BIBLIOGRAPHY

TOMIN, GEORGETTE T. APRIL 2011. Rates of Vermicompost and Frequency of Sunflower Extract Application on Some Soil Properties and Performance of French Beans (*Phaseolus vulgaris* L.)

Adviser: Wilma L. Marquez, MSc.

ABSTRACT

The study was conducted at the Organic Demo Farm, Benguet State University, La Trinidad, Benguet from December 2010 to March 2011. The objectives of the study are: to determine the effect of rates of vermicompost on some soil properties and on the performance of French beans; to determine the effect of frequency of fermented wild sunflower extract on some soil properties and performance of French beans; and to determine the best combined effect of rates of vermicompost and frequency of fermented wild sunflower extract on some soil properties and performance of French beans.

The rate of vermicompost and frequency of FWSE application evaluated showed marked effects on the growth and yield of French beans and on some physical and chemical properties of the soil.

The best combination observed was the application of 30 tons ha^{-1} of vermicompost and FWSE every 14 days, which, when applied to plants, produces high marketable yield and also affects some physical and chemical properties of the soil. On the other hand, application of FWSE at 7 days interval is effective in terms of nodule production and pod length.

TABLE OF CONTENTS Page

INTRODUCTION

French beans must be grown in fertile open soil. Being members of the legume family, they have nitrogen-fixing bacteria in their root nodules and these need lots of air in the soil, so the structure must be loose and open. Fairly light soil to which plenty of organic material has been added would be ideal.

Legumes can be used as good substitute for protein such as fish, meat, rice, corn and eggs. The immature pods are rich in vitamins while the mature dry seeds are rich in protein, carbohydrates and fats. Aside from the benefits it directly provides to farmers, it is also beneficial in maintaining soil productivity due to its roots being able to fix atmospheric nitrogen in symbiosis with a bacteria to make the soil fertile (Tomas, 2008). For other nutrients needed for its growth and development, basal and other form of farm supplementation is applied as fertilizer.

Organic fertilization or the use of animal excreta has been commonly and extensively employed on cultivated soils. Organic matter supplies or replenishes plant nutrient element which are needed by plants for its growth and development. Aside from this, organic matter alters the pH of the soil solution, chelates heavy metal ions, supports microbial life in the soil by releasing carbon dioxide, accelerates the chemical weathering of minerals, and has effects on the physical conditions and water holding capacity of the soil (Rodriguez, 1981). In addition, organic matter helps in the conservation of soil fertility and also reduces fertilization costs (Angnen, 1983).

Fertigation is the application of fertilizers, soil amendments, or other water soluble products through an irrigation system. The benefits of fertigation over traditional broadcast or drop fertilizing methods include: increased nutrient absorption by plants, reduced fertilizer and chemicals use, reduced leaching in the water table and reduced water usage due to the plant's increasing root mass that is able to trap and hold water (Wikipedia, 2008).

Fertilizer rate trials compare plant responses to a nutrient applied as a fertilizer at different rates. Ideally, growth, yield or quality improves with increasing nutrient addition until the deficiency is eliminated. Response curves and fertilizer requirements often depend on the plant characteristic that is observed and measured; growth, yield and quality attributes need not respond alike (Singer and Munns, 2006).

Liquid fertilizers play an important role in plant growth particularly leafy vegetable crops. It gives a very important source of mineral elements and food for the plant. It has been extensively used in irrigated lands for direct application to crops (Zulueta, 1982). Liquid fertilizer is applied through sprays and is absorbed by plants, thus, supplying immediately the nutrient elements and simultaneously checking symptoms caused by deficiency of certain elements.

The study was conducted to determine:

1: The effect of rates of vermicompost on some soil properties and performance of French beans;

2: The effect of frequency of fermented wild sunflower extract (FWSE) application on some soil properties and performance of French beans;

3: The best combined effect of rates of vermicompost and frequency of fermented wild sunflower extract (FWSE) application on some soil properties and performance of French beans.

The study was conducted at the Organic Demo Farm, Benguet State University, La Trinidad, Benguet from December 2010 to March 2011.

REVIEW OF LITERATURE

Importance of Vermicompost

Vermicompost is the by-product (excreta) of earthworm digestion and has been shown to increase plant growth and production, as well as to a variety of arthropod pests (Little, 2008).

Vermicompost, also known as worm castings and vermicast, is different from compost produced by other composting methods. It has more nutrient levels because worm castings contain millions of microbes that help break down nutrients into plant available forms. As the worms deposit their castings, their mucous is a beneficial component and this is absent from compost produced by hot or cold composting. The mucous component slows the release of nutrients preventing them from washing away with the first watering. Worm compost is usually too rich for use alone as a seed starter. It is useful as a top dressing and as an addition to potting mixes at a rate of one part castings to 4 parts mix. Some seed pits are reported to germinate in vermicompost easily (Sustainable Agricultural Technologies, Inc., 2010).

Vermicompost is beneficial for soil in many ways by improving the physical structure of the soil, the biological properties of the soil, the water holding capacity of the soil, and the root growth and structure of the plant. It also attracts deep-burrowing earthworms already present in the soil enhances germination, plant growth, and crop yield. In addition, vermicompost also increases microbial activity, decrease plant and soil susceptibility to pest and disease and lessen compaction leading to better aerated soils and higher nutrient levels and availability of nutrients to the plant (Sustainable Agricultural Technologies, Inc. 2010).

Lagman (2003) stated that vermicompost alone as planting medium can provide conditions essential for the growth and development of pechay, green onions and bush beans for container and urban gardening due to the favorable physical and chemical properties. Aside from being an excellent planting medium, vermicompost is recommended as soil conditioner to increase yield of some crops. He further recommended that garden soil with poor tilth should be amended with vermicompost.

In the study conducted by Azarmi in 2008, addition of 5, 10 and 15 tons/ha of vermicompost in soil had significant positive effect on the uptake of element nutrients such as P, K, Fe and Zn. Also, vermicompost had improved the bulk density and porosity of soil.

Worm casts also contain five times more nitrogen, seven times more phosphorus, and eleven times more potassium than ordinary soil. These are main minerals needed for plant growth, but the large numbers of beneficial soil micro-organisms in worm casts have at least as much to do with it. The casts are also rich in humic acids, which condition the soil, have a perfect pH balance, and contain plant growth factors similar to those found in seaweed (Addison and Hiraga, 2010).

Wild Sunflower

Brady (1974) as cited by Durante (1982) mentioned that wild sunflower has been known to be a good source of organic nitrogen. Besides being free, it is readily available in the farm. Also, Brady (1974) as cited by Durante (1982) stated that sunflower as organic fertilizer, insures vigorous growth of plants and influences nutrient absorption due to its role in granulation thereby improving the physical and chemical properties of the soil.

Wild sunflowers are naturally occurring and are abundant in the Cordillera Region. Organic farmers are using this as fertilizer which is applied fresh or decomposed and fermented as foliar (Malucay, 2008). Sunflowers can be used to extract toxic ingredients from soil such as lead, arsenic and uranium. Victor (1974) as cited by Baldo (1989) stated that wild sunflower can be a perfect starter of compost as it hastens decomposition.

According to Caccam (1984), sunflower could enhance better and more yield than other fertilizers (Sagana 100 and Chicken Manure) and could give a more favourable effects on the yield. In addition, Durante (1982) stated that green pod yield applied with wild sunflower affected the height of the plants and the number of root nodules of the plants during flowering and harvest.

A study by Malucay in 2008 showed that those that were applied with 8 tsp/liter of fermented wild sunflower had the highest yield while the control has the lowest. This indicates that at any rates of applied fermented wild sunflower extract with indigenous microorganisms, there is an effect on the yield of cabbage since it contains macro elements and microelements important for plant growth and development.

Palaleo (1978) as cited by Durante (1982), noted that chemical analysis of composted wild sunflower are as follows: 70.2 me/ 100g compost (CEC), 0.38% N, 96.60ppm P, 6567.5 ppm K, 7.90% OM, 3206.0 ppm Ca, and a pH of 6.89.

Organic Liquid Fertilizer

Organic liquid fertilizers are produced naturally. Of these, fermented plant juices are considered to have gone through the process of fermentation which involves the breakdown of carbohydrates by microorganism.

Fertilization with irrigation allows the grower to make several applications to closely matched growth needs. Fluid fertilizers, applied as liquids, can be sprayed on the ground for broadcasting or topdressing, injected into the soil, added to irrigation water or sprayed on plant leaves (Plaster, 1997).

Formulated liquid fertilizer is referred to as any liquid that contains one or more available plant nutrients (Malucay, 2008).

Joiner (1981) as cited by Fateg (2003) reported that liquid fertilizer application is the most commonly used post plant surface applied systems. Benefits include ease and uniformity of application, low labor requirement and ability to automate the system. Moreover, Collings (1962) as cited by Fateg (2003) reported that liquid fertilizers offer advantages over dry fertilizers such as less fertilizer is usually required, the avoidance of injury to seedling roots from heavy application of dry fertilizers, better distribution of small quantities of fertilizer is secured, fertilizer of poor condition can be utilized, maximum crop response maybe obtained during dry weather and light application maybe applied according to the needs of plants. In addition, Fateg (2003) reported that application of formulated liquid fertilizer gave high significant effect on the growth and yield of Chinese cabbage.

Fermented plant juice (FPJ) is a fermented extract of the plant's blood and chlorophylls. Brown sugar is used to extract the essence through osmotic pressure. Therefore, FPJ is a rich enzyme solution full of these bacteria; invigorating plants and animals (Cho, 2009).

Effects of Organic Fertilizer
on Physical Properties of Soil

Daoines (1994) stated that organic fertilizers when incorporated in the soil before planting can also improve soil structures and conserve soil moisture. With this, vegetable production is ideal because the soil is rich in organic matter. Also, Follet (1981) as cited by Daoines (1994) emphasized that the organic residues on the surface of the soil are protection against raindrop and splash erosion. It also helps reduce the extremes of surface soil temperature, surface crushing and delay spring planting.

PCARRD (1982) as cited by Imong (2003) reported that organic fertilizer supply some amount of nutrient requirements to the crop and promote favorable soil properties such as granulation and good tilth needed for efficient aeration, easy root penetration and improved water holding capacity. In addition, Cooke (1982) said that simple supply of organic matter helps keep the soil loose and prevents packing, facilitates digging and cultivating. It also enables the roots to readily increase water holding capacity and to improve food production in the form of essential nutrients needed by the plants.

Organic matter improves conditions of all mineral soils for many reasons. Organic matter helps sandy soils by increasing their water and nutrient – holding capacity and improves clay soils by loosening them and improving their tilth. Organic matter acts as a major reservoir of soil nutrients. Both fresh and organic matter and humus absorb water like sponge, holding about six times their own weight in water. This is extremely important in naturally dry and sandy soils. In fact, the water and nutrient – holding capacity of organic matter is its major benefit in sandy soils (Plaster, 1997). In addition, Mabazza (1997) revealed that organic fertilizer turn heavy soil lighter, more crumbly, friable and they hold light soil particles together to act as anchor against erosion and to increase the water holding capacity of soil.

Effects of Organic Fertilizer
on Chemical Properties of Soil

Organic matter alters the pH of the soil solution, chelates heavy metal ions and supports microbial life in the soil by releasing carbon dioxide. It also accelerates the chemical weathering of minerals, and helps water holding capacity of the soil (Rodriguez, 1981).

Effects of Organic Fertilizer
on Plant Growth

Fertilizers are used to provide minerals that are lacking in some soils, and to replace the minerals removed from the soil by crops. Organic farmers use manure, composts, which are a mixture of decaying organic matter that is rich in beneficial soil microorganisms, and other natural materials to nourish soil organisms which in turn, make minerals available to plants (Hynes, 2009).

Organic fertilizers are produced through composting. The process involves the decomposition of plant and animal materials into organic matter or humus with the help of microbes and other organisms. Although humus has low nutrient contents, it helps improve the structure, porosity and water retention of the soil that increases its biologically available moisture (Lagman, 2003).

Vermicompost is one of the organic fertilizers produced through composting with the action of earthworms. It can be produced in about four to five weeks provided that the optimum conditions for earthworm growth and development are met. Earthworms are useful soil dwellers that fed on organic materials and in return will produce humus (vermicompost) through their excreta or waste product (Lagman, 2003).

Compared with inorganic sources of nutrients, organic fertilizer are not immediately soluble in water and not readily leached because they have to breakdown to become partially soluble. They can act as slow-release source of plant nutrient and can stimulate microbial activity (Soffe, 2003).

Fertilizers are sources of plant nutrients that can be added to soil to supplement its natural fertility. The use of fertilizer is a very important way to reduce the unit cost of producing food and fiber. A farmer who uses fertilizer effectively has a great competitive advantage over one who does not (Thompson and Troeh, 1973).

Proper use of fertilizer leads to the production of more nutritious food. Organic and mineral fertilizers are equally good for plants and for animals.

Overseas (1972) as cited by Rodriguez (1981) reported that organic fertilizers such as compost and green manure are very important in vegetable production. Application of organic matter not only helps maintain soil fertility but also makes continuous production of vegetable. In addition, Edward (1998) as cited by Azarmi (2008) claimed that, vermicompost can significantly influence the growth and productivity of plants significantly.

Koshino (1990) as cited by Tomas (2008) stated that the nutrient elements from organic fertilizer which are released slowly are particularly important in avoiding salt injury; thus, enduring a continuous supply of nutrient during the growing season and in producing product of better quality.

Organic fertilizers can provide the macro elements and microelements which plants need for growth. The microelements are released gradually upon decomposition of the organic matter (Tomilas, 1996).

MATERIALS AND METHODS

The materials used in the study were French bean seeds; organic materials such as vermicompost and fermented wild sunflower extract; planting guide, tags and other farm implements needed in the land preparation. Plastic drum (preferably 200 L), indigenous microorganisms, Lactic Acid Serum, muscovado sugar, fermented plant juice and calcium phosphate were also used. Chemical reagents, laboratory equipments and glass wares required in the analysis of nutrient elements were all found at the Soils laboratory.

Preparation of Fermented Wild Sunflower Extract

The fresh wild sunflower (67 kg) was shredded or chopped and loaded in a 200 L capacity drum, and was added with 20 L water, 1 L Indigenous Microorganisms, 1 L Lactic Acid Serum. The drum was placed in a slanting position to avoid the spilling of the solution. For the mixture, 3 L was obtained and was added with 1 kg muscovado sugar, 2 tablespoon fermented plant juice and 2 tablespoon calcium phosphate and was fermented for seven days. For the solution, 1 tablespoon was mixed in 1 L water and used for irrigation (Tinoyan, 2010). The basis for the sunflower extract application was from Mr. Tinoyan's practice that the best frequency observed was once a week (Figure 1).

Fermented wild sunflower extract was applied 15 days after seed emergence and applied according to frequencies. Application of FWSE was done until 73 days after planting.

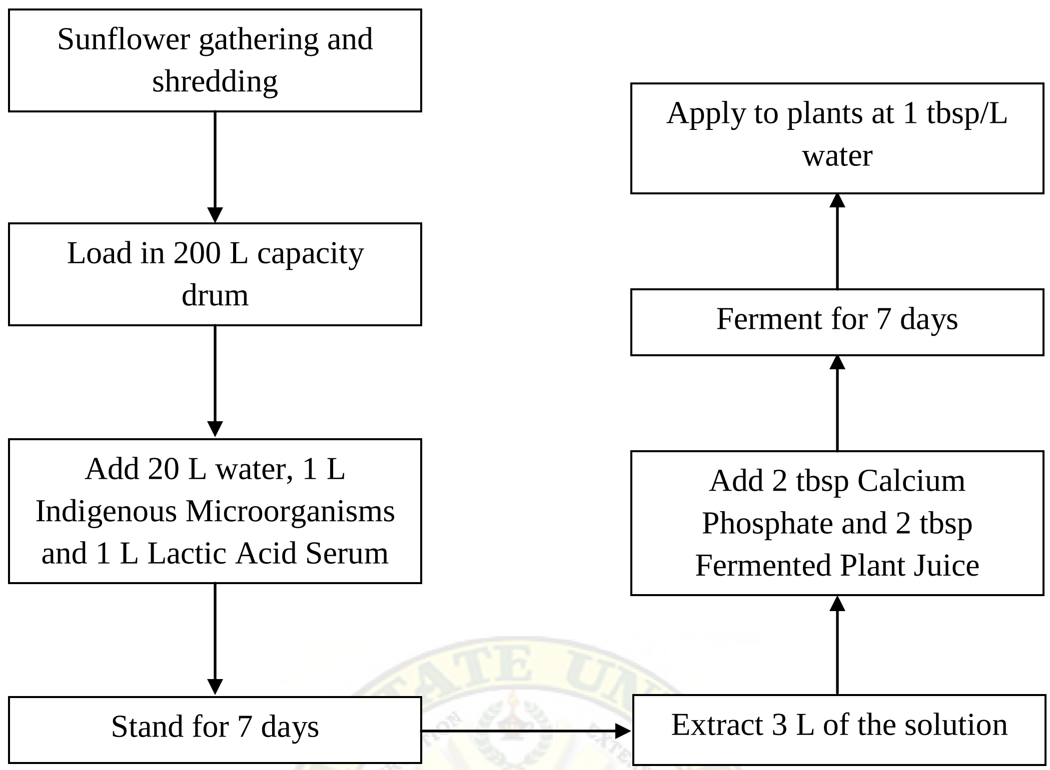

Figure 1. Process of making fermented wild sunflower extract

An area of 168 m^2 was thoroughly prepared and divided into three (3) blocks of equal size. Then each block was further subdivided into 4 main plots for the different rates of vermicompost. Each main plot was subdivided into 4 subplots for the frequency of fermented sunflower extract irrigation. The sub plots measure of 1 X 3m each.

Seeds were directly planted with a distance of 25 cm x 25 cm. Three (3) seeds were dropped per hill and covered with soil.

The computed amount of vermicompost were weighed according to rates (0, 10, 20, and 30 tons/ha) and applied in the plots. Watering was done twice a week. Manual picking of insects and weeding was done to minimize the pests.

The different treatments are as follows:

Main Plot (Rates of Vermicompost)

R_1 – 0

R_2 –10 tons/ha

R_3 –20 tons/ha

R_4 –30 tons/ha

Sub plot (Frequency of Fermented Wild Sunflower Extract Application)

F_1 – control

F_2 – applied every 7 days

F_3 - applied every 10 days

F_4 - applied every 15 days

The different treatments were laid out in a split – plot design and replicated three times.

The data gathered were the following:

A. Soil Analysis

1. Chemical Properties of the Soil.

1.1 Soil pH. The initial and final pH was determined using the 1:2.5 $CaCl_2$ solution by electrometric method.

1.2 Organic matter content of the soil (%). Organic matter content was determined using Walkley-Black method.

1.3. Total Nitrogen content of the soil (%). This was computed by multiplying the %OM content with the factor 0.05.

2. Physical Properties of the Soil

2.1 Bulk density of the soil (g/cm^3). Initial and final bulk density was obtained using the core method. The working formula was:

$$Db = \frac{\text{Oven Dry Weight of the Soil (g)}}{\text{Volume of Soil } (cm^3)}$$

2.2. Water holding capacity of the soil (%). This was determined through saturation method. Water was allowed to saturate the soil in the core sampler with the bottom of the cylinder submerged in water to be saturated through capillarity.

$$\%\ WHC = \frac{\text{Wt. of saturated soil – Wt. of oven dry soil (g)}}{\text{ODW of the soil (g)}} \times 100$$

2.3. Porosity (%). This was computed using the formula:

$$\text{Porosity} = \left[1 - \frac{BD}{PD} \right] \times 100$$

Assume that D_P = 2.65 g/cm

B. Growth and Yield Parameters

1. Marketable pod yield ($g/3m^2$). Yield was taken by weighing uninfested pods harvested per plot. Harvesting was done five times.

2. Non-marketable pod yield ($g/3m^2$). Yield was taken by weighing diseased/ insect infected pods harvested per plot.

3. Average pod length (cm). Ten sample plants from each treatment were obtained. Measuring of pods was done for the first three harvests. The measured value was divided by 10 plants.

4. Average number of nodules per plant. Nodule counting was done during flowering stage through destructive sampling wherein six sample plants (two hills) were

uprooted from each treatment. Nodules from the six sample plants were counted and were divided by six.

C. Pest Infestation and Disease Infection Rating.

This was done through ocular observation of the 10 sample plants in each treatment and was rated as follows:

Scale	Description	Remarks
1	No infection/infestation	Highly resistance
2	1-25 % of the total plant	Mild resistance
3	26-50 % of the total plant	Moderate resistance
4	51-75 % of the total plant	Susceptible
5	75-100 % of the total plant	Very susceptible

D. Statistical Analysis

The data gathered was statistically analyzed using the ANOVA. The significance between treatment means was analyzed using the Duncan's Multiple Range Test (DMRT).

E. Return on Cash Expenses. This was taken by recording all the expenses and computed using the formula:

$$\text{ROCE (\%)} = \frac{\text{Gross Income} - \text{Total Expenses}}{\text{Total Expenses}} \times 100$$

RESULTS AND DISCUSSION

Analysis of Organic Fertilizers Used

The vermicompost used was analyzed by Center for Rural Technology Development (CRTD) and was found to contain 1.66% N, 1.57% P_2O_5 and 0.77% K_2O (Table 1). Analysis done by the Saint Louis University laboratory on the fermented wild sunflower extract was found to contain 12.5 ppm N, 200 ppm P_20_5 and 100 ppm K_2O

Changes in Some Physical Properties of the Soil

Bulk Density

Effects of rates of vermicompost. The initial bulk density of the soil was 1.36 g/cm^3. This value decreased after harvest to a range of 1.17 to 1.21 g/cm^3 with 30 tons/ha having the highest value (Table 2). However, there were no significant differences among the treatments. This showed that the decreased bulk density in the soil was mainly due to the enhanced microbial population and activity that resulted in the formation of aggregates and increased porosity (Manivannan *et al.*, 2007). In addition, Cooke (1982) said that simple supply of organic matter helps keep the soil loose and prevents packing, facilitates digging and cultivating. Also, it agrees with the theory that the greater the organic matter, the lower the bulk density.

Table 1. Analysis of organic fertilizers used

FERTILIZERS	N	P_2O_5	K_2O
Vermicompost	1.66%	1.57%	0.77%
Fermented Wild Sunflower Extract	12.5 ppm	200 ppm	100 ppm

Table 2. Physical properties of the soil as affected by the rates of vermicompost and frequency of fermented wild sunflower extract application

TREATMENT	BULK DENSITY (g/cm^3)	POROSITY (%)	WATER HOLDING CAPACITY (%)
Rates of Vermicompost			
Control	1.17	55.82	60.81
10 tons/ha	1.20	54.91	60.52
20 tons/ha	1.20	54.78	57.94
30 tons/ha	1.21	54.47	64.10
Frequency of Fermented Wild Sunflower Extract Application			
Control	1.18	55.35	57.06 [b]
Every 7 days	1.19	54.97	65.45[a]
Every 10 days	1.19	54.10	61.43 [ab]
Every 14 days	1.202	54.65	59.45 [ab]
Interaction (RxF)	Ns	ns	*
Initial	1.36	48.55	50.21

Means within a column having the same letters are not significantly different at 5% level by DMRT
ns – not significant
* - significant

Effects of frequency of FWSE application. Application of FWSE did not significantly affect the bulk density of the soil. Bulk density values were similar in the treatments having a range of 1.18 to 1.20 g/cm^3.

Interaction effect. There was no significant effect on the interaction of vermicompost and frequency of FWSE on the bulk density of the soil. However, application of 30 tons/ha of vermicompost and FWSE every 14 days affected the bulk density.

Porosity

Effects of rates of vermicompost. Porosity of the soil range from 54.47 to 55.82%. However, no significant differences between treatments were observed. These porosity however improved from the initial of 48.55%. This is in accordance to what Brady and Weil (2002) stated that a well granulated soil has more total pore space and greater overall WHC than the one with poor granulation or one that has been compacted. The greater total pore space indicates a greater overall WHC. Also, an increase in porosity of well structured soil results mainly from greater amounts of large pores in which water is held with little tenacity.

Effects of frequency of FWSE application. Application of FWSE did not significantly affect the porosity of the soil.

Interaction effect. There was no significant effect from the interaction of vermicompost and frequency of FWSE.

Water Holding Capacity (WHC) of the Soil

Effects of rates of vermicompost. Presented in Table 2 is the effect of rates of vermicompost on the WHC of the soil after harvest. The varying rates of vermicompost did not significantly affect the WHC of the soil. However, after harvest the WHC increased from a range of 0.61 to 0.64 ml/g. This could be attributed to the decrease in bulk density and increase in porosity as compared to the initial value. According to Manivannan *et al.* (2007), the increased WHC was due to increased porosity and decreased bulk density of the soil due to vermicompost application and these in turn provide greater aeration and drainage. In addition, PCARRD (1982) as cited by Imong (2003) reported that organic fertilizer supply some nutrient requirements to the crop and promote favourable soil properties such as granulation and good tilth needed for efficient aeration, easy root penetration and improved water holding capacity. Organic matter helps sandy soils by increasing their water and nutrient – holding capacity and improves clay soils by loosening them and improving their tilth. Organic matter acts as a major reservoir of soil nutrients. Both fresh and organic matter and humus absorb water like sponge, holding about six times their own weight in water. This is extremely important in naturally dry and sandy soils. In fact, the water and nutrient – holding capacity of organic matter is its major benefit in sandy soils (Plaster, 1997). In addition, as OM increases, the water-holding capacity increases because of the affinity organic matter has for water. The amount of organic material in a soil also influences the water holding capacity (Ball, 2011).

Effects of frequency of FWSE application. Application of fermented wild sunflower extract significantly affected the water holding capacity of the soil (Table 1). Application of FWSE at a frequency of every 7 days greatly affected the WHC of the soil with a mean of 65.445 % which is significantly different from the control but is not significantly different from those applied every 10 and 14 days. This finding implies that the more frequent application of the FWSE, the WHC decreases. The result could be attributed to the increase in bulk density and decrease in porosity.

Interaction effect. A significant interaction effect between rates of vermicompost and frequency of FWSE on the WHC of the soil was observed. Application of FWSE every 7 days with vermicompost rate of 20 tons/ha effected the best with regards to WHC. Moreover, addition of OM increases the WHC as compared to the control.

Changes in Some Soil Chemical Properties

Soil pH

Effects of rates of vermicompost. Application of vermicompost significantly affected the pH of the soil after harvest (Table 3). Application of 30 tons/ha vermicompost resulted to the highest soil pH of 5.74. The results showed that vermicompost has the ability to increase pH in the soil. Also, Singh (2002) as cited by Panaden (2010) reported that since vermicompost are decomposed by worms, this can contribute in adding calcium carbonate, a compound which helps moderate soil pH. On the other hand, control plants obtained the highest pH of the soil that reasons could have been due the improved Organic Matter content of the soil.

If the pH of the soil solution is increased above 5.5, Nitrogen (in the form of nitrate) is made available to plants. Phosphorus, on the other hand, is available to plants when soil pH is between 6.0 and 7.0 (Soil Science Education, 2010).

Effects of frequency of FWSE application. There is no significant effect from the application of FWSE on soil pH after harvest. Soil pH after harvesting also improved from the initial pH of 5.12 which shows the effect of organic fertilizers such as vermicompost and FWSE. Further, it is also observed that even the soil pH in the control (no vermicompost and FWSE) increased. The increase could have been due to the strong rains in January which could have caused contamination of the control plot with those applied with vermicompost.

Interaction effect. Results show that there is no significant effect on the interaction between the two variables. However, application of 30 tons/ha of vermicompost and FWSE every 7 days having the highest pH.

Organic Matter Content of the Soil

Effects of rates of vermicompost. A highly significant effect was obtained from the application of vermicompost. A trend noted was that as the rate of vermicompost

Table 3. Chemical properties of the soil as affected by the rates of vermicompost and frequency of fermented wild sunflower extract application

TREATMENT	pH	OM (%)	N (%)
Rates of Vermicompost			
Control	5.623 [ab]	3.038 [c]	0.148 [c]
10 tons/ha	5.553 [b]	3.602 [bc]	0.179 [b]
20 tons/ha	5.672 [ab]	4.002 [ab]	0.200 [a]
30 tons/ha	5.742 [a]	4.352 [a]	0.198 [a]
Frequency of Fermented Wild Sunflower Extract Application			
Control	5.626	3.803	0.191
Every 7 days	5.691	3.804	0.181
Every 10 days	5.634	3.722	0.175
Every 14 days	5.640	3.663	0.179
Interaction (RxF)	ns	Ns	ns
Initial	5.12	3.34	0.17

Means within a column having the same letters are not significantly different at 5% level by DMRT

ns – not significant

applied was increased, OM also increased. The application of vermicompost at 30 tons/ha yielded the highest organic matter content of the soil of 4.35% while the control showed the lowest OM content of 3.03, which decreased from the initial of 3.34%. Control treatment was also improved with the presence of microorganisms which they provide the condition which allows the soil to plow itself wherein the OM content of the soil is maintained. Also, being previously applied with chicken dung and planted with broccoli, the succeeding crop benefited from the nutrients in the soil.

Effects of frequency of FWSE application. Application of fermented wild sunflower extract improved the soil organic matter. From the initial soil OM of 3.34%, OM at harvest improved to 3.66 to 3.80%. Among the treatments with FWSE application, (every 7, 10 and 14 days) application of FWSE every 7 days revealed the highest OM content after harvest. Among these FWSE treatments, the trend is the more frequent application (or higher application), the higher the OM content afterwards. The lowest soil OM content was from the infrequent application or every 14 days application. The increase in soil OM in the control could be due to beneficial microorganisms activated during land preparation acting upon the OM previously applied like chicken dung and organic debris from the previous broccoli crop.

Interaction effect. There is no significant effect between the interaction of the two variables. However, organic matter content of the soil was improved with the application of 30 tons/ha of vermicompost and FWSE every 7 days. The range of the OM observed was increasing from 20 tons/ha to 30 tons/ha of vermicompost and decreasing frequency of FWSE application.

Nitrogen

Effects of rates of vermicompost. The effect of different rates of vermicompost on the N content of the soil is significant (Table 3). There was an increase of N content of the soil from the initial content of 0.17. Vermicompost application at a rate of 20 tons/ha showed the highest N content after harvest which was significantly higher than those applied with 10 tons/ha and the control. Lagman (2003) found out that organic matter of vermicompost supplies the nitrogen required for plant growth. In addition, Panaden (2010) stated that worms produced pounds of nitrogen during decomposition process.

Effects of frequency of FWSE application. Application of fermented wild sunflower extract at different frequency did not have a significant effect on N content of the soil. Among the treatments fertigated with FWSE, frequent fertigation (every 7 days) was analyzed to have the highest N content. Similar to the result on the soil OM content, the control showed high N content, higher than the initial.

Interaction effect. No significant effect was obtained on the interaction between the different rates of vermicompost and frequency of fermented wild sunflower extract. However, plants applied with 30 tons/ha of vermicompost and FWSE at every 7 days interval resulted to improved N content of the soil.

Growth and Yield Parameters

The performance of French beans to the different treatments is seen in Figures 2, 3, 4 and 5. Further, from the observation, it was noted that, with varying rates of vermicompost and application of FWSE, the more the plants become robust. Moreover, it was also observed that control plants applied with FWSE produced flowers together with the plants applied with rates of vermicompost.

The following figures show the vegetative stage of plants applied with rates of vermicompost and frequency of FWSE application.

Figure 2. Control plants (no vermicompost) as affected by frequencies of FWSE application

Figure 3. Plants applied with 10 tons/ha vermicompost as affected by frequencies of FWSE application

Figure 4. Plants applied with 20 tons/ha vermicompost as affected by frequencies of FWSE application

Figure 5. Plants applied with 30 tons/ha vermicompost as affected by frequencies of FWSE application

<u>Average Number of Root Nodules at Flowering Stage (49 DAP)</u>

<u>Effect of rates of vermicompost</u>. The average number of root nodules is presented in Table 4. Results showed that generally, the application of vermicompost effected greater number of root nodules than the control. Plants applied with 30 tons/ha gained the highest number of root nodules having a mean of 30.585 followed by those applied with 20 tons/ha and 10 tons/ha.

Effect of frequency of FWSE application. Fertigation using FWSE in French beans significantly produced more root nodules than the control (no fertigation). Results show that more root nodules was obtained from plants fertigated with FWSE every 10 days (F_3) followed by F_2 and F_4. This shows that FWSE enhanced nodule formation.

Analysis of fermented wild sunflower extract had been found to contain 12.5 ppm Nitrate nitrogen, 200 ppm Potassium and 100 ppm Phosphorus. It indicates that the

Table 4. Average number of nodules as affected by the rates of vermicompost and frequency of fermented wild sunflower extract application

TREATMENT	AVERAGE NUMBER OF ROOT NODULES
Rates of Vermicompost	
Control	25.903
10 tons/ha	30.543
20 tons/ha	25.888
30 tons/ha	30.585
Frequency of Fermented Wild Sunflower Extract Application	
Control	22.806 [b]
Every 7 days	29.931 [a]
Every 10 days	30.083 [b]
Every 14 days	27.236 [b]
Interaction (RxF)	ns

Means with the same letters are not significantly different at 5% level by DMRT
ns – not significant

available nutrients were utilized by plants during nodule formation. According to Pereira and Bliss (1989) as cited by Panaden (2010), plants need phosphorus to fix nitrogen.

Also, O'Hara *et al.,* (1988) as cited by Panaden (2010), Phosphorus, together with Sulfur are required for nodule metabolism and tend to be concentrated in the nodules when the plant is deficient in these nutrients. In addition, Durante (1982) stated that green pod yield applied with wild sunflower affected the height of the plants and the number of root nodules of the plants during flowering and harvest.

Interaction effect. Plants treated with 30 tons/ha vermicompost and applied with fermented wild sunflower extract every 10 days produced higher average number of root nodules. The availability of high amounts of organic fertilizer like vermicompost plus the nutrient rich extract enhanced root nodule production.

Average Length of Pods

Effect of rates of vermicompost. Shown in Table 5 is the average length of bean pods. It can be concluded from the result that as the rate of vermicompost applied is increased to 30 tons/ha, pods produced are significantly longer. It can also be noted that application of vermicompost even at the lowest rate tested (10 tons/ha) will result to longer bean pods. The longest pods were harvested from those applied with 30 tons/ha followed by those applied with 20 tons/ha with pod lengths of 13.11 cm. An average pod length of bean is 11cm, but a net decrease occurred with further maturation.

Effect of frequency of FWSE application. Pod length was not significantly affected by the frequency of fermented wild sunflower extract applied (Table 5). This shows that application of wild sunflower will not significantly affect the pod length. Length of pods ranged from 12.6 to 12.7 cm.

Interaction effect. No interaction effect was observed on the length of pods. However, results showed that application of vermicompost at 30 tons/ha and application of FWSE every 14 days produced the longest pods.

Table 5. Average pod length as affected by the rates of vermicompost and frequency of fermented wild sunflower extract application

TREATMENT	AVERAGE POD LENGTH (cm)
Rates of Vermicompost	
Control	11.9 [b]
10 tons/ha	12.6 [ab]
20 tons/ha	12.9 [a]
30 tons/ha	13.11 [a]
Frequency of Fermented Wild Sunflower Extract Application	
Control	12.6
Every 7 days	12.6
Every 10 days	12.6
Every 14 days	12.7
Interaction (RxF)	ns

Means with the same letters are not significantly different at 5% level by DMRT
ns – not significant

Marketable Pod Yield

Effect of rates of vermicompost. A significant effect of the vermicompost on the marketable yield of the plants was revealed. Results showed that an increase in vermicompost rates from 10-30 tons/ha correspondingly increased the pod yield of French beans from 162.633 to 221.417 g/3m^2 were. The control produced the lowest pod yield of 85.9 g/3 m^2 while the highest pod yield was obtained from plants fertilized with

Table 6. Marketable pod yield as affected by the rates of vermicompost and frequency of fermented wild sunflower extract application

TREATMENT	MARKETABLE POD YIELD (g/3m^2)
Rates of Vermicompost	
Control	85.9[b]
10 tons/ha	162.6[bc]
20 tons/ha	175.9[ab]
30 tons/ha	221.4[a]
Frequency of Fermented Wild Sunflower Extract Application	
Control	167.1
Every 7 days	159.7
Every 10 days	152.2
Every 14 days	166.9
Interaction (RxF)	ns

Means with the same letters are not significantly different at 5% level by DMRT
ns – not significant

30 tons ha-1 vermicompost with a mean pod yield of 221.4 g/3m^2 which is almost triple on the yield from the control. The result is attributed to the high nutrient content of vermicompost. Analysis of the vermicompost (by CRTD) used contains 1.66% N, 1.57% P_2O_5, 0.77 % K_2O and beneficial microorganisms. It also attracts deep-burrowing earthworms already present in the soil enhances germination, plant growth, and crop yield (Sustainable Agricultural Technologies, Inc. 2010). Bishop *et al.* (1985) as cited by Panaden (2010) discovered that with the action of rhizobium bacteria living on the roots of leguminous plants, the nitrogen in the air is converted into ammonium ion (NH_4^+) through nitrogen fixation which can be made absorbable to plants. Further, according to Durante (1982), green pod yield applied with wild sunflower affected the height of the plants and the number of root nodules of the plants during flowering and harvest.

Also, Manivannan *et al.*, (2007) reported that vermicompost contains higher amount of humic acid content and biologically active substances such as plant growth regulators. In addition, vermicompost is the by-product (excreta) of earthworm digestion and has been shown to increase plant growth and production, as well as to a variety of arthropod pests (Little, 2008).

Effect of frequency of FWSE application. There is no significant effect obtained from the application of fermented wild sunflower extract on the total pod yield. However, application of FWSE at an interval of every 14 days out yielded the other treatments. The control plants out yielded those plants applied with FWSE which could have been due to the adequate supply of FWSE which made the plants very robust at the expense of pod production. The very robust vegetative growth could have blocked the entry of sunlight to the growing shoots where flowers are produced thus minimizing flower formation and pod formation/production.

Interaction effect. A significant effect was obtained from the interaction of the two variables during the third and fifth harvest. Plants applied with 30 tons/ha of vermicompost with FWSE every 14 days produced the highest pod yield. Moreover, plant nutrients contained by the FWSE could have been just enough for pod production (Table 6). And with the combination of the nutrients contained in the vermicompost, it would have been utilized by plants during their vegetative growth and pod formation.

Non-marketable Pod Yield

Effect of rates of vermicompost. The different rates of vermicompost significantly affected the production of non-marketable pods (Table 7). An increasing weight of non-marketable pods was gathered with increasing vermicompost rate.

Plants applied with vermicompost at 20 to 30 tons ha^{-1} produced high weight of non marketable with means of 17.08 and 25.58 $g/3m^2$ respectively. This could be due to increased occurrence of pest and diseases with the increase in yield. It is shown in Table 6 that the same treatments had the highest yield while the control had the lowest.

Effect of frequency of FWSE application. There was no significant effect obtained from the results. However, application of FWSE at an interval of every 7 days yielded the least non marketable yield while the control produced the highest non-marketable yield. There could be the possibility that the sunflower have an insecticidal effect.

Interaction effect. No significant effect was obtained on the interaction of the two factors. However, application of 30 tons/ha and FWSE at an interval of every 7 days

Table 7. Non-marketable pod yield as affected by the rates of vermicompost and frequency of fermented wild sunflower extract application

TREATMENT	NON-MARKETABLE POD YIELD ($g/3m^2$)
Rates of Vermicompost	
Control	6.3[c]
10 tons/ha	8.2[b]
20 tons/ha	14.5[a]
30 tons/ha	14.6[a]
Frequency of Fermented Wild Sunflower Extract Application	
Control	11.5
Every 7 days	10.6
Every 10 days	10.7
Every 14 days	10.8
Interaction (RxF)	ns

Means with the same letters are not significantly different at 5% level by DMRT.
ns – not significant

revealed the highest non-marketable yield. Results could have been due to the treatments applied that it makes the plants robust that favoured diseases formation and insects' infestation.

Total Pod Yield

Effect of rates of vermicompost. The total pod yield of the plant increases with the increasing rates of vermicompost (Table 8). The highest yield was obtained from plants applied with 30 tons/ha with a mean of 1151.93 $g/3m^2$ followed by 20 tons/ha with a mean of 955.38 $g/3m^2$. This result coincides with the statement of Tomilas (1996) that organic fertilizers can provide the macro elements and microelements which plants need for growth. The microelements are released gradually upon decomposition of the organic matter.

Effect of frequency of FWSE application. Plants applied with FWSE at an interval of every 14 days have highest yield with a mean of 892.375 g than those frequently applied. Reasons for low yield could be due to the frequent application of

Table 8. Total pod yield as affected by the rates of vermicompost and frequency of fermented wild sunflower extract application

TREATMENT	TOTAL POD YIELD ($g/3m^2$)
Rates of Vermicompost	
Control	455.33^{c}
10 tons/ha	810.88^{bc}
20 tons/ha	955.38^{ab}
30 tons/ha	1151.93^{a}
Frequency of Fermented Wild Sunflower Extract Application	
Control	889.83
Every 7 days	813.54
Every 10 days	777.75
Every 14 days	892.38
Interaction (RxF)	ns

Means with the same letters are not significantly different at 5% level by DMRT
ns – not significant

FWSE that Nitrogen might have been applied in a large amount causing a robust plant in the expense of yield.

Interaction effect. Application of 30 tons/ha of vermicompost and an interval of every 14 days of FWSE produced the highest total pod yield of the plant.

Other Observations

Semi-Loopers Infestation

Effect of rates of vermicompost. Table 9 shows the insect infestation rating as influenced by the different rates of vermicompost. Pest infestation is just slight at 45 DAP with ratings of 1.18 to 1.40 then it was lessened at 52 DAP.

Effect of frequency of FWSE application. A highly significant effect was obtained from plants applied with fermented wild sunflower extract at different frequencies. From the results, insect infestation decreased from 45 DAP to 52 DAP. It can be observed that frequent FWSE application (7 days interval) had the highest pest infestation. It was noted that FWSE application at 7 and 10 days interval produced more vigorous plants and vigorous plants most of the time are succulent which could have been the reason pest favoured these plants.

Interaction effect. It was found that the results were highly significant. Results showed that application of 30 tons/ha of vermicompost and FWSE at an interval of every 10 days greatly affects the pest infestation of the plants. Further, control plants have less insect infection than the other treatments. This result could be due to the robust plants which insects favoured.

Bean Rust Infection

Effect of rates of vermicompost. Plants applied with 20 to 30 tons/ha of vermicompost have slightly higher bean rust infection than those of the control (Table 10). Results could be due to the robust growth of plants where diseases are favoured.

Table 9. Semi-loopers infestation rating 45 and 52 days after planting

TREATMENT	PEST RATING 45 DAP	52 DAP	AVERAGE
Rates of Vermicompost			
Control	1.18	1.03 [c]	1.11
10 tons/ha	1.48	1.38 [a]	1.43
20 tons/ha	1.41	1.16 [b]	1.28
30 tons/ha	1.35	1.13 [b]	1.24
Frequency of Fermented Wild Sunflower Extract Application			
Control	1.33	1.11 [b]	1.22
Every 7 days	1.48	1.38 [a]	1.43
Every 10 days	1.28	1.09 [b]	1.19
Every 14 days	1.33	1.13 [b]	1.23
Interaction (RxF)	*	**	

Means within a column having the same letters are not significantly different at 5% level by DMRT.
* - significant
** - highly significant
1- No infection 2 – 1-25% of the plant 3 – 26-50% 4 – 51-75% 5 – 76-100%

Effect of frequency of FWSE application. Plants applied with FWSE at an interval of every 14 days were observed to have less disease infestation. Frequent application of nutrient rich FWSE which produced robust plants exhibited higher bean rust infected plants.

Interaction effect. No significant effect was obtained from the interaction between rates of vermicompost and frequency of fermented wild sunflower application.

Table 10. Bean Rust infection as affected by the rates of vermicompost and frequency of fermented wild sunflower extract application

TREATMENT	BEAN RUST INFECTION RATING		
	23 DAP	38 DAP	AVERAGE
Rates of Vermicompost			
Control	1.95	1.97	1.96
10 tons/ha	1.93	1.99	1.96
20 tons/ha	2.01	1.98	1.99
30 tons/ha	1.98	1.99	1.99
Frequency of Fermented Wild Sunflower Extract Application			
Control	1.96	1.99	1.98
Every 7 days	2.02	2.00	2.01
Every 10 days	1.98	1.97	1.97
Every 14 days	1.91	1.97	1.94
Interaction (RxF)	Ns	ns	

Means within a column having the same letters are not significantly different at 5% level by DMRT.

ns – Not significant

1 - No infection 2 – 1-25% of the plant 3 – 26-50% 4 – 51-75% 5 – 76-100%

Return on Cash Expenses

Table 11 shows the return on cash expenses (ROCE) of French beans as affected by different treatments. The result shows that all control treatments obtained the highest ROCE. The low ROCE obtained from the different treatments was due to greater production expenses over the total sales of the product coupled with the early maturity and termination of the study due to bad weather and diseases.

There were only five harvests whereas under controlled environment (greenhouse), organic practitioners report 7-13 harvest.

Table 11. Return on cash expenses

TREATMENT	YIELD (kg/m^2)	GROSS INCOME (Php)	VARIABLE COST (Php)	NET INCOME (Php)	ROCE (%)
R1F1	0.476	47.6	43.05	4.55	10.57
R1F2	0.361	36.1	119.85	- 83.75	-69.88
R1F3	0.440	44	100.65	-56.85	-56.28
R1F4	0.544	55.4	81.45	-26.05	-31.98
R2F1	0.754	75.4	67.05	8.35	12.45
R2F2	0.844	84.4	194.88	-110.48	-56.69
R2F3	0.761	76.1	175.68	-99.58	-56.68
R2F4	0.884	88.4	156.48	-68.08	-43.51
R3F1	1.064	106.4	91.05	15.35	16.86
R3F2	1.031	103.1	218.88	-115.78	-52.90
R3F3	0.757	75.7	199.68	-123.98	-62.09
R3F4	0.970	97	180.48	-83.48	-46.25
R4F1	1.256	126.5	115.05	11.45	9.95
R4F2	1.018	101.8	242.88	-141.08	-58.09
R4F3	1.153	115.3	223.68	-108.38	-48.45
R4F4	1.171	117.1	204.48	-87.38	-42.73

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The experiment was conducted to determine the effect of rates of vermicompost and frequency of fermented wild sunflower extract application on some soil properties and performance of French beans at the Organic Demo Farm of Cordillera Organic Agriculture Development Center, Benguet State University, La Trinidad, Benguet from December 2010 to March 2011. Specifically, the study was conducted to determine the effect of rates of vermicompost on some soil properties and performance of French beans; to determine the effect of frequency of fermented wild sunflower extract on some soil properties and performance of French beans; and to determine the best combined effect of rates of vermicompost and frequency of fermented sunflower extract application on some soil properties and performance of French beans.

Application of vermicompost and FWSE improves the soil properties of the soil at the end of the experiment. Bulk density decreases while porosity and water holding capacity increase. On the other hand, chemical properties were also improved; pH, Organic Matter and Nitrogen content of the soil increase from initial analysis. Further, FWSE contributed to the increase of water holding capacity of the soil.

Agronomic parameters were also increased with the application of the treatments. Nodule production was increased with the application of 10 to 30 tons/ha of vermicompost and FWSE at every 7, 10 and 14 days. Furthermore, longer pods were also obtained from treatment applied with different rates of vermicompost and frequencies of FWSE thereby increasing the marketable yields of all the treatments. In addition, the degree of Bean Rust and Semi-loopers' infection decreases with the

application of FWSE. Application of 30 tons/ha of vermicompost and FWSE every 14 days is the best combination among the treatments.

Conclusions

Based on the results and findings, application of 30 tons/ha of vermicompost and FWSE every 7 days effected the highest for agronomic parameters like nodule production which indicates that nitrogen was needed by plants in nodule production. Further, application of 30 tons/ha and FWSE at 14 days interval affected the pod length and marketable yield. Also, in terms of disease and insect infestation, plants applied with an interval of 10 to 14 days are very effective.

Recommendations

It is recommended that a follow-up study using the FWSE as main source of fertilizer to leafy vegetables to verify and determine its effects on the growth and yield must be conducted since the marketable pod yield was highest at more frequent application of FWSE. Pot experiments on the treatments are also recommended to easily observe its effects on the plants.

To keep the production expenses, the use of cheaper and low input, fresh sunflower could be explored.

LITERATURE CITED

ADDISON K. and M. HIRAGA. 2010. Compost and Organics. Retrieved from: http:// journeytoforever.org/compost_worm.html

ANGNEN, P.C. 1983. Effect of different kinds and rates of organic fertilizer on the growth and yield of celery. BS Thesis. Benguet State University, La Trinidad, Benguet. P.2.

AZARMI, R. 2008. Influence of vermicompost on soil chemical and physical properties in tomato (*Lycopersicum esculentum*) field. African Journal of Biotechnology. Vol. 7 Pp. 2397 – 2401. Retrieved 18, August 2008 from: http:// www.academic journals.org/ ajb/PDF/pdf2008/18 July/ Azarmi %20 et %20 al. pdf.

BALDO, M. S.1989. Comparative study of azolla and sunflower composts combined inorganic fertilizer on the growth and yield of white potato using stem cuttings. BS Thesis. Benguet State University, La Trinidad, Benguet. P. 5.

BALL, J.2011. Soil and Water Relationships. Retrieved 2011 from:http:/www.agviselabs.com/tech_art/whc.php.

BRADY, N.C and R.R. WEIL. 2002. The Nature and Properties of Soils. Thirteenth Edition. McMillan Publishing Company. USA. Pp. 24, 188.

CACCAM, C.A. 1984. Comparative effect of some selected organic fertilizers on the growth and yield of garden pea. BS Thesis. Mountain State Agricultural College, La Trinidad, Benguet. P 18.

CHO, H.K. 2009. Korean Natural Farming Handbook – Fermented Plant Juice. P. 106-121. Retrieved from: http://rooftopecology.wordpress.com/2009/10/25/korean-natural-farming-fermented-plant-juice/

COOKE, G.K. 1982. Fertilizer and Soil Amendments. USA. Mc Graw Hill Publishing Inc. P. 61.

DAOINES, E.S. 1994. Effect of organic fertilizer on the growth and yield of potato. BS Thesis. Benguet State University, La Trinidad, Benguet. Pp. 32-33.

DURANTE, B.C. 1982. Effects of different rates of wild sunflower on the growth and yield of inoculated garden pea. BS Thesis. Mountain State Agricultural College, La Trinidad, Benguet. Pp 1, 2, 64.

FATEG, G.P. 2003. Effect of formulated liquid fertilizers on the growth and yield of Chinese Cabbage (*Brassica chinensis*). BS Thesis. Benguet State University, La Trinidad, Benguet. Pp. 4,5

HYNES, E. 2009. Microsoft Encarta. 1993-2008 Microsoft Corporation.

IMONG, H.M. 2003. Integrated nutrient management using vermicompost and chicken dung for zucchini production. BS Thesis. Benguet State University, La Trinidad, Benguet. P.5.

LAGMAN, C.A. JR. 2003. Performance of horticultural crops using formulated compost as growing medium. BS Thesis. Benguet State University, La Trinidad, Benguet. Pp.1, 8, 56-57.

LITTLE, A. G. 2008. Vermicompost - mediated host plant effects on generalist and specialist lepidopterous pest species. Retrieved 2008 from: http://esa.confex.com/esa/2008/ techprogram/paper 38743.htm

MABAZZA, F.B. JR. 1997. Production of six promising garden pea line as affected by organic fertilizer. BS Thesis. Benguet State University, La Trinidad, Benguet. P. 16.

MALUCAY, E.T. 2008. Utilization of formulated wild sunflower extract as organic fertilizer for cabbage. BS Thesis. Benguet State University, La Trinidad, Benguet. Pp. 4, 8,9,10,11.

MANIVANNAN, S, M. BALAMURUGAN, K. PARTHASARATHI, G. GUNASEKARAN AND L.S. RANGANATHAN. 2007. Journal of Environmental Biology. Effect of vermicompost and crop productivity – beans. Retrieved March, 2009 from: http://www.jeb.co.in/journal_issues/200903_paper_20.pdf

PANADEN, E. D. 2010. Nodulation of French beans (*Phaseolus vulgaris L.*) as influenced by vermicompost. BS Thesis. Benguet State University, La Trinidad, Benguet. Pp.13, 16, 23.

PLASTER, E. J. 1997. Soil Science and Management. Third edition. Delmar Publishers. International Thompson Publishing Inc. Pp. 133, 235, 242.

RODRIGUEZ, S.B. 1981. Effects of different kinds and rates of organic fertilizer on the growth and yield of sugar beet. BS Thesis. Benguet State University, La Trinidad, Benguet. Pp. 1, 4-5.

SINGER, M.J and D.N. MUNNS. 2002. Soils, an Introduction. Fifth Edition. Pp 191-192.

SOFFE, R.J. 2003. The Agricultural Notebook by Blackwell Science Ltd. A Blackwell Publishing Company. 20th Edition. Pp. 38, 46-47.

SOIL SCIENCE EDUCATION. 2010. The Importance of Soil pH. Retrieved 2010 from: http://soil.gsfc.nasa.gov/soil_pH/plant_pH.htm

SUSTAINABLE AGRICULTURAL TECHNOLOGIES, INC. 2010. Vermicompost and Flow Through Vermicompost Bins. Retrieved from: http://www.composttea.com/vermicompost.htm

SUSTAINABLE AGRICULTURAL TECHNOLOGIES, INC. 2010. Vermicompost and Flow Through Vermicompost Bins. Retrieved from: www.wormwigwam.com).

TOMAS, H. B. 2008. Organic fertilizer mixtures as potting media for bush bean (*Phaseolus vulgaris*) production. BS Thesis. Benguet State University, La Trinidad, Benguet. P. 5.

SOIL SCIENCE EDUCATION. 2010. The Importance of Soil pH. Retrieved from: http://soil.gsfc.nasa.gov/soil_pH/plant_pH.htm

TOMILAS, M.D. 1996. Response of sweet pea to residual fertility from organic fertilizer application in clay loam soil. BS Thesis. Benguet State University, La Trinidad, Benguet. P. 1.

THOMPSON, L.M. and F.R. TROEH. 1973. Soils and Soil Fertility. Third Edition. TATA McGraw – Hill Publishing Company Ltd. New Delhi. P. 215.

TINOYAN, E. 2010. Practical Guide on Natural Farming System: Crop Production (Personal Interview).

WIKIPEDIA. 2008. Fertigation. Retrieved 13 August 2010 from http://en.wikipedia. org/wiki/Fertigation.

ZULUETA, G.T. 1982. Response of celery to different kinds and concentrations of liquid fertilizers. BS Thesis. Mountain State Agricultural College, La Trinidad, Benguet. P 2.

APPENDICES

Appendix Table 1. Bulk density of the soil (g/cm^3)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	1.08	1.19	1.11	3.38	1.13
	F_2	1.05	1.14	1.32	3.51	1.17
	F_3	1.07	1.26	1.3	3.63	1.21
	F_4	1.06	1.21	1.26	3.53	1.18
SUB TOTAL		4.26	4.80	4.99	14.05	1.17
R_2	F_1	1.08	1.17	1.18	3.43	1.14
	F_2	1.19	1.21	1.21	3.61	1.20
	F_3	1.19	1.27	1.1	3.56	1.19
	F_4	1.27	1.24	1.23	3.74	1.25
SUB TOTAL		4.73	4.89	4.72	14.34	1.20
R_3	F_1	1.19	1.23	1.23	3.65	1.22
	F_2	1.21	1.23	1.13	3.57	1.19
	F_3	1.15	1.18	1.27	3.60	1.20
	F_4	1.13	1.25	1.1	3.48	1.16
SUB TOTAL		4.68	4.89	4.73	14.30	1.19
R_4	F_1	1.24	1.2	1.22	3.66	1.22
	F_2	1.18	1.3	1.15	3.63	1.21
	F_3	1.22	1.12	1.18	3.52	1.17
	F_4	1.27	1.26	1.14	3.67	1.22
SUB TOTAL		4.91	4.88	4.69	14.48	1.21
GRAND TOTAL					57.17	
MEAN						1.19

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	4.26	4.80	4.99	14.05	1.17
R_2	4.73	4.89	4.72	14.34	1.20
R_3	4.68	4.89	4.73	14.30	1.19
R_4	4.91	4.88	4.69	14.48	1.21
BLOCK TOTAL	18.58	19.46	19.13		1.19
GRAND TOTAL				57.17	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	3.38	3.51	3.63	3.53	14.05	3.51
R_2	3.43	3.61	3.56	3.74	14.34	3.59
R_3	3.65	3.57	3.60	3.48	14.30	3.58
R_4	3.66	3.63	3.52	3.67	14.48	3.62
FERT. TOTAL	14.12	14.32	14.31	14.42		3.57
GRAND TOTAL					57.17	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.025	0.012			
Factor A	3	0.008	0.003	0.25^{ns}	4.76	9.79
Error (A)	6	0.065	0.011			
Factor B	3	0.004	0.001	0.37^{ns}	3.01	4.72
AxB	9	0.033	0.004	1.04^{ns}	2.32	3.30
Error (B)	24	0.084	0.004			
Total	47	0.219				

^{ns} = Not significant

C.V. = 8.81%
C.V. = 4.98%

Appendix Table 2. Total porosity of the soil (%)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	59.25	55.09	58.11	172.45	57.48
	F_2	60.38	56.98	50.19	167.55	55.85
	F_3	59.62	52.45	50.94	163.01	54.34
	F_4	60	54.34	52.45	166.79	55.60
SUB TOTAL		239.25	218.86	211.69	669.80	55.82
R_2	F_1	59.25	55.85	55.47	170.57	56.86
	F_2	55.09	54.34	54.34	163.77	54.59
	F_3	55.09	52.08	58.49	165.66	55.22
	F_4	52.08	53.21	53.58	158.87	52.96
SUB TOTAL		221.51	215.48	221.88	658.87	54.91
R_3	F_1	55.09	53.58	53.58	162.25	54.08
	F_2	54.34	53.58	57.36	165.28	55.09
	F_3	56.6	55.47	52.08	164.15	54.72
	F_4	57.36	52.83	58.49	168.68	56.23
SUB TOTAL		223.39	215.46	221.51	660.36	55.03
R_4	F_1	53.21	54.72	53.96	161.89	53.96
	F_2	55.47	50.94	56.6	163.01	54.34
	F_3	53.96	57.74	55.47	167.17	55.72
	F_4	52.08	52.45	56.98	161.51	53.84
SUB TOTAL		214.72	215.85	223.01	653.58	54.47
GRAND TOTAL					2642.61	
MEAN						55.05

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	239.25	218.86	211.69	669.80	55.82
R_2	221.51	215.48	221.88	658.87	54.91
R_3	223.39	215.46	221.51	660.36	55.03
R_4	214.72	215.85	223.01	653.58	54.47
BLOCK TOTAL	898.87	865.65	878.09		55.05
GRAND TOTAL				2642.61	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	172.45	167.55	163.01	166.79	669.80	167.45
R_2	170.57	163.77	165.66	158.87	658.87	164.72
R_3	162.25	165.28	164.15	168.68	660.36	165.09
R_4	161.89	163.01	167.17	161.51	653.58	163.40
FERT. TOTAL	667.16	659.61	659.99	655.85		165.16
GRAND TOTAL					2642.61	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	28.836	14.418			
Factor A	3	12.122	4.041	0.25^{ns}	4.76	9.79
Error (A)	6	95.131	15.855			
Factor B	3	2.887	0.962	0.18^{ns}	3.01	4.72
AxB	9	57.537	6.393	1.24^{ns}	2.32	3.30
Error (B)	24	123.520	5.147			
Total	47	320.032				

^{ns} = Not significant

C.V. = 7.24%
C.V. = 4.13%

Appendix Table 3. Water holding capacity of the soil (%)

WHOLE PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	43.42	55.31	65.01	163.74	54.58
	F_2	60.57	68	67.33	195.90	65.30
	F_3	45.64	62.34	69.4	177.38	59.13
	F_4	60.48	63.71	68.48	192.67	64.22
SUB TOTAL		210.11	249.36	270.22	729.69	60.81
R_2	F_1	49.45	58.68	57.81	165.94	55.31
	F_2	65.36	69.15	66.94	201.45	67.15
	F_3	63.9	65.22	63.67	192.79	64.26
	F_4	55.93	54.4	55.75	166.08	55.36
SUB TOTAL		234.64	247.45	244.17	726.26	60.52
R_3	F_1	50.42	54.26	55.49	160.17	53.39
	F_2	63.15	66.39	69.65	199.19	66.40
	F_3	50.01	58.63	52.34	160.98	53.66
	F_4	65	55.65	54.24	174.89	58.30
SUB TOTAL		228.58	234.93	231.72	695.23	57.94
R_4	F_1	64.66	66.12	63.91	194.69	64.90
	F_2	61.96	57.77	69.07	188.80	62.93
	F_3	76.48	66.81	62.66	205.95	68.65
	F_4	61.56	54.41	63.78	179.75	59.92
SUB TOTAL		264.66	245.11	259.42	769.19	64.10
GRAND TOTAL					2920.37	
MEAN						60.84

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	210.11	249.36	270.22	729.69	60.81
R_2	234.64	247.45	244.17	726.26	60.52
R_3	228.58	234.93	231.72	695.23	57.94
R_4	264.66	245.11	259.42	769.19	64.10
BLOCK TOTAL	926.89	775.75	1025.53		60.84
GRAND TOTAL				2920.37	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	163.74	195.90	177.38	192.67	729.69	60.81
R_2	165.94	201.45	192.79	166.08	726.26	60.52
R_3	160.17	199.19	160.98	174.89	695.23	57.94
R_4	194.69	188.80	205.95	179.75	769.19	64.10
FERT. TOTAL						60.84
GRAND TOTAL					2920.37	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	143.631	71.816			
Factor A	3	229.905	76.635	1.14^{ns}	4.76	9.79
Error (A)	6	400.495	66.749			
Factor B	3	454.616	151.539	7.65**	3.01	4.72
AxB	9	553.455	61.495	3.10*	2.32	3.30
Error (B)	24	475.257	19.802			
Total	47	2257.359				

** = Highly significant
* = Significant
^{ns} = Not significant

C.V. = 8.81%
C.V. = 4.98%

Appendix Table 4. Soil pH

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	5.56	5.66	5.46	16.68	5.56
	F_2	5.73	5.78	5.54	17.05	5.68
	F_3	5.67	5.71	5.57	16.95	5.65
	F_4	5.71	5.5	5.59	16.80	5.60
SUB TOTAL		22.67	22.65	22.16	67.48	5.62
R_2	F_1	5.61	5.54	5.51	16.66	5.55
	F_2	5.61	5.53	5.64	16.78	5.59
	F_3	5.55	5.52	5.41	16.48	5.49
	F_4	5.64	5.59	5.49	16.72	5.57
SUB TOTAL		22.41	22.18	22.05	66.64	5.55
R_3	F_1	5.61	5.62	5.78	17.01	5.67
	F_2	5.81	5.8	5.58	17.19	5.73
	F_3	5.56	5.69	5.85	17.10	5.70
	F_4	5.56	5.56	5.64	16.76	5.59
SUB TOTAL		22.54	22.67	22.85	68.06	5.67
R_4	F_1	5.85	5.72	5.59	17.16	5.72
	F_2	5.75	5.82	5.7	17.27	5.76
	F_3	5.7	5.72	5.66	17.08	5.69
	F_4	5.94	5.69	5.77	17.40	5.80
SUB TOTAL		23.24	22.95	22.72	68.91	5.74
GRAND TOTAL					271.09	
MEAN						5.65

TWO-WAY TABLE
REPLICATION x MAIN PLOT

MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	22.67	22.65	22.16	67.48	22.49
R_2	22.41	22.18	22.05	66.64	22.21
R_3	22.54	22.67	22.85	68.06	22.69
R_4	23.24	22.95	22.72	68.91	22.97
BLOCK TOTAL	90.86	90.45	89.78		22.59
GRAND TOTAL				271.09	

TWO-WAY TABLE
MAIN PLOT x SUB PLOT

MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	16.68	17.05	16.95	16.80	67.48	16.87
R_2	16.66	16.78	16.48	16.72	66.64	16.66
R_3	17.01	17.19	17.10	16.76	68.06	17.02
R_4	17.16	17.27	17.08	17.40	68.91	17.23
FERT. TOTAL	67.51	68.29	67.61	67.68		16.94
GRAND TOTAL					271.09	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.037	0.019			
Factor A	3	0.229	0.076	6.80*	4.76	9.78
Error (A)	6	0.067	0.011			
Factor B	3	0.031	0.010	1.31^{ns}	3.01	4.72
AxB	9	0.066	0.007	0.94^{ns}	2.32	3.30
Error (B)	24	0.189	0.008			
Total	47	0.619				

* = Significant C.V. = 1.86%
^{ns} = Not significant C.V. = 1.57%

Appendix Table 5. Organic Matter content of the soil (%)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	3.18	2.83	3.12	9.13	3.04
	F_2	3.24	4.07	3.15	10.46	3.49
	F_3	2.26	2.86	3.49	8.61	2.87
	F_4	2.18	2.72	3.35	8.25	2.75
SUB TOTAL		10.86	12.48	13.11	36.45	3.04
R_2	F_1	3.24	3.49	3.84	10.57	3.52
	F_2	3.55	3.35	3.64	10.54	3.51
	F_3	3.44	4.07	3.69	11.20	3.73
	F_4	3.38	4.12	3.41	10.91	3.64
SUB TOTAL		13.61	15.03	14.58	43.22	3.60
R_3	F_1	3.46	4.55	3.95	11.96	3.99
	F_2	4.09	3.89	3.98	11.96	3.99
	F_3	3.92	3.66	4.04	11.62	3.87
	F_4	4.15	4.35	3.98	12.48	4.16
SUB TOTAL		15.62	16.45	15.95	48.02	4.00
R_4	F_1	4.7	4.58	4.7	13.98	4.66
	F_2	3.38	4.64	4.67	12.69	4.23
	F_3	4.35	4.61	4.27	13.23	4.41
	F_4	3.38	4.7	4.24	12.32	4.11
SUBTOTAL		15.81	18.53	17.88	52.22	4.35
GRAND TOTAL					179.91	
MEAN						3.75

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	10.86	12.48	13.11	36.45	3.04
R_2	13.61	15.03	14.58	43.22	3.60
R_3	15.62	16.45	15.95	48.02	4.00
R_4	15.81	18.53	17.88	52.22	4.35
BLOCK TOTAL	55.90	62.49	61.52		3.75
GRAND TOTAL				179.91	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	9.13	10.46	8.61	8.25	36.45	9.11
R_2	10.57	10.54	11.20	10.91	43.22	10.81
R_3	11.96	11.96	11.62	12.48	48.02	12.01
R_4	13.98	12.69	13.23	12.32	52.22	13.06
FERT. TOTAL	45.64	45.65	44.66	43.96		11.24
GRAND TOTAL					179.91	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	1.582	0.791			
Factor A	3	11.460	3.820	50.85**	4.76	9.79
Error (A)	6	0.451	0.075			
Factor B	3	0.169	0.056	0.38ns	3.01	4.72
AxB	9	1.512	0.168	1.12ns	2.32	3.30
Error (B)	24	3.587	0.149			
Total	47	18.761				

** = Highly significant
ns = Not significant

C.V. = 7.32%
C.V. = 10.31%

Appendix Table 6. Total Nitrogen content of the soil (%)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	0.16	0.14	0.16	0.46	0.15
	F_2	0.16	0.16	0.16	0.48	0.16
	F_3	0.11	0.14	0.17	0.42	0.14
	F_4	0.11	0.14	0.17	0.42	0.14
SUB TOTAL		0.54	0.58	0.66	1.78	0.15
R_2	F_1	0.16	0.17	0.19	0.52	0.17
	F_2	0.18	0.17	0.18	0.53	0.18
	F_3	0.17	0.2	0.18	0.55	0.18
	F_4	0.17	0.21	0.17	0.55	0.18
SUB TOTAL		0.68	0.75	0.72	2.15	0.18
R_3	F_1	0.17	0.23	0.2	0.60	0.20
	F_2	0.2	0.19	0.2	0.59	0.20
	F_3	0.2	0.18	0.2	0.58	0.19
	F_4	0.21	0.22	0.2	0.63	0.21
SUB TOTAL		0.78	0.82	0.80	2.40	0.20
R_4	F_1	0.24	0.23	0.24	0.71	0.24
	F_2	0.17	0.23	0.23	0.63	0.21
	F_3	0.22	0.23	0.21	0.66	0.22
	F_4	0.17	0.24	0.21	0.62	0.21
SUB TOTAL		0.80	0.93	0.89	2.62	0.22
GRAND TOTAL					8.95	
MEAN						0.19

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R1	0.54	0.58	0.66	1.78	0.15
R2	0.68	0.75	0.72	2.15	0.18
R3	0.78	0.82	0.80	2.40	0.20
R4	0.80	0.93	0.89	2.62	0.22
BLOCK TOTAL	2.80	3.08	3.07		0.19
GRAND TOTAL				8.95	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R1	0.46	0.48	0.42	0.42	1.78	0.45
R2	0.52	0.53	0.55	0.55	2.15	0.54
R3	0.60	0.59	0.58	0.63	2.40	0.60
R4	0.71	0.63	0.66	0.62	2.62	0.66
FERT. TOTAL	2.29	2.23	2.21	2.22		0.56
GRAND TOTAL					8.95	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.003	0.001			
Factor A	3	0.021	0.007	8.41*	4.76	9.79
Error (A)	6	0.005	0.001			
Factor B	3	0.002	0.001	1.28^{ns}	3.01	4.72
AxB	9	0.006	0.001	1.57^{ns}	2.32	3.30
Error (B)	24	0.010	0.000			
Total	47	0.046				

* = Significant C.V. =17.38%

^{ns} = Not significant C.V. = 11.26%

Appendix Table 7. Average number of nodules at flowering stage

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	11.50	19.17	19.67	50.33	16.78
	F_2	24.17	33.50	25.00	82.67	27.56
	F_3	26.17	27.17	21.50	74.83	24.94
	F_4	19.83	27.50	21.33	68.67	34.33
SUB TOTAL		81.67	107.33	87.50	276.50	25.903
R_2	F_1	30.83	22.50	24.33	77.67	25.89
	F_2	33.83	27.83	34.17	95.83	31.94
	F_3	33.67	34.00	37.50	105.17	35.06
	F_4	31.83	24.17	31.83	87.83	29.28
SUB TOTAL		130.17	108.50	127.83	366.50	30.543
R_3	F_1	17.83	19.50	25.00	62.33	20.78
	F_2	36.33	23.00	30.50	89.83	29.94
	F_3	30.50	18.00	26.33	74.83	24.94
	F_4	28.50	25.67	29.50	83.67	27.89
SUB TOTAL		113.17	86.17	111.33	310.67	25.888
R_4	F_1	21.83	26.83	34.67	83.33	27.78
	F_2	28.50	29.33	33.00	90.83	30.28
	F_3	31.17	29.00	46.00	106.17	35.39
	F_4	23.17	33.33	30.17	86.67	28.89
SUB TOTAL		104.67	118.5	143.83	367.00	30.585
GRAND TOTAL					1320.67	
MEAN						28.230

TWO-WAY TABLE
REPLICATION x MAIN PLOT

MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	81.67	107.33	87.50	276.50	92.17
R_2	130.17	108.50	127.83	366.50	122.17
R_3	113.17	86.17	111.33	310.67	103.56
R_4	104.67	118.50	143.83	367.00	122.33
BLOCK TOTAL	429.67	420.50	470.50		110.06
GRAND TOTAL				1320.67	

TWO-WAY TABLE
MAIN PLOT x SUB PLOT

MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	50.33	82.67	74.83	68.67	276.50	69.13
R_2	77.67	95.83	105.17	87.83	366.50	91.63
R_3	62.33	89.83	74.83	83.67	310.67	77.67
R_4	83.33	90.83	106.17	86.67	367.00	91.75
FERT. TOTAL	273.67	359.17	361.00	326.83		82.54
GRAND TOTAL					1320.67	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	88.567				
Factor A	3	494.753	164.918	2.579^{ns}	4.76	9.79
Error (A)	6	383.614	63.957			
Factor B	3	416.242	138.747	10.635**	3.01	4.72
AxB	9	154.074	17.119	1.312^{ns}	2.32	3.30
Error (B)	24	313.101	13.046			
Total	47	1850.350				

** = Highly significant
^{ns} = Not significant

C.V. =28.32%
C.V. = 12.79%

Appendix Table 8. Pod length 61 days after planting (cm)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	12.26	11.41	12.74	36.41	12.14
	F_2	11.35	12.12	12.30	35.77	11.92
	F_3	11.93	12.16	12.43	36.52	12.17
	F_4	12.87	12.54	13.34	38.75	12.92
SUB TOTAL		48.41	48.23	50.81	147.45	12.288
R_2	F_1	12.46	13.43	13.23	39.12	13.04
	F_2	12.99	13.33	12.23	38.55	12.85
	F_3	13.01	12.64	13.86	39.51	13.17
	F_4	12.59	12.93	13.07	38.59	12.86
SUB TOTAL		51.05	52.33	52.39	155.77	12.98
R_3	F_1	13.27	13.77	13.55	40.59	13.53
	F_2	13.96	13.86	12.50	40.32	13.44
	F_3	13.57	13.02	13.08	39.67	13.22
	F_4	13.05	13.41	13.47	39.93	13.31
SUB TOTAL		53.85	54.06	52.60	160.51	13.375
R_4	F_1	14.15	13.61	12.78	40.54	13.51
	F_2	14.43	12.92	13.63	40.98	13.66
	F_3	13.53	13.43	13.72	40.68	13.56
	F_4	14.19	13.24	13.73	41.16	13.72
SUB TOTAL		56.30	53.20	53.86	163.36	13.613
GRAND TOTAL					627.09	
MEAN						13.064

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	48.41	48.23	50.81	147.45	49.15
R_2	51.05	52.33	52.39	155.77	51.92
R_3	53.85	54.06	52.60	160.51	53.50
R_4	56.30	53.20	53.86	163.36	54.45
BLOCK TOTAL	209.61	207.82	209.66		52.26
GRAND TOTAL				627.09	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	36.41	35.77	36.52	38.75	147.45	36.86
R_2	39.12	38.55	39.51	38.59	155.77	38.94
R_3	40.59	40.32	39.67	39.93	160.51	40.13
R_4	40.54	40.98	40.68	41.16	163.36	40.84
FERT. TOTAL	156.66	155.62	156.38	158.43		39.19
GRAND TOTAL					627.09	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.169	0.085			
Factor A	3	11.984	3.995	8.71**	4.76	9.79
Error (A)	6	2.750	0.458			
Factor B	3	0.394	0.131	0.60^{ns}	3.01	4.72
AxB	9	1.739	0.193	0.89^{ns}	2.32	3.30
Error (B)	24	5.197	0.217			
Total	47	22.235				

** = Highly significant C.V. =5.18%

^{ns} = Not significant C.V. = 3.56%

Appendix Table 9. Pod length 64 days after planting (cm)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	11.82	11.92	10.90	34.64	11.55
	F_2	10.94	12.50	11.56	35.00	11.67
	F_3	11.97	12.70	11.91	36.58	12.19
	F_4	12.35	12.57	11.37	36.29	12.10
SUB TOTAL		47.08	49.69	45.74	142.51	11.878
R_2	F_1	11.89	12.84	12.28	37.01	12.34
	F_2	12.51	12.82	12.73	38.06	12.69
	F_3	13.21	12.51	11.91	37.63	12.54
	F_4	13.23	12.95	11.90	38.08	12.69
SUB TOTAL		50.84	51.12	48.82	150.78	12.565
R_3	F_1	13.13	13.20	12.06	38.39	12.80
	F_2	12.69	13.51	12.97	39.17	13.06
	F_3	12.39	12.95	12.70	38.04	12.68
	F_4	12.81	13.61	12.27	38.69	12.90
SUB TOTAL		51.02	53.27	50.00	154.29	12.86
R_4	F_1	13.12	12.71	13.90	39.73	13.24
	F_2	13.68	12.97	12.26	38.91	12.97
	F_3	13.23	12.87	12.26	38.36	12.79
	F_4	13.34	13.15	13.01	39.50	13.17
SUB TOTAL		53.37	51.70	51.43	156.50	13.043
GRAND TOTAL					604.08	
MEAN						12.59

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	47.08	49.69	45.74	142.51	47.50
R_2	50.84	51.12	48.82	150.78	50.26
R_3	51.02	53.27	50.00	154.29	51.43
R_4	53.37	51.70	51.43	156.50	52.17
BLOCK TOTAL	202.31	205.78	195.99		50.34
GRAND TOTAL				604.08	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	34.64	35.00	36.58	36.29	142.51	35.63
R_2	37.01	38.06	37.63	38.08	150.78	37.70
R_3	38.39	39.17	38.04	38.69	154.29	38.57
R_4	39.73	38.91	38.36	39.50	156.50	39.13
FERT. TOTAL	149.77	151.14	150.61	152.56		37.76
GRAND TOTAL					604.08	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	3.066	1.533			
Factor A	3	9.405	3.135	11.24**	4.76	9.79
Error (A)	6	1.673	0.279			
Factor B	3	0.343	0.114	0.53^{ns}	3.01	4.72
AxB	9	1.414	0.157	0.73^{ns}	2.32	3.30
Error (B)	24	5.168	0.215			
Total	47	21.069				

** = Highly significant C.V. =14.89%

^{ns} = Not significant C.V. = 3.69%

Appendix Table 10. Pod length 67 days after planting (cm)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	11.48	11.72	11.45	34.65	11.55
	F_2	10.31	11.65	11.58	33.54	11.18
	F_3	11.48	11.77	11.71	34.96	11.65
	F_4	11.34	12.03	12.02	35.39	11.80
SUB TOTAL		44.61	47.17	46.76	138.54	11.545
R_2	F_1	10.99	12.37	12.35	35.71	11.90
	F_2	11.72	12.27	12.01	36.00	12.00
	F_3	12.79	13.00	11.91	37.70	12.57
	F_4	12.28	12.40	12.83	37.51	12.50
SUB TOTAL		47.78	50.04	49.10	146.92	12.243
R_3	F_1	12.20	13.09	12.45	37.74	12.58
	F_2	12.24	12.78	12.79	37.81	12.60
	F_3	12.14	12.69	12.28	37.11	12.37
	F_4	11.60	12.61	12.14	36.35	12.12
SUB TOTAL		48.18	51.17	49.66	149.01	12.418
R_4	F_1	12.76	13.06	13.10	38.92	12.97
	F_2	13.00	13.01	11.99	38.00	12.67
	F_3	12.81	12.41	12.03	37.25	12.42
	F_4	12.76	13.16	11.97	37.89	12.63
SUB TOTAL		51.33	51.64	49.09	152.06	12.673
GRAND TOTAL					586.53	
MEAN						12.22

TWO-WAY TABLE
REPLICATION x MAIN PLOT

MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	44.61	47.17	46.76	138.54	46.18
R_2	47.78	50.04	49.10	146.92	48.97
R_3	48.18	51.17	49.66	149.01	49.67
R_4	51.33	51.64	49.09	152.06	50.69
BLOCK TOTAL	191.90	200.02	194.61		48.88
GRAND TOTAL				586.53	

TWO-WAY TABLE
MAIN PLOT x SUB PLOT

MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	34.65	33.54	34.96	35.39	138.54	34.64
R_2	35.71	36.00	37.70	37.51	146.92	36.73
R_3	37.74	37.81	37.11	36.35	149.01	37.25
R_4	38.92	38.00	37.25	37.89	152.06	38.02
FERT. TOTAL	147.02	145.35	147.02	147.14		36.66
GRAND TOTAL					586.53	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	2.136	1.068			
Factor A	3	8.390	2.797	10.90**	4.76	9.79
Error (A)	6	1.539	0.256			
Factor B	3	0.184	0.061	0.46^{ns}	3.01	4.72
AxB	9	2.417	0.269	2.02^{ns}	2.32	3.30
Error (B)	24	3.192	0.133			
Total	47	17.858				

** = Highly significant C.V. =14.47%

^{ns} = Not significant C.V. = 2.98%

Appendix Table 11. Marketable pod yield 61 days after planting (g)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	150	50	125	325.00	108.33
	F_2	75	50	150	275.00	91.67
	F_3	150	100	100	350.00	116.67
	F_4	200	75	175	450.00	150.00
SUB TOTAL		575.00	275.00	550.00	1400.00	116.667
R_2	F_1	200	100	350	650.00	216.67
	F_2	225	150	225	600.00	200.00
	F_3	200	125	175	500.00	166.67
	F_4	175	125	225	525.00	175.00
SUB TOTAL		800.00	500.00	975.00	2275.00	189.583
R_3	F_1	400	150	300	850.00	283.33
	F_2	500	175	250	925.00	308.33
	F_3	400	100	200	700.00	233.33
	F_4	350	250	300	900.00	300.00
SUB TOTAL		1650.00	675.00	1050.00	3375.00	281.250
R_4	F_1	400	350	450	1200.00	400.00
	F_2	575	150	225	950.00	316.67
	F_3	425	250	300	975.00	325.00
	F_4	500	225	425	1150.00	383.33
SUB TOTAL		1900.00	975.00	1400.00	4275.00	356.083
GRAND TOTAL					11325.00	
MEAN						235.938

TWO-WAY TABLE
REPLICATION x MAIN PLOT

MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	575.00	275.00	550.00	1400.00	466.67
R_2	800.00	500.00	975.00	2275.00	758.33
R_3	1650.00	675.00	1050.00	3375.00	1125.00
R_4	1900.00	975.00	1400.00	4275.00	1425.00
BLOCK TOTAL	4925.00	2425.00	3975.00		943.75
GRAND TOTAL				11325.00	

TWO-WAY TABLE
MAIN PLOT x SUB PLOT

MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	325.00	275.00	350.00	450.00	1400.00	350.00
R_2	650.00	600.00	500.00	525.00	2275.00	568.75
R_3	850.00	925.00	700.00	900.00	3375.00	843.75
R_4	1200.00	950.00	975.00	1150.00	4275.00	1068.75
FERT. TOTAL	3025.00	2750.00	2525.00	3025.00		707.81
GRAND TOTAL					11325.00	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	199062.50	99531.250			
Factor A	3	394830.73	131610.24	11.00**	4.76	9.79
Error (A)	6	71770.833	11961.806			
Factor B	3	14622.396	4874.132	1.17^{ns}	3.01	4.72
AxB	9	21263.021	2362.558	0.57^{ns}	2.32	3.30
Error (B)	24	99583.333	4149.306			
Total	47	801132.81				

** = Highly significant C.V. =18.63%
^{ns} = Not significant C.V. = 12.19%

Appendix Table 12. Marketable pod yield 64 days after planting (g)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	135	126	205	466.00	155.33
	F_2	31	130	205	366.00	122.00
	F_3	78	230	123	431.00	143.67
	F_4	180	154	145	479.00	159.67
SUB TOTAL		424.00	640.00	678.00	1742.00	145.17
R_2	F_1	232	229	181	642.00	214.00
	F_2	409	406	151	966.00	322.00
	F_3	379	304	45	728.00	242.67
	F_4	380	256	397	1033.00	344.33
SUB TOTAL		1400.00	1195.00	774.00	3369.00	280.75
R_3	F_1	203	477	332	1012.00	337.33
	F_2	177	377	174	728.00	242.67
	F_3	151	224	245	620.00	206.67
	F_4	154	476	121	751.00	250.33
SUB TOTAL		685.00	1554.00	872.00	3111.00	259.25
R_4	F_1	324	430	193	947.00	315.67
	F_2	275	214	489	978.00	326.00
	F_3	279	426	422	1127.00	375.67
	F_4	248	326	241	815.00	271.67
SUB TOTAL		1126.00	1396.00	1345.00	3867.00	322.25
GRAND TOTAL					12089.00	
MEAN						255.21

TWO-WAY TABLE
REPLICATION x MAIN PLOT

MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	424.00	639.20	678.50	1741.70	580.57
R_2	1400.00	1195.70	774.00	3369.70	1123.23
R_3	684.70	1553.70	872.00	3110.40	1036.80
R_4	1126.00	1396.20	1345.00	3867.20	1289.07
BLOCK TOTAL	3634.70	4784.80	3669.50		1007.42
GRAND TOTAL				12089.00	

TWO-WAY TABLE
MAIN PLOT x SUB PLOT

MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	465.50	366.40	431.30	478.50	1741.70	435.43
R_2	642.20	965.50	728.50	1033.50	3369.70	842.43
R_3	1012.00	728.40	620.00	750.00	3110.40	777.60
R_4	946.80	977.80	1127.60	815.00	3867.20	966.80
FERT. TOTAL	3066.50	3038.10	2907.40	3077.00		755.56
GRAND TOTAL					12089.00	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	42021.500	21010.750			
Factor A	3	241148.73	80382.910	5.38*	4.76	9.79
Error (A)	6	89581.333	14930.222			
Factor B	3	4199.229	1399.743	0.16^{ns}	3.01	4.72
AxB	9	88422.521	9824.725	1.15^{ns}	2.32	3.30
Error (B)	24	204118.50	8504.938			
Total	47	669491.50				

* = Significant C.V. =20.74%
^{ns} = Not significant C.V. = 13.45%

Appendix Table 13. Marketable pod yield 67 days after planting (g)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	79	60	30	169.00	56.33
	F_2	30	9	20	59.00	19.67
	F_3	40	7	50	97.00	32.33
	F_4	130	30	40	200.00	66.67
SUB TOTAL		279.00	106.00	140.00	525.00	43.750
R_2	F_1	120	49	70	239.00	79.67
	F_2	140	49	60	249.00	83.00
	F_3	200	79	80	359.00	119.67
	F_4	180	218	50	448.00	149.33
SUB TOTAL		640.00	395.00	260.00	1295.00	107.917
R_3	F_1	140	58	100	298.00	99.33
	F_2	170	228	100	498.00	166.00
	F_3	130	118	40	288.00	96.00
	F_4	150	49	60	259.00	86.33
SUB TOTAL		590.00	453.00	300.00	1343.00	111.917
R_4	F_1	250	156	250	656.00	218.67
	F_2	210	50	80	340.00	113.33
	F_3	186	20	74	280.00	93.33
	F_4	204	105	225	534.00	178.00
SUB TOTAL		850.00	331.00	629.00	1810.00	150.917
GRAND TOTAL					4973.00	
MEAN						103.63

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	279.20	105.20	140.00	524.40	174.80
R_2	640.00	395.00	260.00	1295.00	431.67
R_3	590.00	452.50	300.00	1342.50	447.50
R_4	850.50	331.00	629.00	1810.50	603.50
BLOCK TOTAL	2359.70	1283.70	1329.00		414.37
GRAND TOTAL				4972.40	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	168.70	59.20	97.00	199.50	524.40	131.10
R_2	239.00	249.00	359.00	448.00	1295.00	323.75
R_3	298.00	498.00	288.00	258.50	1342.50	335.63
R_4	656.00	340.00	279.80	534.70	1810.50	452.63
FERT. TOTAL	1361.70	1146.20	1023.80	1440.70		310.78
GRAND TOTAL					4972.40	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	46260.875	23130.438			
Factor A	3	70904.250	23634.750	6.73*	4.76	9.79
Error (A)	6	21057.625	3509.604			
Factor B	3	9260.917	3086.972	1.88^{ns}	3.01	4.72
AxB	9	46921.417	5213.491	3.17*	2.32	3.30
Error (B)	24	39458.167	1644.090			
Total	47	233863.25				

* = Significant C.V. =20.74%

^{ns} = Not significant C.V. = 13.45%

Appendix Table 14. Marketable pod yield 70 days after planting (g)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	90	128	98	316.00	105.33
	F_2	28	110	100	238.00	79.33
	F_3	50	100	99	249.00	83.00
	F_4	80	104	130	314.00	104.67
SUB TOTAL		248.00	442.00	427.00	1117.00	93.08
R_2	F_1	70	153	210	433.00	144.33
	F_2	68	130	128	326.00	108.67
	F_3	99	200	97	396.00	132.00
	F_4	80	100	125	305.00	101.67
SUB TOTAL		317.00	583.00	560.00	1460.00	121.67
R_3	F_1	150	205	180	535.00	178.33
	F_2	140	160	160	460.00	153.33
	F_3	129	190	78	397.00	132.33
	F_4	100	290	210	600.00	200.00
SUB TOTAL		519.00	845.00	628.00	1992.00	166.00
R_4	F_1	142	160	135	437.00	145.67
	F_2	129	130	170	429.00	143.00
	F_3	160	180	90	430.00	143.33
	F_4	130	220	80	430.00	143.33
SUB TOTAL		561.00	690.00	475.00	1726.00	143.83
GRAND TOTAL					6295.00	
MEAN						131.15

REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	247.50	442.00	426.00	1115.50	371.83
R_2	316.50	583.00	559.70	1459.20	486.40
R_3	519.00	845.00	628.40	1992.40	664.13
R_4	561.00	690.00	475.00	1726.00	575.33
BLOCK TOTAL	1644.00	2560.00	2089.10		524.43
GRAND TOTAL				6293.10	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	315.50	238.00	248.00	314.00	1115.50	278.88
R_2	433.00	325.70	395.50	305.00	1459.20	364.80
R_3	535.00	460.00	397.40	600.00	1992.40	498.10
R_4	436.80	429.20	430.00	430.00	1726.00	431.50
FERT. TOTAL	1720.30	1452.90	1470.90	1649.00		393.32
GRAND TOTAL					6293.10	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	26169.792	13084.896			
Factor A	3	34972.729	11657.576	6.90*	4.76	9.79
Error (A)	6	10142.208	1690.368			
Factor B	3	4356.563	1452.188	1.03^{ns}	3.01	4.72
AxB	9	8756.688	972.965	0.69^{ns}	2.32	3.30
Error (B)	24	33960.000	1415.000			
Total	47	233863.25				

* = Significant C.V. =39.67%

^{ns} = Not significant C.V. = 28.68%

Appendix Table 15. Marketable pod yield 73 days after planting (g)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	26	10	39	75.00	25.00
	F_2	15	9	39	63.00	21.00
	F_3	20	23	28	71.00	23.67
	F_4	30	25	36	91.00	30.33
SUB TOTAL		91.00	67.00	142.00	300.00	25.00
R_2	F_1	76	20	118	214.00	71.33
	F_2	65	112	80	257.00	85.67
	F_3	63	62	34	159.00	53.00
	F_4	64	39	104	207.00	69.00
SUB TOTAL		268.00	233.00	336.00	837.00	69.75
R_3	F_1	96	110	41	247.00	82.33
	F_2	87	104	49	240.00	80.00
	F_3	22	20	53	95.00	31.67
	F_4	82	71	41	194.00	64.67
SUB TOTAL		287.00	305.00	184.00	776.00	64.67
R_4	F_1	114	46	118	278.00	92.67
	F_2	98	32	50	180.00	60.00
	F_3	154	158	130	442.00	147.33
	F_4	127	110	130	367.00	122.33
SUB TOTAL		493.00	346.00	428.00	1267.00	105.58
GRAND TOTAL					3180.00	
MEAN						66.25

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	90.40	65.80	143.50	299.70	99.90
R_2	267.10	232.30	336.00	835.40	278.47
R_3	286.60	305.70	184.40	776.70	258.90
R_4	493.20	345.70	429.00	1267.90	422.63
BLOCK TOTAL	1137.30	949.50	1092.90		264.98
GRAND TOTAL				3179.70	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	74.60	62.90	71.10	91.10	299.70	74.93
R_2	213.90	256.30	158.20	207.00	835.40	208.85
R_3	247.60	239.90	94.70	194.50	776.70	194.18
R_4	278.40	180.20	442.40	366.90	1267.90	316.98
FERT. TOTAL	814.50	739.30	766.40	859.50		198.73
GRAND TOTAL					3179.70	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	10501.792	5250.896			
Factor A	3	67297.729	22432.576	3.65ns	4.76	9.79
Error (A)	6	36822.208	6137.035			
Factor B	3	8605.396	2868.465	1.25ns	3.01	4.72
AxB	9	83490.187	9276.687	4.05**	2.32	3.30
Error (B)	24	54946.667	2289.444			
Total	47	261663.98				

** = Highly significant C.V. = 24.89%
ns = Not significant C.V. = 20.50%

Appendix Table 16. Non-marketable pod yield 61 days after planting (g)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	1	0	0	1.00	0.33
	F_2	2	0	0	2.00	0.67
	F_3	9	0	0	9.00	3.00
	F_4	0	0	0	0.00	0.00
SUB TOTAL		12.00	0.00	0.00	12.00	1.00
R_2	F_1	0	0	0	0.00	0.00
	F_2	0	2	0	2.00	0.67
	F_3	0	0	0	0.00	0.00
	F_4	0	2	0	2.00	0.67
SUB TOTAL		0.00	4.00	0.00	4.00	0.33
R_3	F_1	9	2	0	11.00	3.67
	F_2	0	0	0	0.00	0.00
	F_3	26	3	2	31.00	10.33
	F_4	0	0	0	0.00	0.00
SUB TOTAL		35.00	5.00	2.00	42.00	3.50
R_4	F_1	28	4	0	32.00	10.67
	F_2	7	0	0	7.00	2.33
	F_3	5	0	0	5.00	1.67
	F_4	2	0	0	2.00	0.67
SUB TOTAL		42.00	4.00	0.00	46.00	3.83
GRAND TOTAL					104.00	
MEAN						2.17

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	12.60	0.00	0.00	12.60	4.20
R_2	0.00	3.60	0.00	3.60	1.20
R_3	35.20	4.50	1.50	41.20	13.73
R_4	41.70	4.00	0.00	45.70	15.23
BLOCK TOTAL	89.50	12.10	1.50		8.59
GRAND TOTAL				103.10	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	1.20	2.40	9.00	0.00	12.60	3.15
R_2	0.00	1.80	0.00	1.80	3.60	0.90
R_3	10.70	0.00	30.50	0.00	41.20	10.30
R_4	32.00	7.20	5.00	1.50	45.70	11.43
FERT. TOTAL	43.90	11.40	44.50	3.30		6.44
GRAND TOTAL					103.10	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	281.902	140.951			
Factor A	3	110.869	36.956	1.23^{ns}	4.76	9.79
Error (A)	6	180.738	30.123			
Factor B	3	116.769	38.923	1.78^{ns}	3.01	4.72
AxB	9	305.641	33.960	1.55^{ns}	2.32	3.30
Error (B)	24	524.320	21.847			
Total	47	1520.239				

^{ns} = Not significant

C.V. =28.88%
C.V. = 18.41%

Appendix Table 17. Non-marketable pod yield 64 days after planting (g)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	15	25	20	60.00	20.00
	F_2	19	20	20	59.00	19.67
	F_3	22	15	21	58.00	19.33
	F_4	19	22	22	63.00	21.00
SUB TOTAL		75.00	82.00	83.00	240.00	20.00
R_2	F_1	18	21	19	58.00	19.33
	F_2	16.5	19	24	59.50	19.83
	F_3	21	16	22	59.00	19.67
	F_4	20	19	25	64.00	21.33
SUB TOTAL		75.50	75.00	90.00	240.50	20.04
R_3	F_1	22	23	18	63.00	21.00
	F_2	14	23	22	59.00	19.67
	F_3	24	22	20	66.00	22.00
	F_4	22	22	25	69.00	23.00
SUB TOTAL		82.00	90.00	85.00	257.00	21.42
R_4	F_1	26	20	24	70.00	23.33
	F_2	22	21	24	67.00	22.33
	F_3	20	20	24	64.00	21.33
	F_4	15	22	20	57.00	19.00
SUB TOTAL		83.00	83.00	92.00	258.00	21.50
GRAND TOTAL					995.50	
MEAN						20.74

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	74.70	81.10	82.80	238.60	79.53
R_2	75.00	74.30	89.60	238.90	79.63
R_3	81.20	89.90	85.50	256.60	85.53
R_4	82.90	83.10	92.40	258.40	86.13
BLOCK TOTAL	313.80	328.40	350.30		82.71
GRAND TOTAL				992.50	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	59.50	58.60	58.70	61.80	238.60	59.65
R_2	57.80	59.50	58.10	63.50	238.90	59.73
R3	63.00	58.80	66.10	68.70	256.60	64.15
R_4	69.90	67.30	63.80	57.40	258.40	64.60
FERT. TOTAL	250.20	244.20	246.70	251.40		62.03
GRAND TOTAL					992.50	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	39.500	19.750			
Factor A	3	34.417	11.472	1.40^{ns}	4.76	9.79
Error (A)	6	48.833	8.139			
Factor B	3	1.083	0.361	0.03^{ns}	3.01	4.72
AxB	9	54.417	6.046	0.59^{ns}	2.32	3.30
Error (B)	24	243.000	10.125			
Total	47	421.250				

^{ns} = Not significant

C.V. =13.83%
C.V. = 15.43%

Appendix Table 18. Non-marketable pod yield 67 days after planting (g)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	1	1	1	3.00	1.00
	F_2	1	1	1	3.00	1.00
	F_3	1	1	2	4.00	1.33
	F_4	1	1	1	3.00	1.00
SUB TOTAL		4.00	4.00	5.00	13.00	1.08
R_2	F_1	1	1	3	5.00	1.67
	F_2	1	1	3	5.00	1.67
	F_3	10	1	4	15.00	5.00
	F_4	4	2	1	7.00	2.33
SUB TOTAL		16.00	5.00	11.00	32.00	2.67
R_3	F_1	3	2	40	45.00	15.00
	F_2	10	2	20	32.00	10.67
	F_3	2	2	2	6.00	2.00
	F_4	1	1.5	2	4.50	1.50
SUB TOTAL		16.00	7.50	64.00	87.50	7.29
R_4	F_1	10	3	30	43.00	14.33
	F_2	3	1	4	8.00	2.67
	F_3	4	1	6	11.00	3.67
	F_4	5	3	15	23.00	7.67
SUB TOTAL		22.00	8.00	55.00	85.00	7.08
GRAND TOTAL					217.50	
MEAN						4.53

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	2.50	2.80	2.40	7.70	2.57
R_2	15.20	5.00	11.00	31.20	10.40
R_3	16.00	7.50	64.00	87.50	29.17
R_4	22.00	7.20	55.00	84.20	28.07
BLOCK TOTAL	55.70	22.50	132.40		17.55
GRAND TOTAL				210.60	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	
	F_1	F_2	F_3	F_4		
R_1	1.50	1.10	3.50	1.60	7.70	1.93
R_2	4.20	5.00	15.00	7.00	31.20	7.80
R_3	45.00	32.00	6.00	4.50	87.50	21.88
R_4	43.00	7.50	10.40	23.30	84.20	21.05
FERT. TOTAL	93.70	45.60	34.90	36.40		13.16
GRAND TOTAL					210.60	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	398.292	199.146			
Factor A	3	356.750	118.917	1.94^{ns}	4.76	9.79
Error (A)	6	366.875	61.146			
Factor B	3	198.250	66.083	1.79^{ns}	3.01	4.72
AxB	9	468.250	52.028	1.42^{ns}	2.32	3.30
Error (B)	24	881.500	36.729			
Total	47	2669.917				

^{ns} = Not significant

C.V. =38.45%
C.V. = 39.50%

Appendix Table 19. Non-marketable pod yield 70 days after planting (g)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	1	2	3	6.00	2.00
	F_2	5	1	2	8.00	2.67
	F_3	1	40	2	43.00	14.33
	F_4	5	6	9	20.00	6.67
SUB TOTAL		12.00	49.00	16.00	77.00	6.42
R_2	F_1	1	7	8	16.00	5.33
	F_2	2	20	2	24.00	8.00
	F_3	2	30	3	35.00	11.67
	F_4	0	20	5	25.00	8.33
SUB TOTAL		5.00	77.00	18.00	100.00	8.33
R_3	F_1	20	25	23	68.00	22.67
	F_2	60	30	10	100.00	33.33
	F_3	1	20	9	30.00	10.00
	F_4	10	50	18	78.00	26.00
SUB TOTAL		91.00	125.00	60.00	276.00	23.00
R_4	F_1	8	50	15	73.00	24.33
	F_2	1	20	10	31.00	10.33
	F_3	10	20	1	31.00	10.33
	F_4	5	40	1	46.00	15.33
SUB TOTAL		24.00	130.00	27.00	181.00	15.08
GRAND TOTAL					634.00	
MEAN						13.21

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	11.10	49.00	14.80	74.90	24.97
R_2	3.70	77.00	18.30	99.00	33.00
R_3	91.00	125.00	59.50	275.50	91.83
R_4	24.00	130.00	27.30	181.30	60.43
BLOCK TOTAL	129.80	381.00	119.90		52.56
GRAND TOTAL				630.70	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	5.30	7.50	42.30	19.80	74.90	18.73
R_2	15.20	24.30	34.50	25.00	99.00	24.75
R_3	68.00	100.00	29.50	78.00	275.50	68.88
R_4	73.20	30.80	31.00	46.30	181.30	45.33
FERT. TOTAL	161.70	162.60	137.30	169.10		39.42
GRAND TOTAL					630.70	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	2702.542	1351.271			
Factor A	3	2031.417	677.139	6.89*	4.76	9.79
Error (A)	6	589.458	98.243			
Factor B	3	44.250	14.750	0.10^{ns}	3.01	4.72
AxB	9	1552.250	172.472	1.24^{ns}	2.32	3.30
Error (B)	24	3334.000	138.917			
Total	47	10253.917				

* = Significant C.V. =38.45%

^{ns} = Not significant C.V. = 39.50%

Appendix Table 20. Non-marketable pod yield 73 days after planting (g)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	2	3	1	6.00	2.00
	F_2	7	2	1	10.00	3.33
	F_3	5	2	2	9.00	3.00
	F_4	6	3	4	13.00	4.33
SUB TOTAL		20.00	10.00	8.00	38.00	3.17
R_2	F_1	4	0	2	6.00	2.00
	F_2	15	9	20	44.00	14.67
	F_3	8	7	16	31.00	10.33
	F_4	6	5	26	37.00	12.33
SUB TOTAL		33.00	21.00	64.00	118.00	9.83
R_3	F_1	4	40	19	63.00	21.00
	F_2	19	10	22	51.00	17.00
	F_3	2	18	18	38.00	12.67
	F_4	7	27	19	53.00	17.67
SUB TOTAL		32.00	95.00	78.00	205.00	17.08
R_4	F_1	21	9	30	60.00	20.00
	F_2	22	19	23	64.00	21.33
	F_3	26	28	40	94.00	31.33
	F_4	28	40	21	89.00	29.67
SUB TOTAL		97.00	96.00	114.00	307.00	25.58
GRAND TOTAL					668.00	
MEAN						13.92

TWO-WAY TABLE
REPLICATION x MAIN PLOT

MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	20.60	10.10	7.60	38.30	12.77
R_2	32.90	19.70	64.00	116.60	38.87
R_3	31.20	95.20	77.20	203.60	67.87
R_4	96.80	95.90	113.50	306.20	102.07
BLOCK TOTAL	181.50	220.90	262.30		55.39
GRAND TOTAL				664.70	

TWO-WAY TABLE
MAIN PLOT x SUB PLOT

MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	6.20	9.80	9.40	12.90	38.30	9.58
R_2	6.10	43.70	29.80	37.00	116.60	29.15
R_3	62.40	50.30	38.60	52.30	203.60	50.90
R_4	59.70	63.10	94.60	88.80	306.20	76.55
FERT. TOTAL	134.40	166.9	172.4	191		41.54
GRAND TOTAL					664.70	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	210.167	105.083			
Factor A	3	3340.500	1113.500	10.45**	4.76	9.79
Error (A)	6	639.000	106.500			
Factor B	3	139.833	46.611	0.92^{ns}	3.01	4.72
AxB	9	544.667	60.519	1.19^{ns}	2.32	3.30
Error (B)	24	1217.500	50.729			
Total	47	6091.667				

** = Highly significant C.V. =18.14%
^{ns} = Not significant C.V. = 14.17%

Appendix Table 21. Total pod yield (g)

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		1	2	3		
R_1	F_1	500	405	522	1427.00	475.67
	F_2	213	332	538	1083.00	361.00
	F_3	376	518	427	1321.00	440.33
	F_4	651	420	562	1633.00	544.33
SUB TOTAL		1743	1677	2052	5464.00	455.33
R_2	F_1	722	580	961	2263.00	754.33
	F_2	941.5	898	693	2532.50	844.17
	F_3	982	824	476	2282.00	760.67
	F_4	909	786	958	2653.00	884.33
SUB TOTAL		3554.5	3088	3088	9730.50	810.88
R_3	F_1	1047	1092	1053	3192.00	1064.00
	F_2	1177	1109	807	3093.00	1031.00
	F_3	887	717	667	2271.00	757.00
	F_4	876	1236.5	796	2908.50	969.50
SUB TOTAL		3987	4154.5	3323	11464.50	955.38
R_4	F_1	1323	1228	1245	3796.00	1265.33
	F_2	1342.2	637	1075	3054.20	1018.07
	F_3	1269	1103	1087	3459.00	1153.00
	F_4	1265	1091	1158	3514.00	1171.33
SUB TOTAL		5199.2	4059	4565	13823.20	1151.93
GRAND TOTAL					40482.20	
MEAN						843.38

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	1743	1677	2052	5464.00	455.33
R_2	3554.5	3088	3088	9730.50	810.88
R_3	3987	4154.5	3323	11464.50	955.38
R_4	5199.2	4059	4565	13823.20	1151.93
BLOCK TOTAL	14483.70	12978.50	13028.00		843.38
GRAND TOTAL				40482.20	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	1427.00	1083.00	1321.00	1633.00	5464.00	1366.00
R_2	2263.00	2532.50	2282.00	2653.00	9730.50	2432.63
R_3	3192.00	3093.00	2271.00	2908.50	11464.50	2866.13
R_4	3796.00	3054.20	3459.00	3514.00	13823.20	3455.80
FERT. TOTAL	10678.00	9762.70	9333.00	10708.50		2530.14
GRAND TOTAL					40482.20	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	91334.002	45667.001			
Factor A	3	3112617.9	1037529.3	27.69**	4.76	9.79
Error (A)	6	224788.71	37464.784			
Factor B	3	117060.61	39020.205	1.69^{ns}	3.01	4.72
AxB	9	236665.05	26296.117	1.14^{ns}	2.32	3.30
Error (B)	24	552160.89	23006.704			
Total	47	4334627.2				

** = Highly significant C.V. =22.81%
^{ns} = Not significant C.V. = 17.98%

Appendix Table 22. Bean rust infection 23 days after planting

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	2.10	1.70	1.90	5.70	1.90
	F_2	2.00	2.00	1.90	5.90	1.97
	F_3	2.10	2.00	1.80	5.90	1.97
	F_4	2.00	1.90	2.00	5.90	1.97
SUB TOTAL		8.20	7.60	7.60	23.40	1.95
R_2	F_1	2.00	2.00	2.00	6.00	2.00
	F_2	2.10	2.00	2.00	6.10	2.03
	F_3	2.00	2.00	1.90	5.90	1.97
	F_4	2.00	1.50	1.70	5.20	1.73
SUB TOTAL		8.10	7.50	7.60	23.20	1.93
R_3	F_1	2.00	2.00	2.00	6.00	2.00
	F_2	2.10	2.10	2.00	6.20	2.07
	F_3	2.10	2.00	2.00	6.10	2.03
	F_4	1.80	2.00	2.00	5.80	1.93
SUB TOTAL		8.00	8.10	8.00	24.10	2.01
R_4	F_1	2.00	2.00	2.00	6.00	2.00
	F_2	2.00	2.10	1.90	6.00	2.00
	F_3	1.90	2.00	1.90	5.80	1.93
	F_4	2.10	2.00	1.90	6.00	2.00
SUB TOTAL		8.00	8.10	7.70	23.80	1.98
GRAND TOTAL					94.50	
MEAN						1.97

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	8.20	7.60	7.60	23.40	7.80
R_2	8.10	7.50	7.60	23.20	7.73
R_3	8.00	8.10	8.00	24.10	8.03
R_4	8.00	8.10	7.70	23.80	7.93
BLOCK TOTAL	32.30	31.30	30.90		7.88
GRAND TOTAL				94.50	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	5.70	5.90	5.90	5.90	23.40	5.85
R_2	6.00	6.10	5.90	5.20	23.20	5.80
R_3	6.00	6.20	6.10	5.80	24.10	6.03
R_4	6.00	6.00	5.80	6.00	23.80	5.95
FERT. TOTAL	23.70	24.20	23.70	22.90		5.91
GRAND TOTAL					94.50	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.065	0.032			
Factor A	3	0.041	0.014	1.16^{ns}	4.76	9.79
Error (A)	6	0.070	0.012			
Factor B	3	0.072	0.024	2.49^{ns}	3.01	4.72
AxB	9	0.144	0.016	1.65^{ns}	2.32	3.30
Error (B)	24	0.232	0.010			
Total	47	0.623				

^{ns} = Not significant

C.V. =7.81%

C.V. = 4.99%

Appendix Table 23. Bean rust infection 38 days after planting

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	2.00	2.00	1.90	5.90	1.97
	F_2	1.90	2.00	2.00	5.90	1.97
	F_3	2.00	2.00	1.80	5.80	1.93
	F_4	2.00	2.00	2.00	6.00	2.00
SUB TOTAL		7.90	8.00	7.70	23.60	1.97
R_2	F_1	2.00	2.00	2.00	6.00	2.00
	F_2	2.10	2.00	2.00	6.10	2.03
	F_3	1.90	2.00	1.90	5.80	1.93
	F_4	2.00	2.00	2.00	6.00	2.00
SUB TOTAL		8.00	8.00	7.90	23.90	1.99
R_3	F_1	2.00	2.00	2.00	6.00	2.00
	F_2	2.00	2.00	2.00	6.00	2.00
	F_3	2.00	2.00	2.00	6.00	2.00
	F_4	1.70	2.00	2.00	5.70	1.90
SUB TOTAL		7.70	8.00	8.00	23.70	1.98
R_4	F_1	2.00	2.00	2.00	6.00	2.00
	F_2	2.00	2.00	2.00	6.00	2.00
	F_3	2.00	2.00	2.00	6.00	2.00
	F_4	2.00	2.00	1.90	5.90	1.97
SUB TOTAL		8.00	8.00	7.90	23.90	1.99
GRAND TOTAL					95.10	
MEAN						1.98

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	7.90	8.00	7.70	23.60	
R_2	8.00	8.00	7.90	23.90	
R_3	7.70	8.00	8.00	23.70	
R_4	8.00	8.00	7.90	23.90	
BLOCK TOTAL	31.60	32.00	31.50		
GRAND TOTAL				95.10	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	5.90	5.90	5.80	6.00	23.60	
R_2	6.00	6.10	5.80	6.00	23.90	
R_3	6.00	6.00	6.00	5.70	23.70	
R_4	6.00	6.00	6.00	5.90	23.90	
FERT. TOTAL	23.90	24.00	23.60	23.60		
GRAND TOTAL					95.10	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.009	0.004			
Factor A	3	0.006	0.002	0.53^{ns}	4.76	9.79
Error (A)	6	0.021	0.004			
Factor B	3	0.011	0.004	0.94^{ns}	3.01	4.72
AxB	9	0.037	0.004	1.09^{ns}	2.32	3.30
Error (B)	24	0.090	0.004			
Total	47	0.173				

^{ns} = Not significant

C.V. =3.19%
C.V. = 3.09%

Appendix Table 24. Semi-looper infestation 45 days after planting

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	1.30	1.40	1.00	3.70	1.23
	F_2	1.30	1.20	1.00	3.50	1.17
	F_3	1.10	1.00	1.20	3.30	1.10
	F_4	1.10	1.40	1.20	3.70	1.23
SUB TOTAL		4.80	5.00	4.40	14.20	1.18
R_2	F_1	1.40	1.00	1.60	4.00	1.33
	F_2	2.10	2.10	2.10	6.30	2.10
	F_3	1.30	1.10	1.20	3.60	1.20
	F_4	1.80	1.00	1.10	3.90	1.30
SUB TOTAL		6.60	5.20	6.00	17.80	1.48
R_3	F_1	1.50	1.70	1.30	4.50	1.50
	F_2	1.50	1.30	1.30	4.10	1.37
	F_3	1.50	1.40	1.30	4.20	1.40
	F_4	1.40	1.50	1.20	4.10	1.37
SUB TOTAL		5.90	5.90	5.10	16.90	1.41
R_4	F_1	1.30	1.30	1.20	3.80	1.27
	F_2	1.60	1.10	1.20	3.90	1.30
	F_3	1.10	1.50	1.70	4.30	1.43
	F_4	1.60	1.50	1.10	4.20	1.40
SUB TOTAL		5.60	5.40	5.20	16.20	1.35
GRAND TOTAL					65.10	
MEAN						1.36

Appendix Table 25. Semi-looper infestation 47 days after planting

MAIN PLOT	SUB PLOT	REPLICATION			TOTAL	MEAN
		I	II	III		
R_1	F_1	1.10	1.00	1.00	3.10	1.03
	F_2	1.10	1.10	1.00	3.20	1.07
	F_3	1.10	1.00	1.00	3.10	1.03
	F_4	1.00	1.00	1.00	3.00	1.00
SUB TOTAL		4.30	4.10	4.00	12.40	1.03
R_2	F_1	1.10	1.10	1.00	3.20	1.07
	F_2	2.10	2.10	2.10	6.30	2.10
	F_3	1.20	1.10	1.10	3.40	1.13
	F_4	1.20	1.30	1.20	3.70	1.23
SUB TOTAL		5.60	5.60	5.40	16.60	1.38
R_3	F_1	1.30	1.10	1.20	3.60	1.20
	F_2	1.20	1.20	1.10	3.50	1.17
	F_3	1.10	1.20	1.20	3.50	1.17
	F_4	1.10	1.10	1.10	3.30	1.10
SUB TOTAL		4.70	4.60	4.60	13.90	1.16
R_4	F_1	1.10	1.10	1.20	3.40	1.13
	F_2	1.10	1.20	1.30	3.60	1.20
	F_3	1.00	1.00	1.10	3.10	1.03
	F_4	1.20	1.10	1.20	3.50	1.17
SUB TOTAL		4.40	4.40	4.80	13.60	1.13
GRAND TOTAL					56.50	
MEAN						1.18

TWO-WAY TABLE REPLICATION x MAIN PLOT					
MAIN PLOT	BLOCK			TOTAL	MEAN
	I	II	III		
R_1	4.30	4.10	4.00	12.40	4.13
R_2	5.60	5.60	5.40	16.60	5.53
R_3	4.70	4.60	4.60	13.90	4.63
R_4	4.40	4.40	4.80	13.60	4.53
BLOCK TOTAL	19.00	18.70	18.80		4.71
GRAND TOTAL				56.50	

TWO-WAY TABLE MAIN PLOT x SUB PLOT						
MAIN PLOT	SUB PLOT				TOTAL	MEAN
	F_1	F_2	F_3	F_4		
R_1	3.10	3.20	3.10	3.00	12.40	3.10
R_2	3.20	6.30	3.40	3.70	16.60	4.15
R_3	3.60	3.50	3.50	3.30	13.90	3.48
R_4	3.40	3.60	3.10	3.50	13.60	3.40
FERT. TOTAL	13.30	16.60	13.10	13.50		3.53
GRAND TOTAL					56.50	

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.003	0.001			
Factor A	3	0.786	0.262	35.91**	4.76	9.79
Error (A)	6	0.044	0.007			
Factor B	3	0.687	0.229	82.47**	3.01	4.72
AxB	9	1.479	0.164	59.14**	2.32	3.30
Error (B)	24	0.067	0.003			
Total	47	3.065				

** = Highly significant

C.V. =7.11%
C.V. = 4.48%

Appendix Table 26. Analysis of fermented wild sunflower extract

Saint Louis University
College of Natural Sciences
NATURAL SCIENCES RESEARCH UNIT (NSRU)

RESULTS OF ANALYSIS

Date reported: March 16, 2010
Sample/s: *Plant extracts*
Test/s Nitrogen, Potassium, Phosphorus

RESULTS:

Test	Sample	
	Fresh wild sunflower extract	Fermented sunflower extract
Nitrate nitrogen	0.5 ppm	12.5 ppm
Potassium	200 ppm	200 ppm
Phosphorus	37.5 ppm	100 ppm

Methodology:
LaMotte™ Combination Test Kit (Model STH series)
Nitrate nitrogen test: Based on Denige's test
Potassium test: based on the fact that potassium salts give a yellow crystalline precipitate with sodium cobaltinitrite
Phosphorus test: phosphates react with ammonium molybdate to produce blue molybdenum oxide color when reduced

Performed by:
Jenner M. Butlong, RPh.
NSRU Laboratory Custodian

Approved by:
Evelyn E. Oda, PhD.
NSRU Research Coordinator

A. Bonifacio St., Baguio City 2600
Tel nos.: **(063) (74) 442-3043; 442-2793 Local (267)**
E-mail: **cnsru@slu.edu.ph**