treatments. All the treatments consistently exhibited high resistances to leaf miner at 30 DAP to 45 DAP except with the control (no fertilizer). Plants applied with T-14 alone and Dolomite + 0.60kg T-14 was recorded to be moderately resistant to leaf miner. Application of Vitazyme + 0.60kg T-14 produced themostnumber and heaviest tubers.

Conclusion

Based on the results, plants applied withVitazyme + 0.60kg T-14 performed the best in terms of its growth, survival, vigorousness, and canopy cover at 30 DAP, 45 DAP, and 60DAP. The plants also produced the highest and heaviest tubers and had the highest yield.

Vitazyme was the best soil enhancer out of the three soil enhancers that were used in the study.

On the return on cash expenses, all the soil enhancers had positive income but quite low ranging only from 11.5% (Nitromax + 0.60kg T-14) to 18.7% (Vitazyme + 0.60kg T-14). The effect of the soil enhancers could be better appreciated during the succeeding planting seasons.

Recommendation

Application ofVitazyme + 0.60kg T-14 is recommended since it performed the best in terms of plant growth, survival, vigor, and canopy cover at 30 DAP, 45 DAP, and 60 DAP.

The study shows that there is profitability of potato tubers applied with soil enhancers.

Further studies using soil enhancers in other farms and planting months are recommended to verify the results. Since some of the soil enhancers are new, the potential of soil enhancers is highly beneficial for the soil and for potato production. These soil enhancers are also recommended for organic production.

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APPENDICES

Appendix Table 1. Meteorological data during the study period

MONTH	AIR TEMPERATURE		RELATIVE HUMIDITY (%)	RAINFALL AMOUNT(mm)	SUNSHINE DURATION(cm)
	MIN	MAX			
November					
1st Week	14.7	22.8	80	10.4	262.2
2nd Week	15.6	23.7	75	0	426.8
3rd Week	14.3	23.8	75	0	457.7
4th Week	15.8	24.5	86	0.7	307.7
MEAN	15.2	23.5	80	2.5	381.4
December					
1st Week	15.0	24.7	75	4.4	371.1
2nd Week	15.3	24.3	79	5.1	375.4
3rd Week	15.6	23.8	75	0.5	480.0
4th Week	16.1	23.8	81	0	420.0
MEAN	15.6	24.2	78	2.4	387.0
January					
1st Week	15.1	24.3	78	0.1	447.4
2nd Week	14.5	24.5	73	0	266.5
3rd Week	14.1	23.7	80	0	315.4
4th Week	13.2	24.0	80	0	440.5
MEAN	13.9	23.9	77	0.03	386.6

Appendix Table 2. Plant survival

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	89.9	99.9	97.4	95.733
0.60 kg (T-14)	100	95.4	95.4	96.933
Vitazyme + 0.60kg (T-14)	100	100	100	100.000
Vitazyme + 0.30 kg (T-14)	100	100	100	100.000
Nitromax + 0.60 kg (T-14)	95.4	96.5	100	97.300
Nitromax + 0.30 kg (T-14)	90.9	100	100	96.967
Dolomite + 0.30 kg (T-14)	90.9	91.9	94.5	92.433
Dolomite + 0.60 kg (T-14)	100	100	95.4	98.467
TOTAL	109.5	111.9	111.8	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	21.663	10.832			
Treatment	7	126.856	18.122	1.88^{ns}	3.39	4.78
Error	14	134.370	9.598			
Total	23	282.889				

^{Ns}= not Significant Coefficient of Variance = 3.19%

Appendix Table 3. Plant vigor at 30 days after planting

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	2	3	2	2.333
0.60 kg (T-14)	2	2	3	2.333
Vitazyme + 0.60kg (T-14)	4	3	4	3.667
Vitazyme + 0.30 kg (T-14)	4	4	3	3.667
Nitromax + 0.60 kg (T-14)	3	4	4	3.667
Nitromax + 0.30 kg (T-14)	4	3	3	3.333
Dolomite + 0.30 kg (T-14)	3	4	3	3.333
Dolomite + 0.60 kg (T-14)	4	3	4	3.667
TOTAL	3.71	7.71	3.71	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	0.000	0.000			
Treatment	7	7.167	1.024	2.68^{ns}	3.39	4.78
Error	14	5.333	0.381			
Total	23	12.500				

^{ns}= not significant Coefficient of Variance = 18.99%

Appendix Table 4. Plant vigor at 45 days after planting

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	2	2	3	2.333
0.60 kg (T-14)	3	3	3	3.000
Vitazyme + 0.60kg (T-14)	4	3	4	3.667
Vitazyme + 0.30 kg (T-14)	3	4	3	3.333
Nitromax + 0.60 kg (T-14)	3	4	4	3.000
Nitromax + 0.30 kg (T-14)	3	3	4	2.667
Dolomite + 0.30 kg (T-14)	3	3	3	3.000
Dolomite + 0.60 kg (T-14)	3	4	4	3.667
TOTAL	3.42	3.71	4	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	0.333	0.167			
Treatment	7	4.500	0.643	1.80^{ns}	3.39	4.78
Error	14	5.000	0.357			
Total	23	9.833				

$^{ns=}$ not significant Coefficient of Variance = 19.38 %

Appendix Table 5. Plant vigor at 60 days after planting

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	3	2	2	2.333
0.60 kg (T-14)	3	4	3	3.333
Vitazyme + 0.60kg (T-14)	4	4	4	4.000
Vitazyme + 0.30 kg (T-14)	3	3	4	3.333
Nitromax + 0.60 kg (T-14)	4	4	3	3.667
Nitromax + 0.30 kg (T-14)	3	4	3	3.333
Dolomite + 0.30 kg(T-14)	3	4	4	3.667
Dolomite + 0.60 kg (T-14)	3	4	4	3.667
TOTAL	3.71	4.14	3.85	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	0.583	0.292			
Treatment	7	5.167	0.738	2.53^{ns}	3.39	4.78
Error	14	4.083	0.292			
Total	23	9.833				

$^{ns=}$ not Significant Coefficient of Variance = 15.81 %

Appendix Table 6. Initial height

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	4.56	4.6	4.64	4.600
0.60 kg (T-14)	5.64	5.74	5.58	5.653
Vitazyme + 0.60kg (T-14)	6.38	6.64	6.42	6.480
Vitazyme + 0.30 kg (T-14)	6.22	6.04	6.2	6.153
Nitromax + 0.60 kg (T-14)	6.04	5.92	5.82	5.157
Nitromax + 0.30 kg (T-14)	5.82	5.88	6	5.900
Dolomite + 0.30 kg (T-14)	5.82	5.84	5.68	5.780
Dolomite + 0.60 kg (T-14)	5.46	5.38	5.56	5.467
TOTAL	6.56	6.57	6.55	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	0.001	0.001			
Treatment	7	6.486	0.927	88.75**	3.39	4.78
Error	14	0.416	0.010			
Total	23	6.634				

**= Highly significant Coefficient of Variance = 1.78 %

Appendix Table 7. Final height (cm)

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	14	13.8	14.4	14.067
0.60 kg (T-14)	17.2	18.2	16.8	17.400
Vitazyme + 0.60kg (T-14)	25.4	27	25.6	26.000
Vitazyme + 0.30 kg(T-14)	23.8	24	25.4	24.400
Nitromax + 0.60 kg(T-14)	20	21.2	19.2	20.133
Nitromax + 0.30 kg(T-14)	19.6	21	18.8	19.800
Dolomite + 0.30 kg(T-14)	21.4	23.8	19.6	21.600
Dolomite + 0.60 kg(T-14)	21.4	22.6	22.6	20.800
TOTAL	23.25	24.51	23.2	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	11.590	5.795			
Treatment	7	295.132	42.162	38.27**	3.39	4.78
Error	14	15.423	1.102			
Total	23	322.145				

**=Highly significant Coefficient of Variance = 5.11%

Appendix Table 8. Canopy cover at 45 days after planting

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	3.5	3.54	3.5	3.513
0.60 kg (T-14)	3.68	3.78	3.84	3.767
Vitazyme + 0.60kg (T-14)	4.48	4.38	4.38	4.413
Vitazyme + 0.30 kg (T-14)	4.28	3.88	4.42	4.193
Nitromax + 0.60 kg (T-14)	3.98	4.18	4.16	4.107
Nitromax + 0.30 kg (T-14)	4.28	3.94	3.98	4.067
Dolomite + 0.30 kg (T-14)	3.92	3.98	4.24	4.047
Dolomite + 0.60 kg (T-14)	4.18	3.94	4.28	4.133
TOTAL	3.43	4.51	32.8	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	0.088	0.044			
Treatment	7	1.584	0.226	10.48**	3.39	4.78
Error	14	0.302	0.022			
Total	23	1.974				

**=Highly significant Coefficient of Variance = 3.65%

Appendix Table 9. Canopy cover at 60 days after planting

TREATMENT	REPLICATION			MEAN
	I	II	III	
Control(no fertilizer)	4.7	4.54	4.58	4.607
0.60 kg(T-14)	5	5.6	5.8	5.467
Vitazyme + 0.60kg (T-14)	6	6.1	6.04	6.047
Vitazyme + 0.30 kg (T-14)	6.2	6.04	5.9	6.047
Nitromax + 0.60 kg (T-14)	5.84	5.9	5.82	5.853
Nitromax + 0.30 kg (T-14)	5.7	5.64	5.8	5.713
Dolomite + 0.30 kg (T-14)	5.64	5.8	5.72	5.720
Dolomite + 0.60 kg (T-14)	5.88	5.74	5.44	5.660
TOTAL	44.96	6.48	6.44	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	0.014	0.007			
Treatment	7	4.459	0.637	17.83**	3.39	4.78
Error	14	0.500	0.036			
Total	23	1.974				

**=Highly significant Coefficient of Variance = 3.35%

Appendix Table 10. Canopy cover at 75 days after planting

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	7.08	6.88	6.98	6.980
0.60 kg (T-14)	7.74	7.52	7.38	7.547
Vitazyme + 0.60kg (T-14)	10.02	9.54	9.04	9.533
Vitazyme + 0.30 kg (T-14)	9	9.38	8.94	9.107
Nitromax + 0.60 kg (T-14)	8.84	8.14	8.48	8.487
Nitromax + 0.30 kg (T-14)	8.34	8.38	8.18	8.297
Dolomite + 0.30 kg (T-14)	7.8	8.84	8.32	8.320
Dolomite + 0.60 kg (T-14)	8.34	8.08	8.08	8.167
TOTAL	9.59	9.53	9.34	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	0.215	0.108			
Treatment	7	13.604	1.943	20.60**	3.39	4.78
Error	14	1.320	0.094			
Total	23	15.140				

**=Highly significant Coefficient of Variance = 3.70%

Appendix Table 11. Number of days from planting to harvesting

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	76	77	76	76.333
0.60 kg (T-14)	77	76	76	76.333
Vitazyme + 0.60kg (T-14)	80	80	79	79.667
Vitazyme + 0.30 kg (T-14)	80	80	80	80.000
Nitromax + 0.60 kg (T-14)	79	80	78	79.000
Nitromax + 0.30 kg (T-14)	78	79	79	78.667
Dolomite + 0.30 kg (T-14)	78	77	77	77.333
Dolomite + 0.60 kg (T-14)	78	78	77	77.667
TOTAL	89.42	89.57	88.85	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	1.750	0.875			
Treatment	7	42.625	6.089	20.06**	3.39	4.78
Error	14	4.250	0.304			
Total	23	48.625				

** = highly significant Coefficient of Variance = 0.71 %

Appendix Table 12. Number of days from planting to emergence

TREATMENT	REPLICATION			MEAN
	I	II	III	
Control(no fertilizer)	14	13	14	13.667
0.60 kg (T-14)	13	14	14	13.667
Vitazyme + 0.60kg (T-14)	10	10	11	10.333
Vitazyme + 0.30 kg (T-14)	10	10	10	10.000
Nitromax + 0.60 kg (T-14)	11	10	12	11.000
Nitromax + 0.30 kg (T-14)	12	11	11	11.333
Dolomite + 0.30 kg (T-14)	12	13	13	12.667
Dolomite + 0.60 kg (T-14)	12	12	13	12.333
TOTAL	13.42	13.28	14	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	1.750	0.875			
Treatment	7	42.625	6.089	20.06**	3.39	4.78
Error	14	4.250	0.304			
Total	23	48.625				

** = highly significant Coefficient of Variance = 4.64 %

Appendix Table 13. Number of days from planting to harvesting

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	76	77	76	76.333
0.60 kg (T-14)	77	76	76	76.333
Vitazyme + 0.60kg (T-14)	80	80	79	79.667
Vitazyme + 0.30 kg (T-14)	80	80	80	80.000
Nitromax + 0.60 kg (T-14)	79	80	78	79.000
Nitromax + 0.30 kg (T-14)	78	79	79	78.667
Dolomite + 0.30 kg (T-14)	78	77	77	77.333
Dolomite + 0.60 kg (T-14)	78	78	77	77.667
TOTAL	89.42	89.57	88.85	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	1.750	0.875			
Treatment	7	42.625	6.089	20.06**	3.39	4.78
Error	14	4.250	0.304			
Total	23	48.625				

** = highly significant Coefficient of Variance = 0.71 %

Appendix Table 14. Number of marketable tubers

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	68	46	56	14.067
0.60 kg (T-14)	73	62	68	17.400
Vitazyme + 0.60kg (T-14)	81	68	58	26.000
Vitazyme + 0.30 kg (T-14)	94	83	86	24.400
Nitromax + 0.60 kg (T-14)	88	91	65	20.133
Nitromax + 0.30 kg (T-14)	92	67	83	19.800
Dolomite + 0.30 kg (T-14)	85	64	52	21.600
Dolomite + 0.60 kg (T-14)	85	71	85	20.800
TOTAL	95.14	78.85	79	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	1073.583	536.792			
Treatment	7	2217.958	316.851	4.55**	3.39	4.78
Error	14	974.417	69.601			
Total	23	4265.958				

**=Highly significant Coefficient of Variance = 11.31%

Appendix Table 15. Weight of marketable tubers (kg)

TREATMENT	REPLICATION			MEAN
	I	II	III	
Control(no fertilizer)	3.2	3	1.3	2.500
0.60 kg (T-14)	4.5	3.2	2	3.233
Vitazyme + 0.60kg (T-14)	8.3	7	4.5	6.600
Vitazyme + 0.30 kg (T-14)	7.2	6	5.5	6.233
Nitromax + 0.60 kg (T-14)	7	4.5	4.5	5.333
Nitromax + 0.30 kg (T-14)	7.2	4.6	5	5.600
Dolomite + 0.30 kg (T-14)	5.8	4	2.7	4.167
Dolomite + 0.60 kg (T-14)	6.2	4.3	3	4.500
TOTAL	7.05	5.22	4.07	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	27.761	13.880			
Treatment	7	43.343	6.192	18.66**	3.39	4.78
Error	14	4.646	0.332			
Total	23	75.750				

**=Highly significant Coefficient of Variance = 12.07%

Appendix Table 16. Number of non-marketable tubers

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	63	82	64	69.667
0.60 kg (T-14)	33	79	103	71.667
Vitazyme + 0.60kg (T-14)	59	59	48	55.333
Vitazyme + 0.30 kg (T-14)	79	38	45	54.000
Nitromax + 0.60 kg (T-14)	66	68	57	63.667
Nitromax + 0.30 kg (T-14)	53	49	79	60.333
Dolomite + 0.30 kg (T-14)	70	40	37	49.000
Dolomite + 0.60 kg (T-14)	62	44	27	44.333
TOTAL	69.28	65.57	65.71	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	54.250	27.125			
Treatment	7	1948.000	278.286	0.69^{ns}	3.39	4.78
Error	14	5625.750	401.839			
Total	23	7628.000				

**=Highly significant Coefficient of Variance = 11.31%

Appendix Table 17. Weight of non-marketable tubers

TREATMENT	REPLICATION			MEAN
	I	II	III	
Control(no fertilizer)	1.5	1.2	2	1.567
0.60 kg (T-14)	1.4	1.4	1.4	1.400
Vitazyme + 0.60kg (T-14)	0.7	0.6	0.6	0.633
Vitazyme + 0.30 kg (T-14)	0.8	0.7	1.2	0.900
Nitromax + 0.60 kg (T-14)	1.2	0.7	1.2	1.033
Nitromax + 0.30 kg (T-14)	1	0.7	1.2	0.967
Dolomite + 0.30 kg (T-14)	1	1	1.4	1.133
Dolomite + 0.60 kg (T-14)	1	1	1.6	1.200
TOTAL	1.2	1.04	1.51	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	0.691	0.345			
Treatment	7	1.796	0.257	8.50**	3.39	4.78
Error	14	0.427	0.030			
Total	23	2910				

**=Highly significant Coefficient of Variance = 11.31%

Appendix Table 18. Total yield per plot

TREATMENT	REPLICATION			MEAN
	I	II	III	
Control(no fertilizer)	4.7	4.2	3.3	4.067
0.60 kg (T-14)	5.9	4.6	3.4	4.633
Vitazyme + 0.60kg (T-14)	9	7.6	5.1	7.233
Vitazyme + 0.30 kg (T-14)	8	6.7	6.7	7.133
Nitromax + 0.60 kg (T-14)	8.2	5.2	5.7	6.367
Nitromax + 0.30 kg (T-14)	8.2	5.3	6.2	6.567
Dolomite + 0.30 kg (T-14)	6.8	5	4.1	5.300
Dolomite + 0.60 kg (T-14)	7.2	5.3	4.6	5.700
TOTAL	8.28	6.27	5.58	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	24.128	12.064			
Treatment	7	27.965	3.995	9.46**	3.39	4.78
Error	14	5.912	0.422			
Total	23	58.005				

**=Highly significant Coefficient of Variance = 11.06%

Appendix Table 19. Computed yield tons/ha

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	9,400	8,400	6,600	8.133
0.60 kg (T-14)	11,800	9,200	6,800	9.267
Vitazyme + 0.60kg (T-14)	18,000	15,200	10,200	14.467
Vitazyme + 0.30 kg (T-14)	16,000	13,400	13,400	14.267
Nitromax + 0.60 kg (T-14)	16,400	10,400	11,400	12.733
Nitromax + 0.30 kg (T-14)	16,400	10,600	12,400	13.133
Dolomite + 0.30 kg (T-14)	13,600	10,000	8,200	10.600
Dolomite + 0.60 kg (T-14)	14,400	10,600	9,200	11.400
TOTAL	16,571	12,542	11,171	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	96.510	48.225			
Treatment	7	111.860	15.980	9.46**	3.39	4.78
Error	14	23.650	1.680			
Total	23	232.02				

**=Highly significant Coefficient of Variance = 11.06%

Appendix Table 20. Leaf miner infestation 30 day after planting

TREATMENT	REPLICATION			MEAN
	I	II	III	
Control(no fertilizer)	1.58	1.22	1.58	1.667
0.60 kg (T-14)	1.22	1.58	1.58	1.667
Vitazyme + 0.60kg(T-14)	1.22	1.22	1.22	1.000
Vitazyme + 0.30 kg (T-14)	1.22	1.22	1.22	1.000
Nitromax + 0.60 kg (T-14)	1.22	1.22	1.22	1.000
Nitromax + 0.30 kg (T-14)	1.22	1.58	1.22	1.333
Dolomite + 0.30 kg (T-14)	1.22	1.22	1.22	1.000
Dolomite + 0.60 kg (T-14)	1.22	1.58	1.58	1.667
TOTAL	1.44	1.54	1.54	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	2	0.333	0.167			
Treatment	7	2.292	0.327	1.96^{ns}	3.39	4.78
Error	14	2.333	0.167			
Total	23	4.958				

** =Highly significant Coefficient of Variance = 11.09%

Appendix Table 21. Leaf miner infestation 40 day after planting

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	1.58	1.22	1.58	1.667
0.60 kg (T-14)	1.22	1.58	1.58	1.667
Vitazyme + 0.60kg(T-14)	1.58	1.22	1.22	1.333
Vitazyme + 0.30 kg(T-14)	1.22	1.22	1.22	1.000
Nitromax + 0.60 kg (T-14)	1.22	1.22	1.58	1.333
Nitromax + 0.30 kg (T-14)	1.22	1.58	1.22	1.333
Dolomite + 0.30 kg (T-14)	1.22	1.22	1.22	1.333
Dolomite + 0.60 kg (T-14)	1.22	1.58	1.22	1.667
TOTAL	1.49	1.54	1.54	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	0.583	0.292			
Treatment	7	1.167	0.167	0.57^{ns}	3.39	4.78
Error	14	4.083	0.292			
Total	23	5.833				

** =Highly significant Coefficient of Variance = 11.31%

Appendix Table 22. Late blight infestation 30 day after planting

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	1.22	1.58	1.58	1.667
0.60 kg (T-14)	1.22	1.22	1.58	1.333
Vitazyme + 0.60kg (T-14)	1.58	1.22	1.22	1.333
Vitazyme + 0.30 kg (T-14)	1.22	1.22	1.22	1.000
Nitromax + 0.60 kg (T-14)	1.22	1.58	1.22	1.333
Nitromax + 0.30 kg (T-14)	1.22	1.22	1.22	1.000
Dolomite + 0.30 kg (T-14)	1.22	1.58	1.22	1.333
Dolomite + 0.60 kg (T-14)	1.22	1.22	1.22	1.000
TOTAL	1.44	1.54	1.49	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	0.250	0.125			
Treatment	7	1.167	0.167	0.76^{ns}	3.39	4.78
Error	14	3.083	0.220			
Total	23	4.500				

** =Highly significant Coefficient of Variance = 12.90%

Appendix Table 23. Late blight infestation 40 day after planting

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	1.22	1.58	1.58	1.667
0.60 kg (T-14)	1.22	1.22	1.58	1.333
Vitazyme + 0.60kg (T-14)	1.58	1.22	1.22	1.333
Vitazyme + 0.30 kg (T-14)	1.58	1.22	1.22	1.333
Nitromax + 0.60 kg (T-14)	1.22	1.58	1.58	1.667
Nitromax + 0.30 kg (T-14)	1.58	1.58	1.22	1.667
Dolomite + 0.30 kg (T-14)	1.58	1.58	1.58	2.000
Dolomite + 0.60 kg (T-14)	1.22	1.58	1.22	1.333
TOTAL	1.6	1.65	1.6	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	0.083	0.042			
Treatment	7	1.292	0.185	0.56^{ns}	3.39	4.78
Error	14	4.583	0.327			
Total	23	5.958				

**=Highly significant Coefficient of Variance = 14.56%

Appendix Table 24. Late blight infestation 60 day after planting

TREATMENT	REPLICATION I	II	III	MEAN
Control(no fertilizer)	1.22	1.58	1.58	1.667
0.60 kg (T-14)	1.22	1.22	1.58	1.333
Vitazyme + 0.60kg (T-14)	1.58	1.22	1.22	1.333
Vitazyme + 0.30 kg (T-14)	1.58	1.58	1.22	1.667
Nitromax + 0.60 kg (T-14)	1.22	1.58	1.58	1.667
Nitromax + 0.30 kg (T-14)	1.58	1.58	1.22	1.667
Dolomite + 0.30 kg (T-14)	1.58	1.58	1.22	1.667
Dolomite + 0.60 kg (T-14)	1.22	1.58	1.22	1.333
TOTAL	1.6	1.70	1.54	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Replication	2	0.583	0.292			
Treatment	7	0.625	0.089	0.26^{ns}	3.39	4.78
Error	14	4.750	0.339			
Total	23	5.958				

** =Highly significant Coefficient of Variance = 14.82%